

**Safety-Related Activities of the IAEA for Radioactive Waste,
Decommissioning and Remediation – 13473**

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ABSTRACT

To fulfil its mandate and serve the needs of its Member States, the IAEA is engaged in a wide range of safety-related activities pertaining to radioactive waste management, decommissioning and remediation. One of the statutory obligations of the IAEA is to establish safety standards and to provide for the application of these standards. The present paper describes recent developments in regard to the IAEA's waste safety standards, and some of the ways the IAEA makes provision for their application.

The safety standards and supporting safety demonstration projects seek to establish international consensus on methodologies and approaches for dealing with particular subject areas, for example, safety assessment for radioactive waste disposal.

INTRODUCTION

The IAEA is authorized, by its Statute, to establish safety standards for protection of health and minimization of danger to life and property, and to provide for the application of those standards at the request of the Member States. Effective implementation of these standards is essential for ensuring a high level of safety. The Division of Radiation, Transport and Waste Safety has particular responsibilities for the safety of spent fuel and radioactive waste management, and has activities in the following topical areas:

- Predisposal management and disposal of radioactive waste from in principle all activities generating radioactive waste;
- Decommissioning of facilities, which include nuclear power reactors, research reactors, fuel cycle facilities as well as other facilities using radioactive material;
- Remediation of facilities and sites that have been radioactively contaminated such as uranium production facilities, areas contaminated as a result of nuclear or radiological accidents or industrial activities where NORM is handled;

- Control and assessment of radioactive releases to the environment with special emphasis on the protection of the public and the environment.

The foundation for all these activities is the safety standards which are regularly reviewed and revised. However, the safety standards alone do not ensure that a high level of safety is established and maintained. The safety standards must be complemented by projects aiming at promoting the practical application of them and activities assisting Member States in building the necessary technical competence and capacity.

The Joint Convention (JC) on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management entered into force in 2001 and has today sixty-four Contracting Parties. Although the JC is not an instrument of the IAEA, the IAEA serves as the Secretariat of the meetings of Contracting Parties and meetings of Subsidiary Bodies. One of the corner stones of the Joint Convention is the Review Meeting of the Contracting Parties, which takes place every three year and the 4th Review Meeting was held in May 2012.

As a consequence of the accident at TEPCO's Fukushima Daiichi nuclear power plant in March 2011 a Nuclear Safety Action Plan was adopted by the IAEA Board of Governors. The Nuclear Safety Action Plan addresses not only the safety of nuclear power plants but also actions directed towards protection of people and the environment from ionizing radiation following a nuclear emergency.

This paper will present the general approach to developing safety standards and give several examples of projects and other IAEA activities supporting the application of the standards. It will also provide an update of activities under the Joint convention and as a result of the Fukushima accident.

SAFETY STANDARDS

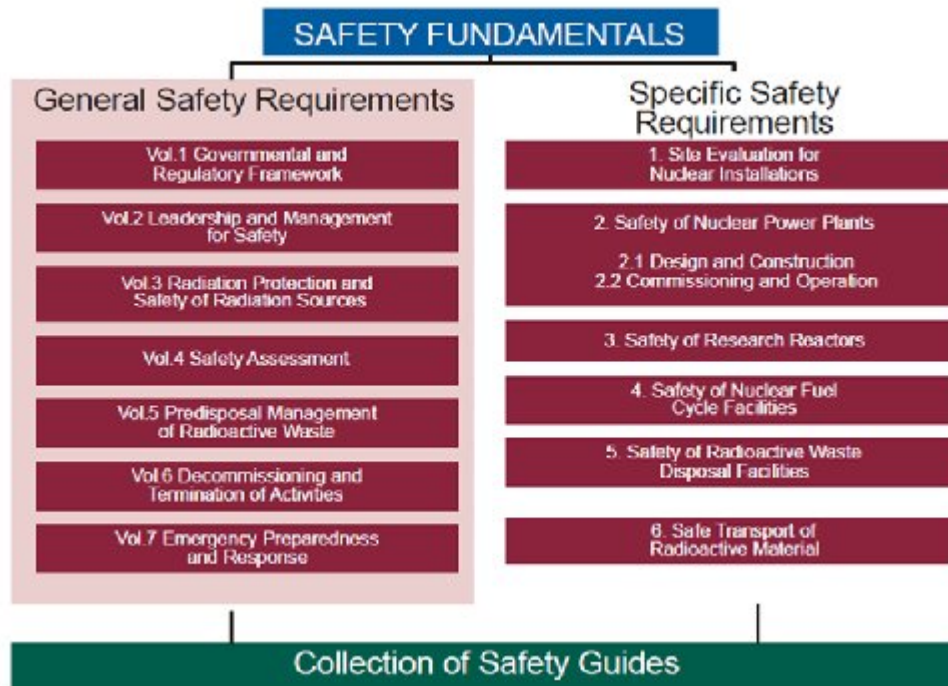
The IAEA safety standards have a status derived from the IAEA's Statute, which authorizes the IAEA "To establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health and minimization of danger to life and property... and to provide for the application of these standards".

It should be emphasized that regulation of safety is a national responsibility and this fundamental principle is expressed in e.g. the Fundamental Safety Principles (SF-1) and in the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. However, internationally agreed safety standards are essential for promoting harmonization and consistency of national regulations.

The safety standards have three hierarchical levels (illustrated in the figure). The highest level is the Safety Fundamentals (SF-1) and this document establishes the fundamental safety objective and principles of protection and safety.

The second level is the Safety Requirements which defines the requirements that must be met to ensure the protection of people and the environment, both now and in the future.

Safety Guides make up the third level and provide recommendations and guidance on how to comply with the requirements.



The preparation and review of safety standards involves the IAEA Secretariat and four Safety Standards Committees for nuclear safety (NUSSC), radiation safety (RASSC), the safety of radioactive waste (WASSC) and the safe transport of radioactive material (TRANSSC). The Commission on Safety Standards (CSS) oversees the entire safety standards programme. The members of the CSS are appointed by the Director General and include senior government officials having responsibility for establishing national standards. All IAEA Member States may nominate experts for the Safety Standards Committees and are consulted during the drafting stage.

A comprehensive set of safety standards (some of which are currently subject to review and revision) has been developed over the years that include waste-related topics such as predisposal management and disposal of radioactive waste, waste classification, decommissioning and remediation, control and assessment of radioactive releases, radiological impact assessment, management of NORM and residues from mining and milling. Lists of all valid Safety Standards as well as of those under development can be found on <http://www-ns.iaea.org/standards/default.asp?s=11&l=90>.

PROJECTS SUPPORTING APPLICATION OF SAFETY STANDARDS

The safety standards provide the internationally agreed safety requirements and guidance on how to comply with them. This is however not sufficient for achieving and maintaining a high level of safety, for example, in radioactive waste management. There is a need to complement the safety standards with specific projects aiming at supporting Member States in applying the safety standards and in building the necessary national competence and capacity.

The Division of Radiation, Transport and Waste Safety organizes several projects on radioactive waste management, which are open to all Member States. The projects are typically implemented over a period of two to four years depending on the scope and content. A common element of most of the projects is the concept of safety case and supporting safety assessment for facilities and activities. The projects cover methodology and principles for developing the safety case as well as practical aspects pertaining to implementation, for example, of an actual decommissioning project or of an operating a facility for radioactive waste management.

Some examples of current or recently completed projects are presented below and a comprehensive list can be found on <http://www-ns.iaea.org/home/rtws.asp?s=3&l=25>.

Decommissioning

The International Project on Use of Safety Assessment in the Planning and Implementation of Decommissioning of Facilities using Radioactive Material (FaSa) was launched in 2008 and concluded in 2011. The project aimed at illustrating the dynamic nature of decommissioning safety assessments and the need for their periodic review and updating, in order to take into account the changing facility status and hazards, the complexity of decommissioning activities at key phases, and/or the stage of decommissioning. It addressed initial safety assessments at early stages once the decommissioning plan was agreed, at key stages of decommissioning after shutdown through to safety assessment on the completion of decommissioning, which could be for the purposes of site release for restricted or unrestricted re-use.

The project addressed immediate dismantling and deferred dismantling of a range of facilities with different hazards and complexities, endpoints and end states (release of the site for restricted and for unrestricted use). The project illustrated its recommendation through test cases, based on real decommissioning projects volunteered by Member States. The test cases included a nuclear power plant, a large research reactor, a mining facility and a fuel fabrication facility.

Many research reactors have been shut down or will be shut down in the near future. The respective countries must develop decommissioning plans, strategy and expertise, and have funds available to safely decommission these reactors. As a response to these needs the IAEA established in 2006 the Research Reactor Decommissioning Demonstration Project (R2D2P). The scope of the project includes all aspects of decommissioning, from establishing a legal and

regulatory infrastructure to the final release of the reactor from regulatory control. The focus is on providing experts from regulatory bodies, operators and contractors with opportunities to learn from research reactors in different phases of decommissioning. The project does not provide a platform for research and development of new technologies. Only commercially available technologies are considered in the project since the aim is to provide concrete examples and practical advice on decommissioning of research reactors.

R2D2P workshops and training courses have been held at facilities that can serve as a teaching laboratory for participants. The participants receive training through lectures and gain practical insights into issues by examining matters at the given site. At workshops R2D2P participants apply the knowledge and information received to resolving site-specific problems, and to practical tasks.

Upon completion of R2D2P the following material will be available:

- A set of information papers and IAEA documents to share lessons learned;
- A set of safety related documents (i.e., decommissioning plan, environmental impact assessment, safety analysis report, health and safety plan, cost estimate, etc.) for use as models by those who are beginning the decommissioning process.

To date twelve workshops and training events have been arranged in six countries (the most recent was at State University of New York at Buffalo in December of 2012). Planning is ongoing for the last workshop(s) of the project but host institutions are not finally decided.

Legacy site management

Past development of commercial and military uses of radioactive material led to the development of many nuclear facilities worldwide. In many countries, these facilities were built and operated before the regulatory infrastructure was in place to ensure that they were effectively decommissioned at the end of their useful life. The legacy from this build up is that many countries now have abandoned nuclear facilities or areas where spills or accidents have occurred that are contaminated with long-lived radioactive and toxic residues that pose substantial environmental and health concerns. The International Forum on the Regulatory Supervision of Legacy Sites (RSLs), which was established by the IAEA in 2010, is focused on efforts to better regulate the existing sites and facilities and avoid the creation of new legacy sites through strong independent regulatory oversight. So far the RSLs project has concentrated on legacies from past uranium production but the intention is to gradually incorporate other types of legacies.

The scope of RSLs activities covers support in development of effective and efficient regulatory processes, such as:

- regulatory requirements and guidance development;
- licensing and authorisation;

- inspection, compliance monitoring and enforcement.

RSLs will compile lessons learned from past experience with legacy site remediation and provide recommendations as to what constitutes good practice for regulatory supervision of legacy sites.

Predisposal management of radioactive waste

The International Project on Complementary Safety Reports: Development and Application to Waste Management Facilities (CRAFT) was initiated in 2011 as a continuation of the previous International Project on Safety Assessment Driving Radioactive Waste Management Solutions (SADRWMS), which had developed a methodology for preparing safety cases and supporting safety assessments for predisposal management of radioactive waste.

The objective of the CRAFT project is to apply the SADRWMS methodology and Safety Assessment Framework (SAFRAN) software tool to representative radioactive waste management facilities and activities.

The SADRWMS methodology addresses approaches to the following aspects:

- Application of safety assessment methodologies for predisposal management of radioactive waste;
- Illustration and practical advice on application of safety assessment methodologies using the flowcharts and case studies;
- Graded approach to addressing a large variety of radioactive materials management challenges;
- Enhancement of confidence and public acceptability of the pre-disposal management practices by scientific safety assessment approach.

The CRAFT project supports operators responsible for preparing and maintaining safety cases for predisposal facilities as well as regulators responsible for reviewing safety cases and for supervision of operational facilities.

Disposal of radioactive waste

The IAEA has projects on the safety of both near-surface and geological disposal facilities for radioactive waste.

The project Practical Illustration and Use of the Safety Case Concept in the Management of Near-Surface Disposal (PRISM) was started in 2009 and completed in 2012. The PRISM project was concerned with the nature and use of the safety case over the lifecycle of a near-surface disposal facility. The emphasis has been on the practical implementation of near-surface

radioactive waste disposal using the safety case. The objective of this project was to share experience and communicate good practice concerning:

- The components and expectations of the safety case and their evolution over the lifecycle of a near-surface radioactive waste disposal facility;
- Decision making at different stages in the facility lifecycle, using the safety case.

The PRISM project has had four dedicated Task Groups that have been established to address specific issues:

- Task Group 1: Understanding the safety case
- Task Group 2: Disposal facility design
- Task Group 3: Managing waste acceptance
- Task Group 4: Managing uncertainty

In each of these tasks, the focus has been on the use of the safety case as a tool to inform decision making (by operators, regulators, and decision and policy makers) throughout the life cycle of the facility.

The key project deliverable is a project report (to be published 2013) based on the task group reports. In addition, a booklet, aimed at managers responsible for implementing near-surface waste disposal, has been prepared describing the use of the safety case in managing disposal at these facilities.

Permanent disposal of high level waste and spent fuel in appropriate geological facilities is major challenge for all countries with a nuclear power programme. IAEA addresses geological disposal through the International Project on Demonstrating the Safety of Geological Disposal (GEOSAF). GEOSAF pays particular attention to the evolution of the safety case with the development of a disposal project and particularly to the regulatory expectations on the development of the safety case in order to enable decisions to be made as part of the licensing process. Whilst the project addresses the elements of the safety case necessary for safety demonstration and the work necessary to support the various safety arguments, it also considers the process of reviewing and evaluating the safety case by regulatory authorities and the needed resources. That is the reason why the project involves regulatory authorities, technical safety organizations and waste management organizations responsible for the development and operation of geological disposal facilities.

The first part of GEOSAF (2008-2011) was largely focused on the safety case for the post-closure phase (long term safety) of a geological disposal facility. During the course of the project it was noted that, after decades of long term safety development, little work had been undertaken internationally to develop a common view on the safety approach for the operational phase of a geological disposal facility. GEOSAF therefore initiated a specific programme of work on the safety of the operational phase. Therefore the second part of GEOSAF, which was launched in

2012 aims at harmonizing approaches to the safety of geological disposal facilities through the development of an integrated safety case covering both operational and long term safety.

Radiological and environmental assessment

The IAEA has since the 1980's continuously assisted Member States on matters related to radiological and environmental modelling and assessment. In November 2012 a new four-year programme was launched, which is concerned with Modelling and Data for Radiological Impact Assessments (MODARIA).

The overarching objective of the IAEA's activities in environmental modelling is to enhance the capabilities of Member States to simulate radionuclide transfer in the environment and, thereby, to assess exposure levels of the public and in the environment to ensure an appropriate level of protection from the effects of ionizing radiation, associated with radionuclide releases and from existing radionuclides in the environment. Specific objectives in the areas of radioactive release assessment, restoration of sites with radioactive residues, and environmental protection are:

- To test the performance of models developed for assessing the transfer of radionuclides in the environment and radiological impact to man and environment;
- To develop and improve models for particular environments and, where appropriate, to agree on data sets that are generally applicable in environmental transfer models;
- To provide an international forum for the exchange of experience, ideas and research information.

At the first plenary meeting of MODARIA in November 2012 it was decided that work should focus on four themes (Remediation of Contaminated Areas; Uncertainties and Variability; Exposures and Effects on Biota; Marine Modelling), under which ten Working Groups were established. These working groups cover a wide range of model applications in planned, existing and emergency exposure situations.

MODARIA Working Groups:

Remediation of Contaminated Areas

- Working Group 1 – Remediation strategies and decision aiding techniques
- Working Group 2 – Exposures in contaminated urban environments and effect of remedial measures
- Working Group 3 – Application of models for assessing radiological impacts arising from NORM and radioactively contaminated legacy sites to support the management of remediation

Uncertainties and Variability

- Working Group 4 – Analysis of radioecological data in IAEA Technical Reports Series publications to identify key radionuclides and associated parameter values for human and wildlife exposure assessment
- Working Group 5 – Uncertainty and variability analysis for assessments of radiological impacts arising from routine discharges of radionuclides
- Working Group 6 – Common framework for addressing environmental change in long term safety assessments of radioactive waste disposal facilities
- Working Group 7 – Harmonization and inter-comparison of models for accidental tritium releases

Exposures and Effects on Biota

- Working Group 8 – Biota modelling: Further development of transfer and exposure models and application to scenarios
- Working Group 9 – Models for assessing radiation effects on populations of wildlife species

Marine Modelling

- Working Group 10 – Modelling of marine dispersion and transfer of radionuclides accidentally released from land-based facilities

The IAEA Action Plan on Nuclear Safety calls for strengthening Member States' capabilities for the assessment of radiological impacts and MODARIA has been designed to meet this request.

JOINT CONVENTION ON THE SAFETY OF SPENT FUEL MANAGEMENT AND ON THE SAFETY OF THE RADIOACTIVE WASTE MANAGEMENT

The Joint Convention on the Safety of Spent Fuel management and on the Safety of Radioactive Waste Management, the first legal instrument to directly address these issues on a global scale, was opened for signature in 1997 and entered into force in 2001.

The Joint Convention applies to spent fuel and radioactive waste resulting from civilian nuclear reactors and applications and to spent fuel and radioactive waste from military or defense programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes, or when declared as spent fuel or radioactive waste for the purpose of the Joint Convention by the Contracting Party. The Joint Convention also applies to planned and controlled releases into the environment of liquid or gaseous radioactive materials from regulated nuclear facilities.

WM2013 Conference, February 24 – 28, 2013, Phoenix, Arizona, USA

Since the Joint Convention entered into force in 2001 there have been four Review Meetings (2003, 2006, 2009 and 2012). The Review Meeting is one of the corner stones of the Joint Convention since all Contracting Parties are obliged to meet and review each other's National Reports.

The most recent Review Meeting was held in May 2012 with more than 600 delegates from fifty-four Contracting Parties. Some of the issues that received particular attention were:

- Development of a comprehensive regulatory framework;
- The effective independence of the regulatory body;
- Implementation of the strategies with visible milestones;
- Funding to secure waste management;
- Education and recruitment of competent staff and employees; and
- Geological repositories for high level waste.

The Review Meeting also noted that the review process generally functions well but that there is room for further improvements. Therefore the Contracting Parties decided to arrange an inter-sessional meeting, which will take place in April 2013. This allows the Contracting Parties to discuss and decide on actions that can be implemented for the 5th Review Meeting in May 2015.

The Summary Report from the Review Meeting is available at <http://www-ns.iaea.org/downloads/rw/conventions/fourth-review-meeting/summary-report-english.pdf>.

INTERNATIONAL PEER REVIEWS

The IAEA arranges international peer reviews on wide range of topics at the request of Member States. One of the best known and most widely used services is the Integrated Regulatory Review Service (IRRS), which is designed to strengthen and enhance the effectiveness of the national regulatory infrastructure of States for nuclear, radiation, radioactive waste and transport safety and security of radioactive sources.

Member States may also request specific peer reviews for particular facilities or activities. In the field of radioactive waste management some examples are:

- Peer Review of Radioactive Waste Management Activities of COVRA, Netherlands (2009);
- An International Peer Review of the Long Term Care Programme of the Former Sites of Uranium Production, Hungary (2011);
- International Peer Review for the Decommissioning Programme of Magnox Limited, United Kingdom (2011);

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- International Peer Review on the Deep Well Injection Practice for Liquid Radioactive Waste, Russian Federation (2013).

The technical basis for the peer reviews is the IAEA Safety Standards and, where appropriate, accepted good practice in the particular field of application.

NUCLEAR SAFETY ACTION PLAN

As a consequence of the accident at the Fukushima Daiichi nuclear power plant in March 2011 a Nuclear Safety Action Plan was approved by the IAEA Board of Governors in September 2011, as endorsed by the IAEA General Conference during its 55th regular session.

The Nuclear Safety Action Plan (NSAP) addresses twelve broad areas. One of these is concerned with protection of people and the environment from ionizing radiation, and it calls for:

- *“Member States, the IAEA Secretariat and other relevant stakeholders to facilitate the use of available information, expertise and techniques for monitoring, decontamination and remediation both on and off nuclear sites and the IAEA Secretariat to consider strategies and programmes to improve knowledge and strengthen capabilities in these areas.*
- *Member States, the IAEA Secretariat and other relevant stakeholders to facilitate the use of available information, expertise and techniques regarding the removal of damaged nuclear fuel and the management and disposal of radioactive waste resulting from a nuclear emergency.*
- *Member States, the IAEA Secretariat and other relevant stakeholders to share information regarding the assessment of radiation doses and any associated impacts on people and the environment.”*

Several of the activities and projects that address the NSAP area for protection of people and the environment from ionizing radiation are:

- A document on lessons learned on decommissioning after nuclear accidents have been drafted;
- An International Experts’ Meeting on Decommissioning and Remediation after a Nuclear Accident, 28 January to 1 February, 2013 in Vienna, Austria;
- On-going work with regard to strategies for managing large volumes of low level waste generated during remediation of contaminated land;
- The MODARIA programme to address capacity building for radiological impact assessments;
- In 2013 direct cooperation will commence with the local government and authorities in the Fukushima prefecture on e.g. off-site remediation and waste management.

CONCLUSIONS

There is a comprehensive set of International Safety Standards providing guidance on all aspects of radioactive waste management, which are regularly reviewed and revised to ensure that they up-to-date and meet the needs of the IAEA Member States.

To further assist Member States in building competence and capacity a number of international projects are on-going, which are open to all Member States.

The IAEA strongly encourages Member States to make use of peer review services since they are a good mechanism for checking alignment with the Safety Standards and international good practices, and for building confidence in national waste management programmes.