INTERNATIONAL ATOMIC ENERGY AGENCY

MEETING REPORT

NUCLEAR POWER PLANT TEST CASE

"Use of safety Assessment in Planning and Implementation of decommissioning of Facilities using radioactive material" (FaSa Project)

Second Joint FaSa Meeting, 7-11th December 2009,
Federal Ministry for the Environment,
Nature Conservation and Nuclear Safety,
Bonn (Germany)

A. BASSANELLI (IT), Chairman, NPP Test Case

(December 2009)

CONTENTS

1. INTRODUCTION

This meeting of the Nuclear Power Plant (NPP) Test Case working group was part of the 2nd joint meeting of FaSa project. The NPP TC WG meeting took place on December 10th in Bonn (GE).

2. MEETING OBJECTIVES

The meeting objectives were to:

- Report on the major highlights since the 1st NPP TC WG meeting held during the 1st Joint meeting of FaSa project held in Wien on November 2008,
- Analyse and discuss the report agreed during the 1st NPP TC WG, to verify its applicability,
- Plan the development of a Report addressing the activities foreseen during the next two years together with the identification of milestones, meeting date and sharing of the activities within the MS participants.

Mrs Patrice McEahern has stepped down from the post of Chair. Alvio Bassanelli (IT) had been nominated as a replacement Chair and accepted the post. The meeting continued with Mr Bassanelli as Chair, Mr Stefan Thierfeldt as Vice-Chair and Mr Jörg Möller as Technical support from Rheinsberg NPP.

It is confirmed that the NPP Test Case will refer to Rheinsberg NPP in Germany.

3. MEETING PARTICIPANTS

The following persons participated in the 2nd FaSa NPP Test Case Working Group meeting held on December 10th in Bonn:

Name	Affiliation	Country
Karine Ghazaryan	Armenian Nuclear Power Plant Metsamor	Armenia
Ivana Davidova	Czech Power Company	Czech Republic
Philippe Auffray	EdF - CIDEN	France
Hermann Langer	Vattenfall	Germany
Kerstin Kühn	Bundesamt für Strahlenschutz	Germany
Stefan Thierfeldt	Brenk Systemplanung GmbH – Vice-chair	Germany
Jörg Möller	Kernkraftwerk Rheinsberg – KKR technical support	Germany
László Juhász	National Research Inst. for Radiobiology and Radiohygiene	Hungary

Name	Affiliation	Country
Anna Maria Motoc	National Research Inst. for Radiobiology and Radiohygiene	Hungary
Alvio Bassanelli	SOGIN s.p.a. - Chairman	Italy
Yukihiro Iguchi	Japan Nuclear Energy Safety Organisation	Japan
Saulius Stravinskas	VATESI (Regulatory Body)	Lithuania
Pjotr Rubtsow	Scientific & Engineering Centre for Nuclear / Radiation Safety	Russia
Mirsolav Drahos	Nuclear Regulatory Authority (UJD)	Slovak Republic
Hakan Lorenz	Barsebäck	Sweden
Andrew Dietzold	UKAEA Cumbira	UK

4. CONSIDERATION ON APPROACHES TO DEVELOP NPP TC

The basic scope of the FaSa project, as recalled in Sect. 3 of Ref. 1, are the following:

- to provide practical and useful recommendations on the evolution and use of safety assessment in the planning and conduct of decommissioning with the view to ensure safe termination of practices.
- To provide recommendations on the use of the safety assessment methodology and recommendations that were developed in the DeSa project.

Due to the following major constrains:

- The activity originally scheduled within three years framework is now due in two years framework,
- Neither WG independent safety assessment of the consequences for accident identified for the specific Test Case nor SSCs independent WG identification need to bel performed. The activity will be based only on the analysis of safety assessments done by Test Case facility,

the NPP TC WG objectives are redirected as follows:

I. Analysis of the overarching safety assessment developed in the Rheinsberg NPP Deco Plan:
    - To investigate on the application of the DeSa methodology,

- To investigate on the application of the Deco Planning WG Report ,
- To illustrate the approaches on the following topics: graded approach, confidence building, review of safety assessment, work control process, defence in depth, technical feasibility, optimization of protection measures
- to provide practical and useful recommendations on the evolution and use of safety assessment to be feebacked to the DeSa Report and FaSa Deco Planning WG Report ,

II. Analysis of the detailed safety assessments developed in the Rheinsberg NPP Deco Conduct phases:

- To investigate on the application of the DeSa methodology,
- To investigate on the application of the Deco Conduct and Termination WGs Reports ,
- To illustrate the approaches on the following topics: graded approach, confidence building, review of safety assessment, work control process, defence in depth, technical feasibility, optimization of protection measures
- to provide practical and useful recommendations on the evolution and use of safety assessment to be feebacked to the DeSa Report and Deco Conduct and Termination WGs Reports.

It is confirmed that the project will focus on radiological hazards to workers, public and the environment. However, it is intended that it will also address conventional hazards during decommissioning that contribute to radiological hazards and their potential consequences.

5. PERFORMANCE OF SAFETY ASSESSMENT

In the following are reported the decisions taken by the NPP TC WG during 2nd meeting (2009) in Bonn on how to proceed to perform the activities defined.

The NPP Test Case WG will reads and discusses the final decommissioning plan of KKR Rheinsberg NPP of 1993 (prepared for the 1st decommissioning licence) and investigates whether all items of the DeSa and FaSa approach have been met. It compares the decommissioning plan with the outcome of the FaSa WG on Decommissioning Planning and on Decommissioning Conduct, with particular emphasis on the overarching safety assessment. The NPP TC WG feeds back the results to these two WGs.

The purpose it is to complete all the Sections of NPP TC Reports [Ref. 4] by November 2011.

The following Steps in the Test Case are envisioned:

Step 1: Sections 1, 2 and 3 of the NPP TC Report [Ref. 4]

Those sections are already available and need to be commented by the MS participants to the NPP TC WG.

During the meeting has been agreed that the following considerations have to be included in the existing NPP TC Report [Ref. 4]:

Waste management *(to be included in Sec. 3.6 of Ref. 4)*

Describe that this is outside DeSa methodology. Describe that this is handled in a centralised facility being equipped with decontamination, segmenting techniques and storage facilities. This is the topic of other IAEA guidance (pre-disposal safety assessments of radioactive waste).

Describe the interface between "our" Test Case and this centralised facility (activity, nuclides, size etc.)., i.e. describe responsibility of Test Case NPP and the centralised storage facility, licensing regime etc.

Occupational dosimetry (control of exposure) *(to be included in Sec. 3.7 of Ref. 4)*

It is assumed that all members of the workforce carrying out the activities described in the safety report are subjected to dosimetry (external dose, incorporation) in a normal working environment (controlled area).

It is also assumed that a suitable management structure is in place, that knowledgeable personnel is available, radiation protection plan, hazard management strategy, knowledge management (maintaining plant know-how) and emergency preparedness are in place

Each MS participants needs to provide comments on the contents of those Sections before the next NPP TC meeting scheduled in May 2010. The final text will be discussed and agreed during next NPP TC meeting on May 2010.

Step 2: Performance of an Overarching Safety Assessment (Objective I)

To develop the remaining NPP TC Report Sections, for the part related to the Overarching Safety Assessment, with particular emphasis to Sections 4 and 5 on Hazard Analysis, has been decided to apply the following considerations.

General Description

The overarching safety assessment deals with the entire decommissioning project. It is based on the data provided in the documents of KKR, in particular in the decommissioning plan of KKR.
It represents the status near the end of the operational phase, with some updates after final shut-down during the transitional phase.
The overall structure of the decommissioning project is described, with phases until end state, including starting points and end points of each phase, including a timeline with milestones (time of next application for licence/permit/approval, expected granting of licence/permit/approval, execution of the work, termination of the phase).
The safety assessment shall acknowledge that with each decommissioning phase, a reduction of the inventory is achieved, leading in general to a reduction of the hazard/risk.

Purpose

The overarching safety assessment will be part of the documentation that is needed to be submitted for obtaining the (first) decommissioning licence in order to reduce workforce, relax technical specification etc.
(see also the purposes identified by the Decommissioning Planning WG – use their documents to complete the list of purposes)

Scope

The work on this Test Case encompasses everything from start of dismantling to the end state – but: with different level of detail: include phase #1 in more detail, the later phases only in a descriptive way.
Defuelling (from the RPV to the spent fuel pool) and management of operational radioactive waste is out of the scope.

Minimum data requirements

- Preliminary radiological characterisation, e.g. dose rate maps, surface contamination maps, activity contents of main components, such as reactor pressure vessel and reactor internals, and the systems and building structures etc.
- underground structures (drainage, shared services) – relevant for reaching the end state and licence termination
- Source terms (nuclide composition and activity concentrations) for routine releases with offgas (through the stack) and waste water (Bq/l water, Bq/m³ air), release rates (m³/h, l/a)
- Technical description / evaluation of dismantling, decontamination and waste handling techniques in-house or externally; waste shipment routes; reasons

for decisions (compare options – on which basis: doses, timescale, waste quantities and their relevant categories …)

- Workforce (number of personnel involved in the various phases and tasks etc.)
- Information of the classification of systems, structures and components (SSC) with relation to safety. Safety-related SSCs have to fulfil higher requirements and could be considered to remain in operation also during an incident / accident (as well as during normal operation). Usual SSCs classified as safety related: e.g. fire fighting, ventilation, measurement, drain collection, others? Information on the evolution of this classification with time / with progress of decommissioning / over the decommissioning phases.

Hazard identification and analyses

The NPP TC WG is only reading and discussing the documentation of KKR with respect to the following items:

- Worker exposure during normal operation: estimate the maximum individual dose for each decommissioning phase from a conservative assessment of working time and dose rate; estimate the collective dose from max. individual dose and number of workers – decide how far this should be carried with respect to waste management (i.e. cutting and waste management at an external waste management facility vs. handling the material in-house).
- Worker exposure from incidents/accidents: use an enveloping scenario (exposure time, release rate/fraction, aerosol concentration, affected volume, activity concentration, breathing rates etc.)
- Doses to a representative person (member of a critical group) of the general public from routine releases to the environment (liquid, gaseous) by taking over the existing analysis of KKR, in combination with a short description of the calculation procedure used for derivation of effective dose and organ dose, including description of the assumptions. (*note: the KKR calculations have been based on the calculation procedure laid down in an Administrative Procedure, part of which has been translated for DeSa already)*.
- Incident / accident analysis with off-site consequences for a representative person (member of the critical group) of the general public: propose a bounding accident scenario for each decommissioning phase (e.g. a fire, drop of a waste container, leakage from tanks – above ground or underground) including a suitable initiating event; use a deterministic approach (i.e. the scenarios are assumed to take place with 100 % probability for the sake of this our analysis).

Implementation of the Results of the Safety Assessment

Illustration of the approaches on the following topics: graded approach, confidence building, review of safety assessment, work control process, defence in depth, technical feasibility, optimization of protection measures
Practical and useful recommendations on the evolution and use of safety assessment to be feebacked to the DeSa Report and Deco Plan WG Report.

Based on the data retrieved according to the abovesaid considerations the volunteers NPP TC MS will be provided a draft text for the Sections from 4 thru 11 of the NPP TC Report [Ref. 4], for the parte addressing the Overarching Safety Assessment.

The work up to this point can commence after the reports from the FaSa Decommissioning Planning WG has been issued (end of March 2010). The participants can make their own evaluation based on the report with the KKR description (October 2008) and any additional data to be provided by Alvio, Jörg or Stefan.

Step 3: Performance of Detailed Safety Assessments

Among the seven phases among which the KKR Deco Plan has been agreed to select detailed safety assessment for inclusion in the test case according the following criteria:

- Recognisable to many member states
- Applicable to many decommissioning applications
- Scenario which results in a significant consequence
- Scenario which impacts the end state

Based on those criteria the analysis will be focused on the detailed safety assessment for the following four phases:

- Phase G03 – Dismantling of systems and component,
- Phase G06 – removal of RPV, removal of reactor internals,
- Phase G07 – decontamination of buildings, clearance,
- Phase End State/licence termination.

Due to the amount of work needed within this Step the activities foreseen will be split in two sub steps:

Substep 3.1 : analysis of Phases G03 and G07,
Substep 3.2 : analysis of phase G07 and end state

Substep 3.1 – Phases G03 and G06

- **Safety Assessment for Phase G03**

General Description

This phase could cover parts of the KKR licensing phase 3 (G03) including pipes, a tank and a steam generator, i.e. only contaminated items, no activation. The

NPP Test Case WG will read and discuss the available documents of KKR and will incorporate relevant results into the decommissioning conduct report.

Purpose

part of the licensing documents for obtaining the licence/authorisation for this decommissioning step

Scope

work to be performed during this phase; including dismantling, decontamination, cutting for further size reduction, packaging for external waste management (including primary and secondary waste) and preparation of transport to the external waste management facility (ZLN/ZAW at Greifswald) and other relevant work

Minimum data requirements

(More) detailed radiological characeterisation of the materials (systems, components) to be included in this phase;
engineering data (sizes, diameters, thicknesses, material specifications); including data on the lifting equipment (capacity, availability)
operational history including annual decontamination during operation and incidents (if any);
identification of interactions with safety relevant systems (that need to be kept operational after this decommissioning phase);
description of the tools, equipment and techniques with which the work is performed
description of the dismantling procedures, including work force, work activities, estimated time required for certain (most important) work packages
description of the waste / transport containers for shipment of material to interim storage / further processing; waste forms (primary: metal; secondary: depends on decontamination / segmenting techniques; e.g. liquid waste from wet decontamination processes)

Hazard identification and analyses

Workers / public (critical group / representative individual) // decommissioning operation as planned / incidents-accidents
Hazard identification: HAZOP methodology could be used as in main DeSa report (long checklist with questions leading to possible hazards); identification and evaluation of consequences for most important hazards (largest consequences) – use of a screening approach, identification of few enveloping scenarios. This would include also the substantiation why certain events would be mitigated or are not deemed to be possible to happen (function of SSCs etc.). The fact that this does not fully adequately cover multiple failures should be addressed.

Application of the Results of the Safety Assessment

Illustration of the approaches on the following topics: graded approach, confidence building, review of safety assessment, work control process, defence in depth, technical feasibility, optimization of protection measures

Practical and useful recommendations on the evolution and use of safety assessment to be feebacked to the DeSa Report and Deco Conduct WG Report.

- **Safety Assessment for Phase G06 (Removal of Reactor Pressure Vessel with Reactor Internals)**

General Description

Removal of the RPV with reactor internals, comparison of two approaches that have been fully analysed indepently:

- in situ dismantling of the RPV and internals and packaging of the segmented parts;
- removal in one piece of the RPV and the reactor internals (which could be left inside the reactor) for interim storage at intermediate storage site (at Greifswald, ZLN)

Comparison of the benefits / disadvantages of both options. Criteria: doses, timescale

Purpose

part of the licensing documents for obtaining the licence for this decommissioning phase (same as above)

Scope

work to be performed for both options of this phase; including operation of the (wet and dry segmenting) segmenting stations, dismantling, (decontamination,) cutting for size reduction, internal transport, preparation for external waste management (including primary and secondary waste) and other relevant work
both options as described above, in addition comparison of storing reactor internals inside RPV or separately.
the assessment of accidents during transport is not part of this work

Minimum data requirements

Characteristics of the RPV and the internals
Capacity of lifting equipment
activity, activation nuclides etc.
Data on the rail connection (weakest bridge, capacity of the heavy load freight car)
data on annular water tank and how it was emptied

Hazard identification and analyses

in general: same as before
incident scenarios: dropping of the RPV and the reactor internals (analysis for the radiological consequences); other internal events, e.g. from previous decommissioning phases still going on (e.g. starting a fire in a different area of the facility that spreads to the current working area); removal of water from annular water tank around reactor (spillage / dropping)

Application of the Results of the Safety Assessment

Illustration of the approaches on the following topics: graded approach, confidence building, review of safety assessment, work control process, defence in depth, technical feasibility, optimization of protection measures
Practical and useful recommendations on the evolution and use of safety assessment to be feebacked to the DeSa Report and Deco Conduct WG Report.

The work can commence after the Rheinsberg meeting on May 2010. The activity will start with the analysis of phases G03 and G06. The participants can make their own evaluation based on the report with the KKR description (October 2008) and any additional data to be provided by Alvio, Jörg or Stefan. A WG discussion on the safety analysis for those phases are scheduled during a NPP TC WG to be held in October 2010.

Substep 3.2 – Phases G07 and End State

- **Safety Assessment for Phase G07 (Preparation of the contaminated buildings for conduct of clearance procedure and release from regulatory control)**

  General Description

  Decontamination (with scabbling or other techniques) of the buildings (of part of the facility) for clearance for demolition of the buildings.
  Description of the starting and end points, of the techniques to be used, the applicable clearance levels etc.

  Purpose

  This safety assessment is part of the licensing documents for obtaining the licence/authorisation for this decommissioning step, i.e. licence/authorisation covering clearance and demolition of buildings.

  Scope

  Set of buildings (e.g. reactor hall), after complete removal of all systems inside the buildings (with the exception of pipework inside walls and floors that is not accessible prior to demolition); i.e. only decontamination of walls, floors (and ceiling, if required) is necessary; clearance measurements, release from control. Handling of building rubble from decontamination during preparation of the buildings is included.
  The options how to deal with residual contamination in the pipework embedded in the building structures should be discussed (a – decontaminate pipes and show compliance with clearance levels; b – remove pipes from the building structure, c – salvage the pipes during building dismantling and treat pipes separately; KKR took only a and b into consideration, but all 3 options should be evaluated for the FaSa Test Case).

The storage, transportation etc. of building rubble from decontamination is usually treated as radioactive waste and is therefore outside the scope of the assessment.
The actual conventional demolition takes place after clearance and is therefore not part of the safety assessment. However, safety aspects from conventional demolition should be taken into account (e.g. the use of explosives and the effect on other installations on the site). This has not been assessed by KKR, so would have to be evaluated by the Working Group – *it remains to be seen whether the WG has sufficient experience to carry out this assessment*.

Minimum data requirements

Operational history with relevance to contamination of buildings
average contamination and possibly (small) activation of the building surfaces, nuclide vectors etc.
characeteristics of the buildings (size, areas, coating of the building surfaces etc.)
preferred decontamination technique, e.g. scabbling, shaving, washing. The various radiological and conventional aspects should be evaluated.

Hazard identification and analyses

basically as above, but possibility of radiological incidents is drastically reduced. Incidents may result from handling of contaminated rubble from demolition.
This is an area where incidents with consequences in the conventional area have a higher potential. Emergency plan might be tailored to conventional accidents. – *It remains to be seen what expertise the WG has at its disposal to cover these conventional hazards.*

Application of the Results of the Safety Assessment

Illustration of the approaches on the following topics: graded approach, confidence building, review of safety assessment, work control process, defence in depth, technical feasibility, optimization of protection measures
Practical and useful recommendations on the evolution and use of safety assessment to be feebacked to the DeSa Report and Deco Conduct WG Report.

- **Safety Assessment for the End State / Licence Termination**

Purpose

This assessment could be performed in substantiation of the FaSa Licence Termination document. It could report on what needs to be done to provide confidence that the site licence can be terminated, e.g. boreholes, environmental monitoring etc.

Description of the site / status

Green field, no building, free release of site

Requirements / Constraints

restored to be part of nature reserve surrounding the site
restrictions on land use according to presecriptions for nature reserve
Release criteria for land; based on 0.3 mSv/a (IAEA) or others values as deemed appropriate by the WG

Demonstration of compliance

dose modelling
radiological map of area
measurements
Dose modelling for the KKR site is not available, as this step has not been planned yet. However, the results of the environmental monitoring programme and other historical information showing tendencies of releases etc. are available.

Application of the Results of the Safety Assessment

Illustration of the approaches on the following topics: graded approach, confidence building, review of safety assessment, work control process, defence in depth, technical feasibility, optimization of protection measures
Practical and useful recommendations on the evolution and use of safety assessment to be feebacked to the DeSa Report and Deco Termination WG Report.

The work can commence after the 3rd FaSa annual meeting of November 2010.
The activity will consist in the analysis of phases G07 and end state.
The participants can make their own evaluation based on the report with the KKR description (October 2008) and any additional data to be provided by Alvio, Jörg or Stefan.
A WG discussion on the safety analysis for phases are scheduled during a NPP TC WG to be held in May- June 2011.

6. NPP TC REPORT CONTENTS

The above said activities will result in a NPP TC Report articulated as follows:

- Section 1 – Introduction *(vs Sect. 1 of Ref. 2)*
- Section 2 - Safety Assessment Framework *(vs Sect. 3.1 of Ref. 2)*
- Section 3 - Description of the facility and decommissioning activities *(vs Rheinsberg NPP documentation)*

- Section 4 – Hazard Analysis : Identification and screening *(vs Sect. 3.3 of Ref. 2)*
  - Subsection 4.1 – Performance of an Overarching Safety Assessment
  - Subsection 4.2 – Performance of Detailed Safety Assessments for:
    - Phase G03 – Dismantling of systems and component,
    - Phase G06 – removal of RPV, removal of reactor internals,
    - Phase G07 – decontamination of buildings, clearance,
    - Phase End State/licence termination.

- Section 5 – Hazard Analysis : Evaluation *(vs Sect. 3.4 of Ref. 2)*
  - Subsection 4.1 – Performance of an Overarching Safety Assessment
  - Subsection 5.1 - Performance of Detailed Safety Assessments for
    - Phase G03 – Dismantling of systems and component,
    - Phase G06 – removal of RPV, removal of reactor internals,
    - Phase G07 – decontamination of buildings, clearance,
    - Phase End State/licence termination.

- Section 6 - Engineering Analysis *(vs Sect. 3.5.4 of Ref. 2)*

- Section 7 - Evaluation of results and safety measures *(vs Sect. 3.5 and Sect. 7 of Ref. 2)*

- Section 8 - Graded Approach *(vs Sect. 4. of Ref. 2 and Ref. 3)*

- Section 9 - Confidence Building in the safety assessment *(vs Sect. 5 and Sec. 6 of Ref. 2)*

- Section 10 – Use of the safety assessment results *(vs Deco Plan, Conduct and Termination WG reports)*

- Section 11 - Summary and Lesson Learned *(vs Sect. 8 of Ref. 2)*

  It address also the following topics: Defence in depth, technical feasibility, optimization of protection measures.

7. LIST OF ACTIONS

The following actions are foreseen among the MS participants:

	Activity	Actors	Due time
1	Step 1	All	NPP TC WG May 2010 meeting

2	Step 2	All	NPP TC WG May 2010 meeting
3	Step 3.1	All	NPP TC WG October 2010 meeting
4	Step 3.2	All	NPP TC WG May-June 2011 meeting
5	Provide comment of final draft of NPP TC Report	All	October 2011

8. NEXT MEETINGS

The WG agreed that there was a need for potentially two future meetings in 2010 to meaningfully progress the draft Test Case report before the next (November 2010) Joint FaSa Meeting.

The following provisional dates were identified for the Test Case Working Group members to reconvene to develop and discuss the draft report:

- Meeting date : 25-28 May 2010,
  Location : NPP Rheinsberg
  Purpose : discuss Overarching Safety Assessment, assign homeworks on licensing phases G03 and G06 to two sub-groups of this Working Groups,

- Meeting date : October 2010,
  Location : To be confirmed
  Purpose : Discus detailed safety assessment for licensing phases G03 and G06,

One additional meeting could be foreseen in May-June 2011 to discuss detailed safety assessment for licensing phases G07 and End State.

9. REFERENCES

[1] FaSa Project Draft Version 1.4 , May 2009

[2] IAEA Safety Report - DeSa Safety Assessment Methodologies for decommissioning of facilities using radioactive material – Draft 3.0 30.05.2008

[3] IAEA Safety Report - Graded approach to Safety Assessment for decommissioning of facilities using radioactive material – Volume III (*Outcomes of the International Project on Evaluation and demonstration of safety during decommissioning of nuclear facilities*)

[4] Description of FaSa NPP Test Case, Draft Version 0.6 (January 2010)

DISTRIBUTION

- NPP Test Case WG participants
- J Kaulard, Chairman, FaSa Project
- A Halle, Fuel Fabrication Test Case Working Group
- K Lauridsen, Research Reactor Test Case Working Group Chair
- A Cadden, Mining and Milling Test Case Working Group Chair
- A Hart, Decommissioning Termination Working Group Chair
- O. Lareynie, Decommissioning Termination Working Group Chair
- P Francois, Decommissioning Conduct Working Group Chair
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- M Pennington, Safety Assessment Implementation Working Group Chair
- D Orlando, Review Working Group Chair
- V Ljubenov, IAEA Scientific Secretary
- J Rowat, Unit Head, IAEA Decommissioning and Radiation Unit
- FaSa website