TURVA-2012: Handling QA

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Goals and principles

Posiva applies a management system that complies with the ISO 9001:2008 standard for all activities, including the production of safety case reports, and requires the application of the same quality assurance principles from all its contractors and suppliers. The ISO standard was first launched in 1997 and has since been subject to continuous maintenance, updating and several internal and external audits.

The purpose of Posiva's quality management system is to ensure, in a documented and traceable way, that Posiva's products – whether in the form of abstract knowledge and information, published reports or physical objects – fulfil the requirements set for them. The general quality objectives, requirements and instructions defined in Posiva's management system also form the foundation for the quality management of safety case activities.

The quality management of the safety case follows the Posiva's general management system, which is based on the ISO 9001:2008 standard and management through processes, but also applies the principle of a graded approach similar to the safety guides for nuclear facilities. This means that the primary emphasis in the quality control and assurance of safety case activities is placed on those activities that have a direct bearing on the arguments and conclusions on the long-term safety of disposal, whereas standard quality measures are applied in the supporting work. The quality management of the safety case aims at traceability and transparency of the key data, assumptions, modelling and calculations.

Regarding the activities related to ONKALO, the management system also takes into account the regulatory requirements of YVL Guide 1.4 "Management System for Nuclear Facilities" (which will be subject to revision in 2013).

Application to TURVA-2012 safety case production

The overall plan, main goals and constraints for the TURVA-2012 safety case production process are presented in the Safety Case Plan (Posiva, 2008). The details of how the Safety

Case Plan 2008 was implemented are described in the long-term safety project plan. The work is managed and co-ordinated by a core group and supervised by a steering group.

A specific quality co-ordinator (QC) has been designated for the activities related to the quality assurance measures applied to the production of the safety case contents. The QC is responsible for checking that the instructions and guidelines are followed and improvements are made in the process as deemed necessary. The QC is also responsible for co-ordination of the external expert reviews, maintenance of schedules, review and approval of products, and management of the expert elicitation process. The QC also leads the quality review of models and data used in the Data Handling and Modelling sub-process (see below). Regular auditing of the safety case production process is carried out as part of Posiva's internal audit programme.

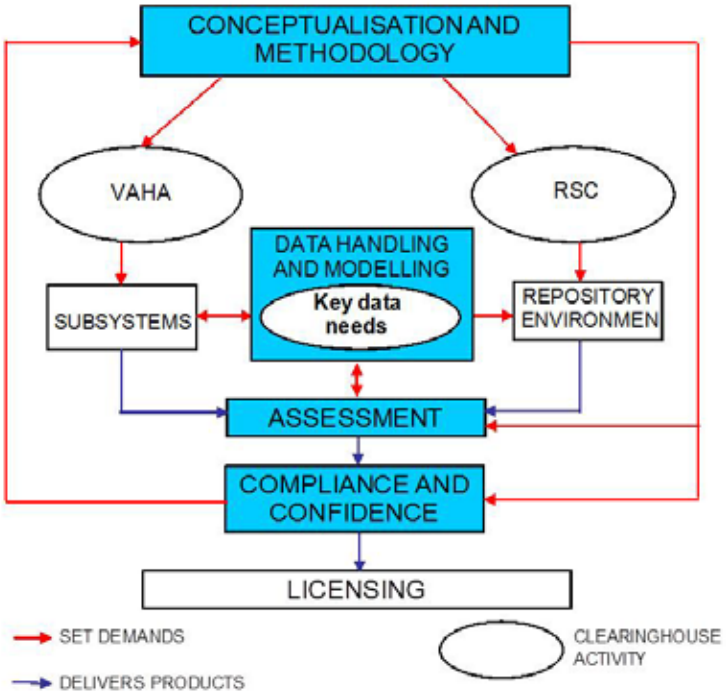
The production of the safety case is divided into four main sub-processes: Conceptualisation and Methodology, Data Handling and Modelling, Safety Assessment, and Evaluation of Compliance and Confidence (Figure 1).

- The Conceptualisation and Methodology sub-process frames the safety case, providing the description of the disposal system, features, events and processes (FEP) analysis and the formulation of scenarios, including system evolution. It guides the definition of the performance targets for the EBS and the bedrock, which form the core of the requirements management system (VAHA), and the basis for the development of an approach to evaluating the suitability of the rock at various scales through application of the rock suitability classification (RSC) system.
- The Data Handling and Modelling sub-process makes the connection between Posiva's main technical and scientific activities and the production of the safety case. It assembles the models and key input data used in the safety case for describing evolution, radionuclide transport and dose assessment. It also identifies key data needs to be developed. It addresses models and data related to the spent nuclear fuel, the EBS and the site (including both geosphere and biosphere).
- The Safety Assessment sub-process identifies the lines of evolution that could lead to the release of radionuclides and formulates the scenarios that are analysed first to quantify the releases from the repository system to the surface environment and then to quantify the radiological impact of those releases to humans, plants and animals.
- The Evaluation of Compliance and Confidence sub-process evaluates compliance of the assessment results with the regulatory criteria and the overall confidence in the safety case, taking into account the completeness of the scenarios considered, uncertainties within the assessment and complementary considerations regarding the long-term safety of geological disposal.

It is essential that the information and data passed between sub-processes be quality assured. The main safety case portfolio reports *Models and Data for the Repository System* and *Biosphere Data Basis* and *Biosphere Assessment* act as the quality assured interface between the safety case activities and the research and technical activities: they include all the essential EBS and site information and data needed for the performance and safety assessment calculations, while more details can be found in the supporting background reports, such as *Site Description, Biosphere Description* and various *Production Lines reports*. The quality of *Site Description* is mainly ensured through the application of scientific principles, while the methods of quality control for the design and implementation depend on the nature of the materials and technology in question.

Figure 1: Main activities of the safety case (production) process

VAHA – requirements management system, RSC – rock suitability classification system



Model qualification and code verification

A range of quality control and assurance measures has been adopted to promote confidence in the models (and codes) and hence to promote confidence in the analysis of the calculation cases. According to Posiva's Safety Case Plan (Posiva, 2008), these quality control and assurance measures comprise:

1. validation of input data for the scenarios and models considered; the limits of applicability of the input data are checked against the assumptions related to the scenarios and models;
2. validation of the models used to analyse the scenarios;
3. verification of assessment codes;
4. validation of the assessment codes for the intended application;
5. documentation of input for the production runs;
6. application of a procedure to ensure codes are correctly applied;
7. documentation of the code versions used;
8. reporting of non-conformities.

Measures 1 and 2 relate to the quality of models and to the selection and checking of data that are implemented in the codes. Actions undertaken to validate and thus promote confidence in the models and data used in TURVA-2012 are described in the reports *Models and Data for the Repository System* and for the surface environment in *Terrain and Ecosystems Development Modelling, Surface and Near-Surface Hydrological Modelling,*

Biosphere Radionuclide Transport and Dose Assessment and *Dose Assessment for Plants and Animals*.

At a more general level, the reports *Features, Events and Processes* and *Complementary Considerations* summarise the understanding of processes relevant to repository performance and safety that can be gained from observations at the site, including its regional geological environment, and from natural and anthropogenic analogues for the repository and its components.

Measures 3 to 8 relate mainly to the selection, testing and application of computer codes used for the radionuclide release and transport calculations and for dose assessment and to the documentation of results. Actions undertaken to verify and thus promote confidence in the computer codes and their application are described in *Assessment of Radionuclide Release Scenarios for the Repository System* and *Biosphere Assessment*.

Verification measures, including benchmarking exercises that address specific functions of the main computer codes used, have been carried out during their development. In addition, benchmarking exercises have been carried out in which results generated by these codes were compared with those generated by other well-tested codes that have been shown to handle the main features, events and processes of relevance. The benchmarking exercises where possible use test cases that are representative of the types of calculations needed for TURVA-2012, and so contribute to validation as well as verification. Finally, external reviews of newly developed codes have been carried out and deficiencies identified in the reviews were addressed before the calculations for TURVA-2012 were undertaken. Based on all these measures, it is concluded that the main codes have been verified and validated to the extent required for use in TURVA-2012. Regarding code application, numerical parameters, such as the size of time steps, are carefully selected to ensure that the model results are sufficiently accurate. A version management system has been used to keep track of any changes in input files and thus maintain the reproducibility of calculation results. An assessment database has been set up for the storage, checking and exchange of input data, intermediate results and final results. Finally, an electronic system, termed *docgen*[1], has been developed to keep track of, and to archive, the results of safety assessment calculations as they are produced. Results of model calculations and their associated input files are downloaded to *docgen* automatically from the assessment database. In this way, it has been possible to follow the progress of the calculations and carry out quality assurance and plausibility checks in a timely manner.

Data clearance

A wide variety of data have been used for the compilation of the safety case. An important activity for ensuring the quality, transparency and consistency of the data used in the safety case is data clearance. Data clearance is the formal procedure to approve the data to be used as input to the models used in the analyses reported in the safety case, such as the assessment of the performance of the repository system, the analysis of the release scenarios and the analysis of radiological consequences.

The raw data produced, e.g. by site investigations or laboratory tests, are usually not directly suitable for the models used in the safety case, and further interpretation and modelling are needed. Sometimes there are no site-specific data available, thus literature data and data from other sources, e.g. data produced for other nuclear waste management organisations, need to be used. The applicability of the data for the specific purpose and

1. The docgen system was originally developed for Nagra, the Swiss National Co-operative for the Disposal of Radioactive Waste. The version used in TURVA-2012 has been extended and adapted for Posiva.

conditions analysed in the safety case is assessed as part of the data clearance process, and potential sensitivity cases to be addressed by modelling are suggested. The data may be in the form of single parameter values, a range of parameter values or a probability distribution function. In some cases, different data apply to specific model variants or versions (e.g. applying to a specific hydrogeological model or repository layout).

The data clearance procedure consists of the following steps: *i)* identification of the data needs; *ii)* collection of suitable data; *iii)* documentation of the suggested data, their intended use and justification for their selection; *iv)* data approval. Separate reports on various categories of data collection have been produced, e.g. regarding climate evolution, solubility and sorption data for the near field and far field, and earthquake frequency.

The clearance process has been implemented according to guidelines that address the documentation of data sources and quality aspects. Single items of data and databases are approved through a clearance procedure supervised by the long-term safety Quality Co-ordinator. Process owners check and approve the data while the Quality Co-ordinator checks and approves the procedure. Data used may also be approved using other Posiva databases like the requirements database VAHA or investigation database POTTI and the respective approval processes. A clearance procedure has been applied to all key data used in the performance assessment (i.e. showing compliance with performance targets and target properties), and in safety assessment (i.e. radionuclide transport analysis and dose calculations).

Where data are subject to particularly high levels of uncertainty, further review of the data by subject matter experts and safety analysts has been carried out and a formal expert elicitation has been applied. Purpose-specific databases have been applied to manage the data clearance procedure in a structured way and to ensure the controlled use and traceability of input data used as input to safety related assessment calculations.

The expert elicitation process has been applied to a specific case (solubility and sorption data) to identify the main sources of uncertainty and determine whether different views may have to be propagated through the safety assessment. This expert elicitation process was initiated, carried out, documented and managed by the long-term safety Quality Co-ordinator. He also recruited the independent experts involved in the process. The clearance procedure is documented in *Models and Data for the Repository System*, *Biosphere Data Basis* and *Biosphere Assessment*.

The *Models and Data for the Repository System* and *Biosphere Data Basis* give an overview of the modelling carried out within the safety case and how the different models link to each other. They also present the key models and data used in the safety case. For each model, the conceptual model, the mathematical model and the codes used are described. This description covers the key assumptions and simplifications. The uncertainties related to modelling and their impact on the results is presented. Also, possible alternative models are discussed and the basis for selection of the specific model is given. Discussion of the data describes the production, qualification and uncertainties related to the data as well as potential alternative data.

In order to assess confidence in the models and data, the applicability of the models and data to the conditions at Olkiluoto and to the safety case purposes as well as the applied quality measures are discussed. Further, the impact of the uncertainties in the models and data on the modelling outcome is assessed and, where necessary, needs for model and data improvements are identified.

Report and product review and approval process

The review and approval process of the safety case production (i.e. main portfolio reports) has been carried out in a fully traceable manner. This has included, first, an internal review by safety case experts and subject matter experts within Posiva's research and development programme and, second, a review by external experts. A group of external experts covering the essential areas of knowledge and expertise needed in safety case production has been set up. The review comments are managed via review templates, which record the review comments and how each comment has been addressed. Upon completion, this template is checked and approved according to the quality guidelines of Posiva.

Quality assurance and quality control measures related to the production and operation of the repository are discussed in detail in the Production Line reports (*Canister*, *Buffer*, *Backfill*, *Closure* and *Underground Openings Production Line*).

Further development

The quality management system is being further developed along with the future steps in the RTD programme when going further towards the construction phase. Important aspects considered in the development of the quality management system are also the regular feedback given by the authorities in their auditing of Posiva's quality management system.