IAEA TECDOC SERIES

IAEA-TECDOC-2016

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The International Working Forum on the Regulatory Supervision of Legacy Sites

A Summary of Activities and Outcomes

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THE INTERNATIONAL WORKING FORUM ON THE REGULATORY SUPERVISION OF LEGACY SITES

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IAEA-TECDOC-2016

THE INTERNATIONAL WORKING FORUM ON THE REGULATORY SUPERVISION OF LEGACY SITES

A SUMMARY OF ACTIVITIES AND OUTCOMES

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2022

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For further information on this publication, please contact:

Waste and Environmental Safety Section
International Atomic Energy Agency
Vienna International Centre
PO Box 100
1400 Vienna, Austria
Email: Official.Mail@iaea.org

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FOREWORD

Over the past several decades much has been accomplished through international cooperation in enhancing regulatory supervision of nuclear power plants and other nuclear fuel cycle facilities. However in the past legacy sites did not receive the same attention. Recognizing this gap, in 2010 the IAEA launched the International Working Forum on Regulatory Supervision of Legacy Sites to bring attention to legacy sites, share information about such sites among participating Member States and promote the application of the IAEA safety standards and good international practices.

During the first decade of its activities, the International Working Forum was successful in achieving its objectives. Representatives of 45 Member States have participated in seven technical meetings and six workshops where information about the management and remediation of legacy sites was discussed and exchanged. Scientific visits were organized to 24 legacy sites, either remediated or undergoing remediation, in five Member States.

This publication captures the activities and outcomes from the first decade of the International Working Forum on the Regulatory Supervision of Legacy Sites. It contributes to a better understanding of the legacy site concept by identifying their common characteristics, even though there is no single definition. The publication presents different regulatory frameworks and processes used to exercise regulatory control and supervision of uranium and other legacy sites, and the use of safety and environmental impact assessments as tools to guide remediation decisions. It also describes successful practices for managing current sites and preventing future legacy sites, and the general skills necessary for regulators to address legacy issues in their countries.

The major outcome of the International Working Forum is the continuous participation of experts from different Member States, including regulators, operators and other professionals who have contributed by sharing their knowledge and experiences and by supporting a unique professional community.

The International Working Forum has proved to be a relevant forum for Member States. It also serves as a robust and independent network for international cooperation between regulators and operators, providing valuable contributions for the effective and efficient regulatory supervision for the management of legacy sites, which is consistent with IAEA safety standards and good international practices.

The IAEA appreciates the contributions from all Member States in the International Working Forum and the experts involved in drafting and reviewing of this publication. The IAEA is grateful to M. Sneve of the Norwegian Radiation and Nuclear Safety Authority, who initiated and served as the first Chair of the International Working Forum. The IAEA is grateful for the financial support provided by Norway and the United States of America.

The IAEA officers responsible for the publication were R. Edge, R. Stenson, M. Roberts and E. Carvalho of the Division of Radiation, Transport and Waste Safety.

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1. INTRODUCTION

1.1. BACKGROUND

In 2010, the International Atomic Energy Agency (IAEA) established the International Working Forum on Regulatory Supervision of Legacy Sites (hereinafter referred to as the RSLS) to promote effective and efficient regulatory supervision of the management of legacy sites, consistent with the IAEA safety standards and good international practices. The main objectives of the RSLS are facilitating collection and exchange of information on radioactively contaminated legacy sites, building mutual support and professional networks through discussing effective and efficient implementation of regulatory supervision, as well as organizing visits to legacy sites.

1.2. OBJECTIVE

The purpose of this publication is to capture the activities of the first decade of the RSLS, and to provide regulators and operators with practical information from Member States regarding the regulatory frameworks and processes utilized to exercise regulatory control and supervision over uranium and other legacy sites. This publication addresses the regulatory framework and the use of safety and environmental impact assessments as tools for supporting decision making related to remediation. It also describes successful practices for managing current sites and preventing future legacy sites, and the general skills necessary for regulators of legacy sites.

1.3. SCOPE

This publication contains a summary of information gathered and discussed during the first decade (2010–2020) of the RSLS, as well as several supporting Annexes. Although there are many different types of legacy sites, during this period, while also discussing legacy sites in general, the RSLS has focused primarily on uranium legacy sites, principally mines and mills, as most of the Member States that have participated in the RSLS have these types of sites.

This publication provides key lessons on successful regulatory practices of Member States in the establishment of an efficient national regulatory framework, establishment of clearly defined remediation criteria, requirements necessary to ensure safe remediation, and the importance of and key strategies for engaging interested parties.

1.4. STRUCTURE

Following the introduction, Section 2 presents the International Working Forum on Regulatory Supervision of Legacy Sites.

Section 3 describes issues that are applicable to legacy sites including the various definitions of legacy sites in Member States. This Section further describes the common causes and characteristics of legacy sites.

Section 4 describes regulatory processes associated with legacy sites, where laws and regulations are discussed, then focuses on safety and environmental impact assessments, and on the professional development of the regulators.

Section 5 summarizes what the RSLS considers to be specific issues for managing uranium legacy sites.

Section 6 summarizes the key lessons from the first phase of the RSLS, including the successful practices for managing existing legacy sites and the prevention of future legacy sites.

Section 7 includes main conclusions and findings from the first decade of the RSLS and potential options for the future of the RSLS.

This publication includes four Annexes that provide more detailed information on the activities and outcomes of the RSLS. Annex I contains a general questionnaire that was sent to the Member States participating in the RSLS. Annex II, Annex III and Annex IV provide information on the activities of the RSLS Working Groups 1, 2 and 3, respectively.

2. THE INTERNATIONAL WORKING FORUM ON REGULATORY SUPERVISION OF LEGACY SITES

2.1. INTRODUCTION TO THE RSLS

The Agency has been implementing several actions associated with legacy sites. Among these was the creation of the RSLS in 2010 to provide a forum for the exchange of information related to the regulation of legacy sites. Through resolution GC(54)/RES/7[1], the IAEA General Conference of 2009 endorsed the creation of the RSLS and encouraged Member States' participation.

Rather than limiting discussion by a narrow, facility specific definition of a legacy site, the RSLS chose to focus on the common characteristics of all legacy sites. These are discussed later in this publication. These include radiological contamination, unclear ownership, inadequate standards, or a lack of regulatory oversight at some point, and insufficient funding for remediation.

In the context of the RSLS, regulatory supervision refers to the full scope of activities that regulatory authorities would be engaged in for legacy sites (e.g. developing legacy site policies, regulations, licensing, inspection, implementation procedures such as review procedures, guidance, review and assessment of legacy site management and remediation practices, plans, procedures and engagement of interested parties).

Managing and remediating legacy sites creates special challenges. In accordance with IAEA Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards [1], legacy sites are considered as an existing exposure situation which is "a situation of exposure that already exists when a decision on the need for control needs to be taken"[2] [2], thus evaluating and managing the site based on the current site conditions and the current radiological reference levels. Legacy sites require the management of existing hazards which may be exposing humans to uncontrolled physical risks, toxic chemical and/or radiological materials. It is common that environmental degradation is found at these sites. Regulatory, technical, societal and financial challenges can be significant when trying to bring these sites into a safe condition.

Regulation of legacy sites is a complex process to ensure the protection of environment and human health, radiation safety and security, through management of solid wastes, liquid effluents and adequate management of other hazards, such as chemotoxic materials and physical hazards like aging infrastructure and degraded structural integrity. Typically, legacy sites are the result of a loss of

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[1] Available at https://www.iaea.org/sites/default/files/gc/gc54res-7_en.pdf.

[2] The term 'Existing exposure situation' is defined in the IAEA Safety Glossary (2018 Edition) [2] as:
"A situation of exposure that already exists when a decision on the need for control needs to be taken.
- Existing exposure situations include exposure to natural background radiation that is amenable to control; exposure due to residual radioactive material that derives from past practices that were never subject to regulatory control; and exposure due to residual radioactive material deriving from a nuclear or radiological emergency after an emergency has been declared to be ended.
- See para. 5.1 and Requirement 52 of GSR Part 3."

Para. 5.1 of GSR Part 3 states that the requirements for existing exposure situations apply to:
(a) "Exposure due to contamination of areas by residual radioactive material deriving from:
  (i) Past activities that were never subject to regulatory control or that were subject to regulatory control but not in accordance with the requirements of these Standards;
  (ii) A nuclear or radiological emergency, after an emergency has been declared to be ended (as required in para. 4.20)
(b) Exposure due to commodities, including food, feed, drinking water and construction materials, that incorporate radionuclides deriving from residual radioactive material as stated in para. 5.1(a).
(c) Exposure due to natural sources (…)".

control over radioactive material on the site at some point during their history, or because past activities were such that the site was operated with inadequate controls and/or no requirements or funds to remediate the site after cessation of operations. Remediation entails "any measures that may be carried out to reduce the radiation exposure due to existing contamination of land areas through actions applied to the contamination itself (the source) or to the exposure pathways to humans" [2][3].

2.2. OBJECTIVES AND SCOPE OF THE RSLS

The overall objective of the RSLS is to promote effective and efficient regulatory supervision for the management of legacy sites, consistent with the IAEA safety standards and good international practices, according to the Terms of Reference of the RSLS[4]. This is being achieved through the collection, collation and exchange of information on legacy sites and the identification of best practices in managing and preventing legacy sites. It is also being achieved through the generation of mutual support through presentations and discussions by Member States on how effective and efficient regulatory supervision can be implemented and maintained.

While there are many different types of legacy sites, the RSLS made a conscious decision to initially focus on the legacy sites at the front end of the nuclear fuel cycle, i.e. those associated with uranium mining and milling (processing). Regardless, many of the observations from the first phase of the RSLS remain applicable to all types of legacy sites, including those associated with nuclear fuel and nuclear weapons test sites or associated with industrial activities with naturally occurring radioactive material (NORM).

2.3. ACTIVITIES AND PARTICIPATION IN THE RSLS

The activities of the first phase of the RSLS included technical meetings, workshops, scientific visits and the work carried out by three Working Groups (WGs). The three WGs addressed enhancing the regulatory framework, safety and environmental impact assessments, and professional development for regulatory bodies.

The Agency provided a Secretariat which was responsible for project planning and coordination of activities, including organizing annual technical meetings. The RSLS project was directed by a Coordinating Group, which consisted of the RSLS chairperson, WG leaders and the Agency Secretariat. The Coordinating Group was responsible for planning technical meetings and coordinating WG activities.

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[3] The term 'Remediation' is defined in the IAEA Safety Glossary (2018 Edition) [2] as:
"Any measures that may be carried out to reduce the radiation exposure due to existing contamination of land areas through actions applied to the contamination itself (the source) or to the exposure pathways to humans.

- Complete removal of the contamination is not implied.
- The use of the terms clean-up, rehabilitation and restoration as synonyms for remediation is discouraged. Such terms may be taken to imply that the conditions that prevailed before the contamination can be achieved again and unconditional use of the land areas can be restored, which is not usually the case (e.g. owing to the effects of the remedial action itself). Often remediation is used to restore land areas to conditions suitable for limited use under institutional control.
- In some contexts (e.g. the wider chemical industry), the terms remediation and restoration are used to describe different parts of overall recovery.
- The term cleanup is used in the context of decommissioning."

[4] The Terms of Reference of the International Working Forum on Regulatory Supervision of Legacy Sites, approved on 15 October 2010 and revised on 17 February 2017, are available in the RSLS Members' Area on the IAEA CONNECT website (https://nucleus.iaea.org/sites/connect/RSLSpublic).

Participation in the RSLS is open to all IAEA Member States. During the first decade of RSLS, experts from 45 Member States participated in the events, as listed in Table 1.

TABLE 1. PARTICIPATING MEMBER STATES BETWEEN 2010 AND 2020

Algeria	Canada	Kazakhstan	Norway	Thailand
Argentina	China	Kyrgyz Republic	Pakistan	Turkey
Australia	Estonia	Malawi	Portugal	Ukraine
Azerbaijan	France	Malaysia	Romania	United Kingdom
Belarus	Germany	Mongolia	Russian Federation	United States of America
Belgium	Hungary	Mozambique	Serbia	Uzbekistan
Brazil	Indonesia	Namibia	South Africa	Viet Nam
Bulgaria	Iran, Islamic Republic of	Niger	Spain	Yemen
Cambodia	Japan	Nigeria	Tajikistan	Zambia

2.3.1. Technical meetings

During the first decade of RSLS, seven technical meetings were held at IAEA Headquarters, Vienna, Austria, as shown in Table 2. The respective meeting reports, agendas, lists of participants and presentations are available in the RSLS Members' Area on the IAEA CONNECT website[5].

TABLE 2. RSLS TECHNICAL MEETINGS

Dates	**Event title**
11–15 October 2010	Technical Meeting on International Forum for Regulatory Supervision of Legacy Sites
17–21 October 2011	Technical Meeting for the International Working Forum on Regulatory Supervision of Legacy Sites
8–12 October 2012	Technical Meeting of International Working Forum on Regulatory Supervision of Legacy Sites (RSLS)
22–24 October 2014	International Working Forum on Regulatory Supervision of Legacy Sites Technical Meeting
9–13 February 2015	International Technical Meeting on Regulatory Control of Nuclear Legacy Sites and Waste Management
28 November – 2 December 2016	Annual Meeting of the International Forum for Regulatory Supervision of Legacy Sites
19–23 November 2018	Technical Meeting of the International Working Forum on Regulatory Supervision of Legacy Sites

[5] Available at https://nucleus.iaea.org/sites/connect/RSLSpublic.

In addition to the technical meetings, an RSLS side event was held as a component of the IAEA General Conference on 20 September 2011 to raise awareness of the RSLS with Member States.

The 2018 technical meeting also included a scientific visit to the IAEA laboratories located at Seibersdorf, Austria.

2.3.2. Workshops and scientific visits

Six workshops were held during the first decade of the RSLS, as shown in Table 3, to provide participants with greater detail in specific aspects of the regulation and management of legacy sites that included scientific visits to 24 legacy sites. The respective meeting reports, agendas, lists of participants and presentations are available in the RSLS Members' Area on the IAEA CONNECT website[6].

TABLE 3. RSLS WORKSHOPS AND SCIENTIFIC VISITS

Dates	Event title and location
13–24 August 2012	International Workshop on Management and Regulatory Oversight of Uranium Legacy Sites: Perspectives from Regulators and Operators, Grand Junction, Colorado, United States of America
28 April – 12 May 2014	Workshop on the Remediation of Uranium Legacy Sites: Canadian Experience, Elliot Lake, Canada
19–21 November 2014	International Workshop on Regulatory Control of Nuclear Legacy Sites, Moscow, Russian Federation[1]
7–10 September 2015	Workshop with Site Visits of the International Forum for Regulatory Supervision of Legacy Sites (RSLS), Sibiu, Romania
16–20 October 2017	Workshop on Planning for Remediation of Legacy Sites under the International Working Forum on Regulatory Supervision of Legacy Sites (RSLS) and Technical Meeting of UMREG, Bessines-sur-Gartempe, France
23–27 September 2019	Workshop on the Concept of a Social Licence in the Remediation of Uranium Legacy Sites, Porto, Portugal

[1] The Moscow workshop did not include a scientific visit to legacy sites.

2.3.3. Working groups

Three Working Groups (WGs) were established during the first technical meeting to focus in greater detail on key issues of interest to the participants in the context of the regulatory supervision of legacy sites, as follows:

(1) Working Group 1 – Enhancing the Regulatory Framework. This WG reviewed the role of regulators in planning legacy management and regulatory supervision of legacy sites as part of an appropriate regulatory framework for dealing with legacy sites.

[6] Available at https://nucleus.iaea.org/sites/connect/RSLSpublic.

(2) Working Group 2 – Safety Assessment Methods and Environmental Impact Assessments. This WG focused on the application of methods for safety and environmental impact assessments required to support the management of legacy sites.

(3) Working Group 3 – Professional Development for Regulators. This WG focused on the professional development and training of regulators to acquire the general competencies necessary for effective regulatory oversight of legacy sites.

WG meetings were held in conjunction with the technical meetings.

3. GENERAL ISSUES RELATED TO LEGACY SITES

3.1. DEFINITIONS OF LEGACY SITES

Although participants identified common characteristics of legacy sites (see Section 3.2), there is no common definition of a 'legacy site' in the Member States. Several Members States have terms that address different categories of legacy sites. Some examples of terminology for 'legacy-type' sites used include the following:

(1) In Australia, 'abandoned mines' refer to areas of former mining activity for which no individual, company, or organization can be held responsible. Such sites may also be called 'derelict' or 'orphan' mines. No particular government agency has statutory responsibility for the remediation of abandoned mines, although some jurisdictions charge a levy to operating mines to create a fund for remediation of abandoned mines.

(2) In Canada, the terms 'orphaned' and 'abandoned' are generally used to refer to historic mines that have not undergone any formal decommissioning, and whose ownership has reverted to the government as the remediator of last resort. Uranium mines in Canada hold the distinction of being the only mines that are also under the regulatory oversight of the Federal (National) Government. In the case of these mines, when the responsibility for site remediation has reverted to the government, the term 'legacy site' has been informally adopted by the regulator. The term 'historic' is used by Federal policy departments to mean that the original owner or operator is no longer able to manage the property safely. The term 'legacy' is being used in a similar context to describe the long term liabilities of the Federal Government with respect to historic operations at Atomic Energy of Canada sites such as the Chalk River Nuclear Laboratories, which is under a nuclear facility licence.

(3) In France, the term 'legacy site' refers to a site polluted by an old or past industrial, medical, or radiological activity or process, for which the former operator responsible for the pollution is unknown or no longer able to control or manage the site.

(4) In the Russian Federation, there is a statutory concept 'contaminated part of area to be remediated' in the current legislation. The Federal Law of 10 July 2001 No. 92-FZ on 'Special Ecological Programmes for Remediation of Contaminated Parts of Sites' includes the following definition: "Radioactively contaminated part of the site is a part posing a hazard to the public health and environment which is to be remediated after having been contaminated as a result of an industrial activity or deposition of hazardous radioactive materials in this part of the site".

(5) In the United States of America (USA), the term 'legacy' is used by the United States Department of Energy (U.S. DOE), Office of Legacy Management, in the context of a programme for the remediation and long term surveillance and maintenance of sites involved in the mining, milling or processing of uranium, as well as other types of sites in the uranium fuel cycle managed by U.S. DOE. Therefore, in the USA the term 'legacy' is applied to a wide range of sites, but only those associated with the front end of the nuclear fuel cycle have been considered in this publication. With respect to uranium mines, the term 'legacy' is often applied to mines established under the auspices of the General Mining Law of 1872 where there was no requirement for the operator to remediate the site once the ore was exhausted or mining ceased for other reasons. The U.S. DOE Office of Legacy Management conducts 'long term surveillance and maintenance' at uranium mill sites that were identified as being abandoned in 1978. These mill sites have now been remediated by the Federal and State governments and licensed to U.S. DOE by the United States Nuclear Regulatory Commission

(U.S. NRC). In some cases, mill tailing disposal cells that remain require ongoing maintenance and monitoring for possibly contaminated groundwater, eventually leading to active remediation. The U.S. DOE Office of Legacy Management also conducts long term surveillance and maintenance at other sites in the nuclear fuel cycle at which remediation has been conducted, but waste is contained on-site or where residual contamination remains (including in groundwater).

3.2. CHARACTERISTICS OF LEGACY SITES

Despite the differences and lack of a consistent terminology, typical characteristics of legacy sites include that they are contaminated, that the original owner or operator is unknown and, therefore, is unable to perform the remediation, or that any remediation and/or management of the site would require government funding. Legacy sites are commonly locations where the responsibility for the remediation and/or long term management of the site has reverted to the government. Differences in terminology have not prevented Member States from identifying common factors that can result in legacy sites and potential solutions to address risks posed by legacy sites.

Legacy sites can arise for many different reasons, but some of the more common causes seen in Member States include the following:

(a) An absence of effective regulatory supervision over at least some of the history of the site;

(b) The lack of a long term strategy for the management and future use of the site;

(c) Weak or missing regulatory requirements and guidance necessary to address decommissioning[7] and closure[8] when operations ended;

(d) Lack of funding for facility decommissioning and closure, or remediation of the site;

(e) Lack of facilities and other arrangements for the management of radioactive waste produced at the site while it was operating.

The RSLS identified common characteristics of legacy sites. Although some individual sites may not have all of them, these include, in no order of importance, the following:

(a) Unsatisfactory or unsafe radiological conditions;

(b) Poor characterization of the current radiological condition and a lack of records or knowledge on the history of the site to ascertain what risks and hazards are present;

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[7] The term 'Decommissioning' is defined in the IAEA Safety Glossary (2018 Edition) [2] as:
"1. Administrative and technical actions taken to allow the removal of some or all of the *regulatory controls* from a *facility*.
- This does not apply for that part of a disposal facility in which radioactive waste is emplaced, or for certain facilities used for the disposal of naturally occurring radioactive material (NORM) or of residues from the mining and processing of radioactive ores. For all of these the term closure is used instead of decommissioning."

[8] The term 'Closure' is defined in the IAEA Safety Glossary (2018 Edition) [2] as:
1. "Administrative and technical actions directed at a disposal facility at the end of its operating lifetime — for example, covering of the disposed waste (for a near surface disposal facility) or backfilling and/or sealing (for a geological disposal facility and the passages leading to it) — and the termination and completion of activities in any associated structures."

(c) Radioactive contamination affecting the off-site environment, or the threat that it may be released at some time;

(d) Other physical and chemical hazards present at the site, particularly because the sites have not been maintained;

(e) Unclear ownership and responsibility for management and remediation activities[9];

(f) Insufficient funds to carry out the responsibilities mentioned above.

Frequently, legacy sites are in a poor condition due to the loss of physical and/or regulatory control over the radioactive material for at least some portion of the site's history or were subject to regulatory control but not in accordance with current IAEA standards. Such loss of regulatory control has often resulted in a degradation of physical control measures, leading to contamination of the environment. Control measures may include both physical containment and institutional controls, such as land use restrictions and security measures to prevent access to the site. From a regulatory perspective, the key issue is that the levels of contamination, and/or the degraded state of the control measures, lead to concerns about the physical, chemical, nuclear and/or radiation safety and security at the site.

The RSLS undertook several scientific visits to legacy sites that, at the time, have been, or were being, remediated. Other legacy sites exist at which regulatory oversight has been re-established, but remediation is yet to commence.

A complication to compiling a list of legacy sites which was discussed by RSLS participants was related to changes in regulatory standards, assessment capabilities, or public expectations. A site that may have been historically remediated and/or released by regulators may no longer be considered acceptable by modern standards.

3.3. TYPES OF LEGACY SITES

Although the initial focus of the RSLS was on uranium legacy sites that are detailed in Section 5, presentations by Member States on a range of radiological and nuclear sites for which they had concern led to the identification of other, different types of legacy sites.

3.3.1. Interim storage sites and facilities for radioactive waste

At these sites, waste is stored prior to it being managed at a permanent disposal facility. This can involve many types of radioactive waste. However, if many years pass without a permanent disposal solution, the interim storage facilities may become the 'de facto' final disposal sites. Since the interim storage facilities were not designed to be permanent, radiological hazards may develop over time. If regulatory oversight is lax or if there is only slow progress being made in developing adequate permanent disposal capacity, interim storage sites themselves may become legacy sites.

3.3.2. NORM sites

In the IAEA Safety Glossary (2018 Edition) [2], NORM is defined as "Radioactive material containing no significant amounts of radionuclides other than naturally occurring radionuclides". The

[9] This specifically relates to remediation in Central Asian and other Member States, where the licensee was an entity that no longer exists, resulting in ownership and responsibility for remediation being unclear and the ability to ensure long term sustainability of the remedial actions being difficult.

exact definition of 'significant amounts' would be a regulatory decision. Material in which the activity concentrations of the naturally occurring radionuclides have been changed by a process is included in naturally occurring radioactive material (NORM). The term is always used in the singular unless reference is explicitly being made to various materials.

A distinguishing feature of NORM industries is that the radionuclides are naturally occurring in the raw material and are concentrated by an industrial process. The residues and/or wastes associated with processing NORM are frequently the by-product of the industrial activity and may pose a risk of contamination of sites. Examples include radioactive residues and contamination created from phosphate industries (e.g. phosphogypsum stacks), or scales and sludges from oil and natural gas drilling. Several IAEA publications describe the radiological implications of NORM industries [3–9]. Radiological contamination and subsequent risks may develop if these materials are not appropriately managed. Some Member States define uranium mining and milling as a NORM activity because it also concentrates the naturally occurring uranium in the ore, while others consider it as part of the nuclear fuel cycle. Uranium or other radioactive material (e.g. thorium) is sometimes also recovered at mines developed primarily for other ores (e.g. copper, niobium, mineral sands).

3.3.3. Nuclear technology and development centres

These facilities may have been abandoned in a contaminated condition, and environmental releases may have occurred. Also, there can be more than one degraded facility on the same site requiring remediation or refurbishment. Chemical and industrial hazards may occur at these sites as well. These facilities are sometimes located adjacent to other, conventional, industrial operations that may still be operating, posing a risk to current workers and their environment.

3.3.4. Former nuclear weapons test sites

In past decades, nuclear weapons testing was conducted in some States. Both below ground and atmospheric testing can leave large areas that require regulatory oversight and control. The most acute radiological risks are immediately after a test when many short-lived radionuclides contribute to high levels of gamma exposure. Because nuclear testing can produce significant quantities of radiological contaminants over large areas, they could become legacy sites in the absence of adequate regulatory or government control.

3.3.5. Sites and facilities affected by accidents and incidents

Radiological accidents have the potential to affect large areas and could become legacy sites if there is inadequate regulatory oversight. A significant issue in managing radioactive contamination from such events is that they may create significant stress and social disturbance among interested parties over extended periods of time. IAEA Safety Standards Series No. GSG-15, Remediation Strategy and Process for Areas Affected by Past Activities or Events [10], addresses the topic of remediation of areas of radiological contamination arising from accidents and incidents.

4. REGULATING LEGACY SITES

Outcomes from the three WGs introduced in Section 2.3.3 are summarized in Sections 4.1–4.3 below, with further details provided in Annexes II to IV.

4.1. GENERAL REGULATORY FRAMEWORKS FOR LEGACY SITES

The focus of WG1 was identifying the regulatory framework (laws, regulations, and guidance) applicable to legacy sites in Member States. In order to manage existing legacy sites and to avoid the creation of new ones, strong and independent regulatory supervision is seen as a key factor. However, up to 2010, little was done internationally to enhance regulatory supervision of the management and remediation of legacy sites, or to share experiences in addressing multi-facetted aspects of radiation safety at legacy sites.

The Agency has issued the following IAEA safety standards and other key publications to assist Member States in establishing the regulatory framework relevant to the management of legacy sites:

- GSR Part 1 (Rev. 1), Governmental, Legal and Regulatory Framework for Safety [11];
- GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards [1];
- GSG-12, Organization, Management and Staffing of the Regulatory Body for Safety [12];
- GSG-15, Remediation Strategy and Process for Areas Affected by Past Activities or Events [10];
- SSG-60, Management of Residues Containing Naturally Occurring Radioactive Material from Uranium Production and Other Activities [13];
- WS-G-5.1, Release of Sites from Regulatory Control on Termination of Practices [14];
- Safety Reports Series No. 79, Managing Regulatory Body Competence [15].

WG1 developed a questionnaire on regulatory framework that was sent to experts from Member States participating in the RSLS. Compiled responses from 20 respondent are provided at Annex II. Based on the experts responses, WG1 observed the following key features for an appropriate regulatory framework:

(1) A regulatory basis underpinned by overall laws on nuclear and radiation safety and security. Development of specific laws for legacy site management may be desirable in some Member States;

(2) A combined national strategy for waste and legacy site management, or if they are separate, developing coherence between them;

(3) A nationally applied comprehensive set of requirements and criteria for legacy sites that are protective to human health and the environment;

(4) A licensing process to identify and enforce regulatory compliance during management of legacy sites;

(5) Site specific standards transparently linked to a set of human health and environmental protection objectives, including radiological and non-radiological issues, implemented though licence conditions and site specific regulations;

(6) Guidance documents on application of all the above;

(7) Staged intervention and staged progression for managing legacy sites (e.g. funding dependent);

(8) Post-remediation evaluation processes to ensure that the remedies put in place for legacy sites remain effective.

The key aspects of managing legacy sites, including regulatory aspects, were identified as:

— A national strategy defining roles and responsibilities;

— Regulatory standards for each stage of management, corresponding to defined end states (i.e. different types of land use). Iterative assessments at each stage. Early engagement of the regulator and its role in strategy development;

— Identifying priorities and then optimizing management and supervision of those priorities;

— Risk based prioritization of funding for interim or phased remediation measures to address short term and long term goals.

Most Member States have some statutory, legislative, and legal frameworks to regulate radiation safety at radioactive legacy sites, including laws, bylaws, government directives, and policies.

The legislation of some Member States include specific provisions for radioactive legacy sites, including uranium legacy sites. However, some national regulatory frameworks do not include such legislative provisions. Despite this, a legal framework for radiation safety at legacy sites is generally provided through a variety of existing regulations.

Several experts from Member States participating in the RSLS noted the objective of their legislation on radiation safety is to protect workers, members of the public and the environment from radiation hazards, both now and in the future. In general, radiation protection legislation in Member States meets the requirements of GSR Part 3 [1] and GSR Part 1 (Rev. 1) [11].

Member States legislative frameworks generally establish one or more regulatory bodies to oversee radiation safety, including those for radioactive legacy sites. Among the Member States, the regulatory authorities are either statutory or non-statutory. Some Member States have several regulatory bodies involved in uranium production and nuclear facilities, including remediation activities, and the cooperative interaction is performed in accordance with Administrative Agreements, Memoranda of Understanding, or other similar documents.

In addition, legislation for uranium production and nuclear facility remediation generally includes the following similar provisions:

— A sufficiently resourced and independent regulatory body;

— Clear responsibilities and obligations for funding the management of radioactive waste and remediation;

— The fulfilling of international obligations;

— Involvement of the public and other interested parties, including other agencies, in the regulatory process;

— Responsibility of the operator for safety (radiation and non-radiation safety) at legacy sites or other operating facilities.

In most of the Member States, legislation establishes or implies the following responsibilities on the regulatory body:

— Development of safety principles and criteria;
— Establishment of regulations and guidance documents;
— Requirement for operators to assess the overall safety aspects of the site or facility;
— Conduct inspections, identify any non-compliances, and issue an inspection report (generally at a frequency pertinent to the risk presented by the site or facility, or at a predetermined frequency);
— Impose sanctions in case of radiation or health and safety violations, up to withdrawal of the licence;
— Notify the public and other interested parties about the regulatory process, current requirements, recommendations, decisions, resolutions, and their justification;
— Provide other governmental bodies, national and international organizations, the public and other interested parties with information about accidents, incidents and irregular events;
— Liaise with regulatory bodies of other Member States and international organizations to promote cooperation and exchange of regulatory information.

The legislation may also establish a procedure for resolving disputes between the regulator and the operator.

In most Member States, regulators are generally authorized with sufficient powers and functionality to meet the IAEA requirements for review, authorization, inspection and implementation of regulations and policies to regulate radiation safety. An appropriately organized and staffed independent regulatory body with clear responsibilities and functions and access to adequate resources is a key element of a regulatory framework.

Some experts from the Member States identified the following issues relating to regulatory supervision of uranium legacy sites:

— Insufficient technical or functional capacity within the regulatory authority to fulfil its responsibilities to review and assess sites and facilities, as well as undertake inspection and enforcement activities;
— The lack of specific policy, safety principles and associated criteria as a basis for regulatory actions related to the legacy sites;
— An underdeveloped or non-existent regulatory framework;
— The lack of a developed structure to create a feedback cycle for the outcomes of inspection and enforcement activities;
— Insufficient funding to inspect sites, take interim measures to protect people and the environment, or perform any phased remediation.

4.2. SAFETY ASSESSMENT METHODS AND ENVIRONMENTAL IMPACT ASSESSMENT FOR LEGACY SITES

Working Group 2 (WG2) focused on the elements of safety assessment (SA) and environmental impact assessment (EIA) related to decontamination and remediation of legacy sites. WG2 identified SA and EIA aspects that are unique to legacy sites in general and more specifically to uranium legacy sites.

The SA serves to control exposures to workers, the general population and the affected environment during each step of the remediation of a site. An EIA will help to establish or define an optimal course of remediation. SA and EIA are the systematic and interrelated processes of evaluating the safety of a legacy site before remediation, and quantifying hazards and potential impact to human health and the environment during and following remediation.

The SA is usually focused on meeting protection measures for occupational exposure or off-site human exposure resulting from the existing impact of hazards at the legacy site or those created during remediation. The SA has to be performed in a systematic manner using a graded approach, commensurate with the hazards, the complexity of the site or activity, and the characteristics of the legacy.

An EIA is used to predict the environmental effects of a specific project and to determine whether these effects can be adequately mitigated before a project is carried out. The scope of the EIA, including the factors considered in the assessment, is established in accordance with Member States requirements for environmental assessment.

WG2 attempted to identify safety and environmental aspects of site remediation or management that are primarily applicable to legacy sites, rather than non-legacy sites. The aspects identified by WG2 are:

- Site characterization or operating data may be missing or in poor quality because many years have usually passed between when a legacy site was active to when its hazards are being remediated.
- Implementation of interim actions to address ongoing threats to human health and environment may be necessary before any further remediation takes place.
- A phased approach to site characterization and remediation may be necessary because of funding limitations, or because of unforeseen site conditions are discovered that require work to at least temporarily be stopped. Interim actions need to be planned for at the outset, where possible.
- Lack of background levels of contaminants of concern may lead to challenges in establishing reference levels and remediation criteria.

WG2 also discussed attributes for managing and preventing legacy sites. These are presented in Section 6.

4.3. PROFESSIONAL DEVELOPMENT FOR REGULATORY BODIES IN RELATION TO LEGACY SITES

The focus of Working Group 3 (WG3) was to study the professional development of regulatory staff. The Group developed a questionnaire that was sent to experts from the Member States, and the compiled responses are provided at Annex IV. Key features of experts responses are given below.

The theme explored by WG1 was that an effective and independent regulatory body of a legacy site needs to have a well developed understanding of the regulatory framework within which it is operating, as outlined in IAEA Nuclear Energy Series No. NF-T-1.2, Best Practice in Environmental Management of Uranium Mining [16]. Similarly, the discussion presented by WG2 on SA and EIA also highlights the critical knowledge needed by an effective regulatory body. Understanding of both aspects contributes to an inspector being able to undertake their role effectively and efficiently.

To build regulatory capacity and develop staff to effectively perform their functions, IAEA Safety Standards Series No. GSG-12, Organization, Management and Staffing of the Regulatory Body for Safety [12], recommends that a regulatory body needs to have the following:

- A training policy;
- An allocated training budget;
- A formalized training programme;
- Individual training plans for staff;
- Procedures for periodic review (to enable delivery of refresher training as required);
- A systematic approach to training, including on-the-job and/or peer-to-peer training.

The responses to the questionnaire provided a wide range of information regarding the type of training programmes provided by the regulatory body. Training and development of the regulatory staff (including inspectors) needs to be provided to ensure that staff are able to apply updated knowledge in areas such as technological developments, new safety principles, concepts and challenges in carrying out their tasks, as presented in IAEA Nuclear Energy Series No. NG-G-2.1, Managing Human Resources in the Field of Nuclear Energy [17]. The key lesson, in further support of information provided by Member States, is that many inspectors learn the necessary skills from their peers and superiors through on-the-job training. Other important and sometimes mandatory training programmes include:

- Diversity and/or cultural training;
- Site specific training (i.e. specific to a mine, former test site, nuclear power plant, etc.);
- Health and safety training;
- Radiation protection and nuclear safety;
- Environmental laws and regulations;
- Waste management;
- Site inspection protocols;
- Risk assessment;

— Use of equipment, such as handheld global positioning system and field monitoring equipment.

Formal assessments and accreditation certificates that are issued at the completion of training courses can provide great benefit to the attendees by enhancing their recognized competencies and qualifications.

In the specific case of legacy site inspectors, it is valuable to include training in the identification and evaluation of radiological risks presented by an individual site. Other specific topics to be included in a training programme for legacy site inspectors include use of field and monitoring equipment, site characterization, safety awareness, communication and conflict resolution.

Re-training for regulators and inspectors is often required after a defined period and is often dependent on the skill area itself (e.g. the use of a specific type of monitoring equipment, or an accredited training course).

There is much guidance provided by the Agency on the types of knowledge a regulator needs to perform the functions of the regulatory body in an effective, efficient and independent manner. In the context of the RSLS, it is pertinent to focus on the knowledge requirements of regulators undertaking inspections of legacy sites. General types of knowledge include an understanding of the type of facility subject to the inspection programme as well as knowledge of the criteria, techniques and mechanics of inspection, assessment, reporting and licensing, as stated in NG-G-2.1 [17]. Specifically, IAEA-TECDOC-1526, Inspection of Radiation Sources and Regulatory Enforcement [18], highlights that inspectors need to develop a sound understanding of aspects such as:

— Safety principles and concepts (including radiation);
— Radiation monitoring instruments and monitoring techniques;
— Comparison of different types of risk;
— National legislation, codes of practice or regulatory guides and existing international safety standards in the field;
— Inspection procedures and survey techniques;
— Ongoing technological developments.

As part of the work undertaken by WG3, experts from the Member States identified the most important skills of legacy site inspectors, including both technical and non-technical skills. These are listed below:

(1) Technical skills:
    (a) Basic radiation protection principles;
    (b) Use of monitoring equipment in the field, particularly related to radiation;
    (c) Safety awareness and risk assessment;
    (d) Knowledge of regulatory framework and associated legislation.

(2) Non-technical skills:

(a) Verbal communication and psychological skills, including negotiation;

(b) Written communication skills, including accuracy and attention to detail;

(c) Critical thinking, decision making, problem solving;

(d) Observational skills.

5. SPECIFIC CONSIDERATIONS FOR URANIUM LEGACY SITES

5.1. BACKGROUND OF URANIUM LEGACY SITES

The focus of the RSLS has initially been on uranium legacy sites, including locations where thorium was mined and milled because of similar characteristics to uranium, since more than 60 percent of the Member States that have participated in the RSLS have uranium legacy sites. A few Member States have legacy sites associated with production of radium from host rock that was later used to process uranium. Finally, some participating Member States have become increasingly important producers of uranium for commercial nuclear power plants and there are concerns about the uranium mines and mills becoming a new generation of uranium legacy sites.

5.2. UNIQUE ATTRIBUTES FOR URANIUM LEGACY SITES

Uranium legacy sites, like other types of legacy sites, may include buildings, waste disposal areas, tailings, groundwater and soil contaminated with uranium or thorium series radionuclides, other chemicals, heavy metals and asbestos, open pits, adits, waste rock piles, tailings ponds, and other infrastructure. Consequently, these sites may present varying degrees of radiological, chemical and physical hazards, remediation complexity, and cost liability. Some of the sites are now under the control of active licences, whereas licences for other sites have never been issued.

In some situations, former operators are financially and technically capable of completing remediation in a reasonable timeframe, however in others it is unable or unwilling to undertake remediation. At some sites, remediation may have been initiated or partially completed, whereas at other sites, it has not yet been planned or initiated.

While uranium legacy sites share many of the characteristics of the broader set of legacy sites as described in the previous Section, there are some attributes that are unique to these types of legacy sites. These attributes include the following:

(a) The radionuclides associated with them are naturally occurring and the legacy sites are frequently located in areas with elevated levels of background radiation. There are significant considerations when remediating uranium legacy sites, including determination of background levels. Developing realistic remediation standards of uranium legacy sites is important but can be more difficult when the local levels of naturally occurring radionuclides in the environment are elevated (and locally variable).

(b) While materials associated with uranium mining and milling are generally of lower activity concentrations and do not pose acute radiological risks, the volumes of waste can be extensive and may pose long term exposure hazards. At some sites, waste can cover many square kilometres.

(c) At many uranium legacy sites, co-constituents with uranium contribute significantly to potential health risks. Metals that may occur at uranium legacy sites that pose health risks include cadmium, lead, radium, vanadium, and molybdenum. Non-metal constituents of concern can include arsenic, selenium, organics, sulphates, and nitrates, some of which may have been released to the environment from processing fluids or from site runoff. At many sites, the potential for acid mine drainage can be a substantial, if not the major, environmental issue. In addition to acidification of local streams and lakes, the acidic nature of the seepage and runoff can lead to elevated levels of metals and radionuclides in these waste streams. Asbestos in the construction of the facilities, or at waste disposal sites, may be another issue of concern.

(d) Uranium legacy mines, often with co-located mills, share many of the characteristics of other hard rock mines that were not remediated after production ended. Often, physical hazards at these sites pose a significant risk to visitors or remediation workers. These hazards can include shafts into which a person may fall, mine buildings or ore handling facilities that are old and collapsing, high walls where ore was excavated, pit lakes where mining extended below the water table, adits, and unstable slopes on mill tailings or mine waste rock piles. Finally, there is a potential for items such as explosives or blasting caps that have been left at the site. These safety hazards may need to be addressed before workers can do extensive site characterization work.

(e) In many regions where uranium mining and/or milling activities occur, people have used material from the legacy sites that can cause new exposure risks. For example, the uniformly sandy nature of mill tailings makes them especially suitable as the sand mix required in concrete, plaster, and mortar. When used to construct the foundation of buildings it can lead to increased levels of radon inside structures. Other uses for mill tailings noted by participants include backfill around water, sewer, and electrical lines; and as base for roads, sidewalks, and concrete slabs.

(f) Groundwater and surface water contamination can be associated with uranium legacy sites, including acid mine drainage. In some areas of the world, uranium mining and milling occurred in relatively arid regions. If mines were located above the water table, the effects on water quality may be minimal. However, these same areas still required water for operating of the mills. A common industry practice for many years was to discharge processing fluids to unlined basins where the water and dissolved metal constituents infiltrated into the ground.

Specific issues to be considered in SA and EIA for uranium legacy sites are the following:

— As waste from such sites may pose a variety of risks and cover a large area, the safety case may evolve as the full scope of a uranium legacy site is understood.

— Use of a graded approach for different stages of the remediation process has to be considered. This includes a phased approach to remediation, particularly at the beginning, to address immediate hazards to site workers or the public.

— Additional interim actions may be needed before actual remediation is commenced, particularly if people are living on or near the contaminated site or making use of site materials (including tailings) from the uranium legacy site.

— The long term storage of radioactive waste is important. Because of the large volume of wastes associated with many uranium legacy sites, disposal in proximity or stabilization of waste on site is often considered or deemed most cost effective.

— Toxicological risks to humans, livestock and the environment (e.g. fish in a stream, wildlife) need to be addressed.

— Acceptance criteria for different type of wastes generated during remediation have to be developed to account for any co-occurring constituents of concern.

— The regulators have to consider all environmental effects of the remediation or interim activities, both on-site and off-site.

5.3. ISSUES RAISED BY RSLS PARTICIPANTS CONCERNING URANIUM AND OTHER LEGACY SITES

The following issues were raised by RSLS members mainly in the context of uranium legacy sites, but they could apply more broadly to other types of legacy sites as well.

5.3.1. Independence of the regulatory body

A concern of some experts from Member States that have participated in the RSLS is that the financial benefits of developing new sources of uranium (the sale of which can bring much needed income to a Member State) will overshadow the need to regulate the activity. In these situations, the RSLS participants agreed that it was important that regulators be independent (e.g. have no financial interests in the operations they oversee) and that their independence be backed by national policies. These measures will promote good regulatory practice and assist in the prevention of future legacy sites.

5.3.2. Financial surety instruments

For operating uranium sites, Member States need to request operators to post bonds or other financial surety instruments to ensure that adequate funds are available to properly decommission and remediate facilities at the end of their lifetime. Some Member States have also developed the legal means to identify past operators of facilities and request them to remediate a site or to contribute to, or reimburse the costs of, addressing the legacy issues at a site. National and international funding sources can assist in reducing hazards associated with former uranium mines and tailings. To ensure receipt of further financial and technical assistance, Member States need to develop national programmes for remediation of former uranium facilities. In the development of national programmes, it is important to identify priorities in future remedial activities in compliance with IAEA safety standards.

5.3.3. Engaging interested parties

There is growing recognition of the value of communicating with and engaging interested parties in all phases of managing legacy sites. In Member States with more mature legacy site programmes, there is normally an expectation, and sometimes even regulatory requirements, that interested parties be included somehow in the assessment and decision making process. However, the approach taken for engaging interested parties needs to be specifically tailored to the social customs and technical capabilities of the audience.

5.3.4. Post-remediation management

At many uranium and other legacy sites, there is a growing recognition of the need for post-remediation management to ensure that the remediation works remains effective, such as ensuring that erosion of a tailings cell is not occurring. Also, if there are contaminants left behind that could pose a risk (e.g. groundwater contamination), it needs to be ensured that activities that could cause inadvertent exposure do not take place. Some Member States have single governmental organizations that are responsible for post-remediation responsibilities for sites. In other cases, post-remediation requirements could be part of an amendment to a licence of a private operator and the cost of it incorporated into financial surety instruments for the site.

5.3.5. Capacity building

A common issue for many Member States that are just beginning to address legacy sites is the need for capacity building, particularly the training of regulators, including those responsible for site inspections. Policies and regulations regarding legacy sites are of little value if there are not credible regulations to implement and enforce them. The range of skills that a regulatory body requires, defines the number of specialist staff that is needed. Additionally, the range of skills required will change over the course of the remediation of a legacy site.

One of the goals of the scientific visits by the RSLS participants to legacy sites was to discuss the key challenges and decisions that regulators and operators had to make, and the process by which they were made. Discussing issues from only a technical perspective would not provide an understanding of the respective roles of operators and regulators in managing a site. It was agreed that hands-on experience working with regulators in Member States with more mature legacy site programmes is invaluable. In addition, the visits to the USA provided the RSLS participants an opportunity to visit an operating uranium mill. Seeing operating facilities can help regulators anticipate what constituents and hazards might be present at a similar facility that is now a legacy site, and even how they may be distributed spatially.

Another important element of training regulators was some type of formal qualification recognition programme where a person could demonstrate their professional growth and credentials, as well as promote ongoing professional development. Many Member States that participated in the RSLS indicated that much of the training for a regulator was on-the-job, with new regulators learning from one's peers. Given this, changes in personnel need to be anticipated so that a regulatory body does not lose critical institutional knowledge due to staff turnover (knowledge transfer).

6. KEY LESSONS FROM THE RSLS

6.1. SUCCESSFUL PRACTICES FOR MANAGING EXISTING LEGACY SITES

Successful regulatory practices exhibited by Member States in managing legacy sites are:

(1) Having statutes, regulations and guidance that govern remediation of sites;

(2) Having a strong independent regulatory body to apply regulations for licensing, inspecting, and enforcement, at legacy sites requiring remediation and post-remediation management. A regulatory framework for legacy sites (or active sites where a goal is to prevent them from becoming legacy sites) significantly increases safety when reinforced by regular on-site inspections. It is important that regulators encourage operators and interested parties to understand their country's regulatory framework, basic radiation protection principles, safety and risk associated with the legacy site and its remediation, and proper use of monitoring equipment;

(3) Maintaining a formal record of closed sites by the government (a national registry), to provide the government an opportunity to plan for and develop capacity for prioritizing and managing funding to perform any required activities related to the remediation of legacy sites. This would include post-remediation monitoring, surveillance, maintenance work and management of any unforeseen issues;

(4) Having a structured path forward to either release a site for unrestricted use or to provide for long term care and maintenance with continued regulatory oversight. This may include phased implementation of a site remedial action plan[10] with the need to initially ensure the site is safe as work commences;

(5) Establishing clearly defined remediation criteria (e.g. soil, groundwater, release criteria for recycled materials, release criteria for sites for future use), in consultation with relevant interested parties, so that licensees can effectively plan for remediation;

(6) Where possible, provide finality by releasing the licensee[11] from any further obligation to conduct additional remediation, if the site is remediated in full accordance with an approved remedial action plan and has achieved the release criteria;

(7) Establishing requirements for the submission, review and approval of the remedial action plan as a licensing action by the regulatory authority;

(8) Ensuring that an adequate site characterization and conceptualization has been performed before the site has entered the remediation phase. It is good practice to analyse all available information including the previous data of national studies and findings and conclusions of various Agency missions and other research projects. This will help to get reliable assessments both of facility (site) conditions and of the impact of the facility on the environment. In addition, if pre-operational site characterization information is not available to establish background radiological and toxic chemical conditions, a process to obtain the information has to be

[10] Requirements on the remedial action plan are established in GSR Part 3 [1], Requirement 49: Responsibilities for remediation of areas with residual radioactive material. While some Member States use the term 'remediation plan', for the purpose of this publication, both terms are considered to be synonymous.

[11] In some States, the licensee was a government entity that no longer exists, the ownership and responsibility for remediation is unclear and the ability to ensure long term sustainability of the remedial actions is difficult. The European Commission, European Bank for Reconstruction and Development, and Commonwealth of Independent States are currently addressing the remediation of uranium mine and/or mill sites with uncertain ownership in Central Asia.

developed by the operator and approved by the regulatory authority, with appropriate input of interested parties;

(9) Ensuring that design criteria for all engineering works are appropriately specified, and obtaining independent as-built verification;

(10) Engaging interested parties in the management of legacy sites. Some key strategies for working with interested parties include:

(a) As early as possible identifying and engaging with community leaders that are both trusted sources of knowledge and liaisons within their communities. This can be especially important if there is potential language or cultural barriers between many of the interested parties and regulators or those conducting remediation of the sites. Addressing the needs and coordinating the available knowledge from all interested public groups living near abandoned facilities often requires significant effort and resources. Local health authorities and relevant research institutes need to be involved in the development of communication efforts for delivery to local populations.

(b) Regulators having a visible presence at the site and being willing to impose requirements on the operator that address issues that have been raised by community members, if permitted by applicable laws or regulations.

(c) Using multiple means to communicate about legacy sites. For example, geographic information systems (GIS) are a common means of storing and analysing site characterization data. Geographic information system products can provide de facto images of site conditions or risks that are more meaningful to some interested parties than verbal or written explanations with many technical terms. Even in Member States with mature programmes for legacy sites, helping interested parties understand basic radiation principles or concepts such as risk can still be challenging. Consequently, good communication skills were identified by the RSLS participants as an important requirement for regulators.

(d) Education of interested parties about the risks at uranium legacy sites is an important aspect of interim measures. For example, a new clean water well drilled as an interim measure to replace the use of drainage water from mines or mill tailings by nearby residents may be a wasted effort if people do not understand the consequences for them continuing to use the original resource. This education may need to be periodically repeated. If regulations are in place regarding land use that may forbid someone from using a resource, these need to be enforced if they are to be fully effective in protecting human health.

(e) Seeking options for the remediated site to be an asset to the community afterwards, such as renewable energy, golf courses, sports fields, or outdoor recreational areas.

6.2. SUCCESSFUL PRACTICES FOR PREVENTING FUTURE LEGACY SITES

Good practices for successfully managing existing uranium sites can prevent them from being legacy ones. Such practices include:

(1) Regulations and guidance that govern the operation of existing sites and that establish the responsibility of operators for ensuring for decommissioning and closure to required standards. This includes land, surface water, and groundwater as well as any materials that may have migrated or been removed from the site;

(2) A strong independent regulatory body to implement regulations through licensing, inspecting, and enforcement including any regulations specific to remediation;

(3) As part of licensing, adequate site characterization has been performed prior to initiation of the operation of the facility;

(4) Site specific requirements for protecting surface and ground water resources in the facility design;

(5) Requirements for assessing the need for radiological exposure mitigation measures by examining different pathways of exposure;

(6) Clearly defined site specific closure criteria, taking into account site background conditions, so that site operators can plan for safe closure and long term post-closure management (e.g. soil, groundwater);

(7) Mechanisms to provide for the funding of closure before the site is licensed. Financial surety arrangements approved by the regulator need to be in place before the commencement of operations, or as soon as practical if an operation is already licensed. Sufficient funds need to be available to safely close and manage any installations, including tailings or waste disposal areas, and for the long term care and maintenance activities that are necessary at the site. The amount of funds to be ensured by such mechanisms has to be based on regulator-approved cost estimates in a regulator-approved closure plan, and needs to be amended periodically throughout the life of the facility;

(8) Requirements to begin closure within a short time after cessation of operations. Because safe site closure requirements are determined on a case-by-case basis and some closure activities may take many years (depending on site complexity and available resources), closure timeframes need to be realistic and well defined. In implementing this approach, the regulator has to establish specific and enforceable milestones for each phase of closure. These schedules need to provide flexibility to allow a licensee or responsible party to demonstrate good arguments for delaying remediation based on technical and risk reduction considerations, or for reasons beyond their control;

(9) Requirements for recordkeeping for siting, construction, commissioning, operation (including monitoring data), maintenance, performance, decommissioning and closure of the site to assist in long term planning and management. Records include the type, amounts, and locations of hazardous (radioactive and chemotoxic) material, and the types and locations of other potential hazards (underground openings, sealed openings to surface, service corridors, physical barriers such as dams or slope stability features) at the site;

(10) Requirements for the institutional control and oversight by regulatory authorities where long term care and maintenance will be necessary.

7. CONCLUSIONS AND FUTURE RSLS ACTIVITIES

7.1. CONCLUSIONS

This publication contains a summary of the activities from the first decade of RSLS that contributed to promote effective and efficient regulatory supervision for the management of legacy sites, consistent with the IAEA Fundamental Principles, safety standards, and good international practices. This objective was achieved through the collection, collation, and exchange of information on legacy sites and the identification of best practices in managing and preventing legacy sites among Member States having participated in the RSLS.

Although most Member States having participated in the RSLS do not have a formal definition of a 'legacy site', the differences in terminology did not prevent Member States from identifying common characteristics of legacy sites and challenges on the regulatory supervision and remediation of legacy sites, for the purposes of the RSLS.

Information was exchanged during seven technical meetings where experts from Member States provided and discussed presentations on how effective and efficient regulatory supervision is implemented and maintained in their respective countries. This was beneficial and facilitated sharing of experience and lessons learned where remediation and long term surveillance and maintenance is being performed.

During the six workshops and scientific visits, Member States representatives had first-hand opportunities to observe 24 legacy sites and approaches to remediation and discuss in detail the regulatory framework, challenges, and successes of the host countries in managing and remediating these legacy sites, including long term management of remediated sites. These Workshops also addressed challenges regarding planning for remediation and the importance of a social licence in the context of remediation projects. Feedback from Member State participants confirmed that the overall objective was met and RSLS provided a valuable mechanism for identifying opportunities for continued improvement while sharing international practices in the practical management of legacy sites.

A benefit to Member States that hosted workshops and scientific visits was to discuss their legacy site programmes with the diverse, supportive group of other RSLS participants. Given the range of experience among Member States, ideas were presented, and issues raised to the host Member States that they may not otherwise have considered.

During the initial years of RSLS, three working groups were created that gathered and consolidated available information on three fundamental aspects of legacy site regulation, regulatory framework, assessment tools and methodology, and training for regulators.

Although the majority of Member States have some statutory, legislative, and legal frameworks to regulate radiation safety, some gaps were identified related to regulatory supervision of legacy sites, such as insufficient technical or functional capacity, the lack of specific policy, safety principles and associated criteria, or an underdeveloped or non-existent regulatory framework as a basis for regulatory actions related to the legacy sites, and insufficient funding to inspect sites, take interim measures to protect people and the environment, or perform any phased remediation.

Regarding the safety and environmental aspects of site remediation or management applicable specifically to legacy sites, rather than non-legacy sites, the main challenges identified were related to insufficient background information and existing data of poor quality for safety and environmental

assessments and establishing of reference levels and remediation criteria, the implementation of interim actions to address immediate risks to human health and environment, and the application of a phased approach to site characterization and remediation in a context of technical and funding limitations.

This publication also identifies the general skills necessary for regulators to address their legacy issues and the topics to be included in specific training programme for legacy site inspectors that include use of field and monitoring equipment, site characterization, safety awareness, communication and conflict resolution.

RSLS proved to be a relevant forum for the Member States and a robust and independent network for international cooperation between regulators and operators, and a valuable contributor to the promotion of effective and efficient regulatory supervision for the management of legacy sites, consistent with the IAEA safety standards and good international practices.

7.2. FUTURE RSLS ACTIVITIES

For the future, RSLS will continue to facilitate sharing of information about lessons learned from experience with legacy site remediation and provide recommendations as to what constitutes good practice for regulatory supervision of legacy sites. The scope of RSLS activities includes supporting the development of effective and efficient regulatory requirements and guidance development. Member States expressed the importance of maintaining the organization of technical meetings and the workshops including scientific visits, identified as most valuable to the participants. Member States have also expressed a desire to exchange information about other types of legacy sites, as described in Section 3, in addition to uranium legacy sites, such as complex nuclear sites and NORM sites.

These aspects will be considered in future RSLS workplans, and in addition to the primary objectives of RSLS, events will be focused on the following themes:

- Identification and prioritization of sites for remediation;
- Planning to avoid future legacy sites;
- Challenges to the regulatory body and strategies to overcome them;
- NORM sites;
- Interim measures to control safety risks of prevent releases;
- Establishing and maintaining institutional controls;
- Long term management of remediated sites;
- Regulatory processes (licensing and authorization, inspection, compliance monitoring and enforcement);
- Social licence.

The information on case studies and knowledge generated on these themes could be used in the development of IAEA publications, namely on the following subject matters:

- Identification and prioritization of legacy sites for remediation;
- Long term post-remediation management.

Member States also identified the need to develop and implement training materials and programmes to enhance the capacity building of technical expertise and knowledge specific to the regulatory supervision of legacy sites, to fill training gaps identified by Member States.

Another relevant activity identified to support Member States in the regulatory supervision of legacy sites is the development of peer reviews to the national policy and regulatory frameworks in the context of remediation, and peer review missions to legacy sites with long-lived radionuclides that will use IAEA safety standards and technical guidance, as well as good international practices.

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Annex I.
GENERAL QUESTIONNAIRE FOR THE IAEA RSLS TECDOC

This Annex contains a general questionnaire that was sent to the Member States' experts participating in the RSLS, regarding the existence of legacy sites, its definition, regulatory framework and procedures, remediation and long-term management, and training of regulatory bodies.

(1) Does your country have a formal definition of a Legacy Site? If yes, please provide it. If not, does your country have an informal definition of a Legacy Site? If yes, please provide it. If not, how is the term 'Legacy Site' used in your country?

Clarification: This question applies not only to uranium sites but to non-uranium sites that are contaminated with radioactive material as well. For our purposes, it does not apply to non-radioactive sites (e.g. sites with only chemical contamination).

(2) Submit up to five case studies of legacy sites in your countries. Case studies should exemplify some challenge. It should also describe how it became a legacy site; what actions have been taken to remediate it; what actions were successful and why; what actions were not successful and why; what are the plans for the future if the legacy site is still in existence. The examples will be added to an Annex of the TECDOC.

Clarification: The purpose of the TECDOC, among other things, is to highlight positive attributes and good practices for managing legacy sites and preventing future legacy sites from a regulatory perspective (i.e., emphasis on laws and regulations, hence the term 'regulatory supervision'). The purpose for requesting case studies is to use them to exemplify these positive regulatory attributes and good regulatory practices. The case studies only need to be long enough to exemplify the positive regulatory attributes/good regulatory practices. A good model to use would be to describe the challenge, provide context, describe the actions taken, the results achieved and highlight the positive regulatory attributes/good regulatory practices.

(3) Describe the licensing and authorizing process for remediation of a legacy site in your country. Describe what federal laws, federal regulations and what guidance documents are applied to the remediation of legacy sites.

(a) Who is the regulator? Is it the national nuclear regulator or another agency or multiple Federal agencies? If they are different, how do these different regulatory bodies interact?

Clarification: For the part that asks, 'how do these bodies interact,' describe how they are formally supposed to interact according to laws and how they really interact in practice if different.

(b) What are the regulatory requirements?

Clarification: This could be a large amount of information, so please summarize the laws and regulations that apply to managing or preventing legacy sites.

(c) What type of regulatory guidance exists?

Clarification: The question is not requesting every guidance document, only those that are applied to legacy sites. In order to be useful, more than titles will be necessary, so please provide a summary of what the guidance document says related to managing or preventing legacy sites.

(4) What guidance documents are used to guide safety assessments and environmental impact assessments for legacy sites in your country? Please describe what these documents contain.

Clarification: As above, the question is not requesting every guidance document, only those that are applied to legacy sites. In order to be useful, more than titles will be necessary, so please provide a summary of what the guidance document says related to managing or preventing legacy sites.

(5) Provide information about Remedial Action Plans in your country.

(a) Is there a requirement for a remedial action plan? Describe.

(b) Is there guidance on what should be in a remedial action plan? Describe.

Clarification: Only need to summarize the information.

(c) How is such a plan approved - by whom and who monitors it?

(6) Provide information about the verification of remediation according to requirements – how and by whom?

(a) Are there provisions for in-process inspections and regulatory oversight during remediation? Describe (inspections, look at procedures, records, check permits interviews with on-site personnel, etc.).

(b) What training are the inspectors required to take? Who provided the training?

Clarification: The purpose of this question is to include in the TECDOC good practices as they apply to training of regulators/inspectors.

(c) Is there a requirement for verifying the remediation? Describe.

Clarification: The verification can take the form of regulations or laws that require verification; or regulations that require that the operator needs to submit information showing the remediation is completed; or that inspectors visit the site and take confirmatory measurements.

(d) Who is responsible for verifying that the remediation is being performed per the requirements/remedial action plan? Describe.

Clarification: This is like 6(a) but asks ‘Who’ is responsible. Is it the regulatory body?

(e) Are there guidance/procedures for verifying that the remediation is being performed per the requirements/remedial action plan? Describe.

(7) Is the site ever released from regulatory control? How is the site released (if still under license) and if there are restrictions after release, who is responsible? Describe.

(8) Provide information about Long-Term Surveillance & Maintenance programmes.

(a) Is there a requirement for such programmes?

(b) Under what conditions/situations would a Long-Term Surveillance & Maintenance plan be warranted?

(c) Who is responsible?

(d) Is there guidance?

(e) How is it evaluated and adjusted over time?

(f) Please provide examples of sites where Long-Term Surveillance & Maintenance programmes are used and what the program encompasses.

Clarification: This may be included in the previous responses but is trying to bring out such aspects as does the programme encompass non-radiological maintenance or only radiological maintenance.

(9) Training: Describe the training requirements/qualifications for regulatory personnel who work on legacy sites. The training should be broken into the various parts of the regulatory process:

(a) Performing and reviewing SAs and Environmental Impact Statements.

(b) Performing and reviewing Remedial Action Plans.

(c) Performing Inspections.

(d) Reviewing Completion Reports.

(e) Reviewing Long-Term Surveillance Plans.

(f) Inspecting against Long-Term Surveillance Plans.

Clarification: The purpose for the training questions is to include positive training attributes/good training practices as applied to the regulators of legacy sites.

Annex II.
WORKING GROUP 1 – ENHANCING THE REGULATORY FRAMEWORK

II–1. INTRODUCTION

Working Group 1 (WG1) focused on laws, regulations, and guidance applicable to legacy sites in various Member States. The objectives of WG1 included:

- Review and analysis of regulatory frameworks for radiologically contaminated legacy sites;
- Review, analysis and generalization of regulatory experiences in planning legacy sites management in Member States with radiologically contaminated legacy sites;
- Review, analysis and generalization of regulatory experiences in supervision and monitoring of radiologically contaminated legacy sites;
- Development of recommendations on enhancing regulatory, normative and legislative frameworks for legacy sites management while recognizing that approaches may vary based on specific situations in Member States.

In the period 2011–2013, WG1 completed the following tasks:

(1) Development of a questionnaire to assess national regulations related to legacy sites in the RSLS Member States;

(2) Analysis of completed questionnaires and other materials submitted by the RSLS Member States;

(3) Summary of national strategies on regulating legacy sites based on the completed questionnaires;

(4) Generalization of regulatory experiences in supervision of legacy sites using examples of legislative frameworks and guidelines developed by the RSLS Member States.

II–2. THE QUESTIONNAIRE TO ASSESS NATIONAL REGULATIONS OF LEGACY SITES

WG1 developed a questionnaire which is presented in Table II–1 and which was forwarded to the RSLS Member States' experts in 2012. Experts were encouraged to provide detailed answers to account for the inherent complexity of the issues in managing legacy sites and to further inform the IAEA activities in this area. More than 70% of the RSLS Member States had completed the questionnaire by 2013 (Table II–2).

The questionnaire was developed in compliance with the applicable IAEA safety standards and based on questionnaires used by the IAEA in its missions to Member States. The IAEA Integrated Regulatory Review Service (IRRS) questionnaire prepared for the mission to the Russian Federation was used as a template. Several modifications were introduced to specifically address regulation of radioactively contaminated legacy sites.

The questionnaire consisted of 35 questions and was divided into the following parts:

(1) Legislative and governmental responsibilities:

   (a) National legislation related to radiation safety;

   (b) Safety of radioactive sites and facilities (including uranium sites and facilities);

   (c) Remediation;

   (d) Public outreach;

   (e) Interaction between various governmental agencies, national and international organizations and regulatory bodies of different Member States;

   (f) Interaction and cooperation between regulators and operators.

(2) Responsibilities and functions of the regulatory body:

   (a) Statutory responsibilities and obligations of regulatory bodies.

(3) Organization of the regulatory body:

   (a) Technical and functional capacities of a regulatory body performing supervisory functions.

(4) Authorization by the regulatory body;

(5) Review and assessment;

(6) Inspection and enforcement;

(7) Development of regulations and guides;

(8) Specification of radioactive legacy sites in the country:

   (a) Characteristics of the radioactive legacy sites and governmental programmes of remediation of the radioactive legacy sites and facilities.

TABLE II–1. QUESTIONNAIRE TO ASSESS THE STATE OF THE NATIONAL LEGACY REGULATIONS

Part I – Legislative and Governmental Responsibilities	
1	Has a legislative and statutory framework been established to regulate the safety of radioactive legacy facilities and sites and activities, including remediation?
2	Does the legislative and statutory framework clearly establish one or more regulatory authorities whose responsibilities cover the radioactive legacy facilities and activities, including remediation?
3	Is the Regulatory Body effectively independent of organizations and bodies charged with the promotion of the radioactive legacy management or responsible for such activities, including remediation?
4	Is the prime responsibility for safe management of the radioactive legacy clearly assigned to the operator?
5	Does legislation set out effective objectives for protecting individuals, society and the environment from radiation hazards, both for the present and in the future?
6	Does legislation allow for the creation of independent advisory bodies to provide expert opinion to, and for consultation by, the government and Regulatory Body? Is involvement of foreign experts allowed?
7	Does legislation set up a means whereby research and development work is undertaken in important areas of safety?
8	Does legislation set out the responsibilities and obligations in respect of financial provision for radioactive waste management, radioactive legacy management and decommissioning?
9	Does legislation or any governmental mechanism implement any obligations under international treaties, conventions or agreements?
10	Does legislation define how the public and other bodies are involved in the regulatory process?
11	Does the legislation ensure that the Regulatory Body has the authority to develop safety principles and criteria and to establish regulations and issue guidance?
12	Does the legislation ensure that the Regulatory Body has the authority to require an operator to conduct a safety assessment?
13	Does the legislation ensure that the Regulatory Body has the authority to enter a site or facility to carry out an inspection? If so, which is the frequency of such inspections? Should such inspections be justified? What kinds of grounds are required for such inspections?
14	Does the legislation ensure that the Regulatory Body has the authority to communicate independently its regulatory requirements, decisions and opinions and their basis to the public?
15	Does the legislation ensure that the Regulatory Body has the authority to make available to other governmental bodies, national and international organizations, and to the public information on incidents and abnormal occurrences and other information, as appropriate?
16	Does the legislation ensure that the Regulatory Body has the authority to liaise with regulatory bodies of other countries and with international organizations to promote co-operation and the exchange of regulatory information?
17	Is there a statutory procedure for resolving disputes between the regulatory body and the operator?
Part II – Responsibilities and Functions of the Regulatory Body	
18	Does the Regulatory Body have defined policies, safety principles and associated criteria as a basis for its regulatory actions with respect to the radioactive legacy?

TABLE II–1. QUESTIONNAIRE TO ASSESS THE STATE OF THE NATIONAL LEGACY REGULATIONS

19	Does the Regulatory Body establish, promote or adopt regulations and guides upon which its regulatory actions with respect to the radioactive legacy are based?
20	Do the Regulatory Body's regulatory principles and criteria take into consideration internationally endorsed standards and recommendations?
21	Does the Regulatory Body confirm the competence of personnel responsible for the safe radioactive legacy management?
22	What is the procedure of interaction between several regulatory bodies? How are contradictions between regulatory bodies resolved?
Part III – Organization of the Regulatory Body	
23	Is the Regulatory Body entirely self-sufficient in all the technical or functional areas necessary to discharge its responsibilities for review and assessment or inspection with respect to the radioactive legacy? Is involvement of foreign experts allowed?
Part IV – Authorization by the Regulatory Body	
24	Prior to the granting of an authorization with respect to the radioactive legacy, are applicants required to submit a detailed demonstration of safety appropriate to the facility, activity or practice?
25	Are applications for authorization reviewed and assessed by the Regulatory Body in accordance with clearly defined written procedures?
Part V – Review and Assessment	
26	Does the Regulatory Body define its review and assessment principles and associated criteria on which its judgments and decisions are based with respect to the specific radioactive legacy site?
Part VI – Inspection and Enforcement	
27	Does the frequency and extent of the inspection depend on potential magnitude and nature of the hazard associated with the radioactive legacy facility?
28	Does the Regulatory Body require inspectors to prepare a report of their inspection activities and findings (see also the next question) to take these findings in the regulation process?
29	What methods of enforcement (e.g. warning letters, penalties, withdrawal of authorization) are available to the Regulatory Body?
Part VII – Development of Regulations and Guides	
30	Does the structure of regulatory documents exist? Does it depend on the nature and extent of the radioactive legacy to be regulated?
31	Do regulations establish requirements with which all operators must comply?
32	Are non-mandatory guides prepared, as necessary, on how to comply with regulations?
33	When developing regulations and guides, does the Regulatory Body take into account internationally recognized safely standards and recommendations such as those of the IAEA?
Part VIII – Specification of Radioactive Legacy Sites in Your Country	
34	The presence and number of radioactive and uranium legacy sites, according to the legacy definition given in the Work Program, adopted on 24 October 2011 at the RSLS Technical Meeting in Vienna?
35	Is there a national program on remediation of radioactive legacy sites and facilities in your country?

TABLE II–2. QUESTIONNAIRE RESPONDENTS

Member State	Respondent's Affiliation
Australia	Australian Government Department of Sustainability, Environment, Water, Population and Communities
Australia	Australian Radiation Protection and Nuclear Safety Agency
Belgium	Federal Agency for Nuclear Control
Brazil	Brazilian Commission of Nuclear Energy
Bulgaria	Nuclear Facilities Inspectorate National Centre for Radiobiology & Radiation Protection
China	Radioactive Waste Management Department, China Institute for Radiation Protection
France	Nuclear Safety Authority
Germany	Saxony State Ministry for Environment and Agriculture
Hungary	National Research Institute for Radiobiology and Radiohygiene
Iraq	Radiation Protection Centre Ministry of Environment
Kyrgyz Republic	State Agency on Environmental Protection and Forestry
Niger	Ministry of Mines and Industrial Development, Direction of Mines
Norway	Norwegian Radiation Protection Authority
Romania	Romanian National Commission for Supervision of Nuclear Activities
Russian Federation	Federal Medical Biological Agency
Tajikistan	Nuclear and Radiation Safety Agency of the Academy of Sciences
United Kingdom	Environment Agency
United Kingdom	Public Health England
United Kingdom	Office for Nuclear Regulation
Ukraine	State Nuclear Regulatory Inspectorate of Ukraine Department of Radiation Safety
Ukraine	Ukrainian Scientific and Research Institute for Hydrometeorology
USA	Department of Energy Office of Legacy Management
Uzbekistan	State Inspectorate 'Sanoatgeokontexnadzorat' under the Cabinet of Ministers
Zambia	Radiation Protection Authority

II–3. SUMMARY OF THE QUESTIONNAIRE RESPONSES

II–3.1. Member States with legacy sites

Many Member States have various legacy sites. Some of the results are provided in Table II–3.

TABLE II–3. LEGACY SITES IN MEMBER STATES HAVING PARTICIPATED IN THE RSLS

Member State	Uranium legacy sites present (#)	Other legacy sites present (#)
Australia	Yes (2)	Yes (3) Nuclear weapon test sites
Belgium	Several NORM legacy sites.	Yes (2) Sites related to former radium production and contaminated banks of a discharge river of nuclear facility.
Brazil	Yes (3)	No response
Bulgaria	Yes (3)	No
China	Yes (6) Some uranium deposits are under decommissioning since 1990, other will be subject to decommissioning.	-
France	Yes (80, plus 25 mining sites)	-
Germany	Yes	-
Hungary	Yes (1)	No
Iraq	Yes All the Iraqi uranium processing sites and facilities were destroyed in 1991 war.	-
Kyrgyzstan	Yes (6)	No
Niger	No	No
Norway	No	No
Romania	50 Uranium deposits, only two large.	No
Russian Federation	Yes (1)	Yes Sites contaminated due to radiation accidents, nuclear weapon tests, allocation of sites for spent nuclear fuel and radioactive waste temporary storage.
Tajikistan	Yes (10)	No
Ukraine	Yes Dneprodzerzhinsk, Zheltye Vody, some other old mines and sites	Areas affected by the accident at the Chernobyl nuclear power plant.

TABLE II–3. LEGACY SITES IN MEMBER STATES HAVING PARTICIPATED IN THE RSLS

Member State	Uranium legacy sites present (#)	Other legacy sites present (#)
United Kingdom	No	Yes
United States of America	Yes	Yes
Uzbekistan	Yes (6)	No
Zambia	No	No

Annex III.
WORKING GROUP 2 – SAFETY ASSESSMENT METHODS AND ENVIRONMENTAL IMPACT ASSESSMENTS

III–1. INTRODUCTION

Working Group 2 (WG2) focused on the implementation of environmental impact assessments (EIAs) and safety assessments (SA) at uranium legacy sites. WG2 identified SA and EIA aspects that are unique to legacy sites in general and more specifically to uranium legacy sites. EIAs help to justify an optimal course of remediation, and SAs may serve to control the exposures to workers, the public, and the affected environment within each step of the remediation of a site. SA and EIA represent the systematic and interrelated processes of evaluating the safety of a legacy site before remediation as well as to quantifying the potential impact of hazards on human health and the environment during the remediation and after completion of the work. Safety assessments have to be performed in a systematic manner using a graded approach, commensurate with the hazards, and the complexity of the site.

Because many years may have passed between the operational period of a legacy uranium site to the time when its hazards are being addressed, the information and data for site characterization may be missing, obsolete or questionable, or, in case they exist, lacking quality assurance. Site characterization is an important component of any legacy site assessment. Site characterization should include historical aspects, radiological and environmental data, and socio-economic considerations. Because of factors such as the loss of records, situations may be encountered that are resulting in the need to revisit an SA and EIA for a uranium legacy site more frequently than at a site that had undergone decommissioning and decontamination or remediation soon after the production had ceased. The newly acquired information may necessitate the review of, for example, previously identified EIA alternatives.

III–2. INTERIM ACTIONS FOR LEGACY SITES

III–2.1. The use of contaminated resources

Because the uranium legacy sites in many Member States have lacked access control, people may have used resources from the site, including the use of tailings in the construction of houses, resulting in radon exposures [III–1]. At other sites, contaminated groundwater from mines or tailings facilities has been used as a source of drinking water for humans and livestock [III–2, III–3, III–4].

In these situations, interim actions may be necessary before performing a full EIA, to address the evident exposure pathways that are a threat to human health and the environment. Interim actions to address situations described above could include providing alternative housing to residents near the sites, drilling new water wells to replace the contaminated water from the mill or mine, as well as educating people living in the vicinity of the site about why the use of material from it may be detrimental to their health.

III–2.2. Physical hazards

There may also be physical hazards for workers at such sites (e.g. building structures that could collapse, open shafts and adits) that can present an imminent risk to workers. Such risks should be dealt with before addressing the risks for public health and safety from exposure to radiation.

Particularly for mines on public lands, federal land management frequently address safety hazards first by sealing or gating shafts and adits and removing decaying mine framing [III–5]. Mine hazards can be mitigated by sealing tunnels and shafts with polyethylene foam plugs or with brick and mortar. These actions have the added benefit at some mines of reducing exposures to radon when radon emissions are concentrated at shafts and audits [III–6].

III–2.3. Phased approach to remediation

A phased approach to reclamation or remediation at legacy mines may include reducing or eliminating safety hazards. Another circumstance that may lend itself to a phased approach is the large volume of waste tailing such as at legacy uranium mills. In some instances, actions taken to locate suitable waste disposal sites or evaluate whether the tailings can be effectively stabilized in place may be done in parallel with shorter term actions to reduce human exposure or mitigate environmental releases while a permeant disposal site is identified and developed.

III–2.4. Distinction between contamination and natural background

Another aspect of uranium legacy sites addressed by WG2 is the common proximity of uranium mines and mills to elevated, but yet natural concentrations of radionuclides and other compounds. For example, uranium in groundwater (as well as other constituents such as arsenic, molybdenum, vanadium, and sulphates) may exceed drinking water standards. However, if the mines and mills are located in mineralized rock bodies, legacy mines may not have contributed more to degradation of groundwater quality than was already a result of naturally occurring constituents in the background. A type of data that may be lacking at uranium legacy sites is characterization of background levels of constituents of concern in various environmental media, including water. Background conditions of environmental media that could serve as a reference standard for eventual remediation of a site may never have been established at a legacy site if there had been no expectations that it would eventually undergo decommissioning and decontamination and remediation (as was the case for many uranium mines).

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Annex IV.
WORKING GROUP 3 – PROFESSIONAL DEVELOPMENT FOR REGULATORS

IV–1. INTRODUCTION

WG3 was focused on the professional development of regulatory bodies. An effective and independent regulatory body of a legacy site has a developed understanding of the regulatory framework within which it is operating [IV–1]. This theme was explored by WG1 and discussed earlier in this publication. Similarly, the discussion presented by WG2 on safety impact assessments also highlighted a critical knowledge needed by an effective regulatory body. Understanding of both aspects contributes to an inspector being able to undertake his/her role effectively and efficiently.

In the early initial term of RSLS, a questionnaire was distributed to Member States to gather information about the training and information requirements of inspectors of legacy sites (the questionnaire is provided in Annex IV–4). The limited number of responses to the questionnaire (n = 16) does not allow for statistically meaningful conclusions to be drawn from the information obtained. Nevertheless, useful information was obtained to highlight the key qualifications and training requirements for regulators, including inspectors, of legacy sites. General themes are apparent and relate to the type of training Member States would like to see their regulatory staff, including inspectors, receive as well as to how training is best delivered to obtain maximum benefit for the individual and the organization. The general trends observed in the data obtained from Member States is supported by information present in IAEA publications.

IV–2. INTRODUCTION WHAT KIND OF KNOWLEDGE DOES A REGULATOR NEED?

In line with IAEA Safety Standards Series No. GSG-12, Organization, Management and Staffing of the Regulatory Body for Safety [IV–2], training of regulatory staff needs to include technical and non-technical aspects, including elements such as fundamentals of inspections, the regulatory framework (technical) and professional communication and leadership skills (non-technical).

Questionnaire respondents were asked to identify the most important skills of legacy site inspectors, including both technical and non-technical skills. The following provides a summary of the Member State opinions in regard to this:

— Technical skills:
  - Basic radiation protection principles;
  - Use of monitoring equipment in the field, particularly related to radiation;
  - Safety awareness and risk assessment;
  - Knowledge of regulatory framework and associated legislation (regulatory fundamentals specific to the country or province).

— Non-technical skills:
  - Verbal communication skills, including negotiation;
  - Written communication skills, including accuracy and attention to detail;
  - Critical thinking, decision making, problem solving;
  - Good personal character;
  - Observation skills.

Most respondents indicated that established programmes include training on radiological risk assessments. It was not possible to determine if such risk assessments were for operating or legacy sites, and it might be useful to provide training courses about the methodology for conducting radiological risk assessments specifically for legacy sites.

The key themes extracted from the responses provided by experts from the Member States provide clear direction for the development of the syllabus for a training programme for inspectors of legacy sites. The technical and non-technical skills identified by Member States' experts need to be delivered as modules of a training course, including some practical sessions (such as the use of field equipment). Based on the information provided by the questionnaires, it is concluded that there would be benefit to organizations to have access to a standardized training programme or skill requirements list for inspectors responsible for legacy sites. It is important to acknowledge that some skills or training components require refreshing after certain periods of time to ensure that the inspectors skills and training remain up to date with current practices and technologies. Member States' experts have highlighted that inspectors require skills both in technical areas as well as soft skills such as negotiation and conflict resolution. This information could support development of a standardized training programme or 'skill set' that includes the following elements:

— Radiation protection management specific to legacy sites;
— Curricula and training materials for each type of legacy;
— Cross-cutting issues, for example training in knowledge of both radiation and chemotoxic effects on humans and the environment, and training in how they are both regulated;
— Use of technical measurement instruments and personal protective equipment;
— Job hazard analysis;
— Project management;
— Team building skills;
— Public and media relations;
— Negotiation skills;
— Report writing (including regulatory improvement);
— Understanding of regulatory infrastructure;
— Understanding of SA and EIA.

Recognized qualifications from on-the-job training, including instrument use, help to support the organization in building public confidence by demonstrating that they are suitably trained and qualified to conduct inspections at legacy sites.

Another major theme drawn from the information collected from Member States' experts in the questionnaire was the preferred delivery mode for training courses. Most stated that on-the-job or peer-to-peer training was preferred and effective. Formalizing this training method to deliver a standardized curriculum has potential to provide a range of benefits to the individual attendee and the wider organization. On-the-job or peer-to-peer training is low cost when compared to other training delivery methods and allows sharing of information to occur within the organization on a time frame that suits operational priorities. Development of a training recognition and tracking system would benefit organizations to notify when formal re-training is required in a particular skill area.

Specifically related to the role of inspectors of legacy sites, the responses to the questionnaire showed that a multidisciplinary approach to inspections is encouraged and an inspector team should be tailored to the expertise that is needed. In addition to well qualified and trained inspectors, there should be a mechanism to incorporate findings from legacy site inspections into future regulatory supervision.

IV–3. DISCUSSION

There was an almost even distribution of responses ('yes' and 'no') to Question 3 (required standard skills or qualifications for inspectors of legacy sites). Key themes extracted from the additional information provided in response to this question highlighted that standard skills (formal and informal knowledge) are commonly transferred to inspectors through on-the-job training rather than through formal courses to provide qualifications. This information supports development of a training programme that ensures information and materials are delivered in a manner that is easily transferrable between inspectors once back in their respective Member States.

A wide range of information was provided by respondents to the questions regarding the type of training programmes provided by the regulatory body. According to IAEA Nuclear Energy Series No. NG-G-2.1, Managing Human Resources in the Field of Nuclear Energy [IV–3], training and development of regulatory body staff (including inspectors) should be provided to ensure that staff are able to apply updated knowledge in areas such as technological developments, new safety principles, concepts and challenges in carrying out their tasks. The key lesson, and in further support of information provided in response to Question 3, is that a lot of inspectors learn the necessary skills from their peers and superiors through on-the-job training. Other training programmes identified include:

- Diversity and/or cultural training;
- Site specific training (i.e. specific to a mine, former test site, nuclear power plant, etc.);
- Health and safety training;
- Radiation protection and nuclear safety;
- Environmental laws, and regulations generally;
- Risk assessment;
- Use of equipment, such as handheld global positioning system.

Several respondents also indicated the use of training courses and workshops held by the IAEA that they send inspectors to attend.

As with Question 3, the responses to Question 6 highlight that the training courses should have information and material delivered in such a way that attendants will be able to take the lessons back to their respective Member States and easily share with their fellow inspectors. Some of the points listed above may be able to be delivered as modules of a training course to build the capacity of legacy site inspectors with Member States.

In support of the responses provided by experts from Member States in relation to training of inspectors of legacy sites, it is important to understand how regulatory bodies deliver such training. In the questionnaire distributed to Member States, respondents were asked how training courses were provided to employees. Table IV–1 presents the responses to this question.

TABLE IV–1. TRAINING DELIVERY MODE

Mode of delivery	Number of responses
Internal courses	7
External contractors	10
On-the-job training	9
Online learning	3
No answer	3

These responses inform that external contractors and on-the job training are the most commonly utilized methods to train inspectors. These results further enforce the conclusions drawn from analysis of responses to Questions 3 and 5. Some respondents indicated that the 'external contractors' were often in the form of fellowships and scientific visits sponsored by the IAEA.

Formalized assessment and certification of training programmes for inspectors can increase the value of the course to both the participants individually and their employer. Formalized assessment leading to recognized qualifications as well as certificates of participation can increase the credibility of the inspectors to the public by demonstrating that they are trained and qualified to undertake their duties. This can then increase the public trust and confidence in the organization itself. Formalized assessment and certification also helps to build technical and then corporate knowledge and a skills base through information sharing by attendees within their organizations [IV–2]. Around half of the respondents to the questionnaire indicated that formal assessment or accreditation certificates were issued upon completion of training courses and programmes.

Successful training programmes are those that include the use of simulators [IV–3], or in the case of legacy site inspectors include training in the field and laboratories. A successful training programme includes clearly defined course objectives and evaluation of training effectiveness [IV–4]. In the specific case of legacy site inspectors, a valuable course also includes training to identify and evaluate radiological risks presented by an individual site. Other specific topics to be included in a training programme for legacy site inspectors include use of field and monitoring equipment, communication and conflict resolution, site characterization and safety awareness.

In relation to the information provided by Member States, respondents to the questionnaire were asked to identify if re-training for inspectors was provided in any of the competency areas required for the role. The majority of responses indicated that re-training was required after a defined period of time and was often dependent on the particular skill area itself (e.g. such as the use of a specific type of monitoring equipment, or an accredited training course). A successful training programme should also detail future re-training options and communicate this to participants, so as to maximize their benefit for the cost of participating in the training course.

IV–4. WORKING GROUP 3 QUESTIONNAIRE

The questionnaire sent to Member States requesting professional qualification information included the following questions:

(1) In your opinion, what are the most important skills that an inspector of legacy sites should have? Please include technical and non-technical skills in your response.

(2) In your country, is there an Agency, Ministry, or Department with responsibility for legacy sites from the nuclear fuel cycle (including uranium production cycle)?

(3) Does your Agency have standard skills or qualifications that legacy site inspectors are required to have?

(4) In your Agency, what are the skills or qualifications that inspectors of operating sites (for example, uranium mining and milling sites, storage and disposal sites and facilities) are required to have? Please detail.

(5) What training programmes does your Agency provide or offer to staff responsible for inspecting operating or legacy sites? Please list and indicate if each is optional or compulsory.

(6) For the training programmes listed in Q5, please provide information on how each of these training programmes are delivered. For example: online learning, external contractors, internal providers, on-the-job.

(7) Do any of the training programmes listed in Q5 include training on radiological risk assessment for sites (legacy or operating)?

(8) Do attendees of any of the training programmes listed in Q5 receive any kind of accredited certification or acknowledgement of course completion?

(9) Do any of the training programme details include formalized assessment?

(10) Are site inspectors (for legacy or operating sites) required to re-train in skills or qualifications after a period of time? Yes / No Please circle.

(11) What area of skills or qualifications would you like to see improved for inspectors of legacy sites operating in your Agency / country?

The purpose of this questionnaire was to gather information about:

(a) The skills of regulators responsible for assessing compliance and inspection of legacy sites;

(b) Current training programmes in Member States for inspectors of legacy sites.

Member States' experts were encouraged to carefully read each question and provide the most relevant and informative responses. They were also asked provide details on both the strengths and weaknesses of existing programmes and training within their country.

For the purposes of RSLS, a legacy site is a facility or area that has not completed remediation and is radioactively contaminated at a level which is of concern to regulatory bodies.

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LIST OF ABBREVIATIONS

EIA	environmental impact assessment
IAEA	International Atomic Energy Agency
IRRS	Integrated Regulatory Review Service
NORM	naturally occurring radioactive material
RSLS	International Working Forum on Regulatory Supervision of Legacy Sites
SA	safety assessment
USA	United States of America
U.S. DOE	United States Department of Energy
U.S. NRC	United States Nuclear Regulatory Commission
WG	Working Group

CONTRIBUTORS TO DRAFTING AND REVIEW

Beauheim, R.	Consultant, United States of America
Carvalho, E.	International Atomic Energy Agency
Edge, R.	International Atomic Energy Agency
Grishechkin, I.	International Atomic Energy Agency
Kiselev, M.	Federal Medical Biological Agency, Russian Federation
Kiselev, S.	State Research Centre, Burnasyan Medical Biophysical Centre, Russian Federation
Lyamzina, Y.	International Atomic Energy Agency
Malouk, A.	Autorité de Sûreté Nucléaire, France
McConnell, K.	Nuclear Regulatory Commission, United States of America
Mezrahi, A.	National Nuclear Energy Commission, Brazil
Orlando, D.	Nuclear Regulatory Commission, United States of America
Persinko, A.	Nuclear Regulatory Commission, United States of America
Roberts, M.	International Atomic Energy Agency
Romanov, V.	Federal Medical Biological Agency, Russian Federation
Samoylov, A.	State Research Centre, Burnasyan Medical Biophysical Centre, Russian Federation
Scissons, K.	Consultant, Canada
Semenova, M.	State Research Centre, Burnasyan Medical Biophysical Centre, Russian Federation
Seregin, V.	State Research Centre, Burnasyan Medical Biophysical Centre, Russian Federation
Shafer, D.	Department of Energy, United States of America
Shaiyldaeva, T.	Consultant, Kyrgyz Republic
Shandala, N.	State Research Centre, Burnasyan Medical Biophysical Centre, Russian Federation
Sneve, M.	Norwegian Radiation Protection Authority, Norway
Stenson, R.	International Atomic Energy Agency
Tayler, K.	Department of the Environment and Energy, Australia
Titov, A.	State Research Centre, Burnasyan Medical Biophysical Centre, Russian Federation
Uiba, V.	Federal Medical Biological Agency, Russian Federation
Van der Steen, J.	Consultant, Netherlands
Walker, S.	Environmental Protection Agency, United States of America
Yankovich, T.	Saskatchewan Research Council, Canada

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