Nuclear Energy Agency task group on Radiological Characterisation for Decommissioning of Nuclear Installations

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ASTRACT

Radiological characterisation plays a significant role in the process of decommissioning of shut-down nuclear facilities in order to ensure the protection of the environment and radiation safety. At all stages of a decommissioning programme or project, adequate radiological characterisation is of crucial importance, not least from a material and waste perspective.

The radiological characterisation is a key element for planning, controlling and optimising decommissioning and dismantling activities.

Experience has shown that data and information from the operation of a facility can – supplemented by recently collected and analysed data and information - be of crucial importance for decisions on waste management and for characterisation of radioactive waste. Once the dismantling has been done, some information may be hard, costly or even impossible to obtain later in the waste management process.

This was the reason why the Working Party on Decommissioning and Dismantling (WPDD) of the OECD Nuclear Energy Agency (NEA) decided in late 2013 to extend the mandate of the Task Group on Radiological Characterisation and Decommissioning (TGRCD) for a second phase focusing on nuclear facility characterisation from a waste and material end-state perspective whereas the first phase focused on overall strategies of radiological characterisation.

This paper gives an overview of the activities and findings within both phases up to now.

Introduction

Radiological characterisation is an important activity in the decommissioning of nuclear facilities. It is the basis for planning, identification of the extent and nature of contamination, assessing potential risk impacts, cost estimation, implementation of decommissioning framework, radiation protection, protection of the environment, and management of material arising from decommissioning, as well as supporting decisions for release of buildings and site. At all stages of a decommissioning programme or project, adequate radiological characterisation is of crucial importance.

Having recognized the important role and significance of characterisation throughout all phases of decommissioning projects, the Working Party on Decommissioning and Dismantling (WPDD) of the OECD Nuclear Energy Agency (NEA) decided in November 2010 to establish an expert group, the Task Group on Radiological Characterisation and Decommissioning (TGRCD).

This multidisciplinary international task group is comprised of representatives from policy makers, regulatory authorities, radioactive waste management and decommissioning organisations and utility owners, and specialist consultants. In total, eleven NEA member countries are represented in this group.

Summary of phase I

The main objective of phase 1 was to develop a NEA status report [2] on selection and tailoring of strategies for radiological characterisation and its importance for safe decommissioning of nuclear facilities. The status report focuses on strategic approaches and issues, rather than providing detailed descriptions of the relevant methods or measurement technologies.

The aim of the status report is to provide decision makers and in general those, that are involved in planning, preparation and/or performance of decommissioning of nuclear installations, with an overview of best practice for radiological characterisation at different stages of decommissioning and to point out areas that could or should be developed further via international cooperation and coordination.

. The report summarises various issues relating to radiological characterisation in a short and succinct way and gives an overview of the issues, the techniques, possible obstacles, strategic aspects and lessons learnt.

To help to achieve this, the Task Group performed several activities, among those a survey for facilities in operation, transition phase or undergoing decommissioning and a radiological characterisation workshop in Studsvik (Sweden) in 2012 with over 120 participants from 23 countries and 4 international organisations [1].

Highlights from phase I

Role and significance of radiological characterisation in decommissioning

In general, the term "radiological characterisation" stands for the determination of the nature, location and concentration of radionuclides in a nuclear installation. It is one of the fundamentals on which a decommissioning project is to be built. Radiological characterisation must be seen as an on-going process and will only cease after successful execution of the final survey and the termination of the nuclear license. Characterisation does not only consist of sampling and measurements. It also involves the evaluation of information from the operating history, calculations, collections of existing data and many more sources.

When a nuclear installation is close to its end of operation, a radiological characterisation programme should be established as soon as possible. It should define an overall approach with principles, methods and steps necessary for the determination of the residual activity in all relevant media and structures, providing a reliable database of information on quantity and type of radionuclides, and their physical and chemical characteristics.

Radiological characterisation with respect to decommissioning shall mainly accomplish the following general objectives:

- Determination of the type, isotopic mixtures and extent of contamination in structures, systems, components and environmental media
- Verifying activation analyses and quantify hard to detect nuclides
- Support of dose modelling to develop dose based release criteria for materials, buildings and the site
- Assessment of decontamination techniques and determine waste classifications for packaging, shipping and disposal
- Determination of necessary remedial actions including the extent of required decontamination
- Provision of dose assessments for the workers during the implementation of decommissioning. Identification of health safety measures required for the protection of workers, general public and environment
- Support of the estimation of decommissioning costs
- Verification that release criteria for the facility and the site will ultimately be met.

The lifecycle of a nuclear facility comprises various phases, starting with a planning and construction phase, over operation up to the transition phase, followed by the dismantling and the final survey for the release from regulatory control. Radiological characterisation is required in each of these phases with different purposes, scopes and varying intensity such as:

- Baseline surveys to determine background radiation levels in siting phase and gathering of information in the construction phase
- Measurement and recording during the operational phase
- Detailed radiological surveys during the transition phase for the development of the final decommissioning plan
- In dismantling phase, radiological characterisation forms the basis for dose assessment, radioactive waste management and clearance
- At the end of decommissioning, a final survey of the site and any remaining structures supports an application for release of the site from regulatory control.

Definition of clear objectives

Measurements, taken either directly or indirectly by sampling, must be appropriate for the intended use of the data obtained. This means that the data quality and data quantity need to be assessed to be appropriate for and to meet the purposes and objectives of the characterisation.

The use of a stepwise procedure assures that the type, quantity and quality of environmental data used in decision making process will be appropriate for the intended application and objective. The "DQO Process" (DQO = Data Quality Objectives) [3] is considered to be appropriate.

Stepwise approach for radiological characterisation

There are certain key activities that are relevant for a radiological characterisation project or campaign during any phase in a nuclear facility lifecycle, and for any type of material or object to be characterized.

- Initiating phase: Definition of objectives of the characterisation project
- Planning phase: Development and implementation of a systematic planning methodology taking into account identified goals and boundary conditions
- Implementation phase: Measurements, sampling and analysis of the samples. The necessity for non-radiological characterisation (e.g. hazardous waste) should also be noted.

- Data Assessment and Evaluation phase: Review and assessment of the data generated by analyses or measurements in order to support conclusions and decisions. Statistical techniques can be applied to data assessment and are applied to characterisation projects as appropriate.
- Finalization phase: Final reporting clearly linked to the initial objectives to translate the data assessment into a meaningful language, comprehensible for the user or customer with transparency for stakeholders' examination.

Management aspects and selection of strategies

The compilation and evaluation of a large data base representing the knowledge on the radiological status of a nuclear facility – historical data from operation as well as recently collected data - implies a significant amount of work. In addition, radiological characterisation is a task which needs to be carried out in a well-structured and coherent manner.

It is recommended to assign the challenge of characterisation from the beginning to a team of experts including staff that is already in charge of the routine operations characterisation as well as additional experts solely for characterisation.

Use of integrated approaches to characterisation

When setting up a characterisation concept or programme, it is a good idea to take into consideration all activities where characterisation data may be required and to identify ways how obtained data could serve several purposes.

When planning radiological characterisation for systems and installations, it is a good idea to devise the characterisation in such a way that it may also provide information for the subsequent characterisation of building surfaces. Likewise, when buildings are characterized, especially for leakages through the foundation and for contamination on the exterior, it may be possible to gain already some insight into the contamination situation on the site.

Nuclide vectors for outside surfaces of systems and metallic structures may be the same as for building surfaces in the same room, as the contamination mechanism may be identical. Samples and measurements may therefore be taken at the systems and structures as well as on building surfaces.

The results of radiological characterisation may be entered into databases that includes or can communicate with a visual representation application for the data to secure an overview of the information gathered for systems and installations as well as of building surfaces in the same room. Such a system helps to identify any inconsistencies in the results. It also enables an assessment whether the available data are sufficient.

Experiences and lessons learned

Experience from many decommissioning projects shows that various unexpected developments may cause delays in the radiological characterisation or increase the required effort and thus may impact the overall decommissioning progress and costs. In the following some of those events are described without any claim for completeness. Careful planning and in particular exchange of information with similar decommissioning projects may help avoiding such failures and impediments.

List of nuclides

One of the most common issues is related to the radionuclides to be included in the characterisation. If for example in the nuclide vectors of a nuclear power plant the alpha contamination has been neglected or has only been characterised as total alpha activity, because initial sample analysis had indicated a low alpha content, extensive and costly repetition of sampling or evaluation will be inevitably required if it turns out later that it would have been necessary to distinguish between various alpha emitting nuclides (Am-241, several U, Pu and Cm isotopes). This could have been avoided if the completeness of the list of nuclides which need to be considered in any characterisation measurement had been assessed in the beginning, e. g. with the help of burn-up calculations.

Variation of nuclide vector within systems

In systems of nuclear power plants, the nuclide vector may change at filters or places where phase transitions (steam – water, water – steam etc.) or a change of the flow direction occur.

The use of certain decontamination techniques may lead to changes in the nuclide vector. In particular chemical decontamination methods have the potential of selectively reducing the amount of certain elements (e.g. metals) while not or only slightly affecting e.g. actinides.

Detection of subsurface contamination

While the protective coating on metallic and building surfaces against contamination is effective for easy decontamination during the operational phase for radiation protection purposes, it is often found to be an obstacle for radiological characterisation as surfaces may have been covered with new layers of paint to keep the surfaces good looking and easy to clean without written information regarding decontamination and proper contamination check prior to applying the new layer of paint.

Very mobile radionuclides like H-3 may cause problems concerning the correct determination of their penetration into metallic structures and in particular into building surfaces.

The possibility of presence of subsurface contamination below buildings and their foundation or in the soil of the site should be clarified as early as possible.

Phase II program and activities

The focus of the Task Group's Phase II that started in 2014 is on strategies how to optimise the characterisation of a nuclear facility from a waste and materials end-state perspective building on the reported results of Phase I. It will neither focus on the end state for the facility or the site nor on characterisation of radioactive waste packages or waste residues.

Objective

Main objective of Phase II is to identify strategic approaches, good practice, issues and risks related to disposal of radioactive waste and clearance of materials, including

- which information should be collected (type, quality, quantity), considerations variations etc.;
- why the information is needed;
- how the information could be gathered and managed;
- when the information could/should be gathered.

Another main objective will be to identify and present examples of best practice and to point at areas that could or should be developed further by international cooperation and coordination. Potential areas for research and development will be highlighted.

Main activities

Several activities are planned for Phase II including:

- Collection and analysis of international and national regulations, standards and guiding documents
- Carrying out an international survey related to facility characterisation from a material and waste end-state perspective
- Identify current strategies and practices for
  - defining objectives and perform planning
  - implementation of characterisation program
  - managing and analysing of data and other information
  - reporting results
- Knowledge management (up to disposal of the waste)
- Case studies

- Define best practice and areas of further development
- Arrange an international symposium organised by the task group will supplement the observations, analyses and evaluations – PREDEC2016.

The Task Group findings and recommendations will be summarised in a status report that is expected to be published in early 2017.

International survey

As mentioned above, one of the activities of Phase II is to perform an international survey within the NEA member countries to gather experiences, get an understanding of the experience among the specialists and also to collect the different specialists view on best practice.

The survey was conducted in the form of a questionnaire. Significant efforts were made for the development and management of the survey. Based on experience from earlier surveys within NEA, the questionnaire was divided into a version for regulators, policy makers and regulators consultant specialists ("Regulators' Questionnaire") and one version for the utility owners, specialised contractors, waste management and decommissioning organisations ("Implementers' Questionnaire") in order to cover all relevant areas such as national context, activities in the initiation phase, planning phase, implementation phase, data assessment, quality assurance but also to reduce the size of the versions to a necessary minimum.

Beside, the recipients of the Implementers' Questionnaire were also asked to provide information on a reference case.

The Task Group's aim was to receive responses for each questionnaire from at least five countries, at least ten responses per questionnaire and in total at least 30 responses in order to be viewed as international representative survey. Another important criteria was to receive at least one response per version from the same country what enables the Task Group to draw a full picture of the experience in this country.

The questionnaires were distributed in late April 2015 and the final responses were received during late summer. The achieved number of responses, the geographical spread as well as the experiences by the responders (as indicated in the responses) were to full satisfaction. More than 50 responses in total.

The conclusion after evaluation of the survey responses is that

- There is a solid experience in radiological characterisation among regulators as well as owners/implementers.
- Responses demonstrate to large extent a common view of regulators and owners/implementers on Good Practice.

- There are several "Do not know" on certain details – most likely due to limited experience of large characterisation projects.
- Reducing uncertainty about waste and identification of waste classification are generally the highest priorities.
- National legislation related to clearance as well as the disposal programs has a significant impact on approaches taken to radiological characterisation.

Case studies

Case studies play an important role in the Task Group's activities as they supplement observations with practical experience. Projects in ten countries within North America, Europe and Asia have been identified to serve as case study objects. Common for all selected objects are significant activities in characterisation for decommissioning in a waste and material perspective. Of special interest are facilities with approaches considered as best practice and/or an extensive experience that has been built up.

References

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