Regulators Workshop on

The Role of Future Society and Biosphere in Demonstrating Compliance with High-Level Radioactive Waste Disposal Standards and Regulations

Stockholm, Sweden, September 11-13, 2001

Final Proceedings
March 2002

Co-Sponsored by:

The U.S. Environmental Protection Agency

and

The Swedish Radiation Protection Authority

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Acronym List

U.S. Environmental Protection Agency (EPA)
High-level radioactive waste (HLW)
International Commission on Radiological Protection (ICRP)
Biosphere Modeling and Assessment Program (BIOMASS)
International Atomic Energy Agency (IAEA)
Biosphere Model Validation Study (BIOMOVS)
US Department of Energy (DOE)
Spent Nuclear Fuel (SNF)
Reasonably Maximally Exposed Individual (RMEI)
National Academy of Sciences (NAS)
Intermediate Level Waste (ILW)
Low Level Waste (LLW)
Representative Volume (RV)
U.S. Nuclear Regulatory Commission (NRC)
Decision in Principle (DiP)
Post Closure Safety Case (PCSC)
Environmental Agency (EA)
Rock Characterization Facility (RCF)
Health and Safety Executive (HSE)
Guidance on Requirements for Authorization (GRA)
National Center for Risk Assessment and Options Appraisal (NCRAOA)
Federal Agency for Nuclear Control (FANC)
de national instelling voor radioactief afval en verrijkte splijtsoffen (NIRAS)
l'organisme national des dechets raadioactifs et des matieres fissles enriches (ONDRAF)
Norwegian Radiation Protection Authority (NPRA)
European Commission (EC)
Environmental Impact Statement (EIS)
Geosphere-Biosphere Interface (GBI)
Swedish Nuclear Power Inspectorate (SKI)
Safety Assessment (SA)
Features, Events, and Processes (FEPs)
Critical group (CG)
Waste Isolation Pilot Plant (WIPP)
Energy Policy Act (EnPA)
Framework for Assessment of Environmental Impact (FASSET)
Agence National por la Gestion des Dechets Radioactifs (ANDRA)
British Nuclear Fuels plc (BNFL)
Centers for Disease Control (CDC)
Commissariat a L'Energie Atomique (CEA)
Centro de Investigaciones Energeticas Medioambientales y Technologcias (CIEMAT)
Empresara Nacional de Residulos Radioactivos SA (ENRESA)
Food Standards Agency (FSA)
National Cooperative for the Disposal of Radioactive Waste (NAGRA)
Institut de Protection et de Surete Nucleaire (ISPN)
United Kingdom Nirex Ltd. (Nirex)
Japan Nuclear Cycle Development Institute (JNC)
Studiecentrum voor Kernenergie/Centre d'Erude del'Energie Nucleare (SCK.CEN)
Swedish Radiation Protection Authority (SSI)

Summary

This report summarizes the proceedings of a workshop, co-sponsored by the U.S. Environmental Protection Agency's Office of Radiation and Indoor Air (EPA) and the Swedish Radiation Protection Authority (SSI), held September 11-13, 2001 in Stockholm, Sweden. The invitations to participate in the Workshop were primarily extended to authorities in countries with major nuclear waste programs involving geological disposal and using performance assessment methodology.

Although much progress has been made, there are still a number of technical and scientific questions and issues related to compliance assessments for geologic repositories, for which it is widely recognized that a common view among regulators would facilitate the understanding of performance assessment internationally. These issues relate to the role of the biosphere and the society in demonstrating compliance. The main objective of the Workshop was to:

Develop a common understanding among regulators of the role of society and the biosphere in demonstrating compliance with the knowledge that issues related to society and the biosphere will gain an increasing amount of attention in future licensing proceedings.

The desire to formulate transparent requirements is shared by all national regulators. The workshop facilitated international communication and information exchange about the biosphere and society's role in compliance demonstration by promoting discussions among regulatory authorities regarding the philosophy behind the health criteria in the legal framework of the regulators. In particular, the co-sponsors encouraged participants to:

- Engage in a frank interchange of views of national regulations, enabling regulators to better understand common elements of various national and international regulations, and to better explain differences when formulating criteria in different legal frameworks, where such differences exist;
- Promote discussion and information exchange regarding the review technique of safety assessments in a stepwise process, evaluating preliminary goals and expectation of compliance;
- Communicate in an open way the goals and rationale of the regulations and, in particular cases, experiences in connection with reviews;
- Discuss joint initiatives in the area of the biosphere and society's role in the safety assessment for compliance demonstration; and
- Communicate results of the discussion to international bodies of regulators, such as the CEC Regulator's Club and the OECD/NEA/RWMC Regulator Forum.

Introduction

The programs for final disposal of high-level radioactive waste (HLW) have come to a mature state in many countries. Technical information available to support decisions varies in time and from stage to stage. There is a strong trend for all waste management institutions to address issues related to stakeholder confidence. Technical expertise and confidence have been shown to be insufficient to justify to the general public that geologic disposal is a viable waste management solution. EPA and SSI originally acknowledged this by co-hosting a conference in Stockholm in 1998 involving technical issues and stakeholder communication. However, there are still a number of technical and scientific questions remaining related to compliance assessments for geologic repositories, for which it is widely recognized that a common view among regulators would facilitate the understanding of performance assessment internationally. These questions and issues are related to the role of the biosphere and society in demonstrating compliance. There is no clear international consensus in this area, yet it is obvious that these issues will gain even more attention in the future, when compliance issues are discussed in the various national licensing proceedings and in the wider public domain.

Although the issues of biosphere and society surrounding the repository are important to the layman, EPA and SSI believe that, at this time, there is a major need for licensing authorities to discuss the principles involved in their definition in the technical context of compliance demonstrations. Therefore, EPA and SSI believed that the 2001 meeting would be more productive if attendance was restricted to regulators. The participants were limited to technical experts able to represent the national regulator or their support organization, as deemed appropriate by the regulator.

The International Commission on Radiological Protection (ICRP) recently made a contribution in the area of post-closure requirements by its recommendations in ICRP Publication 81. The publication contains guidance regarding risk or dose levels relevant for -- although not directed exclusively to -- geologic disposal of HLW and SNF. Work is in progress within various international bodies about the possible response to the views presented in this document. The existence of promulgated regulations, even before the publication of general guidance, such as ICRP 81, underlines the fact that international consensus work is lagging behind, and in need of broad discussion.

There have also been recent advances in biosphere modelling as a result of the efforts of the Biosphere Model Assessment (BIOMASS) program, conducted by the International Atomic Energy Agency (IAEA) with the support of sponsors, including operators and regulators, and involving a wide range of participants from many technical disciplines and different social, political and cultural backgrounds. This program has contributed toward building an international consensus regarding modelling radionuclide transport within a given biosphere, and has provided advice for procedures involved in constructing a reference biosphere model. Basic knowledge emerging from BIOMASS and its predecessor, the Biosphere Model Validation Study (BIOMOVS), is a necessary condition for a meaningful discussion of the authorities' requirements of any calculation involving the biosphere.

Finally, some examples of existing and proposed rules, criteria, and standards were expected to give fruitful examples for the discussion among authorities. Both the Swedish regulation for protection of the environment, the US standards and criteria, and several other regulations, served as starting points for the discussions.

Each participant presented a "country report" on the current situation regarding operational and regulatory development. During the later portion of the Workshop, participants gave presentations and, in some cases, wrote substantive papers on various topical issues of relevance.

Following each presentation, detailed discussions were held and the participants raised salient points and commented on issues of concern. The discussions, as well as mutually agreed-upon steps to be taken in the future are recorded in the report.

Workshop Participants

The following people attended the Workshop. They are listed below in alphabetical order along with contact information:

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Workshop Agenda

Tuesday, September 11, 2001

9:00 a.m.-1:00 p.m.	*Opening*
Welcome Address	Dr. Holm, SSI
Opening Statement	Mr. Clark, EPA
Overview of the BIOMASS Project	Mr. Torres-Vidal, IAEA

1:00 p.m.-5:00 p.m.	*Country/Agency Reports*
Environmental Protection Agency (EPA), USA	Mr. Clark
Nuclear Regulatory Commission (NRC), USA	Mr. McKenney
International Commission on Radiological Protection (ICRP)	Dr. Valentin

Wednesday, September 12, 2001

9:00 a.m.-1:00 p.m.	*Country/Agency Reports, cont.*
Radiation and Nuclear Safety Authority (STUK), Finland	Ms. Sjöblom
Environment Agency (EA), UK	Mr. Streatfield
Federal Agency for Nuclear Control (FANC), Belgium	Dr. Blommaert
Norwegian Radiation Protection Authority (NRPA)	Ms. Sneve
Radiation Protection Centre, Lithuania	Mr. Klevinskas
Swedish Radiation Protection Authority (SSI)	Dr. Larsson
Swedish Nuclear Power Inspectorate (SKI)	Dr. Westerlind

1:00 p.m.-5:00 p.m.	*Position Reports/Papers*
Critical Group versus Reasonably Maximally Exposed Individual – Risk or Dose?	Mr. Clark, EPA
Sustainable Development in the Context of HLW Criteria	Dr. Jensen, SSI
The Society and Biosphere >> 1000 Years	Ms. Sjöblom, STUK
Environmental Concentrations	Mr. Avila, SSI

Thursday, September 13, 2001

9:00 p.m.-1:00 p.m.	*Position Reports/Papers, cont.*
Institutional Controls and Human Intrusion	Dr. Jensen, SSI
Protection of Other-Than-Human Species (FASSET)	Dr. Larsson, SSI
Closing Remarks and Conclusions	All Participants

Overview of the BIOMASS Project

September 11, 2001 -- Welcome from Dr. Lars-Eric Holm, Director of the newly named Swedish Radiation Protection Authority (formerly Institute). Dr. Carl-Magnus Larsson, SSI, led the introductions.

Dr. Larsson highlighted the fact that the first workshop of this kind was held in 1998. The 1998 workshop was the first real opportunity to engage stakeholders (industry, regulatory and other groups) on the topics of the biosphere and high-level radioactive waste disposal. The discussions were constructive and opposing views were discussed openly. Dr. Larsson also stressed that there has been a fundamental change in how regulators and others are viewing the biosphere, the environment, how society will change and how the biosphere will change over time. The current focus is on how social and environmental changes in the biosphere will affect each other.

An Overview of the BIOMASS Project: Carlos Torres-Vidal, International Atomic Energy Agency

Mr. Torres-Vidal provided a description of the BIOMASS program, especially with respect to Theme 1 on reference biospheres: Radioactive Waste Disposal. BIOMASS Theme 1 aims to develop the concept of "Reference Biosphere" into a practical system for application to the assessment of the long-term safety of geological repositories for radioactive waste. A primary goal of the program is to develop a subset of example reference biospheres, which can provide a useful point of reference as broadly applicable indicators of potential radiological impact for radionuclide releases occurring in the long term. A key measure of BIOMASS Theme 1 success was the request by the U.S. Department of Energy (DOE) for, and subsequent completion of, a peer review by the IAEA of the Yucca Mountain project biosphere-modelling program.

BIOMASS is a complicated program, but 20 Working Documents have been produced, and are included on a CD ROM, along with draft technical materials and the project schedule.

The Reference Biosphere Methodology is the result of discussion from many interested parties. Sponsors included:

- Agence National por la Gestion des Dechets Radioactifs (ANDRA), France;
- British Nuclear Fuels plc (BNFL), United Kingdom;
- The Centers for Disease Control and Prevention, USA;
- Commissariat a L'Energie Atomique (CEA), France;
- Centro de Investigaciones Energeticas Medioambientales y Technologicas (CIEMAT), Spain;
- Empresara Nacional de Residuos Radioactivos SA (ENRESA), Spain;
- The Food Standards Agency, United Kingdom;
- The National Cooperative for the Disposal of Radioactive Waste (NAGRA), Switzerland;
- Institut de Protection et de Surete Nucleaire (IPSN), France;
- United Kingdom Nirex Ltd. (Nirex), United Kingdom;
- Japan Nuclear Cycle Development Institute (JNC), Japan;
- Studiecentrum voor Kernenergie/Centre d'Etude de l'Energie Nucleare (SCK.CEN); and
- The Swedish Radiation Protection Authority (SSI)

It provides a structure for analyzing the biosphere, bearing in mind the big problems of making assumptions for biosphere change, due to natural and human influences. Mr. McKenney and Dr. Larsson commented that the BIOMASS methodology can and should be applied to biosphere analysis for issues other than just deep geological disposal.

Justification for the system and details about how to best describe the biosphere system are important outputs from BIOMASS. BIOMASS also provides guidance on developing bases for assumptions about critical and other hypothetical exposure groups and guidance on the application of data. The problem is one of choosing parameter values. The assessment context helps by advising on issues such as cautious or realistic assessment requirements, but the Data Protocol outlines a procedure that helps determine where the always-limited resources should be spent on improving data assumptions. This means spending most resources on important, but uncertain, processes. These are difficult to identify generically, presenting a problem for BIOMASS as to where to spend resources. A message for the future is to use previous assessments (appropriately) thereby focusing resources more effectively.

The sequence of example reference biospheres, from very simple to more complicated, illustrates how to use the methodology. But the examples also provide useful details about the types of modelling (even an international point of reference for how to do the modelling). Furthermore, at least for the well-understood scenarios 1 and 2A (agricultural use), the quantitative results are good points of reference. For Example 2B (natural groundwater release to agricultural and semi-natural systems), the quantitative results are also valid for use elsewhere, but they should only be interpreted when taking into account the details of the geosphere-biosphere interfaces, which can vary locally. So in this case, the models can be viewed as points of reference, but it is important to take local parameters, e.g., groundwater flow, into account, when applying results locally.

Discussion

- Dr. Clark inquired about what IAEA is doing next in terms of using the output and outcomes of the BIOMASS project. Mr. Torres-Vidal indicated that he will be developing a "safety report" on how to apply the findings, but he is not certain when this will be available or what the report will contain.
- Dr. Larsson agreed that a safety document is required, because so many countries are in the process of making decisions on repositories. There is a need for a safety report on how to conduct the biosphere assessment.
- Mr. McKenney and Mr. Clark commented that the United States has required release rate limits in addition to individual dose but then shifted to only individual dose for Yucca Mountain in response to Federal legislation and public comments.
- Other participants raised concerns about the principles behind the assessment. If the model is not predictive in nature, why not adopt a very different basis? Mr. Torres-Vidal responded that any given repository will affect the system in different ways, but future societies will be able to respond in a sustainable way using the BIOMASS methodology.

Country Reports

Mr. Ray Clark, U.S. Environmental Protection Agency (EPA)

Mr. Clark provided a description of 40 CFR Part 197, EPA's standards for the Yucca Mountain site and the waste issues (see Attachment B for full presentation). The potential storage and disposal facility will not just house HLW and Spent Nuclear Fuel (SNF), but could also contain other wastes and excess plutonium. Highlights include:

- History of Part 197: The 1992 Waste Isolation Pilot Plant (WIPP) Land Withdrawal Act exempted Yucca Mountain from EPA's generic standards. Congress also passed the Energy Policy Act (EPAct), which required EPA to set standards for Yucca Mountain and establish a limit on individual dose.
- Public Input
- Outline of the Standards
  - Storage
  - Disposal
- Storage Standards: 15 millirem/year committed effective dose equivalent (for people outside of disposal site)
- Disposal Standards (Individual Protection)
- Reasonably Maximally Exposed Individual (RMEI)
  - Hypothetical person; rural-residential living style; has characteristics of people currently living in the town of Amargosa Valley, Nevada, USA.
- The Accessible Environment is defined as anywhere outside of controlled area. The controlled area is defined as no larger than 300 square kilometers. Mr. Smith commented that much of the analysis that would be done during the performance assessment was already done during formation of the rule. This is unusual and different from other regulatory agencies in the world. Mr. McKenney commented that EPA had to develop a site-specific rule and had to take into account available data. Further, the definition of controlled area was changed because of specific (versus generic) site characteristics. Mr. Smith and other participants agreed that this approach has implications for the use of society and biosphere in performance assessments.
- Disposal Standards (Human Intrusion): The National Academy of Sciences (NAS) provided EPA with recommendations to test the "resilience" of the Yucca Mountain disposal system. Only undisturbed performance (borehole and likely natural events) is considered. The timing of the intrusion is when drillers would not notice package penetration.
- Disposal Standards (Ground Water Protection): EPA made a policy decision to include separate groundwater protection standards. EPA used maximum contaminant levels in the representative volume (RV). RV is site-specific driven and is based on annual withdrawal.

- Other provisions
  - 10,000-year regulation period: events that have a probability of less than 1 in 10,000 are not analyzed,
  - Assume that society, the biosphere (except climate) and conditions would stay the same,
  - Must vary geologic and hydrogeologic.
- Five lawsuits filed to date

Discussion

- Yucca Mountain was exempted from EPA's generic standards in 1992.
- In 1992, Congress passed the Energy Policy Act to set standards for Yucca Mountain. Congress required EPA to contract with the NAS to provide technical input for the Yucca Mountain standards. The report was completed in 1995.
- Changes from the proposed rule are small.
- Dr. Larsson asked whether the final rule was changed to reflect changing society/biosphere? The 'Catfish farm' in the proposed rule implies a lot of prescription, especially since the catfish farm is no longer operational. Mr. Clark responded that the final rule (Page 32092) prescribes assumptions that reflect current technologies and living patterns. Language in the final rule means that data are current and present (appropriate for reading). RMEI is akin to a critical group (it is a reasonably high dose, but not the highest possible).
- Mr. Smith commented that the rule includes lots of site-specific details, e.g. definition of accessible environment. These details limit the need for DOE to consider a range of issues, which in other countries would need to be included in the TSPA. There is no right or wrong answer, but more analysis has been done in developing the standards than in most other countries.
- Dr. Larsson expressed interest in the RMEI definition. Specifically, were the characteristics in the proposed rule changed? Mr. Clark responded that there were no dramatic changes.

Mr. Christepher A. McKenney, U.S. Nuclear Regulatory Commission (NRC)

Mr. McKenney provided a description of the NRC's regulatory approach, based on the proposed postclosure criteria and safety assessment (see Attachment B for full presentation). Highlights include:

- Regulatory Approach: Risk-informed, performance-based criteria; geologic repository must include a system of multiple barriers. In NRC's approach, it was assumed that legal battles would be a part of the process.
- Proposed Postclosure Criteria
- Postclosure Safety Assessment: performance confirmation program begins at construction phase. This means that during the time of operations and the closure (but before final closure) that a number of assessments must be done. The performance assessment is a "living document."
- Individual Dose Limit: expected annual dose
- Compliance period and viability of 10,000 years

- Reference Biosphere and Critical Group: climatic conditions can vary (from semi-arid to arid). There is a farming community located approximately 20km from site. Land use, lifestyle, and diet, assumed constant over time. Things that change as a result of climate/irrigation can change assumptions. Very small numbers of variables are assumed to change over time. Defendable performance assessment.
- Human Intrusion Scenarios are virtually identical to those of EPA.
- NRC's primary role is to determine whether license applications comply with NRC regulations and are in accordance with the EPA standards.

Discussion

- Mr. Torres-Vidal expressed concern that that biosphere is held constant in the NRC process. Mr. McKenney asserted that, in fact, the biosphere can change over time. It is primarily human physiology that is held constant.

- Dr. Jensen raised questions on NRC's human-intrusion scenarios. Does NRC consider any intrusions other than drilling, as recommended by NAS? Mr. McKenney indicated that any alternate scenario or receptor that is brought to the attention of the NRC would have to be taken into account. The 'expected dose' term is being removed in the final NRC rule because of confused interpretations (e.g. expected dose value). Also, "permanent closure" necessarily means that human intrusion is impossible.
- Dr. Larsson asked for elaboration on environmental standards. Dr. Clark responded that DOE has a separate set of requirements for protecting biota. There is nothing in the Yucca Mountain requirements specific to protection of biota themselves. From a practical standpoint, there is no existing or defensible basis for protecting the biota (nothing from NAS, etc.).
- The participants were interested in the roles of regulators in the U.S. including EPA, NRC, DOE and, in particular, who establishes environmental protection regulations in the United States. Mr. Clark, Dr. Clark, and Mr. McKenney stressed that regulatory authority in the United States depends on various laws. For Superfund sites, there is a specific Superfund law that says that the biota must be considered. So if a site in question is a DOE Superfund site, then DOE must consider the biota. EPA then has to the authority to approve DOE's plans and actions. EPA works within a general framework for environmental protection from all insults and sometimes is responsible for self-regulation. In the case of nuclear defense activities, DOE serves as the regulator. In the case of Yucca Mountain, DOE is a regulated agency.
- EPA develops environmental standards for radiation to be implemented by NRC and/or by DOE. EPA also serves as a regulator in specific cases (e.g. for clean air and WIPP).
- NRC primarily establishes regulations for commercial activities involving radiation.
- Dr. Clark asked Mr. McKenney about changes envisioned by NRC. Mr. McKenney responded that there are "no built-in changes to the regulations because anyone can request changes at any time." The NRC also has ability to make changes at any time if necessary but the public can always request changes. All requests are "formal" and are treated as such.

Dr. Jack Valentin, Scientific Secretary of the International Commission on Radiological Protection (ICRP)

Dr. Valentin provided an overview of ICRP, the basic assumptions under which it operates, and the progress made throughout the years in developing recommendations. Highlights of Dr. Valentin's presentation include:

- What is ICRP? It is a registered charity in England and Wales established for the public benefit to advance the science of Radiological Protection. In particular, ICRP provides recommendations and guidance on all aspects of protection against ionizing radiation.
- What is the aim of ICRP recommendations? To provide an appropriate standard of protection for man without unduly limiting actions.
- Radioactive waste is an international problem. Mass quantities of waste exist but no agreed solution for radiation protection of the environment.
- By the time solutions are found, the problem will have changed.
- Natural background radiation is prevalent. For most people, natural exposure is very much larger than the nuclear power contribution.
- Dose response relationship: high doses = deterministic harm due to cell killing. Dose to embryo/fetus = mental retardation. Stochastic late harm = cancer, hereditary, other, LNT.
- ICRP does not aim to get rid of the collective dose precept but to criticize it. One possible way forward is to focus on "controllable dose."
- Dr. Valentin provided an overview of ICRP documents on nuclear waste management.
- The old idea that to protect man means that the environment is protected de facto, should be reversed and ICRP is thinking about it now.
- ICRP is not so directly concerned with protection of society from consequences of intentional intrusions.
- New recommendations will reflect a re-focus towards individual protection with optimization coming second. On it's own, this shift does not change things, but the optimization process will also change. This should include a greater focus on stakeholder consultation.

Discussion

Dr. Clark asked about ICRP's vision for the 21st century. Dr. Valentin says that ICRP will seek to update the methods of optimization. One new item is to better involve stakeholders in a "bottom-up" (as opposed to a "top down") approach to decision making.

Ms. Kirsti-Liisa Sjöblom, Radiation and Nuclear Safety Authority, Finland (STUK)

Ms. Sjöblom provided an overview of STUK's regulatory system and Finland's spent nuclear fuel (SNF) disposal program (see Attachment B for full presentation). Highlights include:

- STUK supervises the regulations issued through the Ministry of Trade and Industry in Finland. For the SNF disposal program, there is a parallel regulatory framework including (a) the technical and safety-related feasibility of concept, and (b) feedback to the siting process.
- STUK's SNF disposal program began in 1983 with site characterization, safety evaluation, technical design, and research and development.
- According to law, STUK has no inspection rights for research facilities. If, however, a research facility becomes part of the repository (or changes to an operating facility), then STUK needs to retain inspection rights. There are unanswered questions and it is not clear when or where the point of change will occur.
- STUK's regulatory involvement goes beyond the Decision in Principle (DiP) process started in 1999. Local and political acceptance at sites was achieved in May 2001 with parliamentary ratification.
- Rulemaking: General safety regulations were issued, a guide for long-term safety has been finished; and a guide for operational safety is currently under preparation.
- R&D: There are still some unresolved issues including the welding of copper canisters and a need to more closely study Bentonite.
- There are still some unresolved issues including the welding of copper canisters and a need to more closely study Bentonite.

Discussion

Dr. Westerlind was interested in the degree to which STUK included the biosphere in making decisions. Ms. Sjöblom stated that it was somewhat rudimentary -- since there were no site-specific studies, there was no reason to believe that the site was unsafe.

Mr. Ian Streatfield, Environment Agency (EA) of England and Wales

Mr. Streatfield gave a summary of the EA's statutory powers and its interaction with the Health and Safety Executive. He briefly discussed the implications for the Agency and industry of the rejection of the planning application for a Rock Characterisation Facility (RCF) in 1997, before outlining the Agency's guidance on requirements for authorization of intermediate-level waste (ILW)/low-level waste (LLW) disposal. Attachment B to this document provides the full text of Mr. Streatfield's presentation. Highlights include:

- The EA's interaction with the Health and Safety Executive (HSE): The HSE has statutory power to regulate waste storage on nuclear sites, whereas the EA regulates discharges from, and disposals on, those sites.
- EA's Powers: Prior authorization must be obtained for the disposal of radioactive wastes.
- Before 1997, repository availability was planned for around 2010-2015. However, rejection of the Nirex planning application for RCF caused delay and uncertainty.
- Implications of the repository delay include degeneration of wastes and packages, uncertainty in storage period, unknown final geologic setting and potential for changes in scientific knowledge and standards.
- EA is currently placing the onus on waste producers to address implications of repository delay.
- Government policy – Cm2919. The current motto is passive safety.
- Described the EA 1997 Guidance on Requirements for Authorization (GRA) for waste disposal. Intended for new, dedicated facilities for disposal of ILW or LLW. However, the general principles will also be applied to future disposals to existing facilities.
- UK Guidance and the Biosphere: guidance is not prescriptive. Future evolution of the site will be considered.
- Other GRA guidance. The onus is on the developer and comparisons with ambient levels in the environment may also be appropriate. The operator will define the geographical area of the site and the EA must agree with the operator.
- Since late 1996, the EA has been using the GRA to review BNFL's developing post-closure safety case (PCSC) for their surface, LLW disposal site at Drigg.
- The EA review of Drigg is coordinated by its National Center for Risk Assessment and Options Appraisal (NCRAOA), with external contractor support. BNFL has made a number of changes to their approach as a result of the EA's review process.
- Subject to satisfactory resolution of issues identified during the EA's review of BNFL's PCSC Development Program, BNFL has the potential to assemble a PCSC that will provide a sufficiently comprehensive examination of the relevant issues to inform regulatory decision-making.

Discussion

Dr. Westerlind was interested in a collective dose requirement. Mr. Streatfield responded that an indicator of collective dose is required and BNFL is preparing this.

Dr. Jensen commented that EA's requirements look very much like those of the Swedish government.

Dr. Larsson commented that EA is a relatively young agency and wanted to know whether there are advantages to having all types of environmental issues under one agency. Mr. Streatfield responded that advantages include the ability to adopt a holistic approach, and to allow co-ordinated regulation to improve the environment as a whole. However, he noted that the nuclear industry in the UK is trying to get one regulator in the UK for nuclear issues (i.e. nuclear safety and environmental discharges/disposals).

Dr. Clark commented that the "individual" (as defined by the EA) is close to the EPA's "RMEI." Dr. Clark commented that an overall emphasis on the environment helps EPA to better communicate with the public. It is clear that EA is attempting to take a holistic approach.

Dr. Walter Blommaert, Federal Agency for Nuclear Control (FANC)

Dr. Blommaert provided an overview of the (FANC) and its role in the management of nuclear wastes. Attachment B to this document provides the full text of Dr. Blommaert's presentation. Highlights include:

- The first Royal decree on nuclear matters was in 1963. Responsibilities were given to three Ministries. By 1980, Belgium became a federal state, with three official languages, but the Federal government deals with nuclear matters.
- FANC grants licenses as well as 'controls' (or regulates), as specified by Decree in 2001. FANC's mission is "to protect the public and the environment against the hazards of ionizing radiation."
- The effect of the 2001 changes is that there is only one Ministry with current responsibilities for nuclear matters (Ministry of the Interior). Until recently, there was little or no attention by authorities to matters of waste disposal. Belgium has accepted the EU RP 122 radionuclide-specific clearance values.
- de national instelling voor radioactief afval en verrijkte splijtsoffen (NIRAS) / l'organisme national des dechets raadioactifs et des matieres fissles enriches (ONDRAF) organization is linked to the FANC and is responsible for radioactive waste -- including collection, transport, and interim storage and inventory management.
- The LLW site selection process resulted in 98 candidate sites in 1996, all of which were rejected by local government officials and/or the public. In January 1998, the government decided to look for disposal sites at existing nuclear sites. FANC is still looking for municipal acceptance.

Discussion

- Dr. Jensen commented on the need for one strong single authority.
- Ms. Sjöblom commented that FANC tasks are remarkably similar to STUK tasks. She also sought clarification on the role of NIRAS. Is NIRAS an independent company? Dr. Blommaert responded that NIRAS is a national institute funded by industry and established by royal decree.
- Dr. Blommaert commented that there is growing interest/concern in non-radioactive components of LLW.

Ms. Malgorzata Sneve, Norwegian Radiation Protection Authority (NRPA)

Ms. Sneve explained the "Lepse" project that was sponsored by the Norwegian government and conducted in cooperation with Sweden, European Commission and Russia. Attachment B to this document provides the full text of Ms. Sneve's presentation. Highlights include:

- Problem of the "Lepse" project: storage barge for 639 damaged fuel assembles in very poor condition. NRPA, through cooperation, established legislation and regulation process.
- Basic Documents: Russian legislation and regulations, standards, guidance and procedures are very similar, in principle, to western countries.
- Relevant Russian Federal Laws are the basis for development of the needed requirements for this project.
- Responsibilities in Russian Federation in radioactive waste management.
  - Minatom,
  - Gosatomnadzor,
  - Ministry of Natural Resources (previous Goscomecology),
  - Gossanepidnadzor (Health Protection Authority).
- There is an overlap and interaction among nuclear safety, environmental and human health protection issues (important to coordinate overlap). It is a very difficult task because Russian agencies do not view each other as partners.
- Legislation systems in different countries are similar, but the implementation of safety regulations in different countries is very different.
- NRPA hopes to avoid delay in implementing of industry projects because of unclear approval processes. Licensing requirements should be better known from the beginning.
- NRPA hopes to avoid misunderstanding over the criteria and norms being applied to the industry projects internationally.
- It is important to facilitate good communication among and within different groups. NRPA learned that productive dialogue is not the norm and that support from the West did not always work as it should.
- Ms. Sneve recommended that all authorities, operators and stakeholders be encouraged to take a holistic view of problems, and not to manage problems on the basis of one issue.
- There is a strong need for international cooperation (a more global and long-term perspective). Looking at the Russian case, the support provided has been in the development of short-term goals, and has not been fully considered by all players -- especially concerns of the Russian regulatory agencies. The short-term perspective could contribute to sustained, long-term problems.
- Nuclear waste is a global issue.

Discussion

The entire group agreed that there is a lot of room for improvement in the area of international cooperation.

Mr. Gintautas Klevinskas, Radiation Protection Center, Lithuania

Mr. Klevinskas provided a historical overview of the development and promulgation of laws and regulations in Lithuania, including the roles and responsibilities of various regulatory authorities. Attachment B to this document provides the full text of Mr. Klevinskas' presentation. Highlights include:

- Lithuania has one nuclear power plant (Ignalina).
- Historical development of regulations in Lithuania:
  - Law on Radiation Protection was passed in 1999.
  - Law on Nuclear Energy was passed in 1996 and amended in 1999.
  - Law on Management of Radioactive Waste was passed in 1999.
  - Law on Decommissioning Unit 1 at the Ignalina Nuclear Plant State Enterprise was passed in 2000.
- Regulatory Authorities
  - The State Nuclear Power Safety Inspectorate (VATESI) has jurisdiction over nuclear safety, licensing and transportation of nuclear materials. VATESI is essentially responsible for "…all things nuclear."
  - The Ministry of Environment is responsible for environmental protection issues, single permits for transportation of radioactive materials, clearance levels, etc.
  - The Radiation Protection Center is charged with radiation protection issues including licensing activities with sources of ionizing radiation, maintaining the state register of sources and worker's exposure, state radiation protection supervision and control and monitoring public exposure to radiation.
  - The Radiation Protection Center was established in 1997.
  - The Web site address for the Radiation Protection Center is: www.rsc.lt/eng/index.html
- Sources of Radioactive Waste in Lithuania
  - Ignalina Nuclear Power Plant (2 units)
  - 1st Unit in 1983, 2nd 1987
  - Power: 1500 MW(el) 4800 MW(th)
  - Type: RBMK (LGWR), 1661 fuel channels in each reactor, approximately 15,000 SNF elements accumulated since 1984
  - Wet storage in reactor pools or dry storage in German casks
  - Three types of waste: solid, liquid and gaseous
- Radioactive Waste Management Agency
  - Established in 2001
  - Manage and dispose of all radioactive wastes
  - Operate storage facilities and repositories
- Strategy on Radioactive Waste Management
  - Draft document in place

- It is expected to be approved in 9/01
- Updated every five years

- Preliminary statements for investigation of locations in Lithuania where HLW can be disposed of are currently in place and three sites have been selected.
- Siting, Design and Construction of Radioactive Waste Management Facilities
  - Must be proposed by Ministry of Economy
  - Designs for the construction or reconstruction, upgrading, expansion, must be coordinated with VATESI and with other responsible state authorities

Discussion

Dr. Jensen asked about the regulation of dose limits upon passage of the laws. He was specifically interested in any proposed regulatory bodies or agencies. Mr. Klevinskas clarified that criteria for disposal, management, regulation and waste acceptance will be discussed during a November 2001 workshop, which will be held in Vilnius.

Ms. Sjöblom commented that Lithuania has successfully simplified the old Soviet Union type regulations by reducing or eliminating unnecessary prescriptive details in the regulations. "They (Lithuania) have been very successful in the modernization of the regulations."

Dr. Carl-Magnus Larsson, Swedish Radiation Protection Authority (SSI)

Dr. Larsson's presentation compared the SSI Regulations on Protection of Human Health and the Environment in Connection with the Final Management of Spent Nuclear Fuel and Nuclear Waste (SSI FS 1998:1) to the BIOMASS Project guidance, ICRP guidance, EPA and NRC proposed rules, and DOE standards. Areas of discussion included the assessment context and philosophy, endpoints, the source term and geosphere-biosphere interface, and the time frame. Attachment B to this document provides the full text of Dr. Larsson's presentation. Highlights include:

- Assessment Purpose
  - The alternative purposes identified by BIOMASS include demonstration of compliance, confidence of policy makers and scientific community, public confidence and guidance to research priorities.
  - SSI FS 1998:1
    - Risk shall be calculated on the basis of relevant scenarios (grouped, e.g., as normal scenarios, less likely scenarios, and residual scenarios) and resulting probabilities of radiation detriment.
    - The risk thus quantified shall not exceed 10^{-6} per year to individuals representative of the most exposed population. Scenarios resulting in doses greater than 1 mSv per year should be treated separately.
    - Environmental consequences shall be assessed as well as the protective capability after the intrusion (SSI FS 1998:1).
    - A safety assessment shall be presented supporting the Environmental Impact Statement (EIS).
- Endpoints
  - BIOMASS guidance: Alternatives identified by BIOMASS include:
    - Individual dose/risk,
    - Collective dose/risk,
    - Doses to biota,
    - Changed radiation environment,
    - Fluxes; and, as a special case,
    - Uncertainties/confidence.
  - SSI FS 1998:1
    - Health protection to the level of 10^{-6} annual risk for individuals representative of the most exposed population. SSI uses hypothetical definitions that are not site-specific. The approach is different from that of the United States.
- Assessment philosophy
  - The BIOMASS guidance distinguishes between "cautious" and "equitable" approaches, although these should not be considered as opposites. One issue is defining the difference between "cautious" and "equitable."
  - SSI FS 1998:1
    - The choice of a 10^{-6} risk standard is "cautious" in the sense that it provides a reasonable allowance and allows for future practices or activities causing discharges from several sources, separated in both space and time.
    - Requirements on optimization and Best Available Technology (BAT) call for a realistic approach.

- Site Context
  - BIOMASS Guidance: The site context must be known in order to establish the appropriate reference (or assessment) biosphere.
  - SSI FS 1998:1: The biosphere at the time of application and its known evolution forms one case, other(s) will be defined as necessary.
- Source-term and geosphere-biosphere interface (GBI)
  - BIOMASS guidance is limited to groundwater release scenarios. It is important to consider the GBI in relation to time-dependent changes, e.g. if climatic evolution will affect the receiving medium.
  - SSI FS 1998:1: Consideration of both the environment and public health effectively rules out limitation to only a well scenario for temperate climates.
- Time Frame
  - BIOMASS Guidance: Time frames will have to be selected on the basis of:
    - Institutional control period
    - Surface environment evolution
    - Engineered barrier degradation
    - Geological evolution
    - Performance Assessment (PA) results
    - Radionuclide decay
  - SSI FS 1998:1
    - Radiation protection standards in principle are not limited in time
    - Quantitative estimates must be provided for the first 1000 years, whereas qualitative judgements become more prominent for longer time periods

Discussion

The group agreed that Dr. Larsson provided a succinct and valuable comparison of the assessment context for nuclear waste disposal. The document lends itself well to a systematic discussion of regulatory guidance.

Dr. Magnus Westerlind, Swedish Nuclear Power Inspectorate (SKI)

Dr. Westerlind presented an overview of SKI's current positions regarding regulating safety in the final disposal of HLW, including basic provisions and SKI's tasks in the disposal program. Attachment B provides the full text of Dr. Westerlind's presentation. Highlights include:

- Waste Safety – Basic Provisions
  - The waste producer has the full responsibility
  - SKI ensures compliance with safety requirements
- SKI's tasks in the disposal program
  - Regulations
  - Review of R&D by waste producer
  - Consultations in the siting process
  - Review license applications

- Supervise and periodically review safety of installations

- The role of the Safety Assessment (SA) depends on the phase of the disposal program
  - Assess safety and demonstrate compliance with safety and radiation protection criteria
  - Provides guidance and basis for performance criteria for barriers, quality control, site selection and characterization and research and development
  - The SA is one important basis for EIS.
- Regulations and competence
  - Clearly stated basic safety requirements (not too prescriptive)
  - Demonstration of compliance is most important
  - SKI has competence for own, independent SA
- SKI's regulations for long-term safety
  - Passive Safety
  - Timeframes should reflect the waste's hazard
  - Disaggregated approach ("risk profile"). SKI does not believe in a single value for risk
- Scenarios
  - Systematic identification based on external FEPs
  - Three scenarios include the main scenario, less likely scenarios and residual scenarios

Discussion

Ms. Sjöblom asked about SKI's ownership of the SA. In particular, Ms. Sjöblom wanted to know whether the SA is conducted all at once or by just studying the weaknesses? Dr. Westerlind responded that SKI uses research to identify weaknesses.

Mr. Streatfield asked about models -- specifically whether SKI used its own models or those of the site developer/operator? Dr. Westerlind responded that SKI uses its own models augmented with separately quality-controlled information. The public has confidence in the separate comprehensive assessment capability.

Mr. McKenney commented that the NRC also has a similar set of independent SA capabilities and has identified issues related to DOE's investigations as a consequence. Mr. Clark commented that EPA has intentionally stayed away from developing independent SA capabilities.

Position Reports and Papers

Mr. Ray Clark, U.S. Environmental Protection Agency (EPA)

Mr. Clark provided an overview of EPA's high-level waste (HLW) standards including a discussion on the form of the individual protection standard and the protected individual. Mr. Clark also addressed the debate on the critical group (CG) versus the reasonably maximally exposed individual (RMEI) and the debate on dose versus risk. Attachment C to this document provides the full text of Mr. Clark's presentation. Highlights include:

- Background
  - In 1992, the Waste Isolation Pilot Plant (WIPP) Land Withdrawal Act exempted Yucca Mountain from EPA's generic standards (40 CFR Part 191)
  - Also in 1992, the Energy Policy Act (EnPA) directed EPA to set an individual-protection standard for Yucca Mountain and contract with the National Academy of Sciences (NAS) to provide technical input
- A Limit on Dose or Risk?
  - The EnPA directed EPA to set a dose limit to protect individuals while the NAS recommended a limit stated as a risk level. In the end, EPA established a limit on individual dose
- Individual-Protection Dose Limit
  - Even though the limit is a dose, it is based upon risk
  - 150 microsieverts committed effective dose equivalent per year
- Who is protected?
  - NAS recommended a critical Group (CG)
  - A small group with unusual habits or sensitivities should not drive the standards
  - Avoid extreme cases and unreasonable assumptions
- Why did EPA not use the probabilistic CG?
  - Would likely average a large number of subgroups receiving no dose. This is inconsistent with the CG concept
  - Most public comments opposed this approach
- NAS also recommended a subsistence farmer CG.
- Why did EPA not use the subsistence farmer CG?
  - Not a reasonable scenario for Yucca Mountain using current conditions
  - EPA could not identify anyone fitting the definition in the downgradient direction
- EPA used the RMEI approach instead (derived from Superfund program).

- Why did EPA choose the RMEI approach?
  - Up until Yucca Mountain, EPA's radiation standards had used maximally exposed individual (highest theoretical dose)
  - Sufficiently conservative to protect the general public
  - Consistent with widely accepted procedure to project doses incurred by individuals over long periods
  - Provides protection similar to the CG approach
  - Conservatism is up to the implementing agency, but the parties must use site-specific data to keep parameter values reasonable
  - RMEI approach is more straightforward than the probabilistic CG
  - This approach has already been used in non-radiation regulations (hazardous waste)

Discussion

Dr. Jensen asked about the scenario of a single plume and how EPA and NRC would address the issue. Mr. Clark and Mr. McKenney agree that there is enough site-specific evidence that renders the scenario virtually moot. However, EPA and NRC would use the highest possible dose as a benchmark.

Dr. Jensen was also interested in how EPA and NRC deal with probability and how the agencies will determine dose in conjunction with societal changes that result from changes in the biosphere. Mr. Clark and Mr. McKenney agree that aggregated and disaggregated approaches must by used.

Mr. Torres-Vidal asked for clarification on the degree to which EPA followed the NAS recommendations. Mr. Clark responded that EPA followed the NAS *objectives* and was able to successfully meet these objectives with the RMEI approach. Dr. Clark commented that EPA was required to follow two types of direction: Congressional and NAS. EPA simultaneously addressed both concerns with the RMEI approach.

Dr. Jensen commented that the international community would not be able to draw upon most of the U.S. experiences because of the site-specific standards and data employed. Dr. Jensen also commented that ICRP has not sufficiently addressed issues specific to the United States, e.g., formal legal restrictions, mandates and precedents.

Dr. Jensen also inquired about the importance of the CG. Specifically, what is the difference between groups and individuals? Dr. Clark responded that the RMEI is a *representation* of an individual based on group data.

Dr. Jensen commented that the discussion still revolves around individuals *as they exist today*. It is important to admit that the United States is not considering doses to individuals as they may exist in the future.

Dr. Mikael Jensen, Swedish Radiation Protection Authority (SSI)

Dr. Jensen opened the floor for discussion on the topic of sustainable development in the context of HLW disposal criteria. Highlights include:

- Assumption: The characteristics of a repository and its environment will change over time, due to degradation processes, geological and climatic change and human-related developments
- Goals of Sustainable Development
  - Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Commission, United Nations, 1987)
  - The effect of the repository must allow society to engage in a large range of activities in the future
- Society
  - Society must be assumed to engage in a large range of activities
- Biosphere
  - A large range of biospheres/biosphere developments must be considered
- Science
  - No ability to accurately predict the above factors

Discussion

Dr. Jensen posed the broad question, "Can the group live with conditions as they exist today?"

Mr. Streatfield responded that all countries are "…bound by laws." In England and Wales, the EA is responsible for regulating radioactive waste disposal in accordance with relevant legislation, having regard to Government Policy. Sustainable development is but one aspect of Government Policy and in carrying out its role the EA contributes to it.

Dr. Larsson commented that *endpoints* in assessments must be linked in order to accomplish sustainable development. Sweden has laws in place regarding sustainable development.

Dr. Jensen commented that ICRP has already provided advice on this issue. According to the ICRP, the public should not be exposed to more than 1 millisievert/year. This is a measurable "target" for sustainable development.

Ms. Sjöblom commented that sustainable development is a "new phrase" for something that is already being rigorously pursued by all participating countries. Ms. Sjöblom does not view sustainable development as a new problem or issue. Dr. Jensen responded that the problem is *prediction*. There is no "right" thing to do because today's regulators and scientists do not know how people will be living in the future. Which of the variables that we hold constant today will change in the future? Dr. Jensen expressed concern about basing all assumptions on what is known about how people live today and the characteristics of the current biosphere.

Ms. Kirsti-Liisa Sjöblom, Radiation and Nuclear Safety Authority (STUK), Finland

Ms. Sjöblom discussed the society and biosphere beyond 1000 years from now. Attachment C to this document provides the full text of Ms. Sjöblom 's presentation. Highlights include:

- Time Periods
  - Operational Period
  - Reasonably Predictable Future
  - Environmentally Unpredictable Future
- Radiation Protection Criteria: Reasonably Predictable Future
  - Government decision of 1999
  - STUK Guide of 2001
- Radiation Protection Criteria: Very Far Future
  - Government decision of 1999
  - STUK Guide of 2001
- Geo-Bio Flux Constraints: Consideration of Local Impacts
  - Assumed Scenarios
  - Well Dilution Factor Issue
  - A Site-Specific GW Flow Analysis
- Dose Conversion Factors

NUCLIDE	DOSE CONVERSION FACTOR (SV/BQ)	CRITICAL SCENARIOS/PATHWAYS
C-14	5 E-13	Lake/fish and sediment/crop
Cl-36	2 E-14	Well/drinking water and lake/fish
Ni-59	4 E-15	Sediment/crop
Se-79	1 E-13	Lake/fish and well/vegetables
Zr-93	1 E-14	Well/drinking water
Nb-94	6 E-14	Well/external radiation
Tc-99	3 E-14	Sediment/crop
Pd-107	5 E-16	Well/drinking water and vegetables
Sn-126	1 E-13	Lake/fish and well/drinking water
I-129	2 E-12	Well/drinking water and vegetables
Cs-135	3 E-13	Lake/fish and sediment/crop
Ra-226	3 E-12	Well/drinking water and vegetables
Th-229	8 E-12	Well, inhalation and drinking water
Pa-231	1 E-11	Well/inhalation and drinking water
U-238	4 E-13	Well/drinking water
Np-237	1 E-12	Well/drinking water
Pu-239	4 E-12	Well/inhalation and drinking water
Am-243	3 E-12	Well/drinking water and inhalation
Cm-245	3 E-12	Well/drinking water and inhalation

- Consideration of large-scale impacts
  - Average dose from seafish: < 1 microSv/a
  - Natural Radionuclide fluxes via local and regional rivers (constraints fit to government requirements)
  - Releases from norm practices
- Pros and Cons as safety indicator: Geo-Bio Flux versus Dose

Discussion

Dr. Jensen commented that STUK's dose conversion factors are "…the first of its type." Although there are no peer reviews of these figures, the scientific community will wait and see about consensus.

Dr. Jensen also asked about STUK's definition of "very far future." Ms. Sjöblom responded that "very far future" is defined as "several thousands of years" and that the definition is still somewhat "soft."

Mr. Rodolfo Avila, Swedish Radiation Protection Authority (SSI)

Mr. Avila discussed environmental concentration, the risks to human health and the environment of a repository, and standards for risk measurement. Attachment C to this document provides the full text of Mr. Avila's presentation. Highlights include:

- Suggestions for risk measurement standards
  - Abandon the critical group concept
  - Consider using probabilistic standards instead
  - Consider use of secondary standards, like concentrations, as a way of simplifying (make possible?) demonstration of compliance

Discussion

Mr. Torres-Vidal stated that Mr. Avila's approach is very similar to that of IAEA and others.

Mr. Torres-Vidal also commented that Mr. Avila's arguments are very similar to those posed by Ms. Sjöblom, although Finland is "…one step ahead" because the country has actually established the standards.

Dr. Jensen commented that Mr. Avila is also addressing problems inherent in probabilistic assessment.

Dr. Mikael Jensen, Swedish Radiation Protection Authority (SSI)

Dr. Jensen gave a short presentation on institutional controls and human intrusion and opened the floor for discussion.

An NEA project in conjunction with Sandia National Laboratory produced an intrusion scenario report for the Waste Isolation Pilot Plant (WIPP). The report concluded that there would be no likely intrusion unless some party literally "dug up" the site.

In 1990, the NEA conducted a systematic study involving many countries. The first seminar was held in 1991 or 1992. The researchers focused on all possible intrusion scenarios and were divided into four teams consisting of four people each. Although the findings were somewhat speculative, researchers concluded that there was a 0% probability of intrusion at the WIPP site.

With respect to archiving information on nuclear waste repositories, the Finnish government passed a regulation entrusting the task of archival to STUK. Although Finland was the first government to pass such a regulation, a similar regulation now exists in Sweden. Every European government to date has agreed on the concept of archiving information on nuclear waste repositories to some degree. The U.S. government indicated that any site must somehow be physically "marked." The NRC, in particular, is requiring that all information be kept "available" but has not specified to whom the archive would be entrusted.

After studying various archives, including those of the German government and the Vatican, Dr. Jensen suggested that archived information about nuclear waste repositories be maintained on three separate levels.

Human intrusion raises the question of who is responsible for safeguarding materials. Dr. Jensen commented that it is complicated in the United States because there is no clear distinction or delineation of responsibilities. Swedish regulations specify that the design of a repository must not change simply in an effort to avoid intrusion. The intruder's dose is not of concern. Rather, the integrity of the repository is considered most important. SKB has discussed different intrusion scenarios with the assumption that the biosphere is the same as the undisturbed case.

What is an intrusion? Dr. Jensen defines an intrusion as any disturbance in the repository area for the performance assessment.

Discussion

Ms. Sjöblom pointed out the possible interest of future people in a big amount of copper to be in the repository according the Swedish and Finnish capsule concept. Mr. Jensen replied that there are some grey areas. The consensus is that people/citizens have fundamental rights to environmental information.

Dr. Carl-Magnus Larsson, Swedish Radiation Protection Authority (SSI)

Dr. Larsson provided an overview of the Framework for ASSessment of Environmental ImpacT (FASSET) program and discussed the environmental effects of radiation on other-than-human species. Attachment C to this document provides the full text of Dr. Larrson's presentation. Highlights include:

- Why the concern for the Environment?
  - Anthropocentric vs. biocentric views
  - Science
  - Formal reasons: international agreements, national regulations
- FASSET partners include 15 organizations in seven countries including four Swedish organizations and 5 UK organizations. The goal is to develop a system for how environmental issues should be addressed as a basis for decision-making.
- Use eco-risk assessment and management model (generic way of looking at environmental effects).
  - Scoping
  - Do assessment (present ICRP method is very strong in assessment phase)
  - Management
- There are three "work packages" (one with environmental dosimetry, the second with exposure pathways and the third with an assessment of environmental effects).
- Umbrella effect is demonstrated in the matrix (mortality, morbidity, reproductive success, scoreable cytogenetic effects). These are most of the endpoints that are relevant to sustainable development.
- Exposure models and dosimetry are not meaningful unless coupled with biological effects. One output will be database with all "umbrella effects" above organized in systematic fashion. Will be available to anyone (decision makers) in meaningful and understandable form.
- Where does this take us? We know that we have exposure pathways (see the matrix/table with Level 1-6 on vertical left hand side and Consideration level, Relative dose level, Likely effect on individuals, and Aspects of concern in Attachment C). The matrix is suggested to illustrate a method to think about.

Discussion

Mr. Torres-Vidal suggests that the matrix include "Level 0" because according to the table, *any* radiation corresponds to some level of risk. Dr. Larsson agreed yet cited that the important consideration is the *systematic* approach and the most appropriate way to communicate to decision makers.

Ms. Sjöblom commented that Dr. Larsson's matrix might not include "boxes" but rather a scale similar to ICRP.

The group raised the issue of "harm" and its definition. Does Dr. Larsson's matrix include the biota? Dr. Larsson responded that "harm" is implicit in the presentation of the boxes and can indeed be taken to the level of "an amoeba." He reiterated the need to acknowledge and develop a systematic basis to measure harm.

Conclusions

The workshop was a success in bringing the relevant organizations together to discuss regulatory issues. Dr. Jensen stated that he was impressed with the objectives of the workshop and the extent to which they were covered in the limited time available. One of the most important aspects of the Workshop was that each country's "constraints" were covered and the participants gained a greater understanding of how different countries work within these constraints and the respective values placed on radiation issues.

There were a number of philosophical and technical questions raised by the participants.

- There is a need for interface (technical and practical) between geosphere and biosphere modellers.
- What do we mean by timeframe?
- There is a need to acknowledge and develop a common framework and integrated approach for protecting the environment.
- There is a need for social science research on public acceptance and attitudes toward nuclear waste disposal.
- We must begin to look at the radioactive waste issue as a global (rather than country-specific) issue.
- There is a need to discuss and agree upon our generation's obligation to properly dispose of waste.
- There is a need to develop and agree upon institutional control measures after closure of a repository.
- There are difficulties coming to common agreements because of different geopolitical and regulatory systems.

All participants indicated that the workshop was technically helpful, collegial and appreciated. Participants also expressed the desire to meet again and continue discussions on the role of future society and biosphere in demonstrating compliance with radioactive waste disposal standards and regulations.

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Attachment B: Country Report Presentations

Attachment C:
Position Reports and Papers