

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Workshop on Engineered Barrier Systems: Design Requirements and Constraints. Jointly organized by the Organization for Economic Co-operation and Development/Nuclear Energy Agency and the European Commission.
Project Number 20.06002.01.081; AI Number 06002.01.081.317

DATE/PLACE: August 26–29, 2003, Turku, Finland

AUTHOR: V. Jain

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PERSONS PRESENT: V. Jain, CNWRA

BACKGROUND AND PURPOSE OF TRIP:

I traveled to Turku, Finland, August 25–30, 2003 to attend the Engineered Barrier Systems (EBS): Workshop on Design Requirements and Constraints. The workshop was organized by the Organization for Economic Co-operation and Development (OCED)/Nuclear Energy Agency in cooperation with the European Commission. The workshop was hosted by Posiva Oy. This workshop was the first in the series of four workshops that are being conducted as part of the Engineered Barrier System Project. This workshop was not aimed to achieve consensus, but to develop a balance of concepts among repository programs. The workshop addressed not only longer-term post-closure conditions, which are generally more stable, but also the earlier more transitory stages of repository behavior during operations and shortly after closure.

SUMMARY OF PERTINENT POINTS:

On August 26, 2003, we toured the Olkiluoto Facility. Finland produces 2,656 MW from its two nuclear power plants each with two reactors. These power plants are located in Olkiluoto and Loviisa. The Olkiluoto Facility has an output of 1,680 MW. The Finnish government has made a decision to construct a fifth reactor of capacity ranging from 1,000–1,500 MW to be located either at Loviisa or Olkiluoto. During the tour we visited Onkalo, an underground rock characterization facility and VLJ—low-level and intermediate-level waste repository. The Onkalo Rock Characterization Facility will be located 420 m below ground and will be a base at which detailed information on bedrock will be obtained to assess repository safety and develop construction engineering solutions. When completed, it will also serve as an access route to the planned repository. According to current plans, the Onkalo access tunnel and ventilation shaft to 420 m depth will take 6–7 years to complete. The access tunnel will be 5.5 km long at an inclination of 1:10. We visited the Onkalo evacuation site where surface soils were removed to expose bedrock characteristics, and several locations where deep boreholes were used for collecting hydrologic data for characterization and extracting bedrock core samples. The bedrock core sample yield is more than 99 percent indicating good quality rock.

Plenary session on August 27, 2003 consisted of seven presentations from various high-level waste repository programs including the United States. Lena Moren (SKB-Sweden) in her keynote address talked about the systematic management of design requirements program at SKB. Moren stressed that systematic management of design requirements is necessary to facilitate communications, avoid mistakes, manage change control, and provide quality assurance. She described a V-model to manage design requirements. This model linked problems/needs to operation/use. The upper end of the V-model linked stakeholder requirements with acceptance test. The stakeholder requirements flowed down to system requirements, subsystem requirements, and design requirements on one side of the V with a link to system testing, subsystem testing, and component testing on the other leg, respectively. Each link works interactively to satisfy problem and need at each level.

Bob MacKinnon (SNL-USA) discussed waste package requirements and design at Yucca Mountain. MacKinnon discussed the evolution of the current waste package and drip shield design, how new information on materials forced changes in the waste package design, and how information from outside resources such as the Nuclear Waste Technical Review Board, State of Nevada, the U.S. Nuclear Regulatory Commission (NRC) is incorporated in the design process. The design process at YMP follows a structured approach that links statutory, regulatory, and design requirements under a defined quality assurance program. The design requirements and process controls are influenced by the importance of each system, its structures, and its components in the overall safety strategy.

Johanna Hansen (Posiva Oy-Finland) talked about the buffer and backfill requirements and the KBS-3 Finnish repository design. Some of the system requirements imposed on the Finnish program are isolation of waste from biosphere, use of multibarriers to retard radionuclide migration, use of proven technologies, construction with minimal impact on geological conditions, retrieval of waste, and economic feasibility. Granite bedrock, tunnel backfill, buffer material, and Cu metal canister provide multibarrier isolation to spent nuclear fuel. Several design concepts of the Finnish program are similar to the Swedish repository design concepts. Some of the issues currently faced by Posiva include scope of disposal that is not well defined; requirements and design are mixed with each other; owners of requirements are not recognized; unverifiable, missing, and contradictory requirements are not evaluated; and method to implement traceability not defined.

Stefan Mayer [ANDRA-France; formerly with the Center for Nuclear Waste Regulatory Analyses (CNWRA)] talked about the requirements and design for the French waste package. The French disposal program is currently evaluating separation and transmutation, deep geologic disposal, and long term storage as possible options for the disposal of high level waste. A feasibility study is planned to be completed by 2005. Evaluation includes reversibility and retrievability as integral components of the study. This is important to the French program because they believe that scientific knowledge is limited and a freedom of choice should be given to future generations to correct potential mistakes. During the discussion, attendees from several European programs agreed that requirements of reversibility and retrievability are important even though they may not be a part of regulations or laws at this time. France has 8 categories with 46 subcategories of intermediate-level waste, 5 categories with 11 subcategories of vitrified high-level waste, and 3 categories with 5 subcategories of spent nuclear fuel that are considered in the baseline for disposal. Clay host rock in Meuse/Haute in Mame region and granite bedrock (no specified site) are being considered for geological disposal. The French waste package consists of carbon steel that will account for limited

oxidation prior to reducing conditions and radiolytic corrosion. The waste package includes handling capability for emplacement and retrieval.

Nina Muller-Heoppe (DBE-Germany) gave a presentation on repository seal requirements and design. Germany has three repositories that are at various stages of operation. Konrad Repository for low- and intermediate-level waste located in oolitic iron ore host rock is licensed but not in operation, Morsleben Repository for low- and intermediate-level waste located in rock salt is currently under licensing for closure and exploration at Gorleben in rock salt for high-level waste and spent nuclear fuel is interrupted due to a moratorium. She stressed that good requirements should be traceable to high-level requirements, safety related requirements should be prioritized, and design should be evaluated on safety principles. In addition, she stated that it is important to avoid contradictory requirements and explore alternate solutions.

Johan Bel (ONDRAF/NIRAS-Belgium) discussed technical concepts for disposal of Belgian vitrified high-level waste and how to make a rational choice between different options. He indicated that during the development of repository designs, the choices have to be made at different stages and these choices could be impacted by external events. Sometimes justification is not evident or subjective information has to be taken into consideration. Belgium is considering three options for disposal of high-level vitrified waste. The first would use a super container design where two waste packages will be packed in concrete super container filled with buffer materials to reduce worker dose and emplaced in a repository tunnel. In this option, transport characteristics of clay during the thermal period are not known. The second option envisions a borehole design (similar to the Swedish design) where waste packages will be vertically located in a tunnel. In this option, potential collapse of clay is a concern (Swedish repository will be located in granitic bedrock that provides strong structural stability). The third option calls for a sleeve design, which will use prefabricated bentonite blocks as a sleeve in a horizontal emplacement mode. The Belgian program is using multi-criteria analysis for the selection of a best option. Eighteen criteria were selected by ensuring that they were comprehensive, discriminatory, unambiguously defined, and without overlaps.

The last presentation was given by Christer Svemar (SKB-Sweden) on the EC prototype repository project. Svemar's presentation highlighted real life engineering challenges to meet extremely rigid design specifications. The Swedish repository design requires accurately bored disposition hole, means to handle water inflow, installation of a bentonite column between borehole and waste package, installation of a 25 tonne canister at the center of the borehole followed by backfilling the drift. Borehole drilling was successful, but the depth of the suction hose from the sump up to the tunnel floor was on the edge of the suction capacity. The disposition hole had to be lined with a plastic bag to avoid water contact with bentonite blocks, which could cause the bentonite blocks to swell and displace. The installation of 10 bentonite blocks each weighing 1.5–2.5 tons required a bottom slab to be placed horizontally to meet clearance specification between waste package and bentonite blocks. Improper installation of bentonite blocks could result in a failure to meet maximum allowable waste package temperature requirement.

Four working group sessions were conducted at the workshop. These included: (A) practical approaches to ensuring traceability in design requirements management; (B) practical approaches to defining design requirements and accounting for uncertainty and constraints; (C) practical approaches to developing/evaluating/selecting between alternative design options and refining selected designs; and (D) practical approaches to linking "high-level" requirements

to detailed requirements/specification. I participated in the working group session B. In this session, we worked on the need for a well-defined organization to address and manage requirements and tracking links between high- and low-level requirements; establishing guidelines for addressing contradictory requirements; the type of difficulties that could be observed in analyzing contradictory requirements; and managing change control.

Workshop findings were summarized and discussed on the final day of the meeting. There was consensus that a methodology of managing requirements can help repository programs. A summary report will be compiled by the Chair Person and issued sometime in fiscal year 2004. They also plan to circulate a summary report for review by different countries and ensure that the report offers a framework useful to all repository programs.

Papers presented at the meeting will be published by NEA at a later date. However, a compilation of presentations made at this meeting are available and can be requested from the author of this trip report. A list of attendees and meeting agenda are attached for additional information. I can be reached by e-mail (vjain@swri.org) or phone at (210) 522 5439, if you would like discuss topics summarized in this trip report.

PROBLEMS ENCOUNTERED:

None.

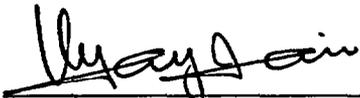
PENDING ACTIONS:

The summary report from the workshop should be received at the NRC and CNWRA, and comments provided to the chair person.

RECOMMENDATIONS:

Participation in this workshop on the EBS project promoted international interaction and collaboration among experts who are responsible for engineering design, characterization, modeling, and performance assessment of EBS, as well as scientists working in disciplines relevant to EBS. It will also increase public confidence, and make NRC/CNWRA activities and decisions more effective, efficient, and realistic by gaining acceptance of international experts. Future participation in these meetings is highly recommended.

SIGNATURES:



Vijay Jain, Manager
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Date

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Budhi Sagar
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Attachments

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Turku-Finland
26-29 August 2003

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Tuesday 26th August 2003 - Olkiluoto Technical Tour

Detailed guidance on how to access to Olkiluoto will be provided to excursion participants directly after the closing of registration at the end of June

It is recommended that participants attending the visit to Olkiluoto should arrive at Turku on the evening of Monday 25th August 2003.

10:00	Departure by bus from Turku/Hamburger Börs to Olkiluoto
12:00	Arrival at Olkiluoto, lunch
13:00	Presentations: current status of Posiva's studies, Olkiluoto site
14:00	Coffee break and identity check
14:30	Tour around drilling site
16:00	Visit to VLJ-repository (LLW/ILW, - 60 m underground)
17:00	Coffee Break and departure for Turku
19:00	Arrival Turku
20:00-21:00	Possibility for registration

Wednesday 27th August 2003 - PLENARY SESSION

Chairperson: Timo Äikäs, Posiva Oy ; Rapporteur: David Bennett, GSL

*Provisional details of the questions to be addressed
by the speakers are given in Annex 2*

08:00	Start of registration
09:00	Welcome Addresses <i>Sylvie Voinis, NEA; Michel Raynal, EC; Timo Äikäs, Posiva Oy</i>
09:15	Introduction to the EBS Project: Scope and Objectives of the Workshop <i>Hiroiyuki Umeki, NUMO</i>
09:30	Keynote Paper, "Systematic Management of Requirements: Theory and Practice" <i>Lena Moren, SKB</i>
10:30	Coffee Break
10:50	"Waste Package Requirements and Design at Yucca Mountain" <i>Bob MacKinnon, USDOE/SNL</i>
11:35	"Buffer and Backfill Requirements and Design for KBS-3" <i>Johanna Hansen, Posiva Oy /SKB</i>
12:20	Lunch Break
14:00	"Requirements and Design of French Waste Packages" <i>Stefan Mayer, Cécile Chapuis and Frédéric Plas, Andra</i>
14:45	"Repository Seal Requirements and Design" <i>Nina Müller-Hoeppe, DBE; Ralf Mauke and Jürgen Wollrath, BfS</i>
15:30	Tea Break

- 15:50** **"Comparing Technical Concepts for Disposal of Belgian vitrified HLW"**
Jean-Paul Boyazis and Johan Bell ONDRAF/NIRAS
- 16:35** **"The EC Prototype Repository Project: Implications of Assessments for Refining Repository Design"**
Christer Svemar, SKB
- 17:20** **Discussion**
- 18:00** **Close and end of the day 1**
- 19:00** **Dinner hosted by Posiva Oy**

Thursday 28th August 2003 - WORKING GROUP SESSIONS

09:00 **Introduction of Working Groups Sessions**
David Bennett, GSL

09:15-10:30 **Parallel Working Groups Sessions**

10:30-11:00 **Coffee Break**

11:00-12:30 **Parallel Working Groups Sessions (cont'd)**

12:30-14:00 **Lunch Break**

14:00-15:30 **Parallel Working Groups Sessions (cont'd)**

15:30-16:00 **Tea Break**

16:00-17:30 **Parallel Working Groups Sessions (cont'd)**

Provisional details of the questions to be addressed by the Working Groups are given in Annex 3. In addition, each Working Group should consider the implications of its work and findings for the forward programme of the EBS Project.

Friday 29th August 2003 - PLENARY SESSION

*Chairperson: Alan Hooper, UK Nirex Limited
Rapporteur: David Bennett, GSL*

9:00 Working Group Findings: Working Group A
9:20 Working Group Findings: Working Group B
9:40 Working Group Findings: Working Group C
10:00 Working Group Findings: Working Group D

.....
10:20 Coffee Break
.....

10:50 Discussion of Workshop Findings

**12:00 Discussion of Recommendations for the EBS Project
Forward Programme and Agreement of logistical steps
(e.g., for publication of workshop proceedings).**

12:30 Close

.....
12:30 Lunch
.....