

IAEA Safety Standards

for protecting people and the environment

National Strategy for Regaining Control over Orphan Sources and Improving Control over Vulnerable Sources

Specific Safety Guide

No. SSG-19



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The site provides the texts in English of published and draft safety standards. The texts of safety standards issued in Arabic, Chinese, French, Russian and Spanish, the IAEA Safety Glossary and a status report for safety standards under development are also available. For further information, please contact the IAEA at PO Box 100, 1400 Vienna, Austria.

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NATIONAL STRATEGY FOR
REGAINING CONTROL OVER
ORPHAN SOURCES AND
IMPROVING CONTROL OVER
VULNERABLE SOURCES



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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

IAEA SAFETY STANDARDS SERIES No. SSG-19

NATIONAL STRATEGY FOR REGAINING CONTROL OVER ORPHAN SOURCES AND IMPROVING CONTROL OVER VULNERABLE SOURCES

SPECIFIC SAFETY GUIDE

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2011

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FOREWORD

by Yukiya Amano
Director General

The IAEA's Statute authorizes the Agency to “establish or adopt... standards of safety for protection of health and minimization of danger to life and property” — standards that the IAEA must use in its own operations, and which States can apply by means of their regulatory provisions for nuclear and radiation safety. The IAEA does this in consultation with the competent organs of the United Nations and with the specialized agencies concerned. A comprehensive set of high quality standards under regular review is a key element of a stable and sustainable global safety regime, as is the IAEA's assistance in their application.

The IAEA commenced its safety standards programme in 1958. The emphasis placed on quality, fitness for purpose and continuous improvement has led to the widespread use of the IAEA standards throughout the world. The Safety Standards Series now includes unified Fundamental Safety Principles, which represent an international consensus on what must constitute a high level of protection and safety. With the strong support of the Commission on Safety Standards, the IAEA is working to promote the global acceptance and use of its standards.

Standards are only effective if they are properly applied in practice. The IAEA's safety services encompass design, siting and engineering safety, operational safety, radiation safety, safe transport of radioactive material and safe management of radioactive waste, as well as governmental organization, regulatory matters and safety culture in organizations. These safety services assist Member States in the application of the standards and enable valuable experience and insights to be shared.

Regulating safety is a national responsibility, and many States have decided to adopt the IAEA's standards for use in their national regulations. For parties to the various international safety conventions, IAEA standards provide a consistent, reliable means of ensuring the effective fulfilment of obligations under the conventions. The standards are also applied by regulatory bodies and operators around the world to enhance safety in nuclear power generation and in nuclear applications in medicine, industry, agriculture and research.

Safety is not an end in itself but a prerequisite for the purpose of the protection of people in all States and of the environment — now and in the future. The risks associated with ionizing radiation must be assessed and controlled without unduly limiting the contribution of nuclear energy to equitable and sustainable development. Governments, regulatory bodies and operators everywhere must ensure that nuclear material and radiation sources are used beneficially, safely and ethically. The IAEA safety standards are designed to facilitate this, and I encourage all Member States to make use of them.

THE IAEA SAFETY STANDARDS

BACKGROUND

Radioactivity is a natural phenomenon and natural sources of radiation are features of the environment. Radiation and radioactive substances have many beneficial applications, ranging from power generation to uses in medicine, industry and agriculture. The radiation risks to workers and the public and to the environment that may arise from these applications have to be assessed and, if necessary, controlled.

Activities such as the medical uses of radiation, the operation of nuclear installations, the production, transport and use of radioactive material, and the management of radioactive waste must therefore be subject to standards of safety.

Regulating safety is a national responsibility. However, radiation risks may transcend national borders, and international cooperation serves to promote and enhance safety globally by exchanging experience and by improving capabilities to control hazards, to prevent accidents, to respond to emergencies and to mitigate any harmful consequences.

States have an obligation of diligence and duty of care, and are expected to fulfil their national and international undertakings and obligations.

International safety standards provide support for States in meeting their obligations under general principles of international law, such as those relating to environmental protection. International safety standards also promote and assure confidence in safety and facilitate international commerce and trade.

A global nuclear safety regime is in place and is being continuously improved. IAEA safety standards, which support the implementation of binding international instruments and national safety infrastructures, are a cornerstone of this global regime. The IAEA safety standards constitute a useful tool for contracting parties to assess their performance under these international conventions.

THE IAEA SAFETY STANDARDS

The status of the IAEA safety standards derives from the IAEA's Statute, which authorizes the IAEA to establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection

of health and minimization of danger to life and property, and to provide for their application.

With a view to ensuring the protection of people and the environment from harmful effects of ionizing radiation, the IAEA safety standards establish fundamental safety principles, requirements and measures to control the radiation exposure of people and the release of radioactive material to the environment, to restrict the likelihood of events that might lead to a loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation, and to mitigate the consequences of such events if they were to occur. The standards apply to facilities and activities that give rise to radiation risks, including nuclear installations, the use of radiation and radioactive sources, the transport of radioactive material and the management of radioactive waste.

Safety measures and security measures¹ have in common the aim of protecting human life and health and the environment. Safety measures and security measures must be designed and implemented in an integrated manner so that security measures do not compromise safety and safety measures do not compromise security.

The IAEA safety standards reflect an international consensus on what constitutes a high level of safety for protecting people and the environment from harmful effects of ionizing radiation. They are issued in the IAEA Safety Standards Series, which has three categories (see Fig. 1).

Safety Fundamentals

Safety Fundamentals present the fundamental safety objective and principles of protection and safety, and provide the basis for the safety requirements.

Safety Requirements

An integrated and consistent set of Safety Requirements establishes the requirements that must be met to ensure the protection of people and the environment, both now and in the future. The requirements are governed by the objective and principles of the Safety Fundamentals. If the requirements are not met, measures must be taken to reach or restore the required level of safety. The format and style of the requirements facilitate their use for the establishment, in a harmonized manner, of a national regulatory framework. Requirements, including numbered ‘overarching’ requirements, are expressed

¹ See also publications issued in the IAEA Nuclear Security Series.

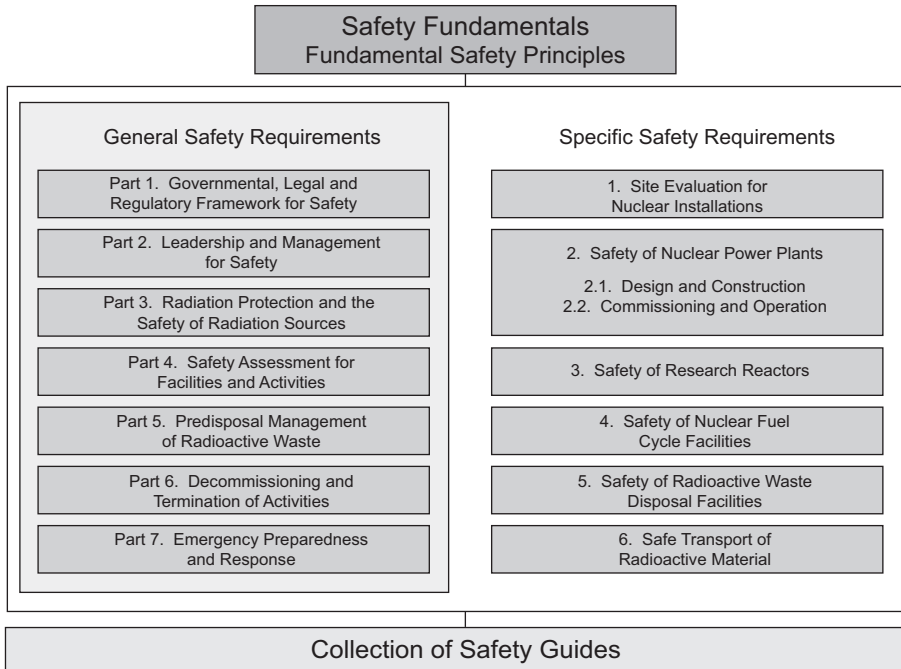


FIG. 1. The long term structure of the IAEA Safety Standards Series.

as ‘shall’ statements. Many requirements are not addressed to a specific party, the implication being that the appropriate parties are responsible for fulfilling them.

Safety Guides

Safety Guides provide recommendations and guidance on how to comply with the safety requirements, indicating an international consensus that it is necessary to take the measures recommended (or equivalent alternative measures). The Safety Guides present international good practices, and increasingly they reflect best practices, to help users striving to achieve high levels of safety. The recommendations provided in Safety Guides are expressed as ‘should’ statements.

APPLICATION OF THE IAEA SAFETY STANDARDS

The principal users of safety standards in IAEA Member States are regulatory bodies and other relevant national authorities. The IAEA safety

standards are also used by co-sponsoring organizations and by many organizations that design, construct and operate nuclear facilities, as well as organizations involved in the use of radiation and radioactive sources.

The IAEA safety standards are applicable, as relevant, throughout the entire lifetime of all facilities and activities — existing and new — utilized for peaceful purposes and to protective actions to reduce existing radiation risks. They can be used by States as a reference for their national regulations in respect of facilities and activities.

The IAEA's Statute makes the safety standards binding on the IAEA in relation to its own operations and also on States in relation to IAEA assisted operations.

The IAEA safety standards also form the basis for the IAEA's safety review services, and they are used by the IAEA in support of competence building, including the development of educational curricula and training courses.

International conventions contain requirements similar to those in the IAEA safety standards and make them binding on contracting parties. The IAEA safety standards, supplemented by international conventions, industry standards and detailed national requirements, establish a consistent basis for protecting people and the environment. There will also be some special aspects of safety that need to be assessed at the national level. For example, many of the IAEA safety standards, in particular those addressing aspects of safety in planning or design, are intended to apply primarily to new facilities and activities. The requirements established in the IAEA safety standards might not be fully met at some existing facilities that were built to earlier standards. The way in which IAEA safety standards are to be applied to such facilities is a decision for individual States.

The scientific considerations underlying the IAEA safety standards provide an objective basis for decisions concerning safety; however, decision makers must also make informed judgements and must determine how best to balance the benefits of an action or an activity against the associated radiation risks and any other detrimental impacts to which it gives rise.

DEVELOPMENT PROCESS FOR THE IAEA SAFETY STANDARDS

The preparation and review of the safety standards involves the IAEA Secretariat and four safety standards committees, for nuclear safety (NUSSC), radiation safety (RASSC), the safety of radioactive waste (WASSC) and the safe transport of radioactive material (TRANSSC), and a Commission on Safety Standards (CSS) which oversees the IAEA safety standards programme (see Fig. 2).

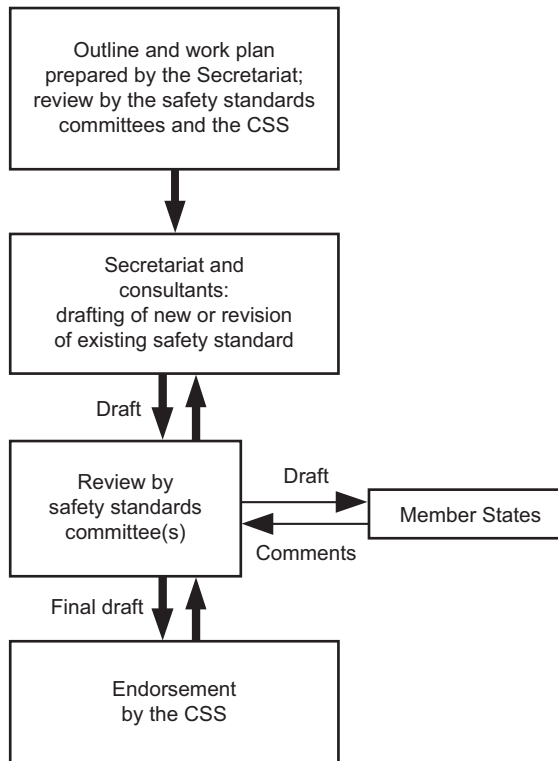


FIG. 2. The process for developing a new safety standard or revising an existing standard.

All IAEA Member States may nominate experts for the safety standards committees and may provide comments on draft standards. The membership of the Commission on Safety Standards is appointed by the Director General and includes senior governmental officials having responsibility for establishing national standards.

A management system has been established for the processes of planning, developing, reviewing, revising and establishing the IAEA safety standards. It articulates the mandate of the IAEA, the vision for the future application of the safety standards, policies and strategies, and corresponding functions and responsibilities.

INTERACTION WITH OTHER INTERNATIONAL ORGANIZATIONS

The findings of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the recommendations of international

expert bodies, notably the International Commission on Radiological Protection (ICRP), are taken into account in developing the IAEA safety standards. Some safety standards are developed in cooperation with other bodies in the United Nations system or other specialized agencies, including the Food and Agriculture Organization of the United Nations, the United Nations Environment Programme, the International Labour Organization, the OECD Nuclear Energy Agency, the Pan American Health Organization and the World Health Organization.

INTERPRETATION OF THE TEXT

Safety related terms are to be understood as defined in the IAEA Safety Glossary (see <http://www-ns.iaea.org/standards/safety-glossary.htm>). Otherwise, words are used with the spellings and meanings assigned to them in the latest edition of The Concise Oxford Dictionary. For Safety Guides, the English version of the text is the authoritative version.

The background and context of each standard in the IAEA Safety Standards Series and its objective, scope and structure are explained in Section 1, Introduction, of each publication.

Material for which there is no appropriate place in the body text (e.g. material that is subsidiary to or separate from the body text, is included in support of statements in the body text, or describes methods of calculation, procedures or limits and conditions) may be presented in appendices or annexes.

An appendix, if included, is considered to form an integral part of the safety standard. Material in an appendix has the same status as the body text, and the IAEA assumes authorship of it. Annexes and footnotes to the main text, if included, are used to provide practical examples or additional information or explanation. Annexes and footnotes are not integral parts of the main text. Annex material published by the IAEA is not necessarily issued under its authorship; material under other authorship may be presented in annexes to the safety standards. Extraneous material presented in annexes is excerpted and adapted as necessary to be generally useful.

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1. INTRODUCTION

BACKGROUND

1.1. Technologies that make use of radioactive sources are used in many practices around the world. Radioactive sources are used in agriculture, industry, medicine, mining, research and education, and they provide many benefits. The safety record of these technologies with regard to the radioactive sources that they employ has generally been good. However, occasionally a lack of appropriate controls, or circumvention of those that exist, has led to sources becoming orphaned or vulnerable — resulting in serious radiological accidents — as well as to harmful environmental, social and economic impacts [1–6].

1.2. An orphan source is a radioactive source which is not under regulatory control, either because it has never been under regulatory control or because it has been abandoned, lost, misplaced, stolen or otherwise transferred without proper authorization. A vulnerable source is a radioactive source for which the control is inadequate to provide assurance of long term safety and security, such that it could be relatively easily be acquired by unauthorized persons [7]. The series of accidents involving such sources initiated international concerns, and the attacks of 11 September 2001 raised further concerns that such sources might be acquired and used for malicious purposes. These concerns have led many States to address issues relating to the control of radioactive sources and the IAEA to initiate a programme of work on the safety and security of radioactive sources. Progress on these efforts can be traced through the proceedings of a series of IAEA international conferences on the subject [8–11].

1.3. The Safety Fundamentals publication, Fundamental Safety Principles [12], establishes the fundamental safety objective and ten fundamental safety principles. The fundamental safety objective, “to protect people and the environment from harmful effects of ionizing radiation”, applies to all

circumstances that give rise to radiation risks¹. Principle 7 states that “People and the environment, present and future, must be protected against radiation risks.” Requirements designed to protect people and the environment from harmful effects of ionizing radiation, and that are relevant to establishing and maintaining control over radioactive sources, are established in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (the BSS) [13] (under revision) and in the Safety Requirements publication Governmental, Legal and Regulatory Framework for Safety [14]. In particular:

- Requirement 9 of Ref. [14] requires States to establish a “system for protective actions to reduce undue radiation risks associated with unregulated sources”. Paragraph 2.25 elaborates on this requirement: “Where unacceptable radiation risks arise as a consequence of an accident, a discontinued practice, or inadequate control over a radioactive source or a natural source, the government shall designate organizations to be responsible for making the necessary arrangements for the protection of workers, the public and the environment. The organization taking the protective action shall have access to the resources necessary to fulfill its function.”
- Paragraph 2.11 of Ref. [13] requires that “The legal person responsible for any sealed source, unsealed source or radiation generator shall, unless the source is exempted, apply to the Regulatory Authority for an authorization which shall take the form of either a registration or a licence.”
- Paragraph 2.34 of Ref. [13] requires, in part, that “Sources shall be kept secure so as to prevent theft or damage and to prevent any unauthorized legal person from carrying out any of the actions specified in the General Obligations for practices of the Standards (see paras 2.7–2.9 of Ref. [13]), by ensuring that:

¹ The term ‘radiation risks’ is used in a general sense to refer to:

- Detrimental health effects of radiation exposure (including the likelihood of such effects occurring).
- Any other safety related risks (including those to ecosystems in the environment) that might arise as a direct consequence of:
 - Exposure to radiation;
 - The presence of radioactive material (including radioactive waste) or its release to the environment;
 - A loss of control over a nuclear reactor core, nuclear chain reaction, radioactive source or any other source of radiation.

“(a) control of a source not be relinquished without compliance with all relevant requirements specified in the registration or licence and without immediate communication to the Regulatory Authority, and when applicable to the relevant Sponsoring Organization, of information regarding any decontrolled, lost, stolen or missing source;

“(b) a source not be transferred unless the receiver possesses a valid authorization”.

- Paragraph 3.10 of Ref. [13] requires that “The relevant Intervening Organizations shall prepare a general plan or plans for co-ordinating and implementing the actions required for supporting protective actions under the emergency plans of registrants and licensees, as well as for other situations that may require prompt intervention. This includes situations involving such sources of exposure as sources illegally brought into the country, falling satellites equipped with sources or radioactive materials released in accidents beyond national borders.”

1.4. The Code of Conduct on the Safety and Security of Radioactive Sources (Code of Conduct) [15], which is a voluntary undertaking intended to help national authorities to ensure that radioactive sources are used within an appropriate framework of radiation safety and security, sets out measures for achieving and maintaining a high level of safety and security of radioactive sources that may pose a significant risk. Basic Principle 7 of Ref. [15] states that “Every State should, in order to protect individuals, society and the environment, take the appropriate measures necessary to ensure: (a) that the radioactive sources within its territory, or under its jurisdiction or control, are safely managed and securely protected during their useful lives and at the end of their useful lives”. Basic Principle 8 of Ref. [15] states that “Every State should have in place an effective national legislative and regulatory system of control over the management and protection of radioactive sources. Such a system should: (b) minimize the likelihood of a loss of control; (c) include national strategies for gaining or regaining control over orphan sources”.

1.5. This Safety Guide provides recommendations on a methodology for establishing a national strategy for regaining such control over orphan sources and for improving control over vulnerable sources. A well developed strategy tailored to the national situation will allow optimum use of resources to ensure that control is first regained over the most dangerous sources. It is assumed that the responsibility for developing and implementing the activities described in this Safety Guide will be assigned by the government to an appropriate body or bodies, such as the regulatory body; technical support organizations; government ministries, agencies or other bodies responsible for specific areas such as health,

environment, industry, metal recycling, mines, and agriculture; regional or local authorities; law enforcement agencies, including customs and border authorities; intelligence organizations; and scientific and research institutes. It is assumed that the assigned body or bodies will coordinate and liaise with other relevant organizations as necessary to ensure proper implementation of the strategy.

1.6. This Safety Guide is complemented by IAEA safety standards and related IAEA publications on regulatory infrastructure, emergency response, security, illicit trafficking and border monitoring, and the management of disused sources [14, 18, 22, 25, 29, 42–44, 48]. While the focus of this Safety Guide is on the development and implementation of a national strategy for remedial action, it is expected that the development of such a strategy will also identify existing weaknesses in national control of sources and will highlight ways to prevent further sources becoming orphaned.

1.7. The terms used in this publication have the meanings ascribed to them in the IAEA Safety Glossary [7], where applicable.

OBJECTIVE

1.8. The objective of this Safety Guide is to provide a methodology for establishing a national strategy for regaining control over orphan sources and improving control over vulnerable sources in order to meet the safety requirements established in the relevant IAEA safety standards [13, 14]. This Safety Guide provides recommendations and guidance on how to assess systematically the national situation, and then how to develop and implement a prioritized national strategy to achieve these goals.

SCOPE

1.9. This Safety Guide describes actions that should be taken by governments and governmental bodies to establish a national strategy for regaining control over orphan sources and improving control over vulnerable sources. It recommends the application of a graded approach in accordance with the category of the source [16].

1.10. Nuclear material, as defined in the Convention on the Physical Protection of Nuclear Material [17], is outside the scope of this Safety Guide, except for the case of radioactive sources incorporating ^{239}Pu . Similarly, radioactive sources

used in military applications are outside of the scope of this Safety Guide. However, radioactive sources formerly used in military applications that may have been abandoned are within the scope.

STRUCTURE

1.11. Each of the three main phases of the methodology for developing a national strategy is dealt with in a separate section. Section 2 provides recommendations on the assessment process. This covers deciding on the scope of the strategy, gathering the necessary information, and determining the nature and magnitude of the problem. Section 3 provides recommendations on development of the strategy, covering identification and prioritization of actions for solutions. Section 4 provides recommendations on implementation of the strategy and includes: obtaining the necessary commitment and resources, implementing the solutions, and then evaluating the impact of the strategy. Appendix I provides an example of the format and content of an action plan for the national strategy; Appendix II provides more information regarding searching for sources. Annex I provides examples from various Member States of the causes of loss of control over radioactive sources, while Annex II outlines some common problems that have been found with control of radioactive sources and solutions.

2. ASSESSMENT OF THE PROBLEM

OVERVIEW

2.1. The following steps should be carried out in the assessment phase of the development of a national strategy for regaining control over orphan sources and improving control over vulnerable sources:

- Deciding on the scope of the strategy;
- Gathering specific information on all aspects of the past and current degree of regulatory control of radioactive sources;
- Identifying problems and potential issues (gap analysis).

These three points are expanded upon in paras 2.2–2.12. This is followed by recommendations on how to gather and evaluate information systematically in each of several key areas.

2.2. The assessment will be iterative as a State's situation changes, and some degree of assessment will be continual. Some decision making will be necessary as part of the assessment, particularly in deciding on the scope of the assessment, in dealing with identified hazards that require urgent action and in modifying the assessment in the light of experience. However, the primary function of the assessment is to collect data on the current situation so that they can be assessed and proposals for improvement can be made.

Deciding on the scope

2.3. The scope of the assessment should be established in order to identify where the subsequent data gathering will be focused. In most cases, the focus should be at least on those sources capable of causing severe deterministic human health effects if not under control. Such sources are in Categories 1, 2 and 3 according to the Safety Guide on Categorization of Radioactive Sources [16], and include aggregations of smaller sources, which may be categorized in accordance with their aggregate activity ratios. However, this is not the only possible choice of focus. The scope of an initial national strategy could be focused on one or more of the following:

- A particular type of source or use of sources (e.g. mobile uses of radioactive sources, including industrial radiography sources; this may be considered appropriate because of the frequency of accidents associated with loss of control of such sources);
- A particular industrial sector where problems have been identified (e.g. scrap metal collection and recycling; this may be considered appropriate because of the frequency of events and the high economic and societal costs associated with unintentionally melting a source);
- A particular geographical region or area (either because of the region's national importance or because in the past fewer resources were devoted to regulatory control in the region);
- A particular aspect of control of radioactive sources such as import or export of radioactive sources;
- Sources in use prior to a national control system being established;
- Industrial sectors that are vulnerable to economic downturn and other market factors, which could lead to a sudden cessation of the use of a particular type of source;
- A sector of use that is critical to the national economy.

In addition, information from national bodies that conduct threat assessments may indicate particular types of radioactive sources that might be vulnerable and requiring attention under a national strategy.

2.4. The scope of the assessment is likely to change with each iteration in the development of a national strategy. While the appropriate focus may be self-evident, in some cases a careful analysis should be performed, perhaps with some preliminary data gathering, in order to determine the appropriate focus. Irrespective of the focus chosen, the delineation of the scope and the underlying reasoning should be recorded appropriately.

2.5. The importance of deciding on an appropriate scope cannot be overstated. An honest evaluation of the available resources should be carried out for both the development and the implementation of the national strategy as this is critical to ensuring that the effort is successful. Some States may be able to devote significant effort to the development of a comprehensive national strategy. However, it is likely that many States will have a limited number of suitably trained staff that can be diverted from their normal activities. Under these circumstances, the resources available should be devoted to producing an initial national strategy that focuses on specific issues and that sets out prioritized actions determined on the basis of past and current conditions. Such States should perform the assessment in an iterative manner, over an extended period, as the national strategy will need to be updated following the completion of existing action items and as a result of changes in conditions. Each assessment should build upon the work performed in previous assessments.

2.6. Once the scope of the assessment has been delineated, a programme of work should be drawn up with clear responsibilities and timescales for tasks.

Gathering specific national information

2.7. As part of the assessment, data should be gathered on sources, both those known to be present in the State and those potentially present in the State. The risk from orphan sources or vulnerable sources cannot be characterized unless information is available on what sources are likely to exist within the State. Characterization of the risk associated with orphan sources should involve an evaluation of both the potential for orphan sources to exist and the potential consequences that such sources may cause. The assessment process should also address whether vulnerable sources, although currently under control, might become orphaned in the future, and whether orphan sources might be introduced into the State from another State.

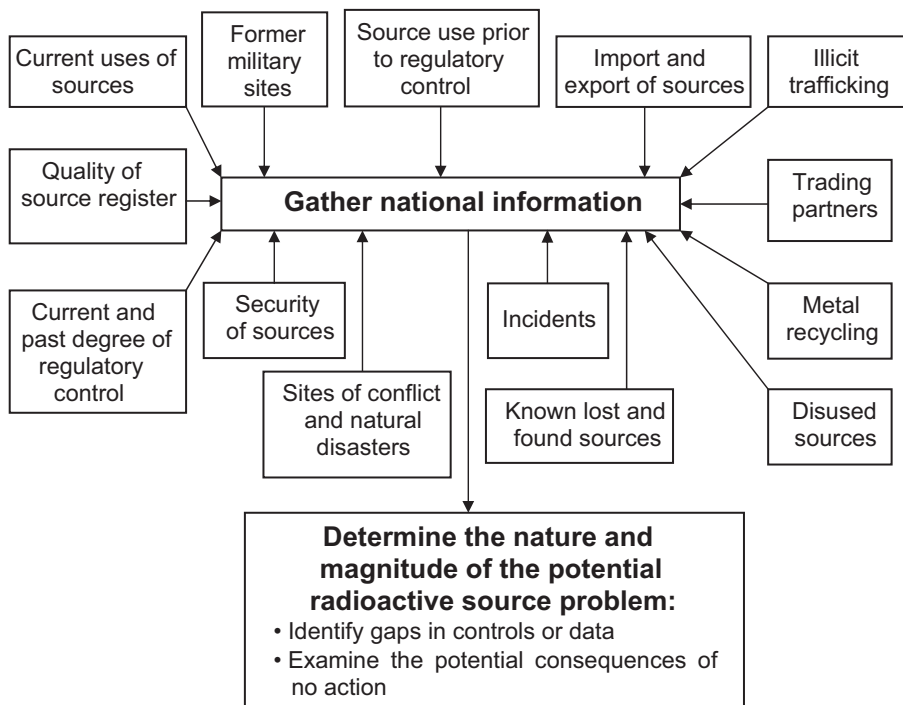


FIG. 1. Assessing the problem.

2.8. Three major aspects of gathering information should be addressed, as follows:

- *What* information is necessary?
- From *where* can this information be obtained?
- *How* can it be gathered?

The primary purpose of Section 2 of this Safety Guide is to provide recommendations on *what* information is necessary. Appendix II provides guidance on the possible sources of information (the *where*) and the methods (the *how*) in the larger context of searching for sources.

Figure 1 illustrates the important data inputs to the information gathering and evaluation phase, each of which is addressed in sequence in Section 2 of this Safety Guide.

Identifying problems and potential issues

2.9. Problems and potential issues should be identified while the data gathering is taking place. As questions are asked and answered, it will become clear where there are gaps in information or where there are problems.

2.10. An evaluation of the nature and magnitude of problems associated with control of radioactive sources should be made by comparing the actual situation with the ideal situation. The ideal situation can be characterized as complete and thorough conformance with relevant national laws and regulations as well as international standards and guidance [12–14, 18–25]. The Code of Conduct on the Safety and Security of Radioactive Sources [15] as well as its supplemental Guidance on the Import and Export of Radioactive Sources [26] are particularly useful in this regard because they provide basic principles and guidelines that are specific to radioactive sources.

2.11. As part of the evaluation process, it should be determined whether deviations from standards that are identified require immediate action. The criteria for this determination should be set on the basis of the potential consequences of the problem. This will primarily depend upon the category of source involved. For example, the loss of a particular Category 1, 2 or 3 source in a city would require immediate action. On the other hand, failure to include on the national register all the fixed gauges present in a particular industrial plant would be something that needs to be remedied; however, because it would be unlikely to lead to an immediate hazardous situation it would have a lower priority.

2.12. The individuals who are assigned to develop a national strategy should know how radioactive source control within a State is required to be handled and they should be sufficiently experienced to prioritize the discrepancies and problems found. If such experts are not available within a State, a peer review mission should be requested in order to obtain assistance.

CURRENT AND PAST DEGREE OF REGULATORY CONTROL

2.13. The assessment of the national situation should begin with a review of the current and past degree of regulatory control over radioactive sources. Reference [14] establishes requirements in respect of an effective regulatory infrastructure, which includes: legislation and regulation; a regulatory body empowered to authorize and inspect regulated activities and to enforce the

legislation and regulations; and sufficient resources and adequate numbers of trained persons. Further requirements on regulatory infrastructure are established in Ref. [13] and guidance is provided in the Code of Conduct [15].

2.14. When analysing the regulatory infrastructure, the focus should be placed on those elements of the regulatory infrastructure that have a direct influence on the probability of loss of control of sources, particularly those in the higher risk categories. A partial list of such elements includes the licensing, inspection, import, export, possession, use and disposal of sources.

2.15. Radioactive sources will have been in use in many States prior to the development of the current regulatory infrastructure. In addition, regulatory infrastructures often change. Thus, the probability of loss of control of a source depends not only upon its historical use, but also upon the status of the regulatory infrastructure in the past.

2.16. The quality of authorizations and inventories in place, and the frequency and quality of inspections in the past should be examined since these will indicate the level of confidence that can be placed in the regulatory control over sources at that time.

2.17. A review of regulatory control in the past may be difficult because of a lack of contemporary documentation and difficulties in finding individuals who can assist in describing former procedures and priorities. The historical review should attempt to discover what was known of source inventories and uses at the time, but this information may be difficult to establish. This historical review should be used to highlight actual and probable losses of control of sources and the possible causes. The review of the current infrastructure will generate a sense of the level of confidence in the safety and security of existing sources and may highlight areas that require further attention and modification.

2.18. Typical problems or issues relating to deficiencies in control are the following:

- A lack of appropriate laws and regulations governing control of radioactive sources;
- A lack of effective independence of the regulatory body in the conduct of its activities;
- A regulatory body with insufficient resources and inadequate numbers of trained persons;

- An inadequate process for authorization, licensing or registration of radioactive sources;
- A non-existent, incomplete or poorly maintained national register of sources (see paras 2.19–2.24);
- No specific authorization or licensing of government owned radioactive sources;
- Inadequate inspection, enforcement and follow-up;
- A lack of sanctions and deterrence measures;
- A licensing fee structure that encourages undesired behaviour on the part of users, for example, imposing high licensing fees on users who simply possess a disused source may result in individuals not requesting authorizations for such sources;
- Prioritization of resources on the basis of geographical regions, political regions or use, rather than on categories of sources.

QUALITY OF THE SOURCE REGISTER

2.19. The existence of a national register of radioactive sources and its quality should be carefully examined, since this will be a prime indicator of whether problems involving orphan or vulnerable sources may be expected. If a source register does not exist or appears incomplete, its establishment and completion should be given a high priority in the national strategy that is subsequently developed. The following sources of information should be searched to assist in the creation or completion of a source register:

- Inventory records of sources maintained by users or others who may be storing sources;
- Records of source manufacturers, distributors and service providers;
- Records of transport or shipping companies, including customs declarations;
- Inspection reports from any authority that may have inspected a particular facility for any reason;
- Event reports and notifications;
- Licensing records, including notifications and original requests for authorization.

2.20. Aside from finding information contained in existing records, there are other methods of collecting data for a source register. Several of these are discussed in detail in Appendix II.

2.21. Even if a national source register exists, it may well be incomplete, which may imply the presence of orphan sources in the State. Therefore, an existing source register should be critically examined to verify its quality, reasonableness and internal consistency. Questions to be considered in this evaluation should include:

- Are all the types of sources used in all the likely or known industrial and medical activities within the State reflected in the register?
- Are the radionuclides and activities identified appropriate for the application of the source? (Table 2 of Appendix I in Ref. [16], which provides the typical range of activities used in various applications, may prove helpful in this review.)
- Are all likely companies or users of a particular practice included in the register?

2.22. In developing a national source register, or in evaluating the completeness or accuracy of a register, priority should be given to ensuring that dangerous sources (Category 1, 2, and 3 sources) are brought under control, although it is recognized that resources are often limited. Sources in lower categories should be dealt with after higher activity sources have been brought under control. However, where data on lower category sources are available or found, they should be recorded in the source register at the same time as data on any dangerous sources. The Code of Conduct [15] also provides guidance in this respect: “Every State should establish a national register of radioactive sources. This register should, as a minimum, include Category 1 and 2 radioactive sources as described in Annex 1 to this Code” (Basic Principle 11).

2.23. For each source in the register, the following information, as a minimum, should be recorded:

- The operating organization authorized to possess the source and associated device, including contact information;
- The authorized use of the source and associated device;
- The unique identification of the source (manufacturer, model number, serial number, and date of manufacture);
- The unique identification of the associated device (manufacturer, model number and serial number);
- The location of the source and/or associated device (installed location or location of authorized use);
- The radionuclide, the source activity and the date on which the activity was measured;

- The category of the source;
- The form of the radioactive material (physical and chemical), including its special form status (see Ref. [19]);
- A record of where the source was received from or transferred to;
- The date the source and/or associated device was entered into the register;
- The planned disposition of the source, including, as applicable, the planned date of its return to its supplier or its transfer to a waste facility.

2.24. A register of radioactive sources should be generated and maintained using database software, rather than spreadsheet or word processing programmes, to enable searching and sorting of data and the generation of reports. There are a number of commercially available programs for maintaining inventories of radioactive material (registers); the Regulatory Authority Information System (RAIS) developed by the IAEA [27], which includes a module for developing and maintaining a source register, may also be used.

CURRENT USES OF SOURCES

2.25. Detailed information should be gathered on the current uses of radioactive sources in the State and the organizations using them. This is fundamental to developing and maintaining a national source register and to identifying possible orphan sources or vulnerable sources.

2.26. The basic process of gathering data on sources based upon their use consists of the following steps:

- Becoming knowledgeable about the various types of source applications commonly in existence (Table 2 of Appendix I in Ref. [16] provides examples of practices using radioactive sources);
- Determining which of these applications or industries are likely to be in use within the State;
- Determining which of them are within the scope of the assessment (as decided in accordance with the recommendations provided in paras 2.3–2.6);
- Gathering user data that are easily obtainable (i.e. conducting an administrative search, as described in detail in Appendix II).

2.27. Such a search will help to establish whether orphan sources exist or whether there is some likelihood that they may exist. The results of such a search may also

indicate that more intensive administrative searches and/or physical searches are warranted.

2.28. Such an administrative search for the purposes of data gathering can be conducted with the help of the information provided in Annex I. In Annex I, typical applications or practices are presented by category of the sources used, starting with practices using Category 1 sources. The industries of interest on which to concentrate the data gathering efforts are also given, along with considerations regarding loss of control that should be taken into account when reviewing each practice using radioactive sources.

2.29. In some cases, such as for irradiation facilities, those performing the assessment will be able to conclude, with a high level of confidence, that orphan sources either do or do not exist. In many other cases, those performing the assessment will determine that sources may be in use, or may have been used, but they will be unable to reach definitive conclusions without further detailed searches. On very rare occasions, the potential risk uncovered by the assessment may justify the immediate initiation of source specific search activities. In general, however, the data gathering stage of the assessment should go into only enough detail to determine whether there is the potential for orphan sources of a certain type to exist. If it is determined that orphan sources of a given type may exist, a further, more detailed investigation should be incorporated as part of the national strategy action plan.

FORMER MILITARY SITES

2.30. While military uses of radioactive sources are specifically excluded from the scope of the Code of Conduct [15] and of this Safety Guide, sources within this sector can become and have become orphan sources, often by being abandoned. Therefore, former military sites should be assessed by means of physical and administrative searches (see Appendix II) to ensure that there are no sources that have been lost or abandoned in these areas. This task will be made easier if information can be obtained from the relevant military authorities regarding what sources have been used, where they were used, and their final disposition.

SOURCES IN USE PRIOR TO THE APPLICATION OF REGULATORY CONTROL

2.31. An assessment should be performed to determine what sources were in use before adequate regulatory control was applied within the State, and whether any of these sources are still not under regulatory control.

2.32. In many States, sources may have been used prior to the establishment of effective regulatory requirements and may not have been disposed of appropriately. Therefore, information should be gathered about the ‘early days’ of radioactive material use as soon as possible, while individuals who were present at the time are still alive. What is regarded as the early days will vary significantly for different States and could range from before the 1920s to the 1990s. Although human memory is very fallible, useful information about the historical situation and the potential for orphan sources to exist can still be obtained from individuals who were the first to work in the various fields of application of radioactive sources (‘pioneers’).

2.33. The earliest uses of radioactive material within more developed States will typically involve radium, particularly in medical and research applications. For developing States, the earliest uses are more likely to be in the medical field, and particularly in cancer therapy using ^{60}Co or ^{137}Cs . In any case, universities and other research centres and institutes are likely to represent some of the earliest users of radioactive sources. Therefore, these are good places to begin enquiries as to the use of sources prior to the application of regulatory control. Once pioneers in the early use of radioactive sources are identified, they should be interviewed regarding:

- The type and number of sources they used, and their typical activities;
- How the sources were obtained and from whom;
- What the sources were used for;
- Details about any incidents involving the sources;
- Where the sources were stored;
- How the sources were disposed of;
- Who their co-workers and/or students were;
- What legislation, regulations or rules were in place and when such rules were established.

2.34. The list in para. 2.33 is not exhaustive, but it provides an indication of the types of questions that might be of use in evaluating the potential for orphan sources to exist. Information provided in the course of such interviews should be

verified by other sources of information wherever possible, but indications of the possible existence of orphan sources in higher categories should be investigated further as part of the development of the national strategy.

2.35. Other individuals who are likely to have relevant information are those who were involved in developing and enforcing regulations. Here it is recognized that regulatory control and its application will have evolved over time. One possible source of information that may lead to the discovery of orphan sources where control was lost in the distant past is records from repositories of radioactive waste. If available, such records should be reviewed for information about the original owners of sources or organizations from which the sources came. Such information should be used to develop further information about current possession of radioactive sources and may indicate the existence of orphan sources.

IMPORT AND EXPORT OF SOURCES

2.36. National practice in the import and export of radioactive sources should be assessed. Experience has shown that failure to control effectively the import and export of radioactive sources can be a major contributor to sources becoming orphaned. Most States import a range of radioactive sources or devices containing them, but only a limited number of States export new radioactive sources or devices.

2.37. Many States have made a political commitment to the Code of Conduct on the Safety and Security of Radioactive Sources [15] and its supplemental Guidance on the Import and Export of Radioactive Sources [26]. Irrespective of whether a political commitment has been made, all States should strive to meet the principles of the Code and to implement the Guidance. However, it is recognized that it will take time for most States to become fully compliant. Therefore, a review of the current and past status of import and export practices should be conducted as an important part of the assessment of the national situation. In particular, large, multinational companies that import sources for temporary use for non-destructive testing or well logging should be questioned, as in the past problems have arisen concerning lack of notification to national authorities of the import of such sources.

2.38. Gathering information on the export of new radioactive sources or devices will generally be relatively easy. There are only a few States that are major exporters of sources. If there is no capability for manufacture of radioactive

sources in the State, it is likely that the only export of sources will be the re-export of sources that had been imported for temporary use within the State or of disused sources to the supplier or State of origin.

2.39. To determine the situation with regard to the import of radioactive sources, data should first be gathered from customs authorities and from known users of radioactive sources. Manufacturers and suppliers of sources are also likely to have information about sources that they have distributed. Although many States have established regulatory requirements for the pre-authorization and licensing of imports, these requirements are sometimes not met or enforced.

2.40. In the past, radioactive sources have become orphaned in customs warehouses. For this reason customs procedures for imports should be examined carefully. Radioactive sources might remain unclaimed from customs for a variety of reasons, including:

- Non-conformity with the customs import manifests;
- Suspected illicit trafficking of radioactive material;
- Inability to contact the recipient;
- Abandonment of the source because of reasons such as cessation of business, bankruptcy, or because the source has decayed to the point where it has no commercial value;
- Lack of desire or ability on the part of the recipient to pay any import duty owed;
- Lack of desire or ability on the part of the recipient to pay for management and disposal of a disused source.

2.41. Reference [19] establishes international requirements for the labelling of packages containing radioactive material. If a package label does not identify clearly that a package contains radioactive material, it is possible that unclaimed sources may enter the public domain through auctions later conducted by customs authorities.

ILLICIT TRAFFICKING

2.42. The occurrence of incidents of illicit trafficking of radioactive material and other events such as seizures of radioactive material being trafficked, the theft or loss of sources, the unauthorized movement or disposal of sources, or recoveries of radioactive sources is symptomatic of weaknesses and vulnerabilities in regulatory control and in security systems. The collection and assessment of

information about such events can provide valuable indications of which sources may be at risk of becoming orphaned, where such sources may be located and which sources or facilities are not under regulatory control, and may also indicate generic problems in the legislative and regulatory framework. Information should also be gathered on illicit trafficking and other unauthorized acts in neighbouring States and further afield.

2.43. The IAEA's Illicit Trafficking Database (ITDB) is an information system for the collection and dissemination of information on incidents of illicit trafficking and other events such as thefts and losses of radioactive material, unauthorized movement and disposal of material, and recoveries of radioactive material [28]. The ITDB is unique in that information on incidents falling within its scope is provided by the States themselves. Information on such events is also collected from open sources, and verification, or otherwise, is sought from the States involved. Each State participating in the ITDB programme appoints a national point of contact, who has access to the information in the ITDB and will therefore be a useful resource in the assessment phase. Participation in the ITDB programme is voluntary, but States that are not members should consider joining as part of their national strategy for regaining control over orphan sources and improving control over vulnerable sources.

2.44. An important factor that may be identified from detailed data stored in the ITDB is that most of the significant recoveries of nuclear material have resulted from the gathering and analysis of intelligence information. This indicates the importance of involving law enforcement agencies, customs authorities and intelligence agencies in efforts relating to the gathering of information on radioactive sources. International and national law enforcement agencies, customs authorities and intelligence agencies should be consulted in the assessment phase, because they may be able to provide relevant, current information based on information gathered from intelligence sources within the State and from wider networks.

2.45. The following information should be taken into consideration or gathered, as part of the preparation for development of a national strategy:

- The number and nature of neighbouring States, as well as the political relationship with them;
- The quality of the regulatory control of radioactive sources in neighbouring States;

- The nature of borders with neighbouring States; i.e. are the borders open or is access to neighbouring States restricted by natural barriers or because of the political situation?
- The number and type of the various ports of entry and exit via land, air or water;
- Radiation detection capabilities at national borders and other relevant locations;
- Estimates of the ease of installation of additional border monitoring equipment;
- Records of illicit trafficking events uncovered via law enforcement or intelligence operations, or existing border monitoring.

2.46. Cooperation should be established between the regulatory body, law enforcement agencies, intelligence organizations, customs authorities, border guards and other authorities at ports of entry to the State. Effective communication and mutual assistance are necessary between such organizations in each of their respective areas of expertise in order to properly assess the extent of illicit trafficking within their State.

2.47. Typical problems that may arise in the collection and assessment of information on the illicit trafficking of radioactive sources are given in the following:

- There has been no communication between the various relevant organizations in relation to a harmonized approach to combating illicit trafficking in the State;
- Information concerning illicit trafficking events has not been provided to or by relevant law enforcement agencies;
- No assessment has been made as to whether or not illicit trafficking is a problem in the State;
- There is evidence of a significant amount of illicit trafficking in the State;
- Personnel who may come into contact with illicitly trafficked radioactive material have not been provided with training in the detection and identification of radioactive material and/or are not in possession of appropriate radiation detectors;
- There is no cooperation or agreements between the various organizations that provide technical support to customs and border authorities or law enforcement agencies;
- There is a lack of border monitoring, even in situations where it would be clearly justified;

- Existing border monitoring equipment is non-operational, inefficient or inadequate.

TRADING PARTNERS

2.48. The potential for imported materials to contain orphan sources should be assessed. If radioactive sources are lost from regulatory control, there is the possibility that the sources themselves may become mixed with other commodities, or that such commodities may become contaminated. Contaminated commodities usually present a much lesser health risk than orphan sources themselves. However, the existence of contaminated commodities can be an important indicator of a lack of regulatory control.

2.49. Few, if any, States have the resources to sample or monitor effectively all goods entering or leaving the State. Therefore, decisions should be made during the development phase of the national strategy to focus resources on the streams of commodities that are most likely to contain sources or to be contaminated and to monitor for those items that may pose the most significant risk. Usually, resources should be focused on imports for the metal recycling industry, as in the past events have occurred in this sector. The flow of these goods (and others that may be identified as being of interest) should be assessed to determine whether the trade is restricted to a limited number of ports, in order to limit the locations where monitoring programmes may need to be considered. Decisions on establishing arrangements for monitoring are complex; however, guidance is provided in Appendix II and Ref. [29].

2.50. In developing a national strategy, the potential for the presence of radionuclides of natural origin in imports should be assessed since these will represent some of the most common radionuclides detected by border monitoring systems. Materials containing radionuclides of natural origin may come from the industries processing minerals such as: bastnaesite, bauxite, fluorspar, ilmenite, monazite, phosphate, pyrochlore, zircon sands, oil and natural gas. Concentrations can vary widely, depending upon the origin of the material and the degree of processing. The use of materials containing radionuclides of natural origin may pose a chronic hazard that should be addressed within the regulatory framework, but does not normally pose an acute hazard.