NUMO

NUMO International Technical Advisory Committee

Short Record of the ITAC-8 Meeting

Tokyo, 30 November – 2 December 2004

1 Introduction

This short note summarises the main points arising from the 8th meeting of the ITAC. Reported ITAC comments for each topic include both discussions in the open sessions and those arising from a subsequent closed session. These were summarised in the presentation by Charles McCombie in the final wrap-up session of this meeting and subsequent discussion. Some abbreviations and acronyms used in this record are summarised in Appendix 1.

2 General Remarks

Major changes at NUMO since ITAC-7 were the assignments of new President K. Fushimi, Vice-President T. Kawaguchi and Executive Director N. Kiyono. President Fushimi welcomed ITAC, introduced new NUMO staff and highlighted some programme developments in an extended opening session. Charles McCombie wished NUMO success in the solicitation process and introduced the ITAC members to the new NUMO staff, emphasising their diversity of experience within the major national and international waste management programmes. By its choice of individual members, NUMO has assured access to information and advice from effectively all major disposal programmes. ITAC appreciates the interest shown by the new NUMO leadership and their involvement in the topical session.

The meeting agenda was well structured. The standard (style, presentation and content) of the NUMO presentations outlining the progress in technical and PR areas (Blocks 1 & 2, below) continues to be extremely good and the level of preparation was greatly appreciated. Despite some staff changes, teams seem to be gaining useful experience and continue to work well together. The special focus of the meeting, resulting from a NUMO proposal, was an examination of "Timescales for compliance" (Block 3), which is a very hot discussion topic in Japan at present. The extensive information material from this session, representing a good use of ITAC, may well be of wide interest in Japan and could be made available to other interested parties (utilities, regulators, etc.).

The interpreters / communicators were again very valuable for key sessions and should also be included in the future.

3 Block 1: Highlights of NUMO activities since last ITAC

3.1 Public relations and site planning activities in NUMO (M. Kuba)

The presentation gave a general update of progress in this area, with a focus on comparison of activities in 2003 and 2004. Establishing NUMO in the public vision is achieved by very active programmes of direct contact (fora & panel discussions) and print & electronic media. Panel discussions have considered the theme "Current Japanese energy and recycle orientation including geological disposal". The TV spot "Homework for electricity consumers" has been continually repeated on many (56) TV stations to build up recognition of NUMO's organisational identity.

Magazine advertisements target a wide range of readerships. They originally utilised attractive analogue images, but have been extended to show a picture of underground space such as a tunnel and subway, in order to more directly illustrate the stability of deep underground structures. In the print media, a new move was the focus on "advertorials" which contain advertising input in an editorial format, tightly focused on the audience of the particular publication (e.g. younger generation, women, etc.). Newspapers (national, regional and local, combined circulation over 40 million) have been selected for campaigns of both advertisements and advertorials.

ITAC very much appreciated being updated on this work, even if it is a little outside of their direct technical remit. They found the presentation by M. Kuba useful and interesting and were impressed by the extent and content of NUMO's PR work. The very large coverage of the population by a diversity of media and other communication approaches was particularly notable. An open question is the extent to which technical teams could be more involved in the early communication with local communities.

The international interest in NUMO's volunteering process continually grows, which will increase pressure for ITAC members to provide local updates to interested groups in their own countries.

The role of surrounding – generally negative communities in the volunteering process was pointed out. A possible technical comment is that the reversibility of the volunteering process may be a topic that could help gain acceptance; if it is possible to back off from the volunteering step, this might be emphasised in large-scale PR efforts.

If there was interest, ITAC members could summarise their own experience (both good and bad) in dealing with potential and actual siting communities at a future meeting. ITAC would also be happy to support NUMO's efforts in gaining acceptance (e.g. Open Forum meetings) if this would help.

3.2 Combined presentation: Feedback after publication of Level-3 documents and Open Forum Discussion & Progress towards establishing an R&D plan (K. Kitayama & T. Ashida)

The publication and distribution process for both the Japanese and English language documents was outlined (copies of the English reports were posted to ITAC members in September). Feedback since publication has included:

- Recognition that the NUMO staged siting process and associated structured Repository Concept (RC) development work represents the current state of the art
- The structured approach proposed for the literature study should be extended to consider later PIA and DIA (and even later implementation) stages
- Flexibility of design options is valuable for NUMO's volunteering approach, allowing responses not only to technical challenges but also to public requirements.

ITAC was interested in any informal feedback from key organisations (no formal feedback has been requested); generally this has only been very general, implying that the reports are considered to be of good standard.

The June 1st Open Forum Discussion (499 participants!), provided an efficient method for publicising these documents and putting them into an international context by an invited presentation and a panel discussion. Issues raised by the audience were carefully listed and will be considered in future presentations (see record of this Forum on the NUMO website). Since the meeting, a series of feedback sheets from Open Forum participants have been analysed and responses are presented in NUMO's Japanese website.

The status of R&D plan development was outlined, based on the current goal of PIA selection. The development of an overall R&D plan covers the areas of:

- Geological environment evaluation technology
- Repository design
- Performance assessment.

NUMO recognises a difference between the viewpoints required to develop such a national programme and its own specific R&D needs for its role as an implementer. For example, the national programme is more generic, based on H12 and focuses on phases until around 2010.

3.3 ITAC comments / feedback

3.3.1 National plan

- ITAC was pleased to learn that NUMO staff are included in the discussion for the development of this plan.

- Regulator involvement in definition of the national R&D plan is not yet established, but should be encouraged.
- A strict separation of science & engineering is not common in other programmes; in any case more integration would be needed in the future, in particular at NUMO.
- Completeness / distribution of responsibilities for R&D tasks; NUMO will need to ensure that there are no gaps in the national R&D programme as they have the best top-down overview; any initial limitations in this national programme should be covered in NUMO's own R&D plan.
- Prioritisation; this may be an important issue to optimise use of limited resources.
- The national R&D plan seems to focus on mapping the status quo, rather than planning ahead; this may be appropriate at present, but moving into a planning mode is a long-term goal. It may be worth showing in a future ITAC meeting how NUMO will utilise the national R&D plan to develop its own work.

3.3.2 NUMO's own R&D plan:

- The structured approach is good but, so far application of design factors has been rather qualitative; NUMO has already planned more detailed analysis of the design factors.
- In the staged development programme, how can NUMO proceed without regulations? NUMO will carry out performance assessments to guide decisions at the end of each step which will, at least, provide transparency and allow checking for consistency with regulations (when they are eventually produced).
- There are obviously key requirements for ensuring required human resources are available – especially in critical areas such as site characterisation.

In any case, ITAC members would like to examine the NUMO detailed R&D programme in further detail. This is a core task for a technical advisory committee and is clearly an area where their experience could be useful.

4 Block 2: Related meetings and R&D

4.1 A proposed work flow for developing NUMO working standards (M. Takeuchi)

This presentation started from a definition of the safety philosophy of NUMO. A key aspect is developing projects in a clear and structured way as illustrated already in the reported work on siting factors, Repository Concepts and a planned safety / performance assessment. In specifying working standards, however, constraints are recognised:

- Absolute (but maybe not yet specified) rules & regulations
- Internationally agreed procedures (IAEA, NEA, ICRP, etc.)
- Limitations in available data (especially at early stages of siting)

- Continuously developing science & technology
- NUMO specified conditions
  - priority of safety
  - inclusion of environmental issues
  - open publication
  - consistency, openness & flexibility.

Presently, the focus is on developing a structured approach to establishing standards for PIA & DIA selection. A key issue is ensuring compatibility of the safety philosophy with the communication (dialogue) strategy. It will also be challenging to demonstrate consistency while, at the same time, ensuring flexibility to respond to changing conditions and requirements. In the future, compliance with regulations will be a clear requirement – but an open question is how to proceed at present in the absence of such regulations (related also to the previous discussion of K. Kitayama's presentation); for example would a clearly conservative approach to formulating working standards be valuable or not? Flexibility in the use of criteria would be needed in any case.

NUMO's established procedures face the additional constraint of allowing for the commitment to involvement of stakeholders. As noted above for the specific case of safety, such stakeholder involvement could also lead to conflicts with technical optimisation. The technical background will also evolve with time.

The term "working standard" was discussed, because this is not a common term in the waste field. The consensus seemed to be that the issues considered are actually covered in other cases by a range of terms: standards, guidelines, principles, procedures & policy. An ITAC recommendation was to consider a kind of hierarchy of terminology:

Principles → Standards → Guidelines → Procedures.

The Swedish documentation of site requirements and the US approach to risk-based decision-making may be of relevance to help re-evaluate terminology. Nevertheless, it was recognised that this was an important area for NUMO to discuss, as many of the issues raised are still not resolved in other advanced programmes.

The lack of regulations was pointed out not to be as critical as sometimes presented as considerable progress can be made by assuming standards commonly found internationally. Moreover, even in countries with well-established regulations, these can change significantly (e.g. USA, Sweden) which can have a major influence on programme development.

In any case, such an iterative process of establishing guidelines in a structured manner is essential for NUMO and ITAC could contribute further when this has developed further. A suggestion is to establish a clear hierarchy and structure of terminology; thereafter input might be provided at the next meeting or produced remotely in the interim. Several ITAC members expressed their willingness to collaborate directly with M. Takeuchi in this area.

Here again good interaction between "science" and "engineering" groups is essential during both RC development and matching RC to sites.

4.2 Enhanced activity on environmental considerations for NUMO's programme (M. Takeuchi)

This presentation started with a general overview of growing environmental awareness in Japan, associated with decreasing acceptance of large-scale projects and increasing demands for public participation in decision making. Minimisation of environmental impact is already identified as an important issue in the development of Repository Concepts and site selection / characterisation.

The EIA requirements are established by Japanese laws and commitments to international conventions, but not explicitly defined for nuclear facilities – which are covered by separate legislation. Nevertheless, a HLW repository will clearly be a large scale project which will inevitably have significant environmental impacts and the potential for negative effects. NUMO distinguishes between Environmental Impact Assessment (EIA), which is applied during project development, and Strategic Environmental Assessment (SEA), which is applied for the earlier policy and concept development process. When concrete site work is initiated, an Environmental Management System (EMS) is implemented. The EMS involves a formal system of considering the environment during planning, implementing, monitoring, correcting non-conformities and continual process review of site actions.

For NUMO, all such activities need to involve openness and dialogue with key (especially local) stakeholders and to ensure that the balancing of alternative approaches to handling various environmental impacts and balancing costs against benefits is carried out together with them. This study area has only recently been initiated by NUMO but the first goal will be investigating the current state of the art in Japan and abroad and establishing a programme which will allow critical input to be delivered as required by NUMO's staged siting and implementation programme. This will require not only documentation, but also improved communication abilities of critical NUMO staff.

ITAC acknowledged that this work is very important and the aims are recognised to be generally accepted as state of the art. SEA could usefully be initiated as soon as possible to provide conceptual guidance. NUMO should encourage this, but the responsible organisation to actually carry out the SEA seems unclear (but should be clarified). Some very top level issues may be identified here (e.g. basic need for geological disposal and comparison with alternatives, including no action) and may well be needed at an early stage (which was not done in the past in most national programmes). This alternative analysis is often considered even when such options are explicitly forbidden by legislation. In the Japanese case, although geological disposal is mandated by law, NUMO staff should be in a position to explain why this option is preferable to other proposed alternatives.

In fact, many stakeholder groups may see environmental impacts as a greater issue than safety per se. It should also be emphasised that environmental impacts are not always negative and can also represent added value. In all such analysis, the focus on local communities should extend beyond the host community, as neighbours may be most critical for projects.

When involving participation with local communities, the aspect of ability of a volunteer to back out (reversibility) could be a critical point – especially considering the extremely long timescales involved. ITAC also requested more information on specific environmental standards (e.g. groundwater quality).

4.3 Repository Concepts (RC) development (H. Ueda)

The October Nagra / NUMO meeting considered three Tasks for FY'04:

1) Structured approach for developing RC
2) Development of a requirements management system
3) Evaluation of performance assessment (PA) codes & databases.

The first of these tasks mainly involves slight extension and more complete documentation of past work (matrices, new meta-analysis approaches). The history of RC work over the last 3 years was briefly summarised and relevant publications listed.

The other two tasks are novel and the meeting involved preliminary brainstorming to identify NUMO's needs and project milestones for FY'04. The requirements management system is focused on NUMO's specific needs and was structured by defining a hierarchy of requirements levels and focusing on decisions which are linked within a decision network. The initial focus will be on RC development but, if successful, it will be integrated with site investigation planning and NUMO's envisaged Quality Management System (QMS).

The third task involves evaluation of NUMO's needs up to the point of repository licensing. By identifying key project milestones requiring PA input, a set of goals for future code / database extension could be specified. The aim is that the model structure will be flexible enough to allow continual development, with improving sophistication available by the time that suitable data are produced. Some of the major developments considered are:

- Explicit consideration of all EBS materials and their interactions
- 3D representation of structures and processes
- Consideration of processes and parameter variations with time.

A review has been initiated to determine the extent to which existing codes would be suitable for such purposes. The output form FY'04 tasks will be discussed and summarised at the RC workshop to be held in Switzerland, 9-11 February 2005.

ITAC acknowledged that, because of the volunteering approach, the NUMO RC programme is necessarily wider than is common in national waste agencies. They welcomed NUMO's Requirements Management approach and also the planned move from qualitative to quantitative assessments.

The long term wish-list presented by NUMO for a "dream code" was noted to provide guidance for developments over the next 3 decades rather than expectations for the near future. The aim to "realistically" represent 3D solute transport was noted to be overly ambitious; "more realistic" or "with appropriate realism" might be better terms. 3D-models, especially of geosphere radionuclide (RN) migration, may not be needed until later programme stages (if actually needed at all).

Also with regard to terminology, the term "post-closure" does not exactly cover all considerations involved for the increasingly pedantic consideration of jargon. The significance of the post-emplacement / pre-closure period may vary between different design options. In terms of the models themselves, distinguishing between "PA" and "design" codes may be worth emphasising as their requirements are different – the former focusing on radionuclide release and transport while the latter may consider a wider range of sub-system performance indicators.

In terms of output of the matrices and other RC development tools, the importance of involving a wider range of experts with appropriate expertise (e.g. mining engineers, nuclear materials, geotechnical, etc.) was emphasised. The development of future codes should be clearly seen in the context of a long term R&D programme, in which the availability of data will expand dramatically at future stages.

4.4 Geological and general information of Chuetsu earthquake (T. Hamada)

As a special, high interest topic, background information on the Niigata Chuetsu magnitude 6.8 earthquake of Oct. 23 2004 was reported. This was not only a large earthquake, but was followed by an unusually large number of strong aftershocks – which can be explained by the understanding of the structure of the associated active fault. The information on collapse of some tunnel sections is now being gathered by NUMO, as this was not expected (unless active faults exist in these tunnels).

Such detailed technical analysis was considered by ITAC to be very valuable. Such presentations demonstrate NUMO's capability to react in a professional way to questions by both the general public and international partners, which is an important aspect of technical confidence-building. For balance, presentations could also give examples of survival of properly engineered structures.

Any future studies of stability of both surface and underground structures could be useful and would be of interest to ITAC. This could provide input to discussion of completeness of active fault maps and respect distances (movement on associated fracture sets).

4.5 ITM activities in early H16 FY (J. Goto)

This presentation contained a lot of technical detail on the extensive tectonic studies being carried out by NUMO. As background, a history of ITM activities was given, with explicit recognition of iterative programme development involving input from ITAC. Leading on from identification of key tectonic issues of interest to NUMO, structured programmes to develop understanding needed to assess volunteer sites and plan preliminary investigation (PI) programmes were outlined. To quantify volcanic and deformation hazards, a wide range of alternative modelling approaches (empirical, deterministic and probabilistic) are being developed and compared by examining their applicability to well defined test cases. A few examples were illustrated for relevant locations in Japan and elsewhere.

ITAC considered this to be a very appropriate area for NUMO to be at the forefront of international activities. Further expansion of the circle of experts involved may be valuable. Organising a major conference on this topic at a key project milestone would be worth considering.

The flow charts were considered by ITAC to be an excellent illustration of a structured strategy of problem solving, which may also be very good for confidence building as it illustrates integration of input from different groups and information. The structures illustrated could be equally well applied to all other important geological data, or, indeed, other R&D areas.

ITAC recognised that the EOS publication (a geological newsletter with a very large audience) that was distributed at the meeting indicates that NUMO's work is both the state of the art and of wide interest to the geoscience community. Further documentation of this work and publication of a few papers in major scientific journals is being planned; ITAC see this as important and it is strongly encouraged. A few reports in NUMO's own publication series on various aspects of this topic would also be good. At a future stage, an ITAC meeting with an extended session on this very important work is recommended – maybe when the results of work from the present FY are complete. This could include an overview of all relevant work and plans for the future.

4.6 Planning site literature studies (A. Deguchi)

A. Deguchi reviewed the background and aims of this project, which has an explicitly defined philosophy and clear objectives. The factors (EFQ, FF) to be considered to determine suitability as a potential PIA have been listed and extended to consider additional data needed for repository design and performance assessment – which extend to regional data when appropriate (e.g. tectonics). Further (as considered in the presentation by M. Takeuchi above), it is notable that environmental concerns are seen as an important issue and hence data requirements for EIA are also listed.

"Literature" resources have also been listed in a fairly comprehensive manner, with explicit consideration of literature which is not openly published. The work flow from literature collection, registration, review, archiving and synthesis of resulting information – based on a structured computer database – has been planned in some detail along with output publications associated with programme milestones. The associated QA structures have also been outlined, and these will be integrated into the database.

ITAC was very impressed by this further evidence of NUMO's structured planning. The emphasis on data for determination of suitability for PIA qualification might be extended to consider the possible case of data needed for setting priorities between potential PIAs, should there be a larger number of volunteers than NUMO can work on at one time. The planning at present emphasises screening out clearly unsuitable site and helping to plan future PI (and RC) programmes rather than comparing sites at this early stage, but consideration of a wider range of aspects is recommended as soon as possible as, even within a single volunteer area, different specific sites or concepts may be possible.

The concern about uneven quality of data (different data for a single site, between sites) was raised. How will uncertainties be managed? ITAC agreed that ensuring high data quality will be a critical part of this process. At a more pedantic level, it was noted that evaluating the quality of literature – which is a critical job – is not really QA in the conventional definition (but can be a component of a QA process). NUMO emphasised that, at present, the emphasis is only on excluding clearly unsuitable sites; data uncertainties can be handled at a later stage (except for the unlikely case of very large numbers of volunteers).

ITAC also noted that the work programme for data collection looks very ambitious – even for a single site. NUMO plans, where needed, to outsource collection activities but data synthesis and interpretation, which probably needs to be done by NUMO in-house, may be the rate-determining steps. There may be value in prioritising data searching to reduce focus on those data which may not be critical until later programme stages. Establishing an outline structure for the final documentation might also be useful. However, the listed further tasks are all necessary and urgent.

Finally, including gathering of local knowledge is certainly valuable. Polling local concerns might be a useful extension to planned activities (although not part of "literature survey" as such, maybe more part of establishing dialogue).

5 Block 3: Timescales for compliance

This session comprised 2 components:

- An international review of compliance timescales by ITAC members focusing on the justification of time-periods, cut-offs and associated criteria in a range of national programmes (much of which is not well documented in the open literature). These are summarised briefly in Appendix 2
- An evaluation of the NUMO position on this topic.

5.1 Relevance to NUMO: NUMO's view (H. Umeki)

The boundary conditions for NUMO are still very uncertain as no safety regulations exist as yet. The Nuclear safety Commission (NSC) has issued some reports giving guidance on the practical aspects of programme development (e.g. for PIA selection).

Early guidelines for H12 (AEC, 1997), however, identified time related factors to be considered in SA and made a recommendation to carry out dose calculations to the time of maximum releases and to consider alternative safety indicators (particularly for longer times). More recent NSC reports (2000, 2004) support these points, the latter also introducing the issue of risk-based criteria and initiating a discussion of timescales. NISA discussions (2003) also emphasise the importance of additionally evaluating system uncertainties at the time of peak dose.

H. Umeki's personal view is that, in the absence of regulations, PA should be carried out without cut-offs, until, at least, maximum release. Nevertheless, focus should be on first few thousand years when assessment is more reliable. Dose will be the primary safety indictor, but risk-based criteria are also considered. Evaluation of performance will utilise international standards with additional use of complementary indicators (as in H12). Evolution of uncertainty with time will be a major concern.

For discussions of period for main quantitative analysis, arguments consider:

- Geological stability in Japan (generically assumed to be about 100 ka)
- Decrease of toxicity with time (below original ore by about 10 ka)
- Assessment of "predictability" of reference model chain models (about 100 ka for both geosphere and EBS)
- Time-dependence and time-evolution of uncertainty in key FEPs and resultant alternative scenarios (e.g. sea-level change on scale of 10 ka, tectonic evolution over 100 ka – 1 Ma; EBS alteration by cement leachates over 10 ka – 100 ka); FEPs can be classified based on "plausibility" over various timescales.

It was emphasised that uncertainty in the time of initiation of particular FEPs may not be critical to the resultant Safety Case; uncertainly may not be a general problem (not all uncertainties are significant).

The case of peak doses occurring after the timescale of relevance for geological stability and applicability of models may give a problem with credibility. This will need to be carefully addressed (although these will clearly be site & RC specific).

Care with the process of handling FEPs and scenarios (breaking down FEP expectation as a function of time) was recommended, as experts may well be too conservative. There are also particular problems with using expert-opinion for generic studies. The risks of regulators over-interpreting such analysis was a topic of discussion as this has to be balanced against the risk of regulations which did not consider such factors at all.

Finally, the regulator / implementer interface (and regulator / general public) can be very important. Experience in different countries has been both positive & negative (or non-existent) in particular cases. For NUMO, there is no advantage in trying to second-guess the regulator and hence NUMO should be prepared to address all technically reasonable issues.

5.2 Timescales: Issues & discussions (N. Chapman)

Some of the big issues include:

- Balancing of concentrate and contain (CC) vs. dilute and disperse (DD) modes, which are at least implicit in all concepts
- Timescales in years (a) for HLW / SF from system analysis fall into specific ranges, with some specific outliers
  - Thermal output: ~10^3
  - Containment: 10^3 - 10^5
  - Geological stability: 10^4 – 10^7
  - Climatic stability (assuming no anthropogenic perturbation): ~10^3 – 10^4
  - Peak releases: 10^5 – 10^7
  - System predictability: diminishes with time
  - Dose / risk assessment: 10^6 – 10^8 …
  - Regulation: compliance cut-off – "at any time"
  - Public concern: ? 10^2 – 10^3 - …
  - Institutional control: 0 – 300 - …?500
  - Retrievability: 0 or undefined
  - Monitoring: 0, 50 or undefined
  - Record keeping: 500 to unlimited
  - Safeguards: 0 (HLW) – unlimited (SF)
  - Time back to nature: ~5 x 10^3 (HLW) - 10^5 (SF)

Extended discussions considered presentation of decay of waste vs. lifetime of various barrier (and control) functions (NB in presentations of multi-barrier performance, terminology noting "latent functions" – as SAFIR 2 – could be useful). Different periods can be defined (although this focuses on radionuclide release in groundwater):

- Institutional control / monitoring (if implemented)
- Complete containment, decay of short-lived RN (simplifies analysis)
- Dilute and Disperse of mobile, long-lived RN
- Residual "ore body" of immobile, long-lived RN.

One option may be containment objectives which are graded for these different periods.

Issues which may be considered by NUMO could include:

- Cut-offs (regulatory / self-imposed)
- Calculation of peak releases
- Incorporation of increasing uncertainty with time; a topic of debate as variations (not always increase) of uncertainty in different parts of the system are very site & concept dependant.
- Time-related function indicators
- Final fate of repository
- Radiotoxicity vs. chemotoxicity (radioactive waste vs. chemical waste)
- Presentations of timescales to meet public concerns
- Matching assessments to regulations.

Discussions become more specific as soon as sites (and concepts) are identified. Even at the point of first contacts with the volunteer communities, some of the timescales issues may need to be addressed, well before regulations are developed. Prior consideration of such points is essential, at the very least, to ensure that any messages presented by different NUMO groups are consistent.

In addition, it was noted that discussion of the evolution of human society is inevitably philosophical and should be avoided; evolution of the biosphere can, however, be very important and may need to be considered even if these are only stylised extreme variants.

Some particular observations resulting from specifically considering the boundary conditions for the Japanese programme within the ITAC closed session included:

- Timescale issues are important to NUMO at the present stage of development of regulations and methodologies, even if not directly relevant to PIA selection
- It is sensible to divide the post-emplacement period into different phases and emphasise the different levels of isolation in each; these can be explicitly represented in "working safety standards".

It is important to determine how and when expert judgement will be needed; expert teams already play an important role in NUMO's programme and, in the future, structuring and balancing (and, maybe, training) different expert groups (both NUMO's own and those of the regulator) may need to be considered.

Some countries already extend analysis to consider doses to non-human recipients, which may also need to be borne in mind by NUMO (although it is not an approach recommended by ITAC).

Factors worth considering when considering timescales when developing "working standards" (which is noted to be very difficult, hence needs more careful consideration) include:

- The timescales for tectonic (geological stability) analyses should be consistent with the level of treatment within PA; if geological stability cannot be assured, this will greatly reduce the significance of any numerical calculations
- Calculations should continue to be carried out for long periods and cover peak maximum at least - it was observed that no recent PA (apart from WIPP) cuts off calculations before 1 Ma, even if geological stability is not assured over these periods
- The period in which discussion of uncertainty and the system understanding is focused could be more in the range of 10^4 – 10^5 a, when both the EBS and the geology may be considered to be reasonably stable; these can be combined with use of stylised biospheres
- Over the first few thousand years, emphasis might be concentrated on robust analysis to show effectively complete containment within the engineered and geological barriers
- Alternative performance indicators (fluxes, natural background) can be valuable as a complement to dose calculations, but their interpretation can be tricky and they need to be used with care – particularly at times when confidence in geological predictability decreases
- In all time periods, potential impacts of low probability events (tectonic, human intrusion) might be usefully evaluated as disaggregated probabilities and consequences.

6 Block 5: Wrap up

For ITAC-9, the date set at ITAC-7 (5-7 April 2005) no longer seems practical and a new date of 10-12 August 2005 was set in its place. The date for ITAC-10 was set as 17-19 January 2006.

Potential topics for future meetings could include:

- ITAC-9
  - R&D activities programme
  - Safety principles, guidelines, working standards
  - Experience in technical and non-technical interactions with communities
- ITAC-10
  - Site characterisation programme
  - Progress on literature study.

A programme should be established well in advance to allow any preparations required by ITAC members and by NUMO staff. For very technical NUMO presentations, it could be useful to have these distributed electronically to ITAC in advance.

A suggestion for the "working standards" topic is that national input for this issue from ITAC could be provided as short notes to M. Takeuchi, who could integrate all of the input and present the synthesis at the meeting (with any additional support from individual ITAC members as required).

At the end of the meetings, President K. Fushimi presented ITAC with copies of the new NUMO calendar, featuring underground facilities in Japan. In concluding, both ITAC and NUMO considered that the meeting had again been valuable and thanked all the participants for their active input and the presenters for their considerable efforts in producing a high-quality product.

List of abbreviations

AEC	Atomic Energy Commission
DIA	Detailed Investigation Area
EBS	Engineered Barrier System
EFQ	Evaluation Factor for Qualification (for siting)
EIA	Environmental Impact Assessment
EMS	Environmental Management System
FEP	Feature, Event, Process
FF	Favourable Factor (for siting)
FY	Financial Year (in Japan from April to March)
HLW	High-Level radioactive Waste
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiation Protection
ITM	International Tectonics Meeting (tectonics consensus forum)
L/ILW	Low- and Intermediate-Level radioactive Waste
NEA	Nuclear Energy Agency of the OECD
NISA	Nuclear and Industrial Safety Agency
NSC	Nuclear Safety Commission
PA	Performance Assessment
PI	Preliminary Investigation (siting)
PIA	Preliminary Investigation Area
PR	Public Relations
QA	Quality Assurance
QMS	Quality Management System
RC	Repository Concept
R&D	Research & Development
RN	Radio-Nuclide
SA	Safety Assessment
SEA	Strategic Environmental Assessment
SF	Spent Fuel
WIPP	Waste Isolation Pilot Plant

Brief summary of key points from the international presentations

A2-1 Canada (K. Nuttall)

The key regulatory document (R104) dates from 1987, but has now been withdrawn.

R104 set general requirements for protection of human health and the environment. The associated guidelines focused on a compliance period of 10 ka, although when risks do not peak by this time, "reasoned arguments" must be used to assure that acute radiological risks do not occur after this time.

The period of 10 ka was set on the basis of expert judgment, considering factors like decrease of radiotoxicity and increase in uncertainty associated with time and the potential for the next glaciation on this timescale, etc.

Two main safety assessments were carried out (1994, EIS; 1996, alternative case study); in the former dose rates were still increasing at 100 ka.

The Seaborn Panel review (1998) recommended numerical calculations until, at least, the time of maximum dose.

Most recent CNSC policy statement (2004) confirms a requirement to carry out assessment until the time of maximum impact; further consultation is ongoing to produce a new regulatory guide based on this policy.

A2-2 Finland (J. Vira)

L/ILW regulations (Government Decision 398/1991) specify a 500a emphasis on performance of the engineered barriers, but no specific cut-off time.

SF disposal regulations based on Nordic "Flag Book" which evolved over the period 1989 – 1999, resulting in a government decision for general safety requirements in 1999 and a regulatory guide for long-term safety (YVL 8.4, 2001).

Considered that doses will be uncertain beyond about 10ka, but recommend that dose assessments can be made for longer time periods but then interpreted as safety indicators, not as predictions of really occurring doses.

In the far future (Ma), emphasis is on a more general "environmental protection", utilising fluxes of RN to the biosphere as compared to natural fluxes as the main performance indicator (as the repository at that time is comparable to a natural ore body).

The resultant Government Decision (478/1999) does not specify time limits but emphasises that individual doses should be predictable for several thousand years – in practice this is the focus for complete containment by the EBS.

Posiva dose or dose indicator calculations run for 1 Ma, with additional calculation of biosphere fluxes and additional discussion of nuclides which peak after this time; tacitly accepted by regulators (define reasonably predictable future as several thousands of years and the "farthest future" as the period beyond a couple of hundred thousand years).

A2-3 France (B. Faucher)

Background: the geological disposal of radioactive waste has not yet been regulated in France and the Stocamines case of chemical waste disposed in a former potash mine was presented as an illustration of timescales for licensing and retrievability (30 year renewable licence with mandatory clause of retrievability).

For L/ILW (short lived, which means an effective half life of 30a or less); post closure monitoring set as 300a (10 half lives) – which is also the period for the safety case; at these sites, limits are set for concentrations of long-lived components, based on the knowledge of waste characteristics when received and accepted in the disposal facility.

The safety rule for HLW (RFS III.2.f) does not consider monitoring or retrieval (since issued before the December 1991 Waste Act) but specifies a compliance period of 10 ka for "geological stability" with specified 0.25 mSv/a limit – beyond 10 ka this dose is considered only as a reference level and there is no specified cut-of in terms of timescale.

The period up to 100 ka requires the consideration of predictable natural events (e.g. glaciation at 50 ka).

EBS requirements are specified in terms of containment for decay of shorter-lived RN, but without any particular time specified. Various altered scenarios with natural or random events of natural origin and conventional nature (human activity) are to be considered (i.e. glaciation at 160 ka, climate change due to global warming, etc.). In the consideration of human actions, preservation of records is assumed for 500 a and therefore, no intrusion scenario (accidental or voluntary) is to be considered during this first 500 years post-closure period.

A2-4 Germany (K. Kühn)

In Germany, there exists no Federal or national licensing authority for nuclear facilities. Licenses are granted by individual state authorities. The Federal Ministry BMU, however, sets regulations, which have never specified timescales.

Two safety commissions (RSK and SSK) made a joint statement in 1988 which presented the opinion that safety analysis must be carried out for 10 ka; after this period such analysis contributes to "forecasts of the isolation potential". The responsible Ministry (BMU) has not transformed this statement into regulations.

For the specific case of the Konrad deep disposal of L/ILW licensing procedure, site-specific safety assessment (SA) was requested until peak dose by the State licensing authority. This was calculated to occur at around 450 ka, but further calculations were carried out to 1 Ma.

In February 1999, AkEnd was set up by BMU. Its final report (December 2002) states that the isolation period should be within an order of magnitude of 1 Ma. There is no official reaction from BMU as yet.

BMU ordered a revision of the Safety Criteria, which were originally published in 1982 and transferred into regulations in 1983. The available latest draft of this revision mentions a period for long-term proof of safety of 1 Ma.

A new safety philosophy from BfS (2004), which, however, was not officially approved by now, specifies five phases:

1)	up to ~50 a:	monitoring possible
2)	up to ~500 a:	information about repository preserved
3)	up to ~10 ka:	barrier system only little changed
4)	up to ~1 Ma:	pollutants are retained in the isolating rock zone and the system can be described
5)	more than 1 Ma:	only qualitative statements can be made.

This draft report was massively criticised, however due to its very low dose limit. Nevertheless, 1 Ma timescale for safety proof will probably be introduced.

A2-5 Sweden (J. Andersson)

SSI regulation (1998) deviated from Flag Book (see Finland presentation above) and specified quantitative analysis for 1 ka, with assessment based on "various possible sequences for the development of the repository" after this time. The main difference between these two time periods seems to be associated with the degree of representation of the biosphere. There is no relaxation in the need to show compliance with the 10^{-6}/year risk level after the first 1ka. SSI is currently suggesting recommending a time cut-off at 1Ma. This recommendation is currently being reviewed by various authorities, SKB and other stakeholders.

SKI (2002) requires safety assessment for "as long as barrier functions are required", but at least 10 ka. For spent fuel, this means a much longer assessment period. Required time can be determined by the decrease in hazard of the waste and alternative safety indicators should be used in addition to risk at long times.

SKB assessments were carried out for 1 Ma. Radiotoxicity analysis indicates effectively same levels as the original uranium ore by 100 ka and were used to argue for an effective cut-off at 1 Ma even though peak doses are calculated to occur later.

A2-6 Switzerland (I. McKinley)

Time cut-off is explicitly excluded by regulations (HSK – R21).

The Entsorgungsnachweis project for co-disposal of HLW, SF & TRU in a clay host rock in a potential siting region in Northern Switzerland argues that quantitative analysis is possible for about 1 Ma, which is supported by the diffusion-dominated transport properties of this rock.

Decay of radiotoxicity is used to show main gain obtained over first 10 ka (during which HLW / SF completely isolated by overpack) with further gains up to about 1 Ma (during which time there are negligible releases from the host rock, most nuclides being contained within the EBS); thereafter there is only very slow reduction of toxicity with time.

The very effective host rock results in calculated "groundwater" doses which peak at around 1 Ma. However, such high isolation means that erosion scenarios could give to high calculated doses, even if these occur only in the distant future (~5 Ma). This is a current discussion topic with the Swiss regulator (HSK).

A2-7 US – Waste Isolation Pilot Plant (WIPP) (E. Webb)

Facility for disposal of military TRU; operational since 1999; standards developed over the period from the early '80s (not well documented) until 1993; site-specific standard (1996); three major performance standards all applied over 10 ka including: limited concentrations in ground water set on a nuclide-specific basis consistent with current drinking water standards which assume

- No greater than a 10^{-6} risk of death per year
- A probabilistic analysis of cummulative release of individual nuclides
- A probabilistic analysis of individual dose that cannot exceed 15 mrem.

Active institutional control is assumed over 100 a.

The disposal facility contains also chemo-toxic waste which is covered by separate regulations which specify a 35a operational period and 30a post-closure monitoring that can be extended at the discretion of the State regulator.

During development of the standards, the following reasoning was used to justify the 10 ka regulator framework:

Arguments in Support

1) Numerically we can simulate much longer than 10 ka, but the assumptions and uncertainties as well as understanding of processes are not meaningful for more than 10 ka. Geology, hydrology, climate are basically predictable over 10 ka but is too

uncertain beyond that point. A window of 10 ka to 100 ka was the window of predictable geology while the physicists aimed at longer time frames.

2) The decline of total activity through time reduces the overall potential for impact by as much as 99.9 % over 10 ka. At 10 ka the radiological activity of the repository is basically the same as natural uranium deposits.

3) The 10 ka requirement is consistent with other regulatory requirements in the United States including hazardous waste substances such as arsenic – RCRA, WIPP, Underground Waste Injection, Low-Level Waste.

4) The 10 ka requirement has been codifieed as public policy in 40 CFR 191, 40 CFR 194, WIPP LWA, 1992 Energy Policy Act (information known and discussed in report).

5) At long time periods the total doses are small compared with daily naturally occurring and other anthropogenic doses (US Average is 360 mrem/a, with peak estimated at 150 mrem at 480 ka for YMP) so that the time frame is just a guide to safety or a time when we look at indicators and not directly meaningful as a specific point in time. If the repository is safe at 10 ka it is likely to be safe beyond that time.

6) Analyses of performance are conservative and therefore the real performance is likely to be much better even over longer times.

7) 10 ka is consistent with the length of all human history and therefore on the same scale as anything feasible to envision from a predictive point of view. In particular the human related biosphere is not predictable beyond 10 ka.

Arguments in Opposition of Current Approach

1) The peak doses and most geological processes occur on the scale of 1 Ma – and a certain degree of scientific knowledge is available on these processes.

2) The choice of time frame is a policy decision rather than a purely technical decision due to underlying uncertainties and therefore the decision requires a public engagement "public rulemaking" process. (Some would argue that already happened (see 4 above). For YMP, the codification was invalidated based on in-adequate rulemaking procedures).

3) There are some inconsistencies with hazardous waste guidelines that assume complete clean up for restoration.

A2-8 US – Yucca Mountain Project (YMP) (M. Apted)

Historical evolution via 1982 NWPA which set 2 separate regulators – EPA & NRC. Regulatory development over 1983 – 1987 in a transparent, technically driven siting process which could be used for any repository; this approach was abandoned in 1987 amendments to NWPA that focused site characterisation solely on the Yucca Mountain (YM) site.

A special safety standard was envisioned by the US Congress because of certain unique features of the YM site (e.g., disposal in unsaturated tuff formations in a hydrologically closed desert basin). Congress directed the EPA to contract a special review of this issue by the US National Academy of Sciences. Their report, the 1995 "Technical Basis for YM Standards" ("TYMS") supported a risk-based standard, with compliance assessment conducted until greatest risk occurs or the limit of "geological stability ", stated as 1 Ma, whichever came first. YM has experienced "recent" volcanic activity over a 100 ka timescale and is in a seismically active region of the US; hence, "geological stability" in this context must refer to the expectation that the past and current trends in tectonic evolution and conditions can be considered broadly representative for the next 1 Ma.

Based on the TYMS report, EPA issued its YM-specific safety standard 40 CFR 197 (2001) (followed by NRC's YM-specific 10 CFR 63) that defined and justified a 10 ka compliance period with EIS calculations to peak dose or 1 Ma. The compliance period is set based on arguments related to major uncertainties in climatic / biosphere evolution of this site.

A recent court challenge focused on the apparent discrepancy between EPA's 10 ka cut-off and the peak-risk recommendation in the TYMS report. This challenge resulted in regulations being vacated by the US Court of Appeals. Future development is uncertain, but could involve either direct endorsement of the 10 ka standard by Congress or development of a new standard for time >10 ka. It is highly probable that the Electric Power Research Institute will attempt to convene a topical workshop on compliance timescales, with specific focus on the YM situation, in early 2005.

One area that may help to inform future debate of timescale for US HLW regulations is comparison to regulatory timescales for deep disposal of hazardous waste. In the US, the maximum compliance time is 10 ka for liquid waste injection, but permits are typically for 30 years with operators responsible for <100 a. For hazardous waste, calculations of releases at ~1 ka for quite probable events (typically >.01 / a) can result in very high risks (e.g. 30 % lifetime risk of cancer), for example, which far exceed the risk levels contemplated in US HLW regulations.

Comments from the NUMO/ ITAC audience mentioned that general international focus is on the period up to 10 ka, with a tendency to avoid assessment beyond 1 Ma. One question raised was "Is quantitative analysis beyond 1 Ma is possible?" The answer, for the case of Sweden, emphasises the enormous age of the host rock (>~1.9 Ga) but the uncertainty of EBS and climate over very long times means that quantitative analysis eventually becomes pointless. The case in Switzerland is a peculiarity of the particular Opalinus Clay host rock. Even if calculations can be carried out to such times, it would ease rigorous demonstration of compliance if a clearly justified cut-off for confirmation of quantitative compliance. It should be noted that on an international basis, there is increasing pressure to extend analysis beyond 10 ka, while generally allowing a different safety/ risk standard to apply corresponding to increasing uncertainties in numerous site conditions even within the context of "geological stability" on the order of 1 Ma.

Questions were also asked about the future of the YMP. The main unknowns center around the DOE's license application – i.e. when will it be submitted and when might this be accepted (docketed) by the NRC. A key uncertainty is the previous EPA and NRC regulations have been vacated. The schedule for conducting open public hearings and eventually promulgating new ones is not yet established.