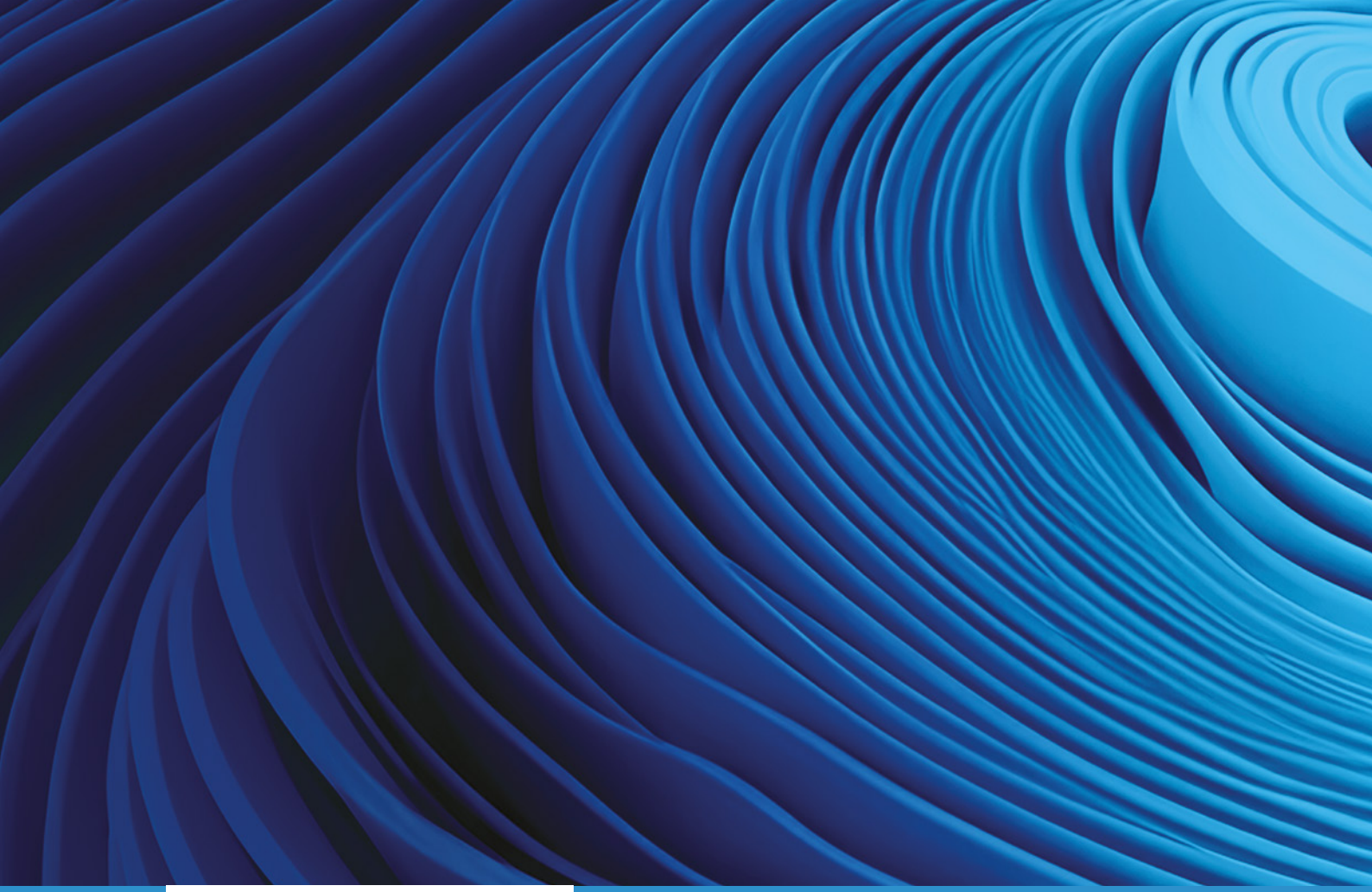

Best Practice Guide

Security of Radioactive Sources Used in Industrial Radiation Processing

April 2025

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Security of Radioactive Sources Used in Industrial Radiation Processing

A JOINT WINS & INTERNATIONAL IRRADIATION ASSOCIATION BEST PRACTICE GUIDE

Why You Should Read This Guide

Gamma irradiation facilities use high activity cobalt-60 radioactive sources to treat a wide range of products and materials. The largest application of gamma irradiation is the sterilisation of single-use medical devices such as surgical gloves, syringes, catheters and surgical implants used in surgery, wound care and other medical treatments.

The radiation processing industry, which includes gamma irradiation facilities, is mature, heavily regulated and has an exemplary safety and security record.

Operators of gamma irradiation facilities range from multinational organisations with multiple sites to small organisations with a single facility. These organisations operate under a variety of legal and regulatory frameworks and have their own internal arrangements and procedures.

Radioactive sources used for gamma irradiation have the potential to cause great harm if not properly managed. A security incident would negatively impact business operations, the reputation of an organisation and the wider irradiation community. An organisation could be held liable for damages, lose business and/or the use of its facilities, and result in a crisis for the organisation.

The risk of terrorism remains a concern and the incidences of cyberattack has significantly increased in recent years, and it is important that security arrangements are assessed and updated on a regular basis. There is therefore a need for the radiation processing industry to take note of international best practice and operational experience.

How We Prepared This Guide

This joint WINS and International Irradiation Association (iia) Best Practice Guide has been developed to supplement other international recommendations and enhance security for gamma irradiation facilities beyond the requirements of national regulations. This guide is based on the experience of security practitioners and managers of gamma irradiation facilities. WINS and iia would like to thank the following organisations that contributed to it:

- Gamma-Service Recycling GmbH
- Nordion (Canada) Inc.
- SQHL (Beijing SanQiangHeLi) Radiation Engineering Technology Co., Ltd
- Sterigenics U.S., LLC
- STERIS Applied Sterilization Technologies, STERIS plc
- Symec Engineers (India) Pvt. Ltd.
- VINCA Institute of Nuclear Sciences, University of Belgrade

This guide also reflects discussions and conclusions from WINS events on the security of radioactive sources that have been held throughout the world.

This guide is a revision to the guide issued in 2020 and takes into account cybersecurity considerations for gamma irradiation facilities.

Wherever possible, this guide uses the same terminology as that found in the International Atomic Energy Agency (IAEA) Nuclear Security Series and Safety Series publications. The preparation of the guide was supported by the US Department of Energy/ National Nuclear Security Administration under Award Number DE-NA0004059.

The iia believes that this joint publication contributes to enhanced understanding of best practice in radiation processing. The iia endorses this guide and believes that it contributes to the safe, secure and beneficial application of irradiation technology.

How You Should Use This Guide

This guide helps business leaders, radiation safety officers, security specialists, radioactive source users or other stakeholders with responsibility for the management of or security of gamma irradiation facilities —understand and manage security risk.

Appendix A provides a set of questions that stakeholders at all levels of the organisation can use to help determine how effective their current security arrangements are for protecting their organisation's radioactive sources. Appendix B defines five different levels of organisational achievement for the security of high activity radioactive sources. Benchmarking where your organisation falls on this scale will help you identify possible gaps in your security infrastructure and provide you with a starting point for improvement.

How You Can Help Improve This Guide

WINS plans to periodically update the information in this Guide to ensure that it continues to contain best practices. We ask that you read and apply this Guide and then share your suggestions for improvement or any other feedback you have. You can email us at info@wins.org or info@iiaglobal.com or fill out the feedback form on the WINS website to share your suggestions.

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Understanding the Risk

Use of Cobalt-60 in Gamma Irradiators

Cobalt-60 is used in radiation processing facilities, specifically gamma irradiators, as the source of radiation for the treatment of material and products. Processing of material and products is done on an industrial scale and for beneficial applications such as sterilisation, microbial reduction, disinfestation and modification of material to improve its performance. Radiation processing is used globally by many industries and for applications that benefit us all every day.

Cobalt-60 is a non-soluble, non-dispersible and non-flammable metal that is specially produced in nuclear reactors. The cobalt-60 is safely removed from the reactors and manufactured into sealed sources that are designed, tested and approved to meet international regulatory standards.

In a gamma irradiator, the cobalt-60 sources are typically positioned in a rack that is located inside a concrete bunker called an irradiation cell. The product to be treated is carried into the irradiation cell by a conveyor system and circulated around the cobalt-60 sources until it has received the specified dose of radiation. When the cobalt-60 sources are not in use, the rack is lowered into a pool of water for safe storage. A very small number of irradiators do not have a storage pool, in which case the sources are lowered into a shielded pit for safe storage.

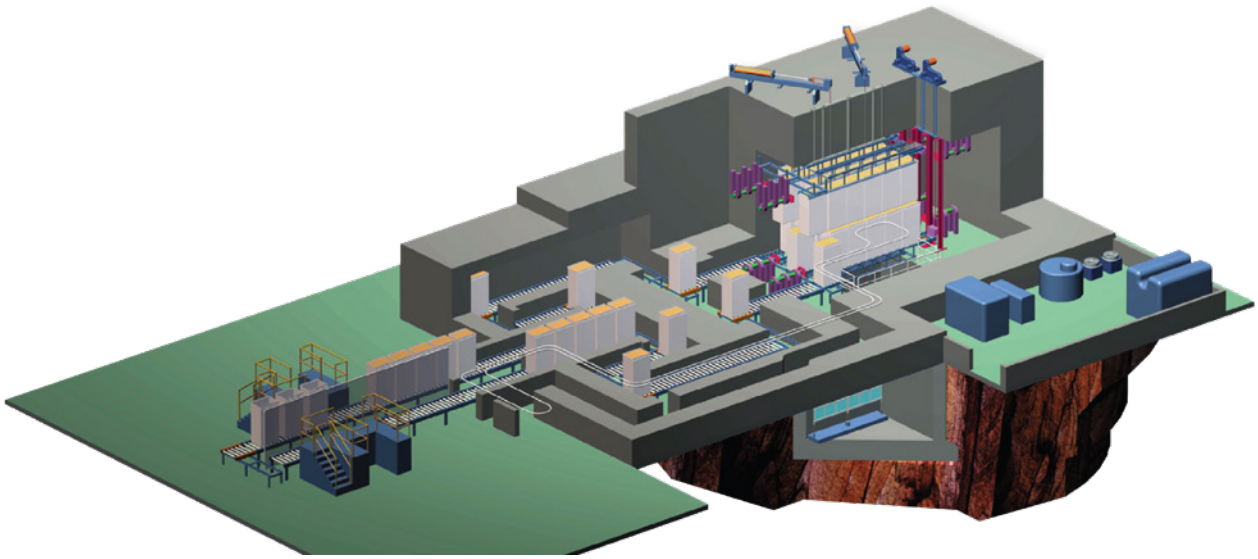


Figure 1: A typical gamma irradiator for radiation processing. This cut away illustration shows the irradiation cell, conveyor system and storage pool. Illustration of type JS1000 irradiator courtesy of Nordion (Canada) Inc.

The joint iia-GIPA White Paper "A Comparison of Gamma, E-beam, X-ray and Ethylene Oxide Technologies for the Industrial Sterilization of Medical Devices and Healthcare Products" (August 31, 2017) states that more than 200 large-scale commercial gamma irradiators are in operation in about 50 countries, utilizing some 400 million Curies (Ci) of cobalt-60. In addition, there are smaller gamma irradiators of the same or similar design that are used on a semi-commercial basis or for research.

Figure 2: A source rack loaded with multiple cobalt-60 sources within the storage pool of a radiation processing facility. Illustration courtesy of STERIS AST.

Categorisation of Radioactive Sources and Accompanying Security Levels

A gamma irradiator used for radiation processing will typically contain from 0.1 to 5 MCi of cobalt-60 made up of many—often several hundred—sources. These sources are categorised in the IAEA Safety Guide No. RG-G-1.9 as Category 1 and provided with the associated security level in IAEA Nuclear Security Series 11-G Rev as follows:

CAT 1.	This source, if not safely managed or securely protected, would be likely to cause permanent injury to a person who handled it or who was otherwise in contact with it for more than a few minutes. It would probably be fatal to be close to this amount of unshielded radioactive material for a period in the range of a few minutes to an hour.
SECURITY LEVEL	Security Level A – Goal is to provide a high level of protection of radioactive material against unauthorised removal

Attractiveness of Radioactive Sources to Threat Actors

Despite their multiple beneficial uses, radioactive sources also pose a potential risk if they are used in a **malicious act**. In broad terms, a malicious act involving radioactive sources can be defined as follows:

An act or attempt of unauthorised removal of radioactive material or sabotage.

Main concern about malicious acts involving radioactive sources used in industrial irradiation are generally associated with the theft of the materials for use in a radiological exposure device (RED).

A RED is created by concealing a strong gamma emitting source in a public place or in the vicinity of a specific individual who is being targeted.

Over the last 50 years, millions of radioactive sources of all types have been distributed worldwide for many different industrial and medical applications. These sources continue to produced, used and stored in very high numbers so an incident of them being targeted maliciously to try and cause harm is conceivable.

Self-Protection

It was long assumed that gamma irradiators were self-protecting due to the very high level of radiation dose (potentially lethal) that would result from exposure to the cobalt-60 sources. However, to fully self-protect, the dose must be sufficient to incapacitate an adversary **before** a malicious act is completed. It is important to recognise that exposure to a high radiation dose may not result in immediate incapacity, allowing time for an adversary or group of individuals to complete a malicious act. Indeed, some adversaries are willing to sacrifice their own life to perform a malicious act. Therefore, the concept of self-protection should not be relied upon when determining nuclear security systems and measures that are necessary to protect and secure these radioactive sources.

Consequences of a Malicious Act

A security incident resulting from the inadequate or negligent management of radioactive sources would likely affect normal business operations and the reputation of an organisation. Depending on a range of factors, the organisation could potentially be held liable for psychological trauma stemming from the incident, as well as for any physical damages. Ultimately, financial losses (loss of the use of facilities, lost business, lost wages, recovery costs, replacement costs, clean-up costs, and medical costs for employees and members of the public) could constitute a crisis for the organisation.

Gamma irradiators use a large number of high activity cobalt-60 sources, so operators must consider the potential consequences of malicious use of these Category 1 sources. They need to maintain facilities and systems that provide an appropriate level of security.

Gamma irradiators are permanent structures, not portable or mobile, and have an inherent level of protection as a result of their substantial irradiation cell with features to prevent unauthorised access. However, opportunities for additional measures exist and are discussed in this guide.

Additionally, some gamma irradiators are highly automated, so operators must consider any impact on security of having a small number or no staff at all on site. Security arrangements must also take into account activities outside of normal operation, such as when sources are being delivered and installed in the irradiator.

Finally, although the theft of the entire cobalt-60 inventory of a gamma irradiator (up to millions of Curies) would be of extremely high concern, from a risk management perspective, the most likely scenarios to consider would probably be the theft of a single source or a small number of sources.

Understanding the Threat

Definition of Threat

In nuclear security terminology a threat, also often referred to as an adversary or a threat actor, is a person or a group of persons with the motivation, intention and capability to commit a malicious act.

Nuclear security threats, threat actors or adversaries can come from outside the organisation (external threat) or from within it (insider threat). An external threat can be a criminal or terrorist, for example. An insider threat is an individual (such as an employee, contractor or supplier) with knowledge, access and authority.

Intention, Motivation and Capability

As stated in the definition above, threats (adversaries) must have intention, motivation and capability to carry out a malicious act. **Intentions** can be numerous and varied, such as publicity for a cause, disruption of the society, actual harm to one or more individuals, or loss of confidence in the government.

An adversary's **motivation** for carrying out a malicious act must be strong enough to overcome the barriers to achieving their intention. Adversaries may have different motivations for malicious activities. Examples of possible motivations include financial or ideological factors, revenge or ego, and coercion.

Furthermore, adversaries must have the **capability** to carry out the act. Adversaries may be highly motivated and have the intent to succeed, but if they do not have the ability to plan their operation, lack the financing and weapons to carry out their plan, or lack the technical skill to use the source for a malicious purpose once they've obtained it, they will fail.

Types of Threats

Threats, whether individuals or groups of adversaries, can come from many different backgrounds and can have a wide variety of motivations. Some examples include:

Common Thieves	Many incidents involving radioactive sources have been perpetrated by individuals who intended only to steal a vehicle or obtain scrap metal to sell and were completely unaware of what the cargo or metal source contained.
Activists	Activists are committed to a cause, such as eliminating nuclear power or saving the environment. Many are willing to take certain illegal actions to achieve political or social change, but they seldom intend to harm others and are not usually armed.
Organised Crime	Organised crime can be defined as 'serious crime that is planned, coordinated, and conducted by people working together on a continuing basis'. Their motivation is often, but not always, financial gain. Although much of the discussion revolves around the consequences that could result from terrorist acts, criminals have also attempted to use radioactive material for malicious purposes.
Terrorists	States around the world have become increasingly concerned that a non-state actor or terrorist group could acquire a radioactive source to use in a malicious act such as a radiological exposure device (RED). The source could be acquired through theft from a licensed user, illicit purchase, or a source that is outside of regulatory control (sometimes referred to as an orphan source) Authorities know that both Islamic State and Al Qaeda sought to obtain radioactive materials for malicious purposes and were willing to invest a significant amount of time and money to achieve their objective.

Cyber Threats

Cyber threat actors may be external to the organisation, an insider, or a combination of the two. Cyberthreat actors can generally be characterised as one of the following:

- **Employee or contractor** with access to digital systems who wishes to cause harm or to facilitate the access of an external threat
- **Recreational hackers:** Someone seeking fame through hacking exploits
- **Hacktivists:** Individuals or groups seeking to make a political statement through a cyberattack
- **Organised crime:** Groups using a cyberattack as a means of extortion or theft for profit
- **Terrorist:** Organisations using cyberattacks to spread fear or cause serious harm
- **Nation States:** Organised entities using a range of cyber tools to engage in espionage and even conflict.

Insider Threat Specificities

An insider who has authorised access to a facility, transport operation, sensitive information, or computer and communications system can use their trusted position for unauthorised or malicious purposes. Unauthorised or malicious purposes can range from a conventional crime, such as financial fraud, to the sabotage or theft of radioactive material.

Insider threats can be active or passive, violent or nonviolent as well as unwitting. An unwitting insider is an insider without the intent and motivation to commit a malicious act who is exploited by an adversary. For example, in a computer-based attack, an unwitting insider may not be aware that certain actions (e.g. clicking a malicious link in an email that is disguised as being from a trusted source) may provide information or authenticated access to an adversary.

Insiders do not have a single profile. They can be any age or sex and can be from any level within an organisation.

Insider adversaries are particularly dangerous because they can use their access, authority and knowledge of a facility to bypass dedicated physical protection systems, safety measures and operating procedures. They also have more time to select vulnerable targets to plan and carry out a malicious act. For example, they could tamper with safety equipment to prepare for an act of sabotage.

The likelihood of a malicious act being successfully carried out can be very high if insiders and external adversaries work together to achieve their intentions.

Like external threats, insiders can have numerous motivations. Some may have applied for a job at a particular organisation with the intention to carry out a malicious act from the beginning. (In other words, they act as moles.) Many insiders had no intention of creating harm when they were first hired, but over time they change. Some may adopt radical political or religious beliefs; some may be experiencing personal issues such as divorce, drug and alcohol addictions; or they could be under financial stresses or subject to some form of extortion.

One of the most common motivations is disgruntlement. The Software Engineering Institute (2013) studied computer-related incidents perpetrated by insiders who had sabotaged some aspect of an organisation and/or harmed a specific individual and found that in 92% of the cases, a specific series of events had triggered their actions. Examples of this could include a negative performance appraisal felt to be unfair, not receiving an expected promotion, personal financial issues, being forced into retirement, losing a job unexpectedly through no fault of their own (as when downsizing occurs), and resentment toward senior management.

Roles and Responsibilities for Radioactive Source Security at Gamma Irradiation Facilities

Many stakeholders, including the international community, States, their national regulators and licensees (gamma irradiator operators), are involved in efforts to strengthen radioactive source security both nationally and internationally. Ensuring effective radioactive source security requires all stakeholders to understand and carry out their responsibilities effectively.

The International Framework

The international community is responsible for developing initiatives and instruments that help strengthen nuclear security in States and increase international cooperation. Some of the most important international instruments have been developed under the auspices of the IAEA; others under the auspices of the United Nations. These instruments contain both binding and non-binding legal obligations and recognise the important role of the IAEA and other international organisations in helping States meet their obligations and commitments.

The IAEA

The International Atomic Energy Agency, which is based in Vienna, Austria, is the leading international organisation for the promotion of the safe, secure and peaceful use of nuclear energy, science and technology. Most countries in the world are members of the IAEA. These member states work together to produce international recommendations and guidance that is implemented primarily by States and their regulatory bodies. States, their regulators and other competent authorities frequently use this guidance to design their own policies and regulatory arrangements at the national level.

The Code of Conduct on the Safety and Security of Radioactive Sources

The most important IAEA document for those with responsibilities for the security of radioactive sources is the Code of Conduct on the Safety and Security of Radioactive Sources. First implemented in 2001, the Code describes how States can safely and securely manage high activity radioactive sources. Following the terror attacks in the US of 11 September 2001, the international community came together to revise the Code. The revised version, which was published in 2004, marked the beginning of a global trend towards the increased control of, accounting for, and security of radioactive sources. This Code currently has two supplementary guidance documents: Guidance on the Import and Export of Radioactive Sources and Guidance on the Management of Disused Radioactive Sources.

The Nuclear Security Series Publications

The IAEA publishes the Nuclear Security Series (NSS) of documents. These documents are developed by IAEA Member States by consensus. The Nuclear Security Series provides recommendations and guidance in a hierarchy of documents:

- Nuclear Security Fundamentals, which describe the fundamental objective and essential elements of a State's national nuclear security regime.
- Recommendations, which set out measures that States could take to achieve and maintain an effective regime.
- Implementing Guides, which provide guidance on how States can implement the recommendations.
- Technical Guidance, which provide more detailed guidance on specific methodologies and techniques for implementing security measures.

The NSS documents cover a range of nuclear and other radioactive materials, facilities and activities. Those publications that are most relevant to the security of radiation processing facilities are set out in "Suggestions for Further Reading".

World Institute for Nuclear Security

The World Institute for Nuclear Security (WINS) was established in late 2008. WINS is an international non-governmental organisation. WINS' overarching goal is to *be of service to the entire world and to address all security issues related to nuclear and other radioactive facilities, activities, and materials, whether under or outside of regulatory control*. To achieve this overarching objective, WINS has the following three operational goals:

1. To be an international forum for nuclear security professionals and stakeholders,
2. To extend WINS' influence on a broad range of stakeholders involved in all areas of nuclear security,
3. To further develop WINS as a high-quality professional institute and ensure the continuous improvement of WINS' in-house capabilities to provide high-quality services.

WINS implements its programme of activities through events, publications, certified training and benchmarking and evaluation services.

WINS has published an International Best Practice Guide Series that covers a wide range of security issues. All WINS guides include the perspective of the operator and address issues that have been raised by WINS members, such as challenges surrounding implementation of security systems. This publication is part of that series.

In the area of certified training, WINS launched the WINS Academy in 2014 to help develop demonstrable competence in nuclear security management through training and certification. The WINS Academy programme offers certification to those that successfully complete one of the WINS academy modules and Alumni have access to digital credentials verifying their completion of the programme. In February 2020, WINS published its certification programme for radioactive source security management. This programme is for anyone who has responsibilities for managing the security of radioactive sources. This could include leaders and managers of healthcare facilities, industrial irradiation, well logging or radiography operations, research institutes, or even law enforcement agencies who want to enhance their knowledge about radioactive source security. An Alumnus of that programme receives a digital credential as a Certified Nuclear Security specialised Professional (CNSsP).

The International Irradiation Association

The International Irradiation Association (iia) was established in 2004 and is recognised as an NGO by the IAEA. It represents the industrial irradiation community that includes gamma, electron beam and X-ray technologies. A core aim of the iia is to promote the safe and beneficial use of irradiation technologies. Members include a diverse range of organisations with an interest in the scientific and commercial application of the technology. Members of iia include manufacturers, producers and suppliers of cobalt-60 and electron beam/X-ray technology, multinational and national radiation processing facility operators, universities, institutes and organisations providing support services. The membership is geographically diverse and provides a basis for network and collaboration.

The iia has links via affiliated and connected organisations to many countries and to the development and oversight of industry best practice. It assists in the drafting of white papers, reports, guidance and reference material for its members and the wider irradiation community.

State Roles & Responsibilities

Legal and Regulatory Framework

Ultimate responsibility for establishing the national nuclear security regime for radioactive source security rests with individual States. The State's first responsibility in this regard is to establish, implement and maintain the overall **framework** for regulating the security of nuclear and other radioactive material. This requires States to enact national laws, develop regulations and guidance documents including codes and standards that assign roles, responsibilities and requirements.

Independent Regulatory Body

The State is also responsible for creating one or more independent **regulatory bodies** with the required resources—technical, human and financial—to regulate nuclear and other radioactive material. The regulatory body should have a clearly defined legal status; be completely independent from operators; and have the legal authority, competence and financial and human resources necessary to perform its responsibilities and functions effectively.

National Threat Assessment

It is the State's responsibility to perform a **national threat assessment** that identifies the motivations, intentions and capabilities of possible adversaries; the likelihood that certain malicious acts may occur; and the potential consequences if a malicious act were to occur. The outputs of the national threat assessment are used for identifying a set of credible threats (design basis threat or representative threat statement) that allow regulators to develop requirements for systems and measures to be implemented by a licensee/operator that are capable of mitigating these threats (performance-based regulations) or requirements that directly instruct operators how to design effective security arrangements for their radioactive sources (prescriptive regulations).

The inputs to a threat assessment and its outputs are typically sensitive (i.e. classified) because these include data obtained from intelligence and law enforcement agencies about the actual threats known to exist within the State or those that could credibly materialise. Because of its highly sensitive nature, the raw intelligence is not generally divulged to operators. However, operators may have crucial information about their location and facilities that should be included in the assessment, so ideally, they will be consulted in the process.

Regulatory Body Roles & Responsibilities

Regulations

It is the responsibility of the regulatory body for radioactive sources to implement regulations and provide guidance on the requirements that operators must fulfil to ensure the safety and security of the radioactive sources under their control. In some cases those regulations are developed by the regulatory body and in other cases the regulations are developed by the legislature or parliament.

The content of regulations for the security radioactive sources developed in each country are dependent on the scope of the primary legislation that they are made under and are typically based on the provisions of the Code of Conduct for the Safety and Security of Radioactive Sources, as well as the guidance in in IAEA NSS No. 14 (*Nuclear Security Recommendations on Radioactive Material and Associated Facilities*), No. 11-G (Rev) (*Security of Radioactive Sources*), and No. 9-G (Rev) (*Security in the Transport of Radioactive Material*).

Regulatory Approaches

There are three basic approaches to regulations: prescriptive, performance-based, or a combination of the two. In a **prescriptive** approach, the regulator specifies all the measures an operator must implement to meet the security goals and objectives. In a **performance-based** approach, the regulator determines the overall goals and objectives and requires operators to design a security system that demonstrably meets these. In the **combined** approach, the regulator draws on aspects of both the prescriptive and performance-based approaches.

Each approach has benefits and drawbacks. For example, the prescriptive approach tends to be the most economical and requires less expertise from the operator. However, this does not help foster the operator-regulator relationship and means that the operator has little or no opportunity to positively impact the regulation. It can also mean that operators may implement only the security measures that are required by the regulations and nothing more.

The performance-based approach encourages operators to take a more proactive approach to security and gives them much more flexibility when it comes to designing their security systems. In addition, it may encourage better communication between the regulatory body and operators. On the other hand, it also requires greater expertise on the part of the operator and can be challenging to implement. One policy objective of a performance-based approach may be to ensure that security is fully integrated into an organisation's risk management policies and practices.

Regardless of which approach is taken, it is important for operators to realise that just because they comply with all regulations, their security system may still not be effective. They need to conduct their own risk analyses and implement additional security measures if the situation warrants it.

The Operator-Regulator Relationship

It is important for operators and regulators to develop a relationship with each other that enables communication to flow back and forth between them. Although it is an operator's responsibility to comply with all regulations, ideally operators should have a role in the development of new regulations, for example if a new regulation will place undue financial burden on operators, they may be able to suggest a different, less costly approach that would lead to similarly effective results. This is one benefit of performance-based regulation as well as systems where regulations are subject to public consultation during the process of development, whether the regulations are performance based or prescriptive.

Operator Roles and Responsibilities

Operators have the primary responsibility for security of their radioactive sources. They therefore have the responsibility for designing, implementing and maintaining security systems for radioactive material in accordance with the regulatory requirements in their State and any additional security objectives defined by the organisation itself.

To ensure that no undue risk to the health of individuals; to reputation, brand and business continuity; or a negative impact on public confidence, an organisation must establish and maintain the requisite financial, human and technical resources necessary to achieve effective security in a way that supports the organisation's operational and business objectives.

It is the operator's responsibility to remedy any non-compliances identified by the regulatory body, investigate the issue according to an agreed time schedule, and take any necessary actions to prevent recurrence. (In turn the regulator needs to verify that the operator has implemented the remedial actions effectively.)

Leadership responsibilities for radioactive source security include:

- Establish clear expectations, accountabilities and policies for security for all management and staff.
- Systematically communicate their security priorities.
- Encourage teamwork and cooperation.
- Establish mechanisms to promote behaviour that supports security, such as encouraging staff to raise concerns and make suggestions for improvement.
- Develop tools and methodologies with which to regularly assess the security culture within the organisation.
- Ensure that all personnel have the skills, knowledge and authorisations they need to carry out their security responsibilities.

A Risk-Informed Approach

Operators should use a risk-informed approach to manage the security of their radioactive sources. This begins with the awareness that security is a corporate-wide responsibility, like safety, in which all of the operator's stakeholders have responsibilities. A risk-informed approach requires that operators regularly assess the risks; develop, evaluate and implement mitigation measures; and monitor and manage the resulting actions for relevance and effectiveness. Such a process helps organisations allocate their resources more effectively and efficiently.

Leadership

The board (or equivalent) and executive management play a crucial role in the effectiveness of their organisation's approach to safety and security because leaders set the policies, determine the corporate risk appetite, allocate funding, and ensure that policies and programmes are developed and implemented.

If leaders fail to carry out their responsibilities effectively and if an incident occurs, the consequences for individuals, communities and the environment—as well as for the organisation's financial stability, reputation and liability—could be significant.

In addition, security culture begins at the top and filters from there throughout the rest of the organisation. This is why any leader's first responsibility is to lead by example. Leaders must clearly demonstrate their belief that a credible threat exists, and that security of radioactive material is important by following all security-related policies and procedures themselves and by treating security as a business risk similar to safety.

Security Policy

A security policy lays the foundation for the management systems that ensure the security of an organisation's radioactive sources. It is the responsibility of the board (or similar body) to create a well-defined policy that demonstrates the organisation's commitment to high quality performance in all its nuclear security activities.

This begins by giving security a high priority, like other business risks, including safety. Leaders should also provide the necessary financial, technical and human resources to carry out all the organisation's security responsibilities. This includes appointing a specific individual with the authority, autonomy and resources to implement and manage security activities. The policy should be clear and be provided to all staff.

Security Plan

The security plan is typically required by the regulatory body to inform its authorisation or approval processes and is the basis of the regulator's understanding of the scope and operation of the security systems and measures.

An effective security plan documents the design, operation and maintenance of the entire security system. It defines the design requirements, documents regulatory compliance, and directs the implementation of the policies and procedures for operation of the security system to ensure all defined security objectives are met.

Usually, no single document can consolidate all security related information. The security plan is the central piece of the security documentation and needs to be structured around key areas and refer to lower-level documentation that can be reviewed independently and in some cases be compartmentalised to reduce the risk that the plan is lost or compromised.

Every permanent or temporary site where cobalt-60 sources are used or stored should have a security plan specific to that location. Furthermore, the security plan should include all information necessary to describe the security approach and the systems used to protect sources. Because such information is sensitive, it needs to be protected and made available only to authorised individuals with a need to know.

To be operationally effective, the security plan should be routinely reviewed, evaluated and updated. Committing to such actions also helps to instil and promote a strong security culture because it stimulates periodic review and rehearsal of security arrangements.

Key areas to be covered by the security plan and associated documents

SECURITY REQUIREMENTS AND OBJECTIVES

- Regulatory Requirements
- Other Security Requirements
- Objective of the Security Plan
- Preparing and Updating the Security Plan

This section provides an overview of the requirements for or basis for the preparation of the security plan, the plan's objective and scope, a description of how the security plan was prepared, and the frequency of its periodical review and update.

FACILITY DESCRIPTION

- Overview
- Radioactive Material and its location
- Categorisation and Security Level
- Physical Description
- Operational Description
- Regulatory Requirements

The facility description provides an overview of the facility mission, a description of the cobalt-60 present, its categorisation and security level, and the physical and operational aspects of the facility.

SECURITY MANAGEMENT

- Roles and Responsibilities
- Training and Qualification
- Access Authorisation
- Trustworthiness
- Information Protection
- Maintenance Programme
- Budget and Resource Planning
- Evaluation for Compliance and Effectiveness

The security management section explains how security management is being implemented. This includes a description of the security roles and responsibilities, how access authorisation is assigned, and the methods used to assess personnel trustworthiness. It also describes how personnel are trained in security, what their qualifications are, how budgets and resources are planned, how sensitive information is protected, and the methods used to regularly evaluate system performance and compliance.

SECURITY SYSTEM

- Threat Information
- Security Assessment Methodology
- Security System Design
- Access Control
- Delay, detection and alarm assessment
- Internal and External Audit, Testing and Assessment of System

The security system section describes the security assessment methodology, how threat information is used to design the security system and the overall security system design. It also provides details on all equipment and procedures put in place to perform the security functions.

SECURITY PROCEDURES

- Routine, Non-Routine and Emergency Operations
- Opening and Closing of Facility
- Key and Lock Control
- Accounting and Inventory
- Acceptance and Transfer

This section outlines the written procedures for personnel including routine, non-routine (e.g. instances of source installation) and emergency operation of the security system, opening and closing of the facility, key and lock control, accounting and inventory, and acceptance and transfer.

RESPONSE

- Roles and responsibilities of onsite security or facility personnel as well as offsite response forces
- Security Events and other Situations of Security Concern
- Communication methods
- Security Event Reporting
- Security during Emergencies and Contingencies
- Increased Threat Level

The response section includes a description of the response to security events, communications during security events, security event reporting, the maintenance of security systems during emergencies and contingencies, and measures to address increased threat levels.

CYBERSECURITY

- Digital components of the security system
- Roles and responsibilities
- Risk, vulnerability and compliance management
- cybersecurity systems and measures
- response arrangements and temporary measures

The cybersecurity section includes a description of the digital components of the security system, the roles and responsibilities for cybersecurity, cybersecurity systems and measures, functionality and performance testing procedures, and response arrangements and temporary measures in the case of a cyber incident affecting the security system.

Effective Physical Protection Systems & Security Management

To ensure the security of their cobalt-60 sources, operators need to implement a security system based upon the functions of deterrence, detection and assessment, delay and response. They also need to take a graded approach to security and ensure that their system provides defence in depth. In addition to these technical measures, operators need to implement security management measures that address such issues as trustworthiness, staff training, information protection, inventory control and incident response and reporting. The underlying basis of all of this is also the robustness of the facility's nuclear security culture.

Physical Protection Functions (Deter, Detect, Delay, Respond)

Physical protection has four functions that form the basis of the security system. The first is to **deter** adversaries from even attempting to steal or sabotage radioactive sources. The second is to **detect** and **assess** any attempts that adversaries might be making. The third and fourth are to **delay** adversaries who are attempting to steal or sabotage sources until an adequate **response** force (e.g. the police) can arrive and interrupt, interdict or neutralise them. Each of these functions is important and works with the others to achieve an effective security system.

In order to ensure that the response time is less than the time required to perform a malicious act, consideration should be given to how: the adversary can be detected and verified as early as possible; delay time can be increased; and response time can be reduced. When designing its security system, the operators should identify credible attack scenarios and implement appropriate detection, assessment and delay elements to ensure a timely response.

Deter

Deterrence occurs when an adversary is dissuaded from undertaking a malicious act because the perceived robustness of a site's security systems would make the attempt too difficult to mount, success would be too uncertain, and/or the consequences for the adversary would be too unpleasant. Deterrence is a by-product of effective physical protection design and of the security culture of an organisation, not a standalone security measure. Therefore, it should not be assumed that deterrence measures alone will be effective against adversaries who have both capability and motivation.

Examples for use at gamma irradiation facilities include perimeter fencing, good lighting, video cameras, signage and, in some cases, the use of security guards. These highly visible measures demonstrate that the facility has multiple layers of robust security in place.

The insider threat can be deterred by the requirement for two people to use multiple authentication methods (e.g. fingerprint and PIN or ID card) to access secure areas. This needs to be supported by a good security culture amongst the staff and the effective implementation of the security procedures.

Figure 3: CCTV can be highly visible and will contribute to both deterring and detecting an adversary.

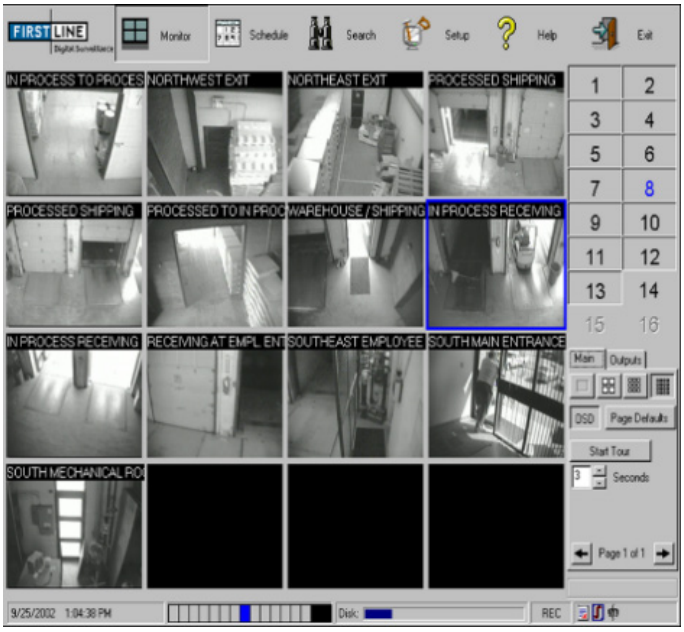


Figure 4: Multiple zones (personnel entrances, goods and warehouse areas, selected rooms etc.) can be monitored at one time. Courtesy of STERIS AST.

Detection and Assessment

Detection is the discovery of an intrusion, an attempt to steal or sabotage radioactive material or any other unauthorised action. Detection measures are intended to create an alert should adversaries attempt to enter an area they are unauthorised to access or to perform an unauthorised action.

Examples of detection and assessment at gamma irradiation facilities include:

- **Access control:** The objective of access control is to ensure that only approved individuals with a need to access certain areas of the facility or the irradiator have access to them. Access can be controlled by a key, an electronic card (e.g. magnetic swipe or proximity pass), PIN code entry or biometric reader. Ideally, an access control system should combine at least two of these measures. Access can be zoned so, for example, all staff have access to the building, but only specifically qualified and approved staff can access the irradiator. Systems should enable temporary security zones for periods of irradiation shutdown when work such as maintenance and source handing may be required. Whenever possible, it is good practice to track and record access to the different zones.
- **Intruder detection and alarm:** Intruder detection systems should be designed so that detection is assured for all feasible paths leading to the gamma irradiator. Detection systems may include motion detectors, door contacts, floor sensors and glass break detectors. Every alarm signal should be reported on-site and off-site, and alarms should be monitored 24 hours a day, seven days a week. It is good practice to categorise and prioritise alarms in order to develop specific response procedures, should the alarm be triggered for instance in a warehouse or at the door of the irradiation cell.
- **Video/CCTV:** If an alarm is triggered, it must be assessed immediately to determine whether the alarm indicates an actual security event, or some form of harmless anomaly (false alarm or innocent alarm). This assessment can be made either by an individual at the location of the alarm or remotely through CCTV and other monitoring systems. Detection without assessment has no value because until an event is detected and verified to be a real security incident, no response can take place.
- **Radiation Detection:** The use of radiation monitors at points of access can provide early detection of the unauthorised removal of a radioactive source. This detection can be alarmed both internally and externally and can be assessed using video/CCTV.
- **Employee Security Awareness Training:** Initial and periodic training on the types of suspicious activity will make employees more aware of security and able to report suspicious activity for additional assessment.

Figure 5: (Courtesy of Symec Engineers)

Figure 6: (Courtesy of VINCA Institute)

Various methods of controlling access are available to operators of irradiation facilities. These include turnstiles and PIN code keypads, as illustrated above.

Delay

Delay should follow detection and assessment. Measures include physical barriers with the purpose of increasing the time it would take adversaries to successfully remove cobalt-60 sources from a facility or carry out an act of sabotage. Multiple layers that create delays can be most effective because the longer adversaries are delayed, following detection and assessment, the greater the chance that an effective response can be mobilised in time to interrupt them.

Delay mechanisms that may compromise safety must not be introduced.

Examples of delay measures that may be used at gamma irradiation facilities include:

- **Heavy-duty doors:** Metal security-rated doors that are secured into robust frames and walls can cause significant delay to unauthorised access, particularly when used in conjunction with high-security locks/interlocks. They should be installed where direct access to the irradiation cell or other sensitive/controlled areas is possible.
- **Source storage pool barriers:** These items can prevent direct access to the rack that holds the cobalt-60 sources. A pool cover of hardened design will prevent access when the source rack is lowered. A source rack shroud may delay access to a raised rack depending on its design, although a raised rack is of less concern as the radiation level will impair an attacker's ability to access the cobalt-60 sources. These items can incorporate security fittings that require specialist tools for removal.
- **Secure tools:** Any tools that could aid an intruder should be locked away when not in use. Special attention should be given to source handling tools, which should be stored in a secure room when not in use.
- **Roof plug and crane:** If applicable, the cell roof plug should be locked into place during routine operation of the irradiator. Any internal crane that is used solely for removing the roof plug should also be locked or disconnected from power when not in use.
- **Circuitous route:** Delay can be caused by forcing an intruder to use an indirect route between the point of accessing the building and the target, the cobalt-60 sources. If practical, forcing an intruder to pass through offices or multiple doors and features such as internal fencing can be used to achieve this. However, consideration must be given to the practicalities of routine radiation processing operations and the flow of product and authorised people through the facility.

Figure 7: Security door and fencing (Courtesy of Gamma-Service Recycling GmbH)

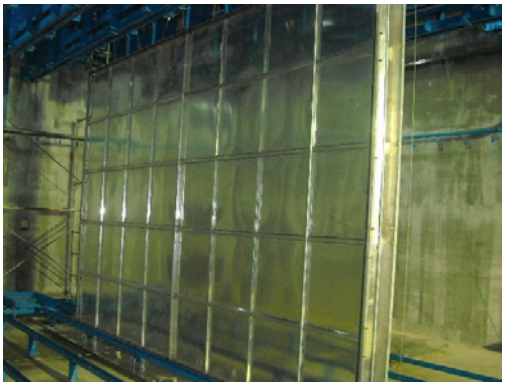


Figure 8: Source rack shroud (Courtesy of SQHL Radiation Engineering Technology Co., Ltd)

Heavy-duty security doors and the use of fencing that causes an intruder to use an indirect route will delay access to secure areas such as the irradiation cell. Depending on its design, a source rack shroud may delay access to the sources.

Response

Response refers to the actions undertaken by onsite security forces (if present) and/or offsite law enforcement to interrupt and interdict or neutralise an adversary while a malicious act is in progress.

Operators of gamma irradiators must respond to any security event in accordance with their security procedures and with a priority for the safety of staff.

Responders need to be properly trained and equipped and have the authority and ability to carry out their assigned actions. They must be familiar with the site, know who is responsible for what, and have the necessary resources to stop the malicious act. A strong relationship and good cooperation between the operator and response force is key to ensuring an effective response at the time of an incident. Regular response training will help to foster this relationship and ensure a better understanding of expectations, capabilities and the irradiation facility.

Graded Approach

Protective measures need to be proportionate to the risk. Knowing how much security is enough is one of the challenges of implementing effective security measures. Too little security may leave sources vulnerable, but too much security wastes money and could unnecessarily impact operations.

To address this issue, regulators and operators should take a **graded approach** toward security. In essence, this means that material with high consequences from malicious use should receive more attention and stricter security measures than material with lower consequences. Category 1 sources, such as the cobalt-60 used in gamma irradiators, need more stringent protection measures than material with lower consequence.

Defence in Depth

The IAEA (NSS No. 14) defines **defence in depth** as "the combination of multiple layers of systems and measures that have to be overcome or circumvented before nuclear security is compromised". Security requirements for *radioactive material* require a designed mixture of hardware (security devices), procedures (access control, follow-up, etc.) and facility design. This approach means that an adversary has to avoid or defeat a number of different security measures in sequence—such as penetrating multiple separate barriers before gaining access to a source rack—in order to be successful. Defence in depth helps to deter or defeat an adversary because it adds uncertainty, requires different techniques and tools, creates additional hurdles and requires more time for an adversary to complete their task (accessing the target).

Security by Design

The ideal approach to securing cobalt-60 sources is to *design-in* or *engineer-in* the required physical security features when designing a new gamma irradiation facility. Costs can be reduced by incorporating security into the original design rather than retrofitting facilities later.

The **security by design** approach enables operators to identify ways in which safety and security design can work with and enhance each other. For example, the wall thickness of an irradiation cell is an important consideration for radiation safety but can also be an important security feature.

Security by design enables engineers to ensure their design is balanced between detection, delay and response elements, all of which need to work together to ensure security. Design must not impact safety and should have a minimal impact on routine radiation processing operations.

Examples of security by design of gamma irradiation facilities include:

- **Security perimeters:** site, warehouse and irradiator perimeters should be designed-in. Within these parameters, **multiple layers** of physical protection are designed-in to be supported by appropriate procedures that enhance security.
- **Access to the irradiator cell** should incorporate hardening, intrusion detection and radiation detection at the personnel and product entry and exit points.
- **The source storage pool** can incorporate a secured cover that blocks access to the source rack when the rack is in the lowered position. These covers should be of hardened design so resistant to a variety of tools and incorporate security fittings so they are not easily removable by attackers.

- **The source rack and modules** should incorporate locking features.
- **Independent systems:** Computer-based security systems should be independent from the irradiator operating system wherever possible, whilst recognising that some interface between the systems is necessary. This can reduce the risk of unauthorised access or overriding one system via the other system.

Figure 9: Access to the irradiator cell should be via a hardened security door fitted with opening detection sensors. Security can work hand in hand with safety, for example by interlocking a mechanical latch bar with the mechanism for lowering the source rack into a safe position as shown. The security of this mechanism, including encasement and tamper detection, should be considered. Illustration courtesy of Symec Engineers.

Figure 10: Access to the sources within the irradiator will be delayed by use of a pool cover. Various designs of solid covers or grills may be used and, in order to be effective, should be of hardened design, resistant to various tools, incorporate security fittings and not easily removeable by multiple attackers. Illustration courtesy of Symec Engineers.

Security During Temporary Operations

Security requirements during temporary operations such as cobalt-60 receipt/dispatch and installation need to be considered and will vary from those during normal irradiator operations.

During cobalt-60 receipt/dispatch, the sources will be inside transport containers, either on or off a vehicle, and there may be the need for greater access to the irradiator building for vehicle movements. For example, doors additional to those used to allow the flow of product being processed may be opened to allow the vehicle and transport containers to access the irradiation cell.

During a cobalt-60 source installation, physical barriers such as the pool cover will need to be removed to enable access to the source rack. There will be a greater need to access the irradiation cell via the maze, and the roof plug may be removed for an extended period of time.

Some layers of security will be removed during these temporary operations. It is therefore important to review these operations in detail, understand any temporary vulnerabilities and put additional security in place to mitigate these vulnerabilities. Temporary security measures may include greater coordination with local law enforcement agencies, additional security/response personnel, reduced personnel access to designated areas, temporary physical barriers and a greater level of video surveillance.

Temporary security arrangements must be recorded as procedures within the security plan. Emergency responders must be made aware of these temporary operations and be briefed on how the situation varies from normal irradiator operation so they can plan to modify their response accordingly.

Information Protection

Information that could compromise cobalt-60 source security is sensitive and needs to be protected. This includes information related to the security plan, access codes, alarm system codes/passwords and intimate details of the physical security element. It also includes the cobalt-60 source inventory, operational procedures, computer systems, transport timing and routes (for both cobalt-60 and products for radiation processing), as well as technical data, blueprints, schematics, designs, security procedures and emergency response plans.

Information protection involves the development, implementation and maintenance of written policies and procedures that describe how to handle sensitive information and protect it from unauthorised disclosure. Operators should evaluate an individual's **need to know** before allowing access to security documents. Information protection policies and procedures should include instructions on how to:

- Protect sensitive information about cobalt-60 sources that are in use or transit.
- Prepare, identify, mark and transmit - both physically and electronically - documents or correspondence containing information about the operator's security programme.
- Control access to information about the operator's security programme.
- Destroy or remove documents from the protected information category when they become obsolete or are no longer sensitive.

If possible, operators should periodically conduct basic radiation safety and security training for the offsite response force.

It is crucial that first responders have a list of the basic contacts at the operator's site and understand:

- The types and quantities of radioactive material and associated devices onsite.
- The potential hazards associated with loss of control of sources.
- Specific facility information (floor plans, entrances, points of egress, etc.)
- Site-specific physical protection measures that the operator uses to monitor premises and delay an adversary from gaining access to the material.

Cybersecurity of Physical Security Systems

A cybersecurity programme is essential to prevent vulnerabilities from being introduced into a physical security system that protects radioactive sources. As more IP-based security components are integrated, the importance of cybersecurity will only grow. While IT staff can assist with the fundamentals of a cybersecurity programme, professional cybersecurity expertise may be required for more complex tasks so that an organisation can develop a thorough and effective programme.

Cybersecurity is a specialist area and is not covered in detail in this guide. Operators are encouraged to read 'Cybersecurity Best Practices for Users of Radioactive Sources' prepared by the US Department of Energy, National Nuclear Security Agency and the iia 'Guide for Assessing Cybersecurity Programs at Gamma Irradiation Facilities'. Further reference documents are set out in the Suggestions for Further Reading. Operators should seek advice from experts who will recommend appropriate cyber security measures, including hardware, software, penetration testing and response procedures.

The ORS Best Practices provides guidance for specific tasks that can be completed to develop a programme depending on the needs of the organization. There are recommended steps for the different stages such as how to commence a cybersecurity programme as well as how to implement, maintain and sustain a cybersecurity programme. Below are steps that can be taken at each of these stages:

Starting a Cybersecurity Programme

Facilities in this stage are likely to not have any formally defined cybersecurity policies, procedures dedicated personnel, or focused training programs. Organisations should then work on identifying which regulations, recommendations, and best practices should be used as the basis documents for their cybersecurity programme.

Developing a new cybersecurity programme should also include defining operational procedures that clearly delineates the roles and responsibilities of all participants in the cybersecurity programme; drafting and implementing procedures to execute the policy actions; and identifying critical digital assets. Clearly defining the criteria for cybersecurity incidents and the corresponding response requirements is crucial. In addition, it is vital that senior management fully endorses the establishment of a cybersecurity programme.

When starting a cybersecurity programme it is important to take the following steps:

- Review national requirements, recommendations and learn from best practices
- Establish cybersecurity policies including roles and responsibilities
- Designate responsible personnel which may be employees or third-party contractors
- Identify critical digital assets
- Conduct a risk analysis and prioritise which security controls to implement
- Identify the capabilities needed and any gaps in the cybersecurity programme
- Use cybersecurity experts to conduct penetration testing to validate perimeter security design and implementation.

Implementing and Maintaining a Cybersecurity Programme

Understanding that cybersecurity is a constantly evolving landscape, no cybersecurity programme can remain the same as the day it was implemented. Cybersecurity controls include technical, physical, and administrative measures. Some of these can be quickly and inexpensively applied to existing security systems. Implementing some of these measures may require assistance of an IT department, cybersecurity professionals, or an external service provider, as they might be too complex for someone without specialized skills. These activities are recommended as essential parts of a comprehensive cybersecurity programme.

The checklist below provides examples of some specific tasks that can be completed as part of maintaining a programme depending on the needs of the organization. It is not intended to be comprehensive but rather illustrative of some of the major actions that may be required.

- Analyse cyber threats and update the threat assessment on a regular basis
- Conduct vulnerability assessment
- Develop a mitigation strategy
- Monitor programme changes
- Develop a testing and evaluation programme
- Ensure adequate data monitoring
- Develop a reporting framework for cybersecurity incidents
- Monitor programme changes
- Assess resource allocation
- Develop a lessons learned strategy
- Share lessons learned with the wider community

Sustaining a Cybersecurity Programme

A mature and well-integrated cybersecurity programme is characterized by its proactive approach to threat intelligence and the implementation of advanced security measures. Such a programme is not static; it continuously evolves, adapting to emerging threats and incorporating improvements to stay ahead of potential risks. Sustainment is key, ensuring that these measures are consistently maintained and updated to provide ongoing protection. Part of sustaining a cybersecurity programme is to ensure that it is assessed on a regular basis including an evaluation of the effectiveness of the cybersecurity measures.

Human Trustworthiness and Reliability

Operators need to know that their staff can be trusted with the sensitive information, critical technology and potentially hazardous materials with which they work. This is why they need to put a human reliability assessment plan in place that carefully vets potential staff before they are allowed access to sensitive information, critical technology or radioactive material. An assessment plan will help to ensure staff remain reliable during their employment and identify procedures to follow when staff terminate their employment.

Vetting

Because vetting helps to determine the trustworthiness and reliability of potential staff, it is a key measure in mitigating the risk posed by insiders. The process can range from a simple confirmation of identity to a comprehensive background check conducted by the national authority that includes verifying whether the individual has a criminal history or any other 'red flags' that might indicate issues of concern, such as politically motivated violence.

Behaviour Observation

It is important to remember that initial vetting does not guarantee future reliability because people's lives, attitudes and circumstances can change over time. Consequently, the trustworthiness of individuals with access to cobalt-60 sources needs to be re-checked periodically, and any new information affecting an individual's reliability needs to be brought quickly to the attention of the appropriate authorities. Staff also need to be trained how to report suspicious behaviours, non-compliance with security procedures, and any other security incidents or concerns they might have.

Measures taken to improve human reliability are more effective when organisations emphasise that safety and security are two sides of the same coin. For example, a human reliability issue involving an individual who is drinking alcohol or taking drugs on the job can be a threat to both safety and security. Because staff are the first and potentially only line of defence against insider threats, they need to have access to a clearly defined and easily utilised programme for sharing concerns. If they notice concerning behaviours, they need to know they have a duty to report them and that a programme is in place for doing so. They also need to know that the issue will be investigated thoroughly and promptly and that they will not be penalised for making a report.

Post-Employment Procedures

Operators need to have written procedures to follow when it comes to the termination of employment. These include such actions as:

- Removing access to sensitive locations, materials and data
- Changing passcodes or combinations
- Removing cyber access
- Collecting all badges, ID cards and parking permits

Special care needs to be taken not to risk the possibility that soon-to-be ex-staff members hear about their termination through unofficial channels while they possess the access, knowledge and authority to impact sensitive operations. A human resources manager needs to hold an exit interview when the employee is informed of this decision, and all of the regular post-employment security steps listed above need to be performed immediately.

Incident Response Planning, Coordination and Reporting

Operators of gamma irradiation facilities need to plan for incident response including development of procedures that should be followed in close coordination with relevant first responders (e.g. police, ambulances and fire departments.) The procedures need to address how to handle emergencies that may be initiated by a safety or a security incident, including maintaining both safety and security systems during the emergency. Planning should include incidents that may arise during temporary situations such during cobalt-60 source delivery, receipt and installation.

All involved in response and the operator need to know who the points of contact are at each other's organisations and have their full, up-to-date contact information. In addition, operators need to determine whether their local emergency responders are available day or night, seven days a week, and whether law enforcement agencies are capable of providing an armed response and arrest perpetrators. If not, they will need to identify and coordinate with the closest response force that can provide such services if the primary response force is off duty. To develop effective coordination, operators need to regularly communicate and periodically meet with their offsite response agencies.

Operators should report security events to the regulatory body and—depending on the circumstances—to law enforcement as well.

All response arrangements should be included in the response plan that typically forms part of the security plan submitted by the operator to the regulatory body for approval and is also subject to regular review and updating.

The response arrangements should also be subject to regulatory controls including requirements for tests, drills and exercises to ensure that the response arrangements are effective and that all stakeholders understand their roles and responsibilities and can carry these out effectively.

Sustaining Security Arrangements

Sustaining cobalt-60 source security arrangements entails a great deal more than compliance with basic physical protection measures and regulations stipulated by the regulatory body. It requires operators to take a proactive approach to security that involves managing the entire lifecycle of their sources from original purchase to final disposal. It also requires taking steps to measure and improve security culture, increase the professional security competence of staff, participate actively in benchmarking and peer review activities, and manage the interface between security and safety.

Whole-Life Approach to Managing Radioactive Sources

When creating a budget and planning resources for cobalt-60 source security, it is important to take a whole-life approach (sometimes called *cradle to grave*) to the management of those sources. This requires operators to plan for and consider the arrangements for the financing of the final handling of their cobalt-60 sources when these sources reach the end of their life.

The radiation processing industry has a good record for the management of their end-of-life radioactive sources. Disused sources are typically returned to the supplier or transferred to another authorised operator. These organisations generally have the capacity to safely and securely manage the radioactive sources they provide and are better able to determine whether disused sources can be reused, recycled or relegated to final disposal.

There are certain considerations that operators should take into account if they plan to return discussed cobalt-60 sources to the supplier or other authorised operator. These will help ensure that these disused sources can be handled in an effective manner:

- Disused sources can be handled in multiple ways (e.g. storage, re-use, recycling) and by multiple authorised organisations. Operators should evaluate their options. Timely handling of disused sources can contribute to security as well as operational flexibility and cost efficiency.
- The end-of-life handling of sources requires funding, and it is important that operators have a financial mechanism (financial provision, bond etc.) to cover this cost. Cobalt-60 sources used in radiation processing have a long operational life, typically 20 years, so it is not usually possible for a supplier or other authorised operator to accurately know the final method and cost of end-of-life handling at the time of supply. This is because operational and regulatory changes are likely to occur over the life of the source as well as direct cost changes. It is therefore important that operators, in coordination with source suppliers, update their plans periodically with current costs and adjust their financial arrangements accordingly.
- The return of disused sources to suppliers is often on a 'one for one' basis (i.e. one end-of-life source can be returned to supplier for each new source supplied). It is important for operators to recognize that different costs may apply for sources that are returned outside of this basis, for example, if a gamma irradiator is being decommissioned and all sources require removal and handling.
- Disused sources in temporary storage within an irradiator are subject to the same security requirements as sources that are in use.
- The categorisation of disused sources as 'radioactive waste' can result in import/export restrictions and may hinder transfer of disused sources to an authorised site for handling. The categorisation of disused radioactive sources is of utmost importance and an operator must understand the regulatory framework and the requirements of other stakeholders when classifying disused source for the purpose of storage, transport, export and handling.

Despite the best planning, there may be a circumstance in which the return of disused sources to the supplier or another authorised operator is not possible or practical (e.g. for regulatory reason, transport issues, closure of supplier), in which case disused sources may be sent to a licensed storage or disposal facility. If long-term storage and/or final disposal options are unavailable in the State, the responsibility for safety and security of disused sources will remain with the operator. This means that the operator will continue to be responsible for maintaining the security of these disused sources in compliance with the requirements of their regulatory body.

Competence Development

It is important that organisations identify positions requiring security skills, along with the necessary knowledge, skills and behaviours or attitudes to perform them effectively. Managers should ensure that individuals filling these positions are demonstrably competent through a combination of education, training and on-the-job experience. They should also manage knowledge carefully, which involves systematically identifying and organising staff knowledge and experience so that it can be retained over time. The organisation should document and evaluate professional development opportunities provided to the staff, keep records of the training, and encourage certification for security competences. Security awareness and training could be integrated with safety and/or other training, thereby minimising the time that staff are away from their job.

Professionalism can be encouraged through such avenues as:

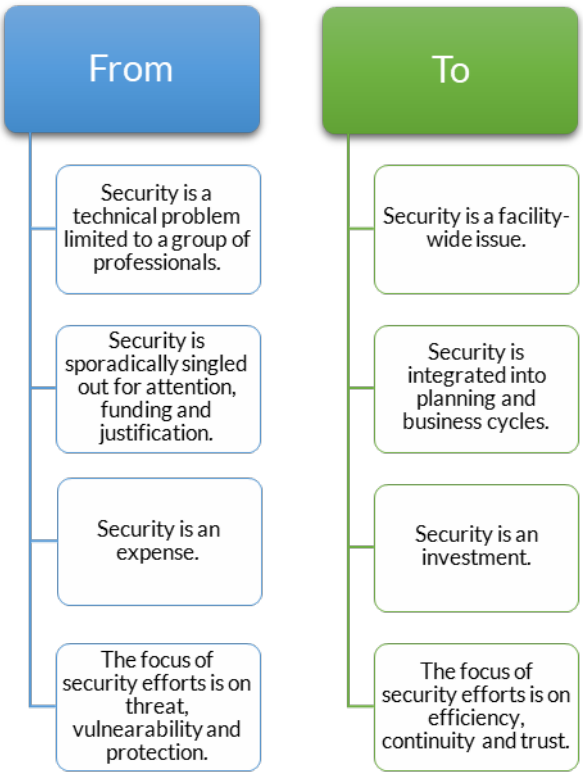
- Certification programmes like the WINS Academy,
- Advanced degrees,
- Participation in international and regional centres of excellence,
- Membership in professional societies, and
- Participation in special training courses and workshops.

Security Culture

Security culture can be defined as the beliefs, values, understandings and behaviours that people—from the board to the general workforce—bring to security.

Experience suggests that security culture may be the single most important aspect of a security system. In an organisation with a strong security culture, staff believe that security threats are real, understand it is their responsibility to contribute to the security of the entire organisation, and adhere to security practices as a normal part of their daily work lives. If they observe an anomaly or hear something suspicious, they report it unhesitatingly to their supervisors. If they make a mistake themselves, they willingly own up to it, seek to understand how it occurred, and work actively to improve their performance. If they have ideas or suggestions for how to improve security, they share them with their managers and colleagues because they know such contributions are encouraged, respected and rewarded.

In contrast, if the security culture is weak, the workforce may resent security features and do their best to ignore or circumvent them. They may be reluctant to express concerns about aberrant behaviours and issues, materially increasing the risk for all concerned. Or they may simply forget about the need to follow basic security procedures, potentially leaving the sources vulnerable. Improving security culture requires that leadership (and subsequently the rest of the organisation) undergo a shift in perspective, as demonstrated in the following graphic.



All personnel with responsibilities for radioactive sources need to be educated about the threat and the proper procedures to follow in relation to the security of sources via ongoing training sessions based on their respective roles and responsibilities. In addition, leadership needs to make the consequences for failing to follow security procedures clear, adhere to the procedures themselves, and demonstrably enforce the consequences when the procedures are not followed correctly.

Leadership also needs to put a variety of mechanisms into place, such as a hotline or non-punitive whistleblowing policy, that clearly demonstrate they welcome communications about security concerns from their personnel. They also need to take actions that are timely, fair and appropriate to resolve such concerns.

Developing a strong security culture is an ongoing, step-by-step process. The aim should be to encourage awareness among staff of the role they play in protecting their organisation's business assets as well as the safety and security of their entire community. Consequently, this is not a one-off exercise. It needs to continue as long as an organisation uses high activity sources.

Evaluation and Continuous Improvement

It is only through the measurement of performance that an organisation can demonstrate to itself and its stakeholders that it is achieving its objectives. Performance objectives most commonly include financial, production/operational, safety and environmental performance. The measurement of **security performance**, however, can be problematic because significant challenges to the system rarely occur. This may lead management to become complacent about security and to the (potentially false) assumption that the security systems are effective. Yet a significant threat or challenge to the system could occur within minutes, leaving little or no time to address underlying managerial and technical weaknesses in the system.

For all of these reasons, measuring performance is essential for effective governance, as well as a critical aspect of building continuous improvement into an organisation's security culture. An effective performance measurement and testing programme requires the combination, integration, and management of all components that positively enhance security—or that would decrease performance outcomes if they were combined ineffectively. People, processes, technologies and environment must all be understood and managed effectively to achieve the best security outcome; failure to do so could decrease security substantially.

Poorly designed or badly implemented performance metrics can have negative consequences for the entire organisation. For example, solely collecting data on the number of security incidents provides no indication of how secure a facility actually is because incidents tend to be such rare events. Furthermore, such measures do not indicate how many attempts have been made or what the response time might be should an incident take place.

Security audits of equipment, procedures and implementation should be performed on at least an annual basis. These audits will help ensure that security is at least maintained and identify areas where improvements or modifications should be made as a result of the changing threat, other local site changes or the arrangements that an operator has with third parties. The programme of audits should also include the assessment of security during temporary operations such as cobalt-60 receipt/dispatch and installation.

Exercises of different kinds can also be carried out and are most effective when they involve, for example, a wide variety of stakeholders (an exercise that tests arrangements for response to security incidents is a good example).

In addition to internal audits and desktop and practical exercises, continuous improvement will result from cooperation with regulators and other third parties. These organisations can: assess the risks and vulnerabilities of a facility or organisation; conduct peer reviews or benchmarking against similar irradiators; and add depth and contribute to the implementation of improvements to security arrangements.

International Support Programmes

As an example, the Office of Radiological Security (ORS), a part of the US National Nuclear Security Administration (NNSA), works with organisations to evaluate existing security systems and provide protection upgrades, guidance and training to enhance the security of high activity radioactive sources. ORS collaborates with partner organisations worldwide on sustainable security, including implementation of regulatory development, security planning and training, transportation security, response planning and training, and the strengthening of inspection and enforcement regimes

Security and Safety Interface

Both safety and security seek to protect human health, property and reputation. Furthermore, many safety features also benefit security. For example, the irradiation cell shielding also provides a layer of delay and interlock mechanisms also provide access control.

On the other hand, safety and security features have the potential to conflict with each other if an understanding of their interface is lacking. For example, barriers designed to prevent access by an intruder (security) could impede egress in an emergency (safety).

These examples highlight the importance of integrating safety and security into an organisation's planning, procedures and culture. To achieve this goal, executive management needs to recognise that both are of equal importance, commit to the effective management of the interface between safety and security, and provide adequate resources and management support to ensure that this takes place. Programmes and procedures should be conceived and developed with both safety and security in mind, in consultation with experts in both disciplines.

Peer Reviews and Benchmarking

Peer Reviews

A peer review is a confidential, systematic process in which a group of independent, experienced practitioners in a particular field assess the quality of work of other professionals in the same field using a set of criteria and levels of performance agreed in advance with the professional community. Although the objectives and structure of peer review mechanisms vary, most involve identifying areas for improvement, sharing experience and highlighting best practices. Peer reviews are not a substitute for regulatory inspections or audits; their influence comes from the peer pressure and scrutiny that they generate, as well as from the credibility of the peer reviewers.

Peer review is an important tool for operators who are responsible for maintaining security for their radioactive sources. In recognition of this, the IAEA has extended its International Physical Protection Advisory Services (IPPAS), which was initially created for nuclear material and nuclear facilities. In Chapter V of the IPPAS guide (2014), the IAEA now provides advice to States about the security of their radioactive material, associated facilities, associated activities, and transport of radioactive material

WINS also publishes guidelines for operators who recognise the value of peer review and want to conduct their own reviews. The guidance emphasises that peer reviews are designed to provide mutual support among professionals, so attitudes and tone should be collaborative, not confrontational. If either party does not understand the purpose of the peer review, then information will not flow effectively between them and the primary purpose will be lost.

Benchmarking

Benchmarking is another effective tool for operators who want to learn best practice and evaluate the effectiveness of their security arrangements for radioactive sources. Appendix B of this guide describes different levels of effectiveness and helps operators better understand where their organisation is doing well and what needs to be done to improve weaker areas.

Conclusion

Cobalt-60 sources are used in radiation processing for multiple beneficial applications. Failure to adequately secure such sources may have serious consequences for individuals, communities and the environment, as well as for the organisation's financial stability, reputation and exposure to liability. It is each operator's responsibility to protect the sources under their control and to ensure that all stakeholders—from senior management to the general staff, contractors and suppliers—understand the concepts and principles underlying the security of radioactive sources and the actions they need to take to understand the threats and minimise the risks.

Effectively managing radioactive source security requires that operators understand and comply with their national regulatory requirements and be aware of and implement best practices. Proper planning and execution of a graded, layered security programme can achieve effective security outcomes without an adverse impact on operations. The most important factor in maintaining effective, proportionate security, however, is security culture. All stakeholders must believe that there is a credible threat and understand that it is their responsibility to contribute to security day-to-day and commit to carrying out their responsibilities to the best of their ability.

Suggestion for Further Reading

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WINS International Best Practice Guides. Available to WINS Members at http://www.wins.org

Appendices

Appendix A – Questions to assess the personal contributions to enhancing the security of radioactive sources in your organisation

Appendix A contains a series of questions that members of an organisation can use to evaluate the security of their radioactive sources. The questions also make excellent prompts for generating discussion. Such a process helps individuals at all levels of an organisation reflect critically on their personal actions and behaviour. It also helps them understand how they can contribute personally to enhancing the security of such sources within their organisation.

QUESTIONS FOR EXECUTIVE MANAGEMENT	
Do you believe the threats to your radioactive sources are credible?	◯ Yes ◯ No
Do you understand the crucial role that leadership plays in your organisation's security culture?	◯ Yes ◯ No
Have the board or senior management created a clear, written policy governing the security of their radioactive sources?	◯ Yes ◯ No
Do you include the possible theft or sabotage of radioactive sources when addressing organisational risk?	◯ Yes ◯ No
Do you understand the regulatory requirements for security that are applicable to your sources?	◯ Yes ◯ No
Does your security programme meet or exceed regulatory requirements for security applicable to your sources?	◯ Yes ◯ No
Are you familiar with the physical protection measures that are in place to keep your organisation's radioactive sources secure?	◯ Yes ◯ No
Have you put a strong, effective human reliability programme (HRP) in place to ensure the trustworthiness and reliability of your staff?	◯ Yes ◯ No

Does your HRP include pre-employment, during-employment and post-employment measures?	◯ Yes ◯ No
Does your organisation have a programme in place that encourages staff to share their security concerns?	◯ Yes ◯ No
If a staff member shares their security concerns, is it welcome input and is prompt action taken in relation to the reported concern?	◯ Yes ◯ No
Do you ensure that your staff regularly obtain professional development and training in security (as appropriate for their positions)?	◯ Yes ◯ No
Does your organisation have an integrated security programme that combines conventional and radiological security?	◯ Yes ◯ No
Do you take a whole-life approach to radioactive source management and security?	◯ Yes ◯ No
Have you put effective end-of-life measures and funding in place for your disused sources?	◯ Yes ◯ No
Do you believe that there are cyber threats that may target your organisation?	◯ Yes ◯ No
Is cybersecurity part of your organisation's overall risk management strategy?	◯ Yes ◯ No
Is there a person or function with overall responsibility for cybersecurity in your organisation?	◯ Yes ◯ No
Does your organisation have a cybersecurity programme?	◯ Yes ◯ No
Is the effectiveness of your cybersecurity programme regularly tested?	◯ Yes ◯ No

QUESTIONS FOR THE RADIATION SAFETY OFFICER / SECURITY MANAGER	
Do you believe the threats to your radioactive sources are credible?	◯ Yes ◯ No
Do you receive periodic briefings on threats to your sources and facility?	◯ Yes ◯ No
Does your physical protection system include deterrence, detection and assessment, delay and response measures?	◯ Yes ◯ No
Do you take a graded approach toward your security system design and implementation?	◯ Yes ◯ No
Does your security system include defence in depth measures?	◯ Yes ◯ No
Do you periodically assess and measure the effectiveness of your security systems?	◯ Yes ◯ No
Do you have a plan to continuously improve your security programme?	◯ Yes ◯ No
Does the entire staff understand their responsibilities for security?	◯ Yes ◯ No
Are the keys, access cards and entry codes that allow access to radioactive sources managed securely?	◯ Yes ◯ No
Do staff receive security training when they are hired?	◯ Yes ◯ No
Do staff receive periodic security training after they are hired?	◯ Yes ◯ No
Do you measure the effectiveness of security training?	◯ Yes ◯ No

Do you believe the security culture at your organisation is good?	◯ Yes ◯ No
Do you conduct surveys periodically about staff attitudes toward security?	◯ Yes ◯ No
Does executive management demonstrate strong support for security?	◯ Yes ◯ No
Do staff understand that it is their responsibility to share any concerns they might have about security with the authorised person?	◯ Yes ◯ No
Is there an established programme for sharing security concern?	◯ Yes ◯ No
Do staff use the sharing concerns programme willingly?	◯ Yes ◯ No
Do you periodically conduct radiation security training for the offsite response force?	◯ Yes ◯ No
Do you periodically exercise your response plan?	◯ Yes ◯ No
Have site folders been created for all of your high activity radioactive sources?	◯ Yes ◯ No
Are your site folders for your high activity radioactive sources readily available if the offsite response force require them when responding to an incident?	◯ Yes ◯ No
Do you believe that there are cyber threats that may target your organisation?	◯ Yes ◯ No
Is there a person or function with overall responsibility for cybersecurity in your organisation?	◯ Yes ◯ No
Does your organisation have a cybersecurity programme?	◯ Yes ◯ No

Are you offered cybersecurity awareness training?	◯ Yes ◯ No
Does your organisation have a plan for response to a major cybersecurity incident	◯ Yes ◯ No

QUESTIONS FOR STAFF	
Do you believe the threats to your radioactive sources are credible?	◯ Yes ◯ No
Do you believe that there are cyber threats that may target your organisation?	◯ Yes ◯ No
Do you know who is responsible for cybersecurity?	◯ Yes ◯ No
Are you offered cybersecurity awareness training?	◯ Yes ◯ No
Do you believe you have personal responsibility for helping to maintain the security of your organisation's radioactive sources?	◯ Yes ◯ No
Did you go through a vetting process when you were first hired?	◯ Yes ◯ No
Do you believe that a vetting process helps to ensure that only trustworthy people are employed?	◯ Yes ◯ No
Did you receive training on radioactive source security when you were first hired? Have you continued to receive such training periodically?	◯ Yes ◯ No
Was the training you received on radioactive source security effective?	◯ Yes ◯ No
Have you continued to receive periodic radioactive source security training?	◯ Yes ◯ No
Do you understand how to use the physical protection measures that are in place, including access measures and alarms?	◯ Yes ◯ No
Does your management respond effectively when security concerns are raised by staff?	◯ Yes ◯ No

Does management clearly demonstrate—through their actions, policies and programmes—that security is important?	◯ Yes ◯ No
Do your managers emphasise how important it is that safety and security work together?	◯ Yes ◯ No
Have you been trained in the protection of sensitive information?	◯ Yes ◯ No
Do you understand the difference between *need to know* and *need to share*?	◯ Yes ◯ No
Do you know what to do if an incident occurs?	◯ Yes ◯ No

Appendix B – Defining different levels of organisational achievement

The following scale presents five stages of development leading to a world-class nuclear security culture, each with its own set of characteristics. Identifying where your organisation falls on this scale will help you understand how effective your nuclear security culture is and what you need to do to improve it.

LEVEL	CHARACTERISTICS
1 **RESILIENT**	Executive management demonstrate their conviction that the threat is real and that security is important by treating security as an integral part of corporate risk, by taking a risk-informed approach toward security, and by taking a whole-life approach toward the management of their radioactive sources Executive management have put a programme in place to encourage a positive security culture. This includes a human reliability programme that helps to ensure the trustworthiness and reliability of all staff and a programme for sharing concerns. It also includes conducting training in security matters at least annually. The design of the physical protection system successfully balances deterrence, detection, delay and response elements and functions. It also follows a defence in depth and graded approach toward security. Security measures are well coordinated with source operation and radiation safety, and the physical protection system is regularly maintained, tested and evaluated. The entire organisation understands that cyber threats exist. The organisation actively assesses cyberthreats and manages cybersecurity risk on a regular basis. Cybersecurity is integrated into the overall risk management strategy and is a recognised process in the management system. The organisation has access to professional cybersecurity expertise. The infrastructure supporting digital assets is understood in detail, and a process for managing changes in the environment is in place. The organisation regularly conducts penetration testing. A process is in place to keep hardware and software in the environment up to date and patched for new vulnerabilities. Operations, security and IT staff frequently hold joint meetings to discuss issues and know exactly what to do should a cyber-attack occur. Furthermore, the responsibilities of suppliers, vendors and outsourcers have also been clearly defined, and the process of leveraging each other's knowledge and expertise is ongoing. Staff believe that a potential threat exists to the organisation's radioactive sources, that security is important, and that they have personal responsibility for security. They have been trained how to keep sensitive information secure, how to recognise red flag behaviours, and how to respond should an incident occur. They are also willing to share any security concerns because they know that management welcomes them and will take appropriate action while insuring confidentiality. There is strong communication between the operator and the offsite response force, who have been trained in both radiation security and radiation safety so that they know how to respond if an incident occurs. Site/target files exist for all radioactive sources in use and storage, and they are complete and up to date.

2
PROACTIVE

Executive management generally believe that the threat is real and that security is important. They are beginning to treat security as an element of corporate risk and are usually successful at taking a risk-informed approach toward security. They also take a whole-life approach toward the management of radioactive sources.

Executive management have put a programme in place to encourage a positive security culture. This includes a human reliability programme that helps to ensure the trustworthiness and reliability of all staff and a programme for sharing concerns. It also includes conducting refresher training in security every two to three years.

The design of the physical protection system balances deterrence, detection, delay and response elements and functions. It also follows a defence in depth and graded approach toward security. Security measures are well coordinated with source operation and radiation safety, and the physical protection system is usually well maintained, tested and evaluated.

Management understand that cyber threats exist and the need for cybersecurity has been incorporated into the security policy. The infrastructure supporting digital systems is understood in detail, and a process for managing changes in the environment is in place. The organisation conducts penetration testing from time to time. Operations, security and IT staff have regular meetings. Should a cyber-attack occur, the responsibilities of each department have been clearly defined, and joint training and practice have taken place to ensure that all responsible parties know exactly what actions to take and when to take them. Furthermore, security discussions with vendors and experts have started.

Most staff believe that a potential threat exists to the organisation's radioactive sources, that security is important, and that they have personal responsibility for security. They have been trained how to keep sensitive information secure, understand what red flag behaviours are, and can recognise some of them. Staff are willing to share major security concerns on an anonymous hotline, and they have a good idea about what to do if an incident occurs.

The operator and offsite response force (police) have met each other, and the officers have received basic training on radiation security and radiation safety in the event of an incident. Site/target files exist for most of the radioactive sources in use and storage, and they are usually complete and up to date.

3

COMPLIANT

Executive management generally understand that the threat is real, that security is important, and that it would be a good idea to treat security as an element of corporate risk. They have also begun to create policies and procedures that would support taking a risk-informed approach toward security. Executive management have briefly addressed what to do with disused sources that reach the end of their lives.

Executive management generally understand the importance of a positive security culture and have put some measures in place to improve it, such as better vetting of new staff and addressing security in the overall training that new hires receive. Current staff occasionally receive refresher training in security, but not on a fixed schedule.

The physical protection system adheres to the basic regulatory requirements, but nothing more. The organisation has implemented simple provisions for deterrence, detection, delay and response and for following a defence in depth and graded approach toward security. Source operation, radiation safety and radiation security are all separate departments that rarely communicate with each other. The physical protection system is maintained at a minimal level. The overall effectiveness of the system is rarely tested or evaluated.

Senior management believe cyber threats are real. As a result, they have charged people with knowledge of infrastructure for digital systems to put cybersecurity measures in place. Detailed documentation has been created that provides a comprehensive overview of this infrastructure. A rudimentary monitoring process is in place. Operations, security and IT staff have regular contact with each other and generally know who would be responsible for taking which actions should a cyber-attack occur. Management knows which outside organisations to contact for information about cyber threats and for help should a cyber incident occur, and they have begun to develop regular contacts with them.

In general, staff believe that a potential threat exists to the organisation's radioactive sources and that security is important, but they do not understand their personal responsibilities for security. They have been trained how to keep sensitive information secure but have not been trained about red flag behaviours. There is a 24-hour hotline available to someone who wants to share security concerns, but it is rarely used. Staff have a basic idea about what to do if an incident occurs.

The operator and offsite response force (police) have met each other briefly, and officers have received basic training on radiation safety, but not on radiation security. Site/target files exist for most radioactive sources and are occasionally updated.

4

REACTIVE

Executive management do not believe their facility faces any real security threats. They assume the radiation safety officer/security director is solely responsible for security. Because they don't believe that security is an issue, they do not treat it as an element of corporate risk. Nor do they take a risk-informed approach toward security. Executive management purchase and use radioactive sources according to regulatory requirements, but they have not addressed what to do with disused sources.

Executive management vaguely understand what security culture means, but have put no measures in place to test, measure or improve it. Staff receive a handout on security issues when they are hired, but that is the extent of their training.

The physical protection system adheres to the basic regulatory requirements, but nothing more. The organisation has implemented basic provisions for deterrence, detection, delay and response and for following a defence in depth and graded approach toward security. Source operation, radiation safety and radiation security are all separate departments that rarely communicate with each other. The physical protection system is maintained at a minimal level. The overall effectiveness of the system is never tested or evaluated.

A few managers believe the cybersecurity threat is real, but their view is not shared widely by other managers in the company. The IT staff handles firewalling, patch management and monitoring for business IT systems, but similar activities do not fully occur in the process control domain and for the security system. Management have instituted a few procedures to test the effectiveness of cybersecurity measures, but they are not applied systematically. Operations, security and IT staff have only informal, irregular contact with each other. They have a generic understanding of each other's interests, methods and definitions, but no joint, cross-disciplinary training is conducted. Nor do they know who would be responsible for what should a cyber incident occur. Management know which outside organisations to contact for information about cyber threats and for help should a cyber incident occur, but they have no formal contact with them.

Staff do not believe that a potential threat exists to the organisation's radioactive sources. Nor do they understand that they have security responsibilities. They have received a brief introduction on how to protect sensitive information but do not understand or recognise red flag behaviours. There is a 24-hour hotline, but staff do not use it. Staff have only a vague idea about what to do if an incident occurs or who would be in charge.

The operator and offsite response force (police) have not met each other, and no officers have received any training on either radiation safety or radiation security. Site/target files exist for major radioactive sources, but they are rarely updated.

5

VULNERABLE

Executive management do not believe their facility faces any security threats. They assume that the radiation safety officer/security director is solely responsible for security. Radioactive sources are generally purchased according to regulatory requirements, but no provision has been made for disused sources.

Executive management do not consider security culture to be a risk. The only emphasis in staff training is on safety issues.

The physical protection system generally adheres to the basic regulatory requirements, but sometimes falls short. The organisation has implemented a few elements of deterrence, detection, delay and response, but has not taken a systematic approach for doing so. Source operation, radiation safety and radiation security do not communicate with each other. Maintenance of the physical protection system is minimal.

Senior management do not believe that cyber threats are real or that this is the potential for cyber-attacks. The IT staff handles firewalling, patch management and monitoring for business IT systems, but similar activities do not occur in the process control domain and for the security system. There are no procedures to test the effectiveness of the cybersecurity measures. Operations, security and IT staff have little contact with each other and do not know who would be accountable for what should a cyber-attack take place. Management do not know which outside organisations are responsible for notifying them if a cyber threat were developing or who could help them if a cyberattack should occur.

Staff do not believe that a potential threat exists to the organisation's radioactive sources. Nor do they understand that they have security responsibilities. Furthermore, they have not received any training on how to protect sensitive information, there is no provision for sharing concerns, and they have no idea what to do if an incident occurs or who would be in charge.

The operator and offsite response force (police) have not met each other, and no officers have received any training on either radiation safety or radiation security. Furthermore, there are no site/target folders.

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