

SPESS F
Document Preparation Profile (DPP)
Version 1 dated 26 April 2018

1. IDENTIFICATION

Document Category or set of publications to be revised in a concomitant manner

Specific Safety Guide

Working ID: DS512

Proposed Title: Borehole Disposal Facilities for Radioactive Waste

Proposed Action: Revision of Borehole Disposal Facilities for Radioactive Waste, IAEA Safety Standards Series No. SSG-1 (2009)

Review Committee(s) or Group: WASSC, NSGC

Technical Officer(s): D.G. Bennett, NSRW.

2. BACKGROUND

The objective of SSG-1 was to “provide guidance on the design, construction, operation and closure of borehole disposal facilities for the disposal of radioactive waste in accordance with the relevant safety requirements”. At that time, the relevant safety requirements were contained in IAEA Safety Series No. 115 (based on the 1996 version of the Basic Safety Standards), WS-R-1 (the 1999 publication on near-surface disposal), and WS-R-4 (the 2006 publication on geological disposal)¹.

The main focus of SSG-1 was on “boreholes having a diameter of no more than a few hundred millimetres and a depth beyond a few tens of metres and up to a few hundred metres”, and “disused sealed [radioactive] sources [DSRS] and small volumes of low and intermediate level wastes”.

Since publication of SSG-1 in December 2009, the relevant Safety Requirements have been revised, several relevant General and Specific Safety Guides have been published (see Section 6 below), and significant further research and development has been done on the borehole disposal concept in preparation for its implementation by Member States in countries such as Ghana, Malaysia and others.

¹ Note that GSR Part 5 on Predisposal Management of Radioactive Waste was published just before SSG-1, but was not referenced in SSG-1.

3. JUSTIFICATION FOR THE PRODUCTION OF THE DOCUMENT

Licensing and implementation of borehole disposal of DSRS is planned to occur in Malaysia and in Ghana in 2018, and many other States (e.g. Cuba, Jordan) are actively interested in developing their own plans for borehole disposal of DSRS that cannot be sustainably managed in other ways. It is timely, therefore, to provide up-to-date guidance on borehole disposal that properly reflects current Safety Requirements and supporting Safety Guides, the revised borehole disposal concepts, and the interest in such States. The revised Safety Guide would provide relevant parties (including potential operators, regulatory bodies and technical support organizations) with an up to date description of borehole disposal and guidance on how safety should be assessed and ensured.

At the 43rd WASSC Meeting in June 2017, Committee members requested the Secretariat to initiate the revision of SSG-1.

4. OBJECTIVE

The overall objective of the revision of Safety Guide SSG-1 is to align it with the current Safety Requirements (for example, GSR Part 5 and in particular SSR-5) and Safety Guides. The objective of the revised Safety Guide is to provide guidance on the development², operation, closure and regulatory control of borehole disposal facilities for disused sealed radioactive sources (DSRS) and small volumes of low and intermediate level radioactive waste to meet the safety requirements.

5. SCOPE

The revised Safety Guide will address borehole disposal facilities for DSRS and small volumes of low and intermediate level radioactive waste. Borehole disposal of other waste types (e.g. spent fuel, high level waste) will not be covered by the revised version of SSG-1.

The revised Safety Guide will cover both predisposal management and disposal (operational and post-closure safety) and their various interdependencies. This is important because predisposal waste management steps at borehole disposal facilities for DSRS are closely integrated with the waste disposal step.

The revised Safety Guide will address borehole disposal facilities in which waste disposal could occur at any depth, but it will not recommend disposal of wastes at depths shallow enough that safety might be adversely affected by inadvertent human intrusion (unless they are sufficiently short-lived and low activity wastes). Different types of borehole facilities will not be distinguished by disposal depth.

The interface between safety and security aspects of borehole disposal facilities will be addressed to the same extent as was done in SSG-1.

² The term 'development' covers all stages before operation of a borehole disposal facility. It includes siting, design, construction and commissioning. Siting encompasses a range of activities from initial site identification, site characterization and confirmation of the site for a disposal facility. While site characterization and site confirmation would be addressed in the safety guide, site selection would be excluded because it includes many aspects that are non-technical and specific to the societal context. General recommendations regarding the technical and scientific aspects of siting would, however, be provided in an Appendix.

6. PLACE IN THE OVERALL STRUCTURE OF THE RELEVANT SERIES AND INTERFACES WITH EXISTING AND/OR PLANNED PUBLICATIONS

It is proposed that the revised Safety Guide would sit in the same position in the structure of the Safety Standards Series as SSG-1. The list of interface documents includes:

- Safety Standards Series No. SF-1, Fundamental Safety Principles (2006).
- Safety Standards Series No. GSR Part 2, Leadership and Management for Safety (2016).
- Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (2014).
- Safety Standards Series No. GSR Part 5, Predisposal Management of Radioactive Waste (2009).
- Safety Standards Series No. GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency (2015).
- Safety Standards Series No. GSG-1, Classification of Radioactive Waste (2009).
- Safety Standards Series No. SSR-5, Disposal of Radioactive Waste (2011).
- Safety Standards Series No. SSG-14, Geological Disposal Facilities for Radioactive Waste (2011).
- Safety Standards Series No. SSG-23, The Safety Case and Safety Assessment for the Disposal of Radioactive Waste (2012).
- Safety Standards Series No. SSG-29, Near Surface Disposal Facilities for Radioactive Waste (2014).
- Safety Standards Series No. SSG-31, Monitoring and Surveillance of Radioactive Waste Disposal Facilities (2014).
- Nuclear Security Series No. NSS-11, Security of Radioactive Sources. Implementing Guide (2009).
- Nuclear Security Series No. NSS-14, Nuclear Security Recommendations on Radioactive Material and Associated Facilities (2011).
- IAEA-TECDOC-1824, Generic Post-Closure Safety Assessment for Disposal of DSRS in Narrow Diameter Boreholes (2017).
- IAEA TECDOC-1827, Model Regulations for Borehole Disposal Facilities for Radioactive Waste (2017).

In addition, reports, including some that update the IAEA borehole disposal concept for DSRS (e.g. regarding the physical designs, the materials for the containers and cementitious barriers and their testing and degradation performance, and security) and which give further information on the safety of disposing of Category 1 and 2 disused sealed radioactive sources, have been developed under a project³ that is aimed at assisting Member States to implement borehole disposal (e.g. in Ghana, Malaysia and elsewhere).

³

7. OVERVIEW

Safety Guide SSG-1 included the following sections:

1. Introduction.
2. Borehole disposal and the safety of radioactive waste management.
3. Borehole disposal and the protection of human health and the environment.
4. Safety in the planning of new borehole disposal facilities.
5. Safety and disposal in new borehole disposal facilities.
6. Implementation of the safety strategy for existing borehole disposal facilities.

It is proposed that the contents and structure of the revised Safety Guide should be consistent with the contents and structures of the Safety Guides on near surface and geological disposal, for example, as shown below:

1. INTRODUCTION
 - Background
 - Objective
 - Scope
 - Structure
2. OVERVIEW OF BOREHOLE DISPOSAL AND ITS IMPLEMENTATION
 - The IAEA concept for disposal of DSRs in narrow diameter boreholes
 - Other borehole disposal concepts
3. LEGAL AND ORGANIZATIONAL INFRASTRUCTURE
 - Government responsibilities
 - Responsibilities of the regulatory body
 - Responsibilities of the operator
4. SAFETY APPROACH
 - Importance of safety in the development process
 - Containment
 - Isolation
 - Multiple safety functions
 - Passive safety
5. SAFETY CASE AND SAFETY ASSESSMENT⁴
 - Scope, preparation, documentation, approval and use of the safety case
 - Understanding and confidence in safety
6. APPROACH TO THE DEVELOPMENT OF A BOREHOLE DISPOSAL FACILITY
 - Step by step development and evaluation
 - Site characterization
 - Design
 - Waste acceptance and predisposal management

⁴ This section will address the issues discussed in SSG-23, including safety assessment models, the use of the graded approach in safety assessment modelling, and the treatment of uncertainties.

Construction
Operation
Closure

7. ASSURANCE OF SAFETY

Surveillance and Monitoring

The period after closure and institutional controls

Systems of accounting for, and control of, nuclear material

Emergency preparedness and response

Managing interfaces between safety and security

Management systems

8. EXISTING DISPOSAL FACILITIES

APPENDIX I: SITING AND SITE CHARACTERIZATION FOR
BOREHOLE DISPOSAL FACILITIES

APPENDIX II: SAFETY ASSESSMENT ISSUES SPECIFIC TO BOREHOLE
DISPOSAL FACILITIES

REFERENCES

CONTRIBUTORS TO DRAFTING AND REVIEW

The 2009 Specific Safety Guide SSG-1 had Appendices that addressed:

- I. Regulatory inspection plan for a borehole disposal facility.
- II. The step by step approach.
- III. Safety case and safety assessment for borehole disposal facilities.
- IV. Site characteristics and characterization of the hydrogeological properties of a site.
- V. A possible surveillance and monitoring programme suitable for a small scale borehole disposal facility.
- VI. Management systems.

The 2009 Specific Safety Guide SSG-1 also had an Annex on the Generic Post-Closure Safety Assessment for Borehole Disposal of Disused Sealed Sources.

It is proposed that the Appendices and the Annex to SSG-1 would be revised as necessary as follows:

- Appendix I of SSG-1 on regulatory inspection would be removed because it is not specific to borehole disposal facilities and might in fact apply to all disposal facilities. Equivalent appendices do not appear in the Safety Guides SSG-29 and SSG-14 on near surface and geological disposal.
- Some material from Appendix II of SSG-1 on the step by step approach will (with suitable revision and updating) be incorporated in Section 6.
- Some material from Appendix III of SSG-1 on the safety case and safety assessment will (with suitable revision and updating) be incorporated in Section 5. Reference would also be made in the main text to SSG-23. This Appendix in the revised Safety Guide will address issues of safety assessment that are specific to borehole disposal facilities (e.g.

assessing the performance of borehole seals and casings, assessing thermal effects in and around boreholes).

- Some material from Appendix IV of SSG-1 on site characteristics and characterization will (with suitable revision and updating) be incorporated in Appendix I to the revised Safety Guide. Material from Section 4.5 of IAEA Tecdoc 1644 on site selection will (with suitable revision and updating) be incorporated in Appendix I to the revised Safety Guide.
- Some material from Appendix V of SSG-1 on surveillance and monitoring will (with suitable updates) be incorporated in Sections 6 and 7.
- Appendix VI of SSG-1 on Management Systems would not be included; instead, reference would be made to DS477.
- The Annex to of SSG-1 on the generic post-closure radiological safety assessment (GSA) would not be included; instead, reference would be made to TECDOC-1824 on Generic Safety Assessment for Disposal of DSRS in Narrow Diameter Boreholes.

8. PRODUCTION SCHEDULE: Provisional schedule for preparation of the document, outlining realistic expected dates for each step (*fill the column corresponding to your proposed document and delete the other columns*):

| | DATE |
|---|----------------------|
| STEP 1: Preparing a DPP | DONE |
| STEP 2: Approval of DPP by the Coordination Committee | Q3 2017 |
| STEP 3: Approval of DPP by the relevant review Committees | Q4 2017 |
| STEP 4: Approval of DPP by the CSS | Q2 2018 |
| STEP 5: Preparing the draft (assuming two consultancy meetings) | Q2 2018 - Q1 2019 |
| STEP 6: Approval of draft by the Coordination Committee | Q2 2019 |
| STEP 7: Approval by the relevant review Committees for submission to Member States for comments | Q4 2019 |
| STEP 8: Soliciting comments by Member States | Q1 2020 |
| STEP 9: Addressing comments by Member States | Q2 2020 |
| STEP 10: Approval of the revised draft by the Coordination Committee Review in NS-SSCS | Q2 2020 |
| STEP 11: Approval by the relevant review Committees | Q4 2020 |
| STEP 12: Endorsement by the CSS | Q4 2020 |
| STEP 14: Target publication date | Q2 2021 |

9. RESOURCES

Estimated resources involved by the Secretariat (person-weeks) and the Member States (number and type of meetings):

Staff: 8 staff weeks for drafting (assuming inputs from necessary staff in NSRW, NSNS and NEFW).

Consultants: 8 consultant weeks (assuming two one-week consultancies, each with four experts).

Feedback Analysis Report
On
Revision by Amendment to the Specific Safety Guide
Borehole Disposal Facilities for Radioactive Waste (SSG-1)

1. BACKGROUND:

The current version of the Specific Safety Guide, **Borehole Disposal Facilities for Radioactive Waste** (SSG-1), was published in 2009. The Safety Guide covers the design, construction, operation and closure of borehole disposal facilities for the disposal of radioactive waste. At the time of its publication, the relevant safety requirements were contained in IAEA Safety Series 115 (the 1996 version of the Basic Safety Standards), WS-R-1 (the 1999 publication on near-surface disposal), and WS-R-4 (the 2006 publication on geological disposal)⁵. The main focus of SSG-1 was on “boreholes having a diameter of no more than a few hundred millimetres and a depth beyond a few tens of metres and up to a few hundred metres”, and “disused sealed [radioactive] sources [DSRS] and small volumes of low and intermediate level wastes”.

2. ISSUE AND BASIS FOR CHANGES:

The Safety Guide SSG-1 on Borehole Disposal was published in 2009 and is the oldest one in the Radioactive Waste Disposal Area – it is not based on the current Safety Standards. One of the objectives of the proposed revision is to update and align it with the current Safety Standards, in particular the Safety Requirements SSR-5 on the Disposal of Radioactive Waste. Parts of the text of SSG-1 have become out of date, and there have been significant progress and developments in thinking since it was published, for example, on safety cases and safety assessments for disposal facilities, on the required management systems, etc. Further justification for the revision of SSG-1 comes from experiences in Member States where borehole disposal is currently being implemented. These projects have had to clarify certain aspects affecting the safety of borehole disposal, and have highlighted some gaps in the content of the guidance contained in SSG-1. For example, on how to determine and optimise the number of boreholes and wastes packages required; something that has been addressed since SSG-1 was published. The revision of SSG-1 is needed to ensure that the guide continues to be a useful reference publication for Member States. At the 43rd WASSC Meeting in June 2017, Committee members requested the Secretariat to initiate the revision of SSG-1. The rationale for this request reflects various drivers, including the following.

Since publication of SSG-1 in December 2009, the relevant Safety Requirements have been revised and several relevant General and Specific Safety Guides have been published. A list of relevant documents includes:

- Safety Standards Series No. GSR Part 2, Leadership and Management for Safety (2016).
- Safety Standards Series No. GSR Part 3, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (2014).
- Safety Standards Series No. GSR Part 5, Predisposal Management of Radioactive Waste (2009).

⁵ Note that GSR Part 5 on Predisposal Management of Radioactive Waste was published just before SSG-1, but was not referenced in SSG-1.

- Safety Standards Series No. GSR Part 7, Preparedness and Response for a Nuclear or Radiological Emergency (2015).
- Safety Standards Series No. SSR-5, Disposal of Radioactive Waste (2011).
- Safety Standards Series No. SSG-14, Geological Disposal Facilities for Radioactive Waste (2011).
- Safety Standards Series No. SSG-23, The Safety Case and Safety Assessment for the Disposal of Radioactive Waste (2012).
- Safety Standards Series No. SSG-29, Near Surface Disposal Facilities for Radioactive Waste (2014).
- Safety Standards Series No. SSG-31, Monitoring and Surveillance of Radioactive Waste Disposal Facilities (2014).
- Nuclear Security Series No. NSS-14, Nuclear Security Recommendations on Radioactive Material and Associated Facilities (2011).
- IAEA-TECDOC-1824, Generic Post-Closure Safety Assessment for Disposal of Disused Sealed Radioactive Sources in Narrow Diameter Boreholes, 2017.
- DS477, The Management System for the Predisposal and Disposal of Radioactive Waste (revision and combination of Safety Guides GS-G-3.3 and GS-G-3.4; in progress at Step 6, August 2017).

Significant further research and development has been done on the borehole disposal concept in preparation for its implementation in countries such as Ghana, Malaysia and others. Key developments, changes and revisions to the concept for disposal of DSRS in boreholes that have taken place since SSG-1 was published in 2009 have included:

Engineering Design

- The development of detailed designs for the disposal containers with revised dimensions (six lengths of disposal container are now considered in the concept), and with grab lifting arrangements and centralisers in order to assist with the emplacement of the waste containers in the borehole.
- Study and specification of the way in which the capsules and disposal containers would be marked (by engraving).
- Review of the materials that could be used for disposal containers and capsules for Category 3 to 5 DSRS and for Category 1 and 2 DSRS based on assessments of their corrosion potentials under relevant conditions.
- Specification of welding requirements for the capsules and disposal containers and procurement of suitable equipment.
- More detailed review and analysis, and specification of the various cement and other admixture materials to be used in the cementitious barriers, and specification of their mix designs and on-site testing protocols.
- Specification of how the cementitious containment barrier, including its lid, would be made and lifted.
- Study and specification of the material and arrangements for the borehole casing and the method of its installation (which may also involve the use of centralisers). Consideration of whether the casing should be closed at the bottom of the borehole and if so how this should be done.

- Design of a down-hole hopper tool for backfill installation.
- Development and testing of a Mobile Tool-Kit (MTK) for the predisposal management of Category 3 to 5 DSRS at the borehole disposal site.
- Integration of the MTK and a pre-existing Mobile Hot Cell (MHC), which can be used for the predisposal management of Category 1 and 2 DSRS, with the borehole, so that disposal can be done directly from these mobile facilities following the necessary predisposal waste management steps.
- Consideration of what quality assurance and quality assurance will be required during borehole construction and disposal facility implementation.

Safety Case and Safety Assessment

- Updated generic safety assessment for the disposal of Category 3 to 5 DSRS.
- Development of software tools for (i) making a preliminary assessment of a site's suitability for borehole disposal of DSRS (The Borehole Disposal Concept Screening Tool), and (ii) assisting with planning predisposal waste management operations and defining the number of waste disposal containers that will be needed for disposal of a particular DSRS inventory (The Source Inventory Management for Borehole Disposal tool SIMBOD).
- Completion of operational safety assessments for the use of the MTK and the MHC.
- Assessment of thermal and radiological effects of higher activity Category 1 and 2 DSRS and of the implications for disposal container and capsule corrosion.
- Peer review of site-specific safety cases and safety assessments for the borehole disposal of DSRS in Ghana and in Malaysia.

Regulatory Support and Licensing

- Development of Model Regulations for Borehole Disposal.
- Development of guidance for regulators on how to review and assess a safety case.

Other general observations and lessons learned since 2009 and that could be more clearly reflected in the revised safety guide include:

- That predisposal options for managing DSRS, including re-purposing/re-use and repatriation could be made clearer in the introduction to the safety guide.
- There is now greater recognition, based on efforts to implement the concept, e.g. in Malaysia, that regardless of the disposal concept, these are still disposal projects that carry all of the usual requirements for the demonstration of safety and the idea that some aspects could be readily dismissed is proving false.
- The level of safety provided by borehole disposal is indeed sensitive to the inventory of DSRS in the borehole(s) and the disposal environment / geological setting - further evidence that this disposal system requires all the same demonstrations of safety as any other disposal concept.

3. AFFECTED SECTIONS OF THE SAFETY STANDARDS:

Considering the wide range of information identified above, all sections of the Safety Guide need revision, but it is emphasized that the revisions needed relate mostly to details of the concept or to gaps that existed in 2009 regarding the arrangements for

implementing the concept – the overall borehole disposal concept remains essentially unchanged. It is proposed that the contents and structure of the revised Safety Guide should be revised to be consistent with the contents and structures of the Safety Guides on near surface and geological disposal.

4. RESOURCED IMPACTED:

It is estimated that 8 staff weeks would be required for drafting (assuming inputs from necessary staff in NSRW, NSNS and NEFW) and that this would be supported by 8 consultant weeks (assuming two one-week consultancies, each with four experts).

5. RECOMMENDATIONS:

The IAEA Secretariat recommends revision of SSG-1.