Nuclear Waste Management Organization of Japan

Mita NN Bldg. 2F, 1-23 Shiba 4-chome,
Minato-ku, Tokyo 108-0014, JAPAN
http://www.numo.or.jp/

Record of the 4th NUMO Technical Advisory Committee (TAC) meeting

Tokyo, 5-7 March 2018

Background

Since the 3rd meeting of TAC, NUMO has used the input provided by TAC to rework the "pre-selection, site-specific" safety case (the NUMO Safety Case, noted as SC in the following) and, in particular, respond to requirements to refine the input geochemical parameters, which are a special focus of this fourth meeting. The list of participants of the meeting is given in Appendix 1 (TAC members), while the programme of the meeting is included as Appendix 2.

This record provides brief documentation of discussions at the meeting, following the "Chatham House Rule" of not attributing comments to specific participants.

Day 1: Monday 5 March

Block 1 Introduction & goals

1. Welcome (President Shunsuke Kondo & Chairman Takayuki Sasaki)

The welcome was given by Dr Shunsuke Kondo, the president of NUMO, who highlighted the importance of international review in assuring quality of the NUMO Safety Case (SC). The Government publication of the nationwide map was a positive action towards finding sites for the initial literature survey (LS), which has been followed up by information meetings by NUMO.

Chairman Prof Sasaki extended President Kondo's welcome and re-emphasised the significance of the nationwide map, noting the critical importance of getting the SC published.

2. Nationwide map (Hiromitsu Saegusa)

Since presentation at TAC#2, the Nationwide map has been published. In the following discussion:

- Differences between light green and green is transport distance: could this cause confusion with the general public, who might assume green is best? Generally there seems to be little reaction from the general public, but this will be a focus of NUMO communication activities.
- It was noted that there is little advance over the analysis of siting factors published by NUMO in 2004 (e.g. evidence of past pyroclastic flows). Including transport as positive factor is sensible.

3. Safety Case status & goals (Tetsuo Fujiyama)

An overview of the goals, programme and logistics by Group Manager Tetsuo Fujiyama (NUMO TAC coordinator) provided guidelines for the rest of the meeting. He provided an updated overview of SC documentation and the current status of production, with particular emphasis on review processes. Discussion considered:

- NUMO problems due to continually responding to external requests for extending the content, which is unreasonable for the current stage of programme. This is against the fundamentals of freezing assessment requirements. Further questions could be covered by subsequent reports or studies. SC report is not a programme milestone, but delays in the "2015 report" have a risk of loss of NUMO credibility. Extension under time pressure also adds risks in terms of assuring quality / consistency.
- When considering THMC issues, background should also be included as it might become an issue in the future depending on the type of waste (production of gas by some TRU waste, production of gas by metal corrosion) and operations.
- Uncertainty of data is noted: a sensitivity analysis should be considered if possible at that stage in order to identify as much as possible the key processes/parameters (design, site) as well as one of the tasks to be performed in the future R&D program of work.
- International TAC review comes too late – maybe initial Japanese material could be translated (even if not fully polished) as soon as possible so that TAC input could be obtained in parallel to the AESJ review.

Block 2 Progress since TAC#3

The focus of this block is the assessment of post closure safety (Chapter 6: 2.2) and the supporting arguments for the assurance of safety (Chapter 7: 2.3). To put this in context, the revision of the reference waters that was a driver for the modifications carried out over the last year is described (2.1).

2.1 Reference Groundwater (Kunio Ota)

Discussion points were:

- DOC data exist, but are not included as characterisation of such organics missing. Maybe include in the future to allow scoping calculation of possible effects.
- Clarification of goals: reasonable goals for GW – not ranges for sensitivity studies.
- Surprisingly low seawater signal in GW datasets. How realistic is the selection of waters to off-shore environments? What picture would the most extreme case bring?
- Seawater contains sulphate: the pyrite equilibrium assumption reduces sulphate – which may impact performance in terms of both SO_4 and Fe concentration and this should be assessed.
- Is 1TU exclusion criterion too strict? Maybe overly-restrictive.
- Are models good enough at higher temperatures? Maybe OK for simple minerals, but trickier for other minerals and some solution species. Not so critical here for GW chemistry, but more critical for RNs.

2.2 Long-term safety assessment

(1) Approach and System understanding (Kiyoshi Fujisaki)

This presentation emphasized progress in response to feedback from last TAC. Discussion points were:

- A large progress made since last TAC regarding the description of the repository evolution. This was the most important missing part in the report as identified in the previous TAC. A more extensive description would be helpful but is probably included in the report.

Mita NN Bldg. 2F, 1-23 Shiba 4-chome,
Minato-ku, Tokyo 108-0014, JAPAN
http://www.numo.or.jp/

- It would further increase confidence if you could list what are the open issues and questions in each stage of the storyboard acknowledging that the site and the design are not completely stabilized. Where are the needs that require to be clarified by e.g. investigations on site, design development and experiments. Based on these one can define the RD&D that needs to be undertaken to address the open questions.
- In later stages of the programme, the current qualitative assessment represented by the storyboards need to be supported by quantitative analyses and modelling. Such modelling may e.g., concern the evolution of the bentonite barrier as a function of changing groundwater composition, degradation of concrete or alterations of the flow field and groundwater chemistry resulting from ongoing uplift. The outcome of such modelling then provides input to more elaborate RN-transport scenarios as well as feeding output to the further detailed EBS design work.
- Colloidal bentonite erosion could be important not only for RN transport and also loss of bentonite that can determine degradation of the EBS. Should be emphasised that may be of a concern only for very few GWs.
- Storyboards could include RNs (currently captured in scenario descriptions). Alternatively note that the storyboards capture how the repository system evolves thus setting the scene for RN transport scenario development.
- Are containers vented – which may also impact expected behaviour.
- The storyboards are very useful, but need to be used with care, as these will evolve and get more detailed as the programme develops (so maybe try to capture also open questions). It is difficult to assess the depth of the work that has been conducted. For example, have microbial effects been assessed thoroughly or superficially. If assessment is superficial, this is fine in the early stage. However, one should point this out and say that these are examples of the argumentation.
- Avoid trying to make the argument that there is proof regarding the impact of some phenomena. Also avoid trying to rule out impacts in order not to have to deal with them in the report. Just point out the open issues. In this early stage of the programme, this is perfectly OK.
- Repository scale, uplift & erosion – how is it covered in system descriptions? More explanation needed.
- Loss of “physical containment”, what is actually included here? Maybe useful to capture in an ontology. Current terminology noted to come from IAEA, but this is not used consistently in different programmes.
- Experience is that during operations there will be changes in chemistry, despite GW management. Impact would be very site-specific.
- Storyboards should avoid timescales and focus on system changes, which can be related to time on a concept- / site-specific basis.
- Are storyboards assured to be consistent over different physical scales? For the RN release case, consistency needs to be checked from inside out and, for evolution, check large – small scale consistency. Maybe needs to be captures in 3D storyboards.
- Construction is very important and needs more consideration (ongoing at present)
- THMC coupling needs to be considered
- NH_4^+ is strongly absorbed by smectite, which might be considered in the future
- Distinguish between concept and design: design is quite detailed at present but this is due to boundary conditions and needs to show application to real sites. Emphasise wider range of options available.
- TRU designs (with / without buffer) are related to heat and release-dominating waste. A wider range of options might be considered (as for HLW concept catalogue). More

Mita NN Bldg. 2F, 1-23 Shiba 4-chome,
Minato-ku, Tokyo 108-0014, JAPAN
http://www.numo.or.jp/

generally, restricting the concepts examined in this stage (horizontal and vertical emplacement for the HLW) is fine, but there needs to be a description in the report of how you will open up the range of options considered once you further into the site selection.

(2) Scenario analysis and PA models (Kiyoshi Fujisaki)

The subsequent discussion covered the following points:

- How does the interaction between releases from different packages get captured? How are the near-field/far-field and far-field/GBI interfaces represented? These should, at least, be described in scenarios and resultant conceptual models.
- Representation of channelling / MD depth – could include non-conservatism and should be described with reference to appropriate SDM.
- Analysis of FEP impacts on safety functions, storyboards, etc. would be good examples of the type of material that TAC could usefully review at an early stage to check consistency & completeness.
- OP lifetime: would a distribution be tricky to implement? Although, for vitrified waste, distribution of failures has a small impact (compared to SF) it would be useful to consider if long enough compared to glass lifetime.
- Why is over-conservatism justified at this early stage (combined together in many cases)? Also some mixing with non-conservatism, which should be clearly noted.
- Gas issues need to be captured in storyboards – even if only highlighted as future issue. Future capability for 2 phase modelling may be needed. In particular, for the TRU waste, the gas issue seems not to be addressed. In Group 2 the 14C might be an issue in the gas phase. Depending on the properties of the host rock partially saturated conditions can prevail for several ten thousands of years in an ILW repository. Describing the system as fully saturated, with the gas saturation as an alternative scenario has been done in the past.
- In France OP containment set only to avoid thermal peak (500y): increasing to 5000y has no effect. Before site selected, a more realistic value should be chosen, e.g. 10 ky. When very conservative values are selected, they should be justified. Maybe think also of QA of steel OP.
- Moving from general discussions, the selection of scenarios to be considered and assigning them as likely / less likely is unclear. Terminology is very confusing.
- Need to list important scenarios that are not currently analysed.
- How is coupling of “less-likely” cases considered? Not considered at present but should be a priority for the future.
- Zircaloy oxide release seems overly pessimistic: it does impact doses in some cases. Maybe worth considering more realistically.
- Excluded FEPs should be explained and distinguished from those screened out.
- Density is a key state variable for defining bentonite performance.

(3-1) PA parameters – part 1 (Takafumi Hamamoto)

This presentation focused on porewater chemistry. Discussion points included:

- Timescale of bentonite conversion to Ca form seem to be long compared to OP lifetime, glass lifetime & peak releases – this should be noted so that results are not over-interpreted.

- Validation (or, at least, model testing) is possible to some extent with some long-term cement / bentonite experiments
- Why magnetite assumed as buffer? Based on experiments; in high carbonate systems siderite could form and impact might be considered in the future.
- Temperature calculations use the data available in the TDB which are, however, known to be limited.
- ISA concentration – conservative value is derived from waste specifications (from JAEA).

Day 2: Tuesday 6 March

2.2 Long-term safety assessment

(3-2) PA parameters – part 2 (Takafumi Hamamoto)

This presentation covered RN release and transport parameters. Note advances since H12, in terms of the updated DB, especially for the host rock. Fundamental methodology similar but improvements implemented where possible. The clear explanation of methodology was considered to be useful.

- Checking TDM model output against relevant lab or field observations is important. A concern is lack of data at relevant temperatures. GW chemistry corrected for T, but not all other data – so consistency needs to be checked (at the start for 25C). Recent data show small T effect on sorption – so focus on solubility. Limiting solution concentrations could be checked against measurements at real sites.
- U at high pH: U(IV) limiting solid assumed – past cement studies indicated Ca-U(VI) mixed solids may be important although the amorphous phase assumed may be reasonably conservative.
- For international reviewers, tendency to check against their own databases – so comparison with databases from other recent SCs could be useful. In particular, parameters that are over-pessimistic might be identified (important as many other conservatisms in SC). Limited comparisons have been carried out, but there seems to be no analogue of the J high carbonate GW. New concepts are being added compared to the H12 database. It is recommended to make a plausibility comparison with diffusion coefficients, sorption coefficients in other programmes, or organize a small review by experts. Just to make sure that the differences you identify can be attributed to differences in the materials and their properties.
- Glass dissolution lifetime seems very conservative. It is based on experimental data, but compared with the Grambow model, taking into account reference chemistry. Again comparison with data/models used in other SCs may be useful. Uncertainties associated with environment may be greater than surface area in terms of developing an unlikely scenario. Glass dissolution lifetime depends on the model that has been considered. As mentioned, it is also important to clearly specify if a residual or an initial leach rate has been assumed.
- Applying IS corrections to bentonite K_d values is not very clear – maybe explain better. Resulting inconsistencies in e.g. actinide K_ds are potentially confusing. This should improve in the future when NUMO has its own K_d measurement programme.

(4) Results of dose calculations for defined scenarios (Keisuke Ishida)

Key points from the discussion were:

Mita NN Bldg. 2F, 1-23 Shiba 4-chome,
Minato-ku, Tokyo 108-0014, JAPAN
http://www.numo.or.jp/

- Definition of dilution at the GBI should not be over-interpreted.
- Very short breakthrough times: needs careful discussion and possibly note that times presented for TRU are from first release from the EBS (which may be hundreds of years after closure due to time required to saturate the EBS and degrade all containment structures – even for the thinner package). In terms of explanation of this very early breakthrough: how sure are you about the conductivity of the fracture network, how representative is the transport regime selected for the scenario analysis? Further:
    - What happens if increased matrix permeability, fracture density is selected?
    - Is the variability within one rock type larger than between the rock types?
    - It needs interaction with the hydrogeologist to assess the impact!
- Pre-Neogene sedimentary rocks now treated also for RN transport. But the lack of data will affect the assessment of the engineered barrier performance. Different barrier performance might affect parameter setting for RN. This needs to be mentioned.
- "No differences between PEM & H12V": comment unjustified as key differences between options are excluded from the safety assessment models used and layouts are not optimised for post-closure safety performance. Maybe note that better models are needed to assess post-closure differences (even though probably small relative to construction & operation issues). This may be a typical example where modelling of system evolution and possibly also more data/experiments would be needed. Issues to consider include e.g., impact of iron on bentonite (probably not a great thing) and the fate of the bentonite that will move outside the PEM when it is corroded (will it form a homogeneous high density layer between the PEM and the host rock)? The latter may be more of a concern.
- Assessment appropriate at present stage: presentation of results is critical, particularly to non-technical stakeholders. Apparently best rock is the one based on poorest knowledge base. Table with comparison of doses is particularly dangerous (slide 17). Maybe simply show that targets are met.
- Lots of consideration of GW chemistry but not flow regimes.

(5) ***Special topic on RN parameters (Takafumi Hamamoto; Ian facilitator)***

Discussion was broken down according to the 6 following topics.

a) Triage
The fundamental question is should a system be used to distinguish between safety-critical and other RNs to avoid confusion / apparent inconsistency? The consensus seemed to be that, at least, this should be captured in the data report that notes sensitivity of assumed data to the resultant performance measures.

b) HLW: RN solubilities / speciation
The fundamental question here is can TDMs be used to directly define RN solubility & speciation? The consensus seemed to be that approach suggested by NUMO was OK. However, in the current generic stage, where site selection is the main topic coming up, demonstrating that you are state of the art in RN transport and TDBs should be sufficient. When prioritizing your RD&D activities, these would probably not be the highest priority. In UK expert elicitation used – but this also brings in problems. The TDB can also be modified to look at impacts of different system assumptions. A better understanding of the impact of temperature on solubility and sorption will be required at the site-specific stage. However there seems to be no general consensus on how critical this issue is in terms of the overall safety case (depends a lot on specific programme boundary conditions).

c) HLW: Transport in compacted bentonite
Here the question is can solute transport in compacter bentonite be quantified in a rigorous manner? The consensus seemed to be that the NUMO proposal is sensible. However, any application of NA noted to be tricky here and expectations should not be high.

d) HLW: RN sorption / retardation in fractured rock
Here, specifically for fractured hard rocks, the issue was whether RN sorption in a fracture flow system can be properly characterised. It was noted that the safety assessment results in Scandinavia were not truly sensitive to the sorption parameters (except, possibly, for Ra for which the uncertainties may matter in some scenarios). The DFN characterisation of the flow field is far more important. Linked also to characterisation of matrix depth. Possibly more of an issue for NUMO (in some possible sites) than in other national programmes.

e) TRU: RN release and transport in the EBS
Given the great complexity / heterogeneity of the EBS for TRU, the question was whether current models and databases were capable of realistically modelling RN release and transport. More complex models are certainly required – e.g. focused on special issues (gas) and considering heterogeneity in the system model instead of the current mixing tank for all waste streams. More realism is especially important for higher flow system. Realistic system evolution should include the geological setting. Very important to determine extent of isolation and delay in releases.

f) TRU: retardation in the altered geosphere
As RNs are release to the far-field after, or in parallel to, development of a complex reaction front (high pH, nitrate, organics): again are current models and databases capable of realistically modelling RN transport? Needs to be looked at on for specific cases to determine if the geosphere is important – in many cases maybe secondary to NF performance. If the geosphere barrier is an important contributor to safety, must be assessed as realistically as possible.

General: there is a need for hierarchy of models for different scales from waste package to repository scale. This may allow R&D topics to be focused, based on the relative importance of the issues identified above.

2.3 Building confidence in the safety case

(1) Structure of Chapter 7 (Tetsuo Fujiyama)

TAC concluded that the plans for Ch 7 are generally quite good and well-structured and based on a large amount of very good work. However:

- Some of the claims are over-exaggerated for the present stage of the programme: these should emphasise that this work represents first steps towards defined goals. Maybe more emphasis in preparation for LS rather than PI. Design requirements are high level, but detailed requirements will certainly be needed later.
- Refinement of siting factors seems to have high priority (actually ongoing). Also consider favourable factors. Although the safety case presented is not a full safety case, general guidance can be developed on what is important from a safety point of view without setting quantitative limits. This could ideally be done using a simplified broad sensitivity analysis.
- A figure showing future evolution of safety cases and how these become more refined based on an expanding knowledge base emphasising stepwise approach would be useful.

Mita NN Bldg. 2F, 1-23 Shiba 4-chome,
Minato-ku, Tokyo 108-0014, JAPAN
http://www.numo.or.jp/

- Arguments for feasibility of siting-engineering design-safety assessment presented as a linear process rather than emphasising key role of feedbacks to give continual tailoring of the entire programme. Requirements might be emphasised and resultant need to resolve conflicts.
- Operational safety work is good, but conclusions should not be overstated in terms of confidence of safety as it is at a very preliminary stage and will be detailed as far as the project will be developed.
- No mention of human resources in terms of ability to move further towards PI; needs to be highlighted as a priority.
- Optimisation should focus on practicality and safety rather than cost
- Flexibility to reassess concepts should be emphasised
- Sub-seabed seems to be a positive option for local communities (UK), so development of concepts further may be a priority (as similarities with under-land may be over-stated).
- Updates of safety case should be linked to programme milestones.
- Ideally, develop a web-based template using advanced KM tools & change management (as shown for H22).
- In next stage, key input from regulators is required. Ideally, the regulatory input should come as soon as possible.

(2) Impact of high carbonate water (Takanori Kunimaru & Takafumi Hamamoto)

Some points from discussion:

- High DIC water production mechanisms, for some cases, seem to imply very slow water flow (e.g. contribution of diagenesis water causing dilution of salinity).
- Whether this is likely (for a specific site), unlikely or very unlikely is unclear – and hence also the dose target.
- Impact on TRU unclear – seems too pessimistic combination of over-conservatisms.
- Should be included within a number of what-if? As it giver weight to a possibly unimportant site characteristic. Maybe better as a supplement to the safety case rather than being highlighted in Chapter 7.

(3) Safety after 1 My (Keisuke Ishida)

Key points from the discussion were:

- Present study is a good starting point, but is poorly linked to the rest of the SC.
- Erosion rates are important and give very big differences between rocks. So should use the maximum uplift expected at a “suitable site” to be conservative and contribute to building confidence.
- Output can be used to consider differences between any impacts calculated before or after the times when geosphere characteristics are uncertain.
- When considering impacts – focus entirely on sensitivity to uplift & erosion and hence on giving guidance to site selection.
- Rock converting into soil should be considered at some point, together with the gradual transition as the repository nears the surface.
- NB used already in PG85 – doses above regulatory guideline at about 100ky: but accepted by regulator.

(4) Arguments based on multiple safety indicators (Keisuke Ishida)

Mita NN Bldg. 2F, 1-23 Shiba 4-chome,
Minato-ku, Tokyo 108-0014, JAPAN
http://www.numo.or.jp/

Key points from the discussion were:

- This presentation is included as Appendix 3.13,This was noted to be good approach and the separation of safety & performance indicators useful.
- These indicators are used in other programmes: other possible indicators
    - France ratio of nuclide flux through different pathways
    - UK – focus on value of barrier actions rather than effect of barrier failures (also in France and Sweden). Actually, in France both are done: indicators such as ratio of flux are used to show the robustness of the repository when a barrier fails or to compare designs
- Rather than WHO water guideline as reference, consider Japanese tapwater guideline if this is different.
- Need to get feedback from Japanese audiences (of different groups)
- Good for understanding also for technical audiences
- NF curve may be useful basis for uplift /erosion

(5) Natural analogues (Tetsuo Fujiyama)

This presentation was outlining plans to cover this topic in Ch 7.

- Consistent with use in Sweden – be aware of constraints in terms of direct applicability
- In terms of new projects – should be focused on phenomena & processes of relevance (e.g. Greenland project supported by Scandinavians)
- Suggestion to include in earlier chapters: NA work in UK called evidence from nature – integrated with lab, field & theoretical work.
- Goals for training and understanding natural systems important in Japan
- Needs to be balanced with other opportunities – e.g. field work, URLs, etc.
- Natural analogues have been looked at and proven to be helpful in specific cases. They however may not bring insights in some key areas, such as kinetics, that can be integrated in our assessments in a helpful manner.

Day 3: Wednesday 7 March

Block 3 TAC closed session & wrap up

TAC key observations and other output from the closed session are summarised. This overlaps to some extent with the preceding record with emphasis on top-level recommendations to NUMO. Within the closed session the top-level messages from Presentation 2.3(1) were discussed and modified to be presented to NUMO. It was emphasised that these were recommendations to be considered by NUMO while drafting Chapter 7 and can be modified as required to meet NUMO's boundary conditions for AESJ review. If possible, all should be implemented in the material presented for NEA review. The key issues were, however, captured.

Comments and questions from NUMO mainly involved clarification and have been implemented within the current record.,

A date was not set for the next TAC as this depends on progress with the production and translation of the SC, but the goal is to have it within a year. TAC members will be informed of potential dates as soon as possible, at least 6 months beforehand.

Mita NN Bldg. 2F, 1-23 Shiba 4-chome,
Minato-ku, Tokyo 108-0014, JAPAN
http://www.numo.or.jp/

Closing address by NUMO Executive Director Umeki emphasised how valuable TAC input has been for the production of this first safety case by NUMO staff and thanked members for their efforts.

Appendices
1. TAC Participants list
2. TAC meeting programme