Nuclear Waste Management Organization of Japan

Mita NN Building, 1-23 Shiba 4-chome,
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www.numo.or.jp

Record of the 7th NUMO Technical Advisory Committee (TAC) meeting

Tokyo, 27-29 September 2022

BACKGROUND

Since the 6th meeting of TAC, NUMO has used the input provided by them to finalise the "pre-siting, SDM-based" safety case (the NUMO Safety Case, noted as NUMO SC in the following), which has now been subjected to international review by NEA. The objectives of this meeting are the following:

1. Presenting the output of the NEA review of the NUMO SC and general lessons learned
2. Review of the NUMO R&D plan
3. Discussion on knowledge management (KM) and assuring required human resources (HR)
4. Discussion on practicalities of moving forward with site characterisation / selection.

The list of participants (TAC members) of the meeting is given in Appendix 1, 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.

Block 2 – Overview of NEA review procedure and output

2.1 Output of the NEA review (Tetsuo Fujiyama)

In this session, NUMO shared the key review output and NUMO's vision/plan for the recommendations made by the International Review Team (IRT) organised by NEA. This was based on the draft NEA review report provided to NUMO for factual checking. Main comments from TAC on this presentation are listed below:

- NUMO's approach to identify key messages from the IRT and assess how these can be acted on is good and the fact that several responses are already reflected in R&D plans shows that NUMO is capitalising on the effort invested for development of NUMO SC.
- Some recommendations from the IRT are applicable only in the future stages of the siting programme. It would be useful to list up all topics to be treated in the future and prioritise them in terms of what is needed now and what is needed at later stages. If NUMO develops a roadmap of the programme, this will make everything you do more visible: which is mainly generic at present and gets more detailed at later stages. It has to be recognised that it is not possible to do everything now (e.g., assessing chemical toxicity of waste).
- As the IRT mentioned, term "containment" used by NUMO may need to be reconsidered to avoid potential confusion with the complete containment of radionuclides within a repository.
- The recommendation of defining safety function indicators: these are only meaningful if combined with more realistic modelling for determination of the important parts of the system. It is important to note these are "when relevant", and depend on the way in which the acceptable performance targets are set. Setting these for engineering and geology too soon could limit ability to choose the most appropriate site within a volunteering context.
- The proposed link of monitoring to reversibility by the IRT is debateable: however there is a lot of work on this in Europe that is available.

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- IRT recommendation on "keeping design options open" can be extended to widening the range considered, as already under consideration in Japan, but the range should not be too great. Nevertheless, there may be some key design principles that should be fixed (e.g., those that are waste-specific) and thus provide focus for the programme.
- Computing platforms for simulations go through significant changes over time, but there has been relative computational stability over the last 15 years. This may well change dramatically in the next decade with the advent of quantum computing: consider building a plan on how you keep abreast of these changes to ensure you have the right tools at the appropriate time.
- Operational safety: NUMO proposals to the IRT's suggestion seem sensible as much knowledge can be taken over from relevant work in other national program as well as nuclear facilities and mining / underground construction industries. Based on WIPP experience, however, there should be special consideration of ease of recovery in case of accidents underground ("resilience").
- Consideration of non-human organisms in safety assessment: this is carried out in some programmes, depending on differences in regulations. Generally, if safety margins are reasonable for humans, there are unlikely to be problems for other organisms. However, such assessment may need to be done in the future, so should be kept in mind and international developments followed. Local community sensitivity also needs to be considered here.
- Assessment is particularly tricky in the case of consideration of chemical toxicity included in wastes: here problems may be avoided by early discussions with waste producers and appropriate regulators.
- Verification and validation (V&V) – may not be rigorous for long-term models, but combination of analogues and credibility arguments may provide "sufficient confidence in validity".
- There should be a cautious approach to any ARTEMIS review that the IRT recommended, which would be more appropriate if there was a major change of the overall Japanese radioactive waste management programme. This needs to be considered by METI, but seems to offer little benefit at the present moment.

2.2 Safety case production – lessons learned (Shogo Nishikawa)

In this session, NUMO explained the lessons learned through the process of producing the NUMO SC report. Main comments from TAC on this presentation are listed below:

- This honest and open self-assessment of lessons learned from problems is very valuable.
- Data management/control system problems experienced were also reported in foreign waste disposal organisations: key lessons learned were effective data freezing and introducing multiple checks of data used (including propagated data at point of use), which should be considered by NUMO.
- Taking the time to learn during development of a first safety case is considered to be of benefit to NUMO.
- For the next SC, you could consider what kind of indicators are needed when comparing sites and disposal system concepts in the site selection process. As you already have the fundamental knowledge gained in the first NUMO SC, the next SC could be developed top-down based on objectives at that stage.
- Quality Management: one of the benefits for the implementer of a national QA programme, is that you design activities to match the regulator requirements. QA requirements can be

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produced (or solicited from the government) to ensure that quality levels are sufficient when used for licensing.

- Meeting the goal of having technical reports in advance of development of the next SC could be helped by taking over / updating relevant SRs of NUMO SC, although overall structure and goals of such SRs could be reconsidered.
- Integration of knowledge to form the SC requires a holistic overview and good interaction between the discipline groups, which is certainly a key NUMO goal but needs to be pursued further.
- Optimisation is very important, but goals may be worth clarification. Note that the importance of optimisation should be borne in mind in most of the other presentation blocks, as this involves close interaction between all technical groups – and possibly others who are responsible for socio-economic and sustainability / environmental impact issues.
- Presentation of dose assessment results: there is general agreement on the goal of being able to present safety in a more easily understood level.
- Time management: this should start with a more realistic time plan. Special dangers arise if unreasonable deadlines are specified: often QA review becomes squeezed if there are production delays, giving a loss of quality.

2.3 Concept for future safety cases (Tetsuo Fujiyama)

In this session, the concept of how NUMO will update its future safety case in the stepwise investigation phases is explained. Main comments from TAC on this presentation are listed below.

- The continuing updating SC (with supporting documentations) can be used to support any major decisions in a structured manner – which needs consideration of the degree of design tailoring at each stage.
- Carefully define limits on number of PI sites possible from the viewpoints of budgets and available characterisation teams / equipment. For a number of volunteers, consider how phasing is handled.
- Repository concept development needs to be accelerated to support the DI decision.
- Other national experience on site selection should be assessed to check more general lessons that can be learned from them.

Block 3 - Ongoing R&D topics of NUMO

In this block, examples of R&D activities currently being undertaken by NUMO to further expand the knowledge base that is integrated into the NUMO SC were presented.

3.1 Expanding scientific knowledge on Pre-Neogene sediments (Yoichi Oshiro, Hideharu Yokota)

This presentation showed the results of systematic data acquisition from existing underground tunnels to expand the geological database on Neogene sedimentary rocks, which are widely distributed deep underground in Japan. Main comments from TAC on this presentation are listed below:

- This kind of work is important for building knowledge and practical experience – maybe expand to consider other relevant rock types where knowledge bases are limited.

- Differences between data obtained and those used in the NUMO SC are understandable, but indicate that some values set in the SC may be over-conservative.
- Results obtained can be compared with similar geological settings studied elsewhere (especially Wellenberg in Switzerland), which can be used for consistency checks.

3.2 Development of the repository layout options for the HLW disposal in Japan (Tetsuhiro Ichimura)

In this presentation, NUMO showed the results of a case study on the design considerations for a disposal facility under the coastal seabed, which was not considered in the NUMO SC. Main comments from TAC on this presentation are listed below:

- This is a very good study, showing the considerations that need to feed into design for sites which may be more complex than SDMs developed in the NUMO SC.
- Need to remember that support services / infrastructure are very dependent on rock characteristics / requirements.
- With ramps for access tunnels, need to consider responses to geological perturbations.
- For such studies, need to be careful that you pick up all relevant requirements and consider practical limits on specific options.

3.3 Improvement of reliability on long-term performance assessment for vitrified waste (Ryuta Matsubara)

In this presentation, NUMO reported on their work to improve the reliability of dissolution models for vitrified waste. Main comments from TAC on this presentation are listed below:

- Good focus on key parameters shown in NUMO SC: going further in the future to more realistically consider the fractured glass monolith would be useful.
- Maybe useful to combine with analogue information to get a handle on long-term dissolution/alteration processes. Could also look at perturbation conditions (e.g., high pH of pore water)
- Could be useful to emphasise role of reducing uncertainties and moving further towards realism.
- May be useful information to be obtained from French and other international work on vitrified wastes. This could be an area for international collaboration.

DAY 2: WEDNESDAY 28 SEPTEMBER

Block 4 - The NUMO R&D plan

In this block, an overview of the Overall R&D Plan for geological disposal program in Japan over the five-year period from FY2023 was presented in each technical field. How the recommendations in the NEA review can be addressed was also discussed.

4.1 Overview of the 5 year R&D plan (Tetsuo Fujiyama)

Main comments from TAC on this presentation are listed below:

- The 5-year R&D plan needs to be put in a longer timescale context. This is certainly important when considering NEA recommendations.

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- It is important to ensure budget is sufficient to meet goals, based on clear prioritisation of R&D issues.

4.2 Geological R&D goals & priorities (Hiromitsu Saegusa)

Main comments from TAC on this presentation are listed below:

- Planning of baseline monitoring seems to be an important topic that needs to be included: both in terms of strategy and technology.
- The R&D needs that have been prioritised are all to do with the evolutionary processes of the geosphere, related to repository evolution. These processes may be relevant for some sites and not others. To understand such processes, NUMO should try to ensure flexibility to tailor work to actual sites.
- In terms of new technology, major advances in geophysics should be carefully assessed (acoustic tomography, micro-seismics…)
- In terms of hidden faults, focus should be on those that are not known to be active, but might be activated in the future or could be LDFs. LDF specification should incorporate understanding of how these features are formed / developed. Special consideration of horizontal features (structure of faults) which would affect the underground repository is also required.
- 4D SDM needs to be shown to applicable: focus is on extrapolation from the past, considering uncertainties.

4.3 Engineering R&D goals & priorities (Yoshito Kitagawa)

Main comments from TAC on this presentation are listed below:

- Nicely structured, showing use of NEA input and putting 5-year R&D plan within the context of a long-scale implementation plan. Can give feedback to detailed planning of PI and DI work.
- As there is over-conservative treatment of the EBS in the NUMO SC, there is still knowledge and insights going into different design options that will evolve over the approximately100 years until repository closure. Thus, close interaction with SA team will be important for realistic modelling of the EBS.
- Under design factors, it is important to add recovery from accidents.
- Under socio-economic, recommend to add Carbon-accounting.

4.4 Operational safety R&D goals & priorities (Satoru Suzuki)

Main comments from TAC on this presentation are listed below:

- Demonstration of durability of safety measures is low priority at present, needed only when designs are much better specified. If waste is packaged, however, some tests can be carried out on these, which can be (or may be already done by) waste producers.
- Bituminous waste may be a special focus, because of the relative vulnerability to fire of this waste form. Extensive work carried out in France should be followed.
- In terms of mitigation in case of abnormal events, scenarios need to be developed that explicitly include recovery (and any required cleanup).
- When accident analyses results in requirements for mitigation, these should be explicitly captured.
- Combinations of accidents should be considered (which may be covered in common mode failure scenarios).

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4.5 Post-closure safety R&D goals & priorities (Kiyoshi Fujisaki)

Main comments from TAC on this presentation are listed below:

- Well-structured move to increased realism, with recognition of the importance of uncertainties, is compatible with recommendations from the NUMO SC review. Also, it is good that sensitivity analysis is explicitly included.
- More realistic modelling does not always require specially developed tools: some general mathematical tools may be applied, although it seems that NUMO is aware of this.
- V&V priorities should be considered, where focus on the EBS may be sensible in early stages with consideration of tests at different scales.
- Limitations of complex models should be recognised; combinations of complex and simple models can be useful to improve system understanding.
- Consider long-term software management to cover computer platform evolution with time.

4.6 Management tools R&D goals & priorities (Shogo Nishikawa)

Main comments from TAC on this presentation are listed below:

- Well-structured approach to RMS / KMS and KB development / use has been illustrated.
- Capture & archiving of decisions is important; may be worth explicitly illustrating.
- After structuring requirements, describing them in detail and defining their level is a large challenge (linked to decision-making). This builds on past RMS developments, but should also access experience in other programmes (e.g., difficulty of propagating high level requirements to more detailed sub-system requirements and specifications)
- TAC understands the importance of KM and RM in NUMO.
- Also, technology transfer and education are indispensable. TAC hope that NUMO will support education leading to interest in the field of geological disposal in universities and hopefully also to younger generations.

Block 5 – KM (Knowledge Management) and human resources

In this block, in order to discuss on how knowledge management and human resource management in geological disposal projects could be implemented, TAC members introduced their countries' approaches to these issues and lessons were identified for NUMO to consider.

5.1 Status in national programmes: GB, US, CH, SE, FI, FR (International TAC)

Key Lessons

- Both KM and HR are recognised to be critical areas in all programmes, but the approach to addressing them varies significantly – maybe due to the different boundary conditions of large and small programmes. If NUMO refers to other countries' approaches, it is necessary to pay attention to differences to the boundary conditions in Japan.
- A key area of interest for NUMO involved capture of tacit knowledge: there were differing degrees to which this was formalised in the national programmes, but more details can be provided to expand on the presentations made by TAC.
- It is important to learn from experience elsewhere, ensure goals are clearly specified to ensure a cost-effective approach (methodology and any tools that may be used) that is embedded in the organisation. Here linking to relevant international initiatives is particularly important.
- Long-term knowledge (and record) preservation is a safety issue that should be borne in mind.

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DAY 3: THURSDAY 29 SEPTEMBER

TAC closed session and wrap up

TAC key observations and other output from the closed session were summarised. Comments and questions from NUMO mainly involved clarification.

TAC has been involved in discussions since 2015 with a particular focus on providing advice on the development of NUMO SC. This was successfully completed. It was confirmed that goals of TAC now will be more on stepwise siting and supporting R&D, also helping NUMO collaborate more closely with other national programmes.

TAC members were thanked for all their hard work over the last 7 years and for the knowledge that they had transferred.

Appendices
1. TAC participants list
2. TAC meeting programme