Record of the JAEA International Workshop on Next Generation Knowledge Management System (KMS) for Geological Disposal of Radioactive Waste

Tokyo

3 – 4 December 2009

19 February 2010

Introduction

This note captures the discussion after each speaker's presentation during the workshop. The workshop agenda, list of participants and speakers' presentations are appended.

1. H. Umeki (JAEA): Conceptual overview of the JAEA KMS

It was noted that there may be some confusion about the objectives of KM – all the information is put into the same 'box' without consideration of requirements and knowing what the final application of the knowledge will be. A top-down system is then developed to use it.

In response, Umeki-san suggested that this was not a problem as it is possible to structure the knowledge to support specific requirements by using particular processes or methods, such as argumentation models. The safety case is currently the focus of the structuring of the knowledge base because it is relevant to all stakeholders. This requires that all the relevant knowledge is connected into these supporting arguments.

It seems that the knowledge management system is currently best for the expert users but what about the knowledge supplier? There will be a need to ensure that the system is accessible to others and particularly also suitable for those who input data – the data suppliers.

There was also discussion of the development of the KMS:

- Has it been considered how the system will be updated? Simply inserting information into the system without control is not constructive. As information increases, how do you update the information without causing inconsistencies. One problem in the SKB system is keeping track of the updating of information and this will be a problem for the KMS too, especially with the requirement for traceability and transparency.

- How will the updated knowledge handling system be connected to the older versions to ensure consistency across developments, e.g. if you do a search one day with the old system, will the results be the same the next day with new version in use.

- How will maintenance affect the system?

Quality management must be an element of this, in particular QA of the software versions before implementation, as well as of the information added. Controlling the process of development is challenging as people will be working on parallel versions, thus quality assuring these versions and implementing them is a difficult process which will be the responsibility of the managers of the system.

The need for the expert systems was queried using an example of permeability measurements where there are many data points but the important point for the safety assessment is to supply one value to the safety case – so why is it necessary to have access to every detail of all the measurements? The key issue here is to use the expert systems within the KMS to filter the data so that human experts can examine the inconsistencies or outliers which are picked up. Human experts must set the criteria for this sort of process but the system can then be left to handle data as it is produced. This can simplify (and reduce the manpower required for) the task of selecting the single value as well as keeping a record of the justification of the value for the safety case.

It was noted that the Knowledge Base (KB) is a part of the KMS – the structures and tools of the KMS must be designed with the tasks and working environment in mind – to foster the

required cooperation between personnel working in different areas, for example. The issue of how we work together is also important. Commitment to a collaborative approach is necessary and needs a buy-in from all relevant organisations.

2. K. Hioki (JAEA): The knowledge base and KM toolkit

It was pointed out that knowledge is dynamic but produced using a static information and QA system and that it is difficult to do everything in the same system. How will this be done, e.g. freezing CoolRep or in argumentation models? Freezing the data is the result of the need to submit reports, etc. As for H12, H3 or SR-Can, the database must be frozen for that point in time. H22 on CoolRep will be similar – the final version of the report will be frozen, but the Knowledge Base will carry on developing. The QMS will also need to respond to developing requirements on a regular basis (perhaps not daily).

It was noted in the first KMS workshop that the QMS must be incorporated within the KMS to make life easier for the knowledge producers and suppliers – this is the pay-off for them accepting and using the KMS/QMS system.

Smart search engines were identified as being critical to use of the knowledge base.

Interface development with knowledge producers will be critical to make it easy for them to use the system as they have a key role in developing the KB. Information producers have to be encouraged to think in a certain way; this is a key aspect. We have to mimic how experts think and then ask them if this is accurate, learning from them to develop the interface.

## 3. H. Osawa (JAEA): Support of safety case development and review

Regarding critical questions in argumentation models – are they questions which the system forces you to address? This would be an important part of the QA system. The formal argumentation model requires that you classify the basis for your argument and, from this, the critical questions arise. At the moment, the critical questions are only for guidance, but once the 'fuel gauge' system indicating levels of confidence is implemented then all the questions will need to be answered as part of the QA. This allows the identification of where further research or information is needed. Eventually, all unanswered questions will be flagged as 'threats' to which an R&D plan must be attached if they cannot otherwise be answered.

The issue of contradictions and decision-making methods was raised: how do you choose the appropriate method for solving an issue? Contradictions are inherent in the requirements and these will need to be addressed by human experts and decisions made in each case, but an argumentation network can aid in identifying where the contradictions are. The system needs both a telescope and a microscope. The 'Management Cockpit' gives a macro-scale (telescope) view of the requirements and evidence boxes within arguments go right down to the detailed (microscope) data and reports. An example was given from the (January 2009) low-pH cement workshop and the argumentation model developed which covered all scales from the highest level questions of the safety case right down to technical considerations of low-pH cement chemistry.

It was pointed out that the KMS project involves KM for JAEA to support NUMO's decision-making. NUMO's RMS will need to interface with the KMS to ensure that decision-making is supported, while decisions are documented in a transparent and traceable manner.

There was some confusion about terminology used in the SCARAB software: warrant is used to link argument statements to their supporting evidence (argument is statement + supporting evidence) and rebuttal is used instead of 'counter-argument' used in previous presentations (see Toulmin's argumentation terminology below).

Toulmin's argumentation model
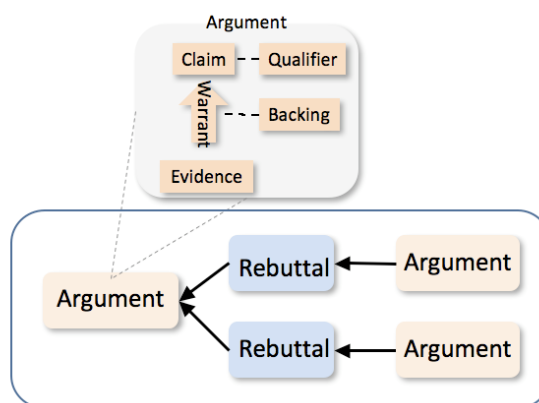
4.   T. Semba (JAEA): Support for site characterisation and geosynthesis

It was pointed out that ISIS is a tool for geosynthesis and is one part of the whole KMS but is currently not fully integrated.

The objectives of ISIS are not clear and need to be better explained. Representing the geosynthesis in the same way as the safety case is one objective, using it as a tool to manage site characterisation is another. The whole undertaking is very ambitious, driven by the recognition that geosynthesis is usually done after the data have been collected and means rewriting history. NUMO has a very short timescale in which to make decisions and a system is needed that will analyse data as it is obtained, in real time. An integrated, dynamic approach to understanding the site is required. It is recognised that this is very difficult as it requires major integration of information in many different areas/types rather than the data visualisation and calculation tools currently available or planned in ISIS

5.   H. Makino (JAEA): Support for repository design and performance assessment

It was explained that e-Par is PA-specific while CoolRep is a portal to the KMS system that is more general and includes other aspects.

There was some discussion of the TRIZ (formal method for innovative solution generation) approach and how it is applied to PA or to practical situations. JAEA would like to use TRIZ to solve conflicts between requirements in order to reach innovative solutions. Currently, it has only been looked at to determine whether it can be applied and is useful. In theory, it could be applied in any area where contradictions arise and trade-offs must be made. This type of top-down approach has been used to resolve conflicts in repository design: at an MRI workshop on alternative repository designs it worked quite well as it brought into focus the

weaknesses of H12 and allowed participants to come up with potential solutions by developing new concepts. During a repository programme, as more site information becomes available, more, and different, conflicts arise: the technique could then allow tailoring of concepts to sites. Whether the particular technique (TRIZ) is used or just the general process (as in the MRI workshop) is still under consideration.

A clearer overview of where all the tools fit into the system is needed – there is a large number of names and acronyms which are not always useful ('Sinbad' was suggested as a single unifying acronym for the tools). The reason for perhaps too much focus on individual tools is that the aim at an early stage was to develop tools for the purpose of obtaining feedback. JAEA have been assembling blocks and now need to show how it all fits together.

The workshop participants would have liked to see more real examples of the tools in action as, to date, there has not been enough to demonstrate that 'it seems to work'.

6.   H. Umeki (JAEA): Putting it all together – CoolRep and integrated QA

QA in CoolRep – what does this relate to?

QA applies to all the content in H22 and the knowledge kernels on the CoolRep site. The key is to know the quality of the content. With time, the QA will be built up and anything critical to the safety case will be visibly quality assured.

CoolRep is the interface to the H22 report as well as the KMS but the KMS has its own entry page. The CoolRep system is very flexible and can allow developments according to users' requirements. The idea is that all supporting data can be accessed through CoolRep and eventually all the data (including external) will have an indication of quality and confidence.

There was further discussion about what CoolRep is – website, part of the KMS, a portal? It is a demonstration of how a safety case could be built on a (web-based) platform – how the linking of tools and data together could be done. CoolRep is a demonstration of tools for the next generation of safety case. It shows how all the tools come together and what future safety cases should look like.

Individual organisations in the waste management field have their own organisation-specific websites, but CoolRep is a website about geological disposal itself.

However, CoolRep does not attempt to completely replace face-to-face discussion. There is a need to take over 'blending' from e-learning where most work can be done online but some face to face is also required. With CoolRep, some face to face will also be necessary, but meetings involving relevant personnel are increasingly being complemented by other methods.
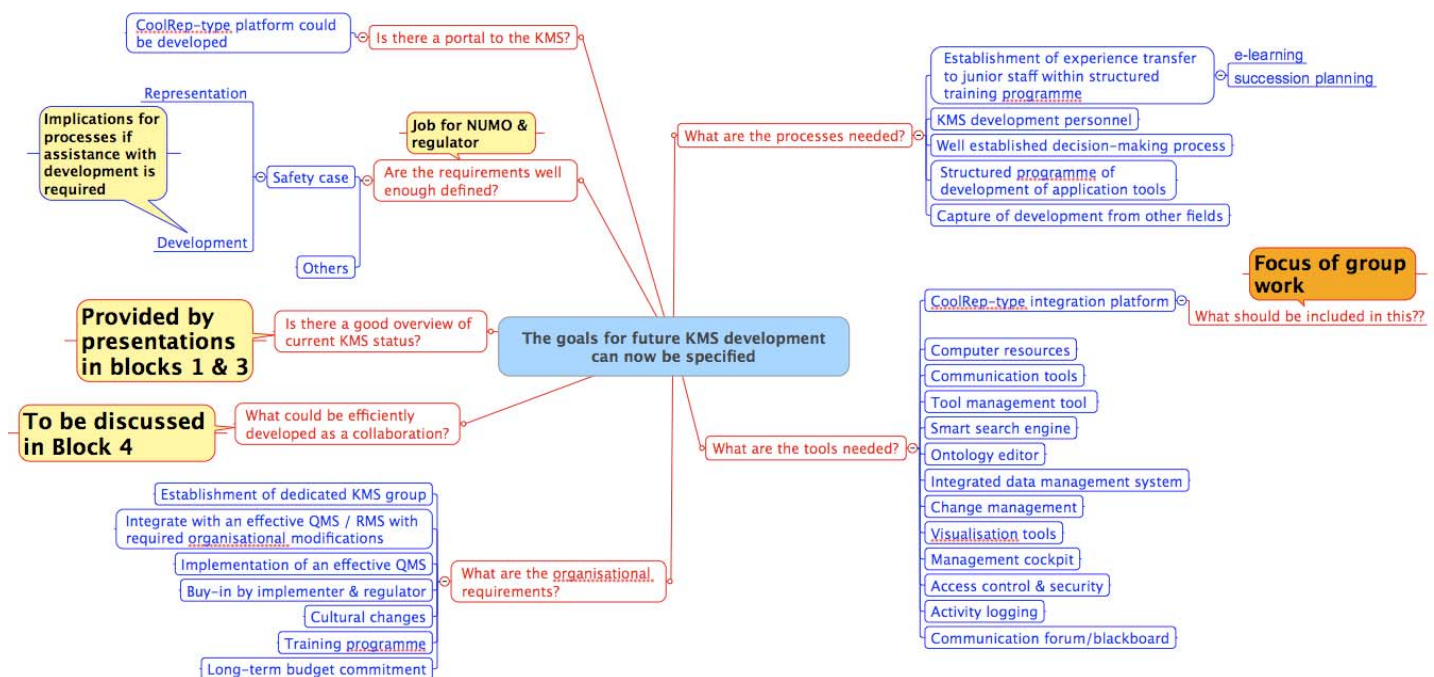
7.   Brainstorming

Discussion of the safety case in CoolRep – is it a representation of the safety case or actually assisting in the development of the safety case? This has implications for the "processes" required in developing the KMS.
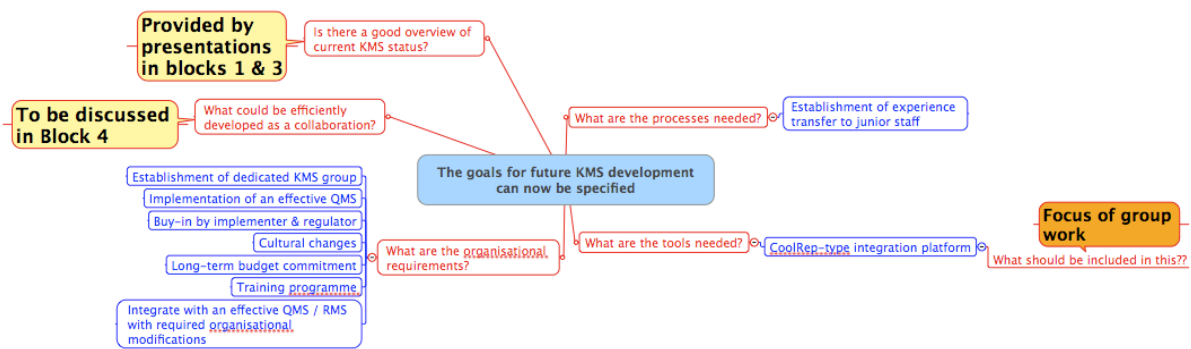
Original argumentation model

The results of the brainstorming were captured in an informal argumentation model (see below).

8. Group work

The working groups were asked to consider what they would like to see implemented on the CoolRep website. Group output is given in bullet points below (as presented), along with discussion, and summarised on the following argumentation model.

8.1 Group 1

- Argumentation models are important

- CoolRep as the interface to the KMS

- Emphasis on traceability and access to all supporting documentation

- Should access be to the same information for different stakeholders?

- Needs very good search engine – smart!

- Security is critical if widely accessible

- Technical user needs shortcuts to critical areas of interest

- How visible will data gaps be? Openness? Customised versions for particular users?

- Clarify openness of knowledge base: restricted database and discussions may be needed

One system to be used for everyone is challenging. Another possibility, for example, is to have customised KMS systems for different users, e.g. NUMO, regulator, general public.

Another issue is who should have access to which level – especially with respect to data or information which is under development or discussion. There is scope for limiting access of different users to different levels of information in some areas.

8.2   Group 2

- Name: keywords to facilitate access by search engines

- Front page concise: introduce concepts, acronyms… (better with linked glossary)

- Manga

- Holistic approach

- View in wider concept

It would be valuable to show the wider context for radioactive waste disposal. Most of the nuclear waste websites take their starting-point as 'waste disposal' without showing where the waste comes from. Mitigation of climate change by use of more nuclear power offers an opportunity to make a top-level justification for managing waste. There is a need to change the perception that waste disposal is holding back increased nuclear power development.

8.3   Group 3

- Name – 'Rep' – report or repository?

- KMS links

- Main beneficiaries may be SC producers & reviewers

- Special consideration of different users

- Indicate sensitivity of different components to overall safety

- Well managed Q&A

The question is whether the main beneficiaries of CoolRep are the general public. At present, the main drive is to get volunteers in Japan. However, in future users may become more technical.

Trust in the implementer comes from developing relationships rather than trying to explain the whole safety case to the general public, so this aspect of CoolRep is more restricted to technical people.

8.4   Group 4

- Management cockpit for safety case

- Procedures for freezing

- Ensuring consistency

- Video / communication

- Linking specialists in different fields / facilitating discussions by putting work in context

CoolRep could be useful for experts to learn about other areas so that they can communicate more effectively with other experts.

Discussion with a specific expert within the CoolRep environment about their areas – could be an efficient communication and discussion tool.
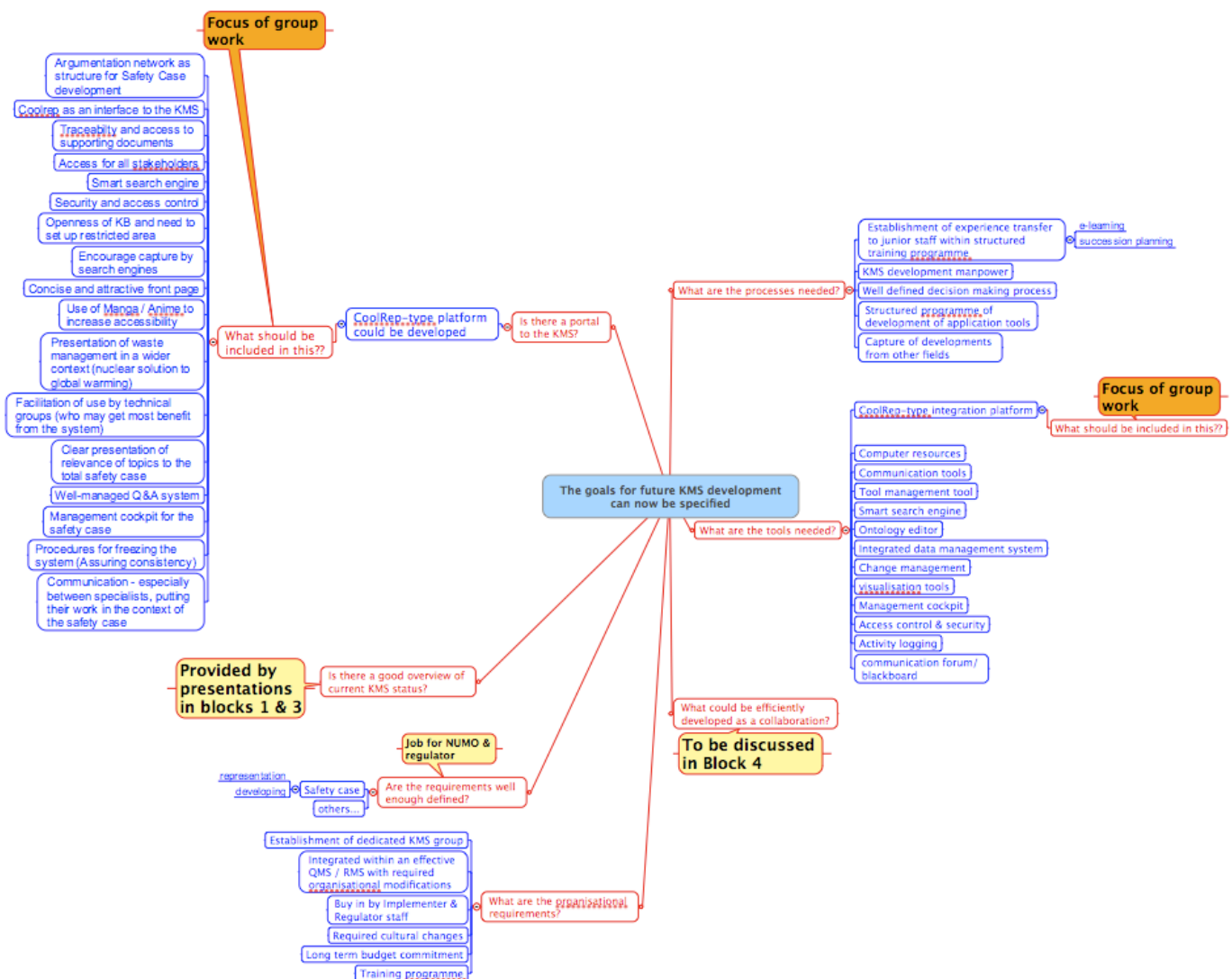
Day 2

9. Fiona Neall: Overview of day 1

It would be good to access the Management Cockpit from the CoolRep home page.

Considering maintenance of the system, the long-term budget requirements should be emphasised.

With respect to CoolRep, it was considered important not to focus too much on interaction with stakeholders (in particular, the general public) when the main users should be technical personnel.

10. E. Forinash (NEA)

Action plans for knowledge management should address both "short term" (i.e., decades) and longer term. For both, it is important to go beyond collecting and storing data. Organisation and maintenance are key issues to ensure continued accessibility of information. Even more crucial is to synthesise and extract learning and to document the basis for decisions; the consolidation of data and management of "tacit" knowledge are not easily done. We need to discuss how to manage this, in particular the need to periodically revisit data and knowledge to make sure that the current understanding is reflected in how this information is retained and used.

11. J. West (BGS)

We should data mine – we need the tools to rework older information. This should be done efficiently and enhance credibility in current activities.

Data and physical media (archiving) – improvement in tools and methods will allow reworking of data (e.g. geophysics) so we need to consider how data are stored if information is to be developed over time as, e.g., processes and computing methods develop.

12. G. Ouzounian (ANDRA)

As part of the traceability of each piece of information, we also need a record of who carried out the work. The QA system should also store the review process documents in the system.

13. M. Nutt (ANL) and S. James (SNL)

JAEA is developing an advanced fuel cycle so KMS in terms of waste management will be extended to take these processes and wastes into account.

14. K. Karasaki (LBNL)

The KMS project is truly an insightful and audacious project that tries to develop one stop shop seamlessly integrating with QA while maintaining transparency. My concern is that although it is an absolute must to develop such a tool, it is going to cost a lot of money (say, ~$64M/year). Under the current budget climate in Japan, JAEA may need to prioritize the efforts. Another concern is that the system has to be made as flexible as possible. Sometimes the decision maker has to compare multiple competing factors that are not directly

comparable like apples and oranges. The weighting on each factor may not be digitally quantifiable. JAEA may want to collaborate with organizations that are carrying out projects aimed at geologic sequestration of CO2.

15.   A. Sneyers (SCK/CEN)

[Safety statements examined in a recent paper by P. Smith et al. (www.nea.fr)]

It was encouraging to hear that the relationship between implementer and research organisation has been so productive in developing the KMS and databases.

Once the safety case (presently under development) is finalised, the regulator will have access to the system as part of the acceptance procedure.

Validation of information (data, models etc.) is part of the QMS fully implemented for current data production but, for older data, everything must be assessed by expert judgement.

16.   J.T. Jeong (KAERI)

KAERI has been developing an automatic quality assurance system, CYber R&D Platform for Radwaste disposal in Underground Systems (CYPLRUS), since 2000. Confidence and Transparency on a disposal work have been improved and it could be helpful for better communication among stakeholders.

17.   J. Andersson (JA Streamflow AB)

There is an analogy between KMS and nuclear installations: safety assessment on paper must be updated as the design changes. In Sweden, as in many other countries, there are formal regulations for examining the safety implications of changes in the design of nuclear installations. Something similar may be required for KMS, i.e. to anticipate and facilitate the implications of changes.

There is a need to compartmentalise so that the complexity of the whole system can be limited for consideration of changes to data, design, etc. However, the linking between compartments is then essential to ensure that the full complexity can be considered. Ironically, compartmentalisation is dependent on identifying the links between areas and components.

Interfaces between scientists and engineers will be needed as engineering design will be constrained by (long-term) safety implications – they need to have a common language to discuss this. It would be desirable if the KMS could provide such a linking platform.

18.   J. Palmu (POSIVA OY)

Mr. Palmu could not attend the Workshop on the Second day. He sent the JAEA his presentation material and the short summary as follows:

The first step for the KMS in Posiva will be to organise the contents of the research work and reports to be utilised in much more approached form. The implementation of the KMS could be realised in semantic web based KMS ontology portal, which combines information from the internal and external information and document systems based on the defined ontology concepts and relations (classes, definitions, relations). For more detailed information see the presentation file.

19.   General discussion

Is an information management system enough or is knowledge management also needed? In general, it was considered that information management is not enough as there is also a need to transfer experience and knowledge to future generations. A rigorous IMS is a necessary basis for KMS.

Only a few years ago, people at the head of organisations could have a complete overview of their programme but this is now impossible due to the explosion of information in all programme areas – even to have an overview of an area such as site characterisation or engineering design is difficult. As ever, this brings up the problem of specialists trying to speak each other's language. Thus, there is a need for generalists to cover as large an area as possible so that they can develop the communication interfaces across the whole programme.

20.   New and developing implementations in CoolRep, Linda McKinley & David McKie

The input developed in the group work was taken over in a demonstration of how the "wish lists" could be (or actually has been) implemented in CoolRep. These features will be taken over where possible to the online English demonstration version.

By way of introduction, the following points were made:

- Comments were made yesterday that Cool Rep is a website, but it is not just a website. It represents a novel and unique approach to presenting information in the area of geological disposal.
- Many of the wishes expressed in the group work have actually already been implemented (e.g. FAQs (Frequently Asked Questions), more transparency of the QA system).
- CoolRep strives to be a balanced gateway for all users. Even experts are beginners in some areas. At present there is some emphasis on information for the public: NUMO needs volunteers and associated jump-points feature prominently on the front page. Once NUMO has a volunteer(s), this can be changed, e.g. to information for siting municipalities.
- Regarding the safety case, the role of CoolRep is to support the implementer and regulator in developing and reviewing the safety case respectively. CoolRep provides access to the tools and knowledge supporting the safety case.

The following new features were developed overnight and demonstrated (a selection of screenshots of these is appended):

- Confusion regarding what CoolRep is and what it does: the explanation (already on the home page) has been moved to a more prominent position and a diagram included to show how the system fits together.
- Tricky terms and acronyms: a button provided access to explanations of acronyms and explanations (partly in manga format) of difficult terms will now appear on each page.
- KMS section: this now includes a preliminary attempt to show how the different tools map onto the safety case (addresses the confusion over the different tools and what they are intended for). The KMS section now has an explanation of the different tools and their functions in a user-friendly format. Users can see whether the tools are functional and launch with the press of a button. A users' forum has also been created.

- Note that FAQs exist, but in a different, more interactive form (Ask CoolRep / CoolRep asks you).

Navigation through the H22 summary was also demonstrated, showing how the format allows inclusion of videos, hyperlinks, etc.). Links to the kernels and an explanation of what the kernels are were also highlighted.

The log-in page for the QA system was also shown, demonstrating the different levels of access to documents depending on the role of the user (author, reviewer, QA manager).

Explanations were also provided of how security can be implemented and how CoolRep has a structure that ensures hits by e.g. Google.

Some comments on the presentation were:

- Feedback feature for users on every page was identified as very unusual, but a nice idea – potentially very useful at different levels, both technical and non-expert.

- It was considered important not to have too much novelty; there is a need for tried and tested features like "FAQs" as well.

- Plans for maintenance of the site were questioned but it was noted that CoolRep is only a demo at the moment and, to some extent, a marketing tool. There is a need for collaborations and links with other organisations to share the maintenance costs.

- A moderator for comment and feedback functions, and possibly a buffered queue, was identified as an eventual requirement as the site goes live.

21.   Structured brainstorming on potential cooperation

Areas of possible future collaboration were identified (summarised on the argumentation model, below):

- Argumentation models – how these can be applied and developed as they are a very interesting tool and widely applicable in many areas. What about a user group or forum on argumentation to provide informal review and share experience?

- More generally, tools will depend on the requirements of the organisation so it may be difficult to develop these in collaboration with other organisations with different requirements.

- Information exchange workshops.

- Information gathering – exchange of access to information bases within user groups (e.g. fuel cycle – of interest to JAEA and DOE and possibly other organisations in future as conditions change and SF is reprocessed).

- Development of discussion networks on information requirements.

- A new way of referencing data – would it be possible to cite other knowledge or information bases via hyperlinks rather than adding references to published reports?

- Sharing large databases (e.g. NEA TDB) could be a way of sharing the burden of their maintenance.

- Using modern technology to make things easier, e.g. change management for databases. While using technology may require some effort at the front end, it should be implemented to relieve the burden, for example in QA (is there a place for autonomous QA (QA by computer alone) as a small part of QMS?).

- RSS feed or alerting function to notify of changes in information bases – could be an important input to quality management systems.

- Development of public communication – information and experience exchange. Ideas for bringing the safety case to the general public could be developed cooperatively and experience shared.

- It is not clear that implementers and regulators will cooperate in sharing information development, even if staff individually cooperate well, as their objectives are somewhat different.

- Data and information preservation (archiving).

- Decision-making process in the KMS system – documenting for traceability and transparency. Tools to assist development of top-level strategic decisions which require major trade-offs, such as development of a strategic environmental assessment.
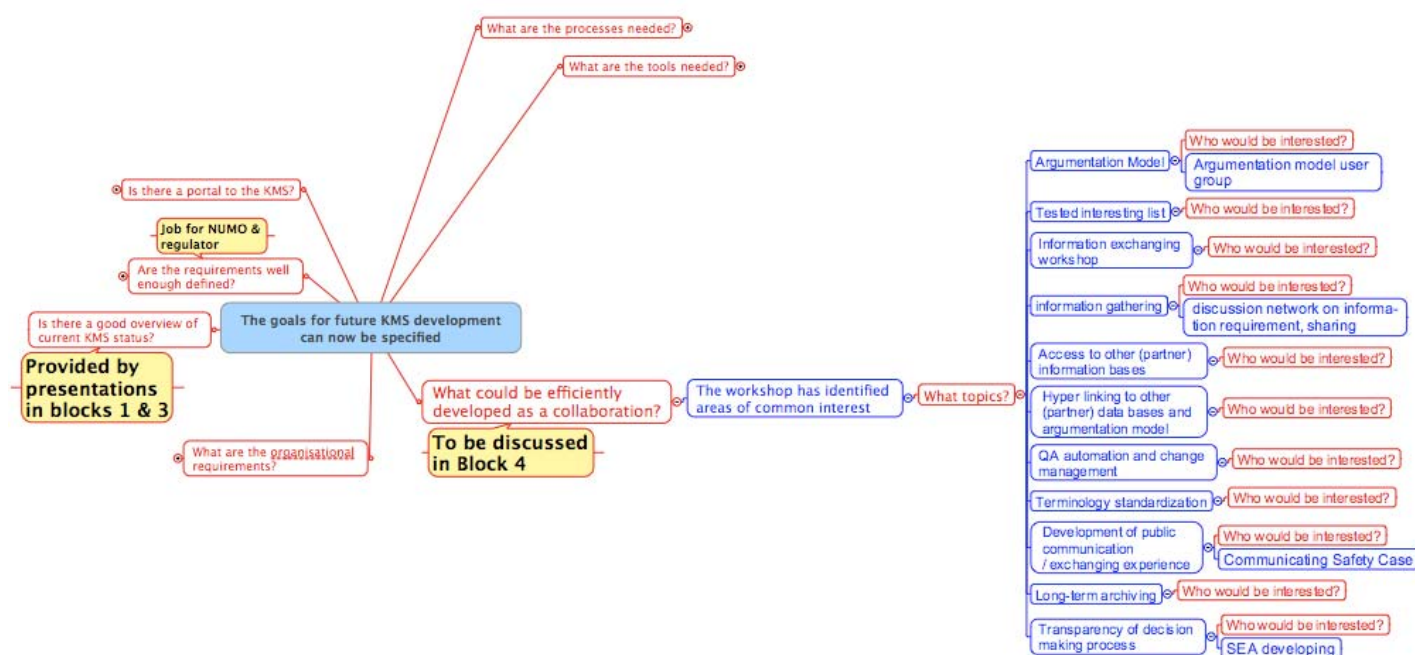
22.   Wrap-up

Although there seemed to be considerable interest in collaboration and a wide range of potential topics were identified, specific actions were not nailed down during this workshop. Instead, JAEA will develop an outline of options for future bilateral or multinational cooperation in the KMS area and circulate this to both workshop participants and other potential partners.