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NUCLEAR ENERGY AGENCY
RADIOACTIVE WASTE MANAGEMENT COMMITTEE

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Working Party on Decommissioning and Dismantling (WPDD)

Proceedings of the Topical Session on Applying Decommissioning Experience to the Design and Operation of New Nuclear Power Plants

Topical Session of the 9th Meeting of the WPDD

Held in Senec, Slovak Republic
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FOREWORD

Set up by the Radioactive Waste Management Committee (RWMC), the WPDD brings together senior representatives of national organisations who have a broad overview of Decommissioning and Dismantling (D&D) of nuclear installations. These include representatives from regulatory authorities, policy bodies, national decommissioning institutions, R&D organizations, industrial decommissioners from the NEA Co-operative Programme on Exchange of Scientific and Technical Information on Nuclear Installation Decommissioning Projects (CPD), as well as cross-representation from the other NEA Committees. The European Commission is a member of the WPDD and the IAEA participates as an observer. This broad participation provides good possibilities for the co-ordination of efforts on activities in international programmes.

At its ninth meeting (11-14 November 2008, at Senec, Slovak Republic), the WPDD held a topical session on *Applying Decommissioning Experience to the Design and Operation of New Plants*. In preparation for this, a survey was issued to reactor design organisations, electricity producers and safety authorities and responses were compiled into a summary report that provided a basis for discussion at the topical session.

This report is in two parts: Part A documents the topical session, summarising the main points from the presentations and discussions and including the rapporteurs' reports. Part B provides a summary compilation of the responses received to the survey undertaken prior to the topical session. Copies of the presentations made are attached to this report in the form of a CD-Rom.

The topical session facilitated an exchange of information and experience between policy makers, regulators, electricity producers, design organisations and decommissioners on approaches and experiences to taking account of decommissioning considerations in the design of third generation reactor systems.

Mr. Gérard Laurent, *Électricité de France*, and Mr. Doug Metcalfe, *Natural Resources Canada*, served as Chairs of the Topical Session and Mr. Harri Tuomisto, FORTUM, and Dr. Allan Duncan, consultant to the Secretariat, served as rapporteurs.

Acknowledgement

The WPDD wishes to express its gratitude to Messrs. Laurent, Metcalfe, Tuomisto and Duncan, as well as to all those participating in the survey and those presenting papers, for their efforts in making the topical session a success.

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Part A

MAIN OUTCOMES OF TOPICAL SESSION ON:

APPLYING DECOMMISSIONING EXPERIENCE TO THE DESIGN AND OPERATION OF NEW PLANTS

A.1 SUMMARY OF PRESENTATIONS AND DISCUSSIONS

Luigi NOVIELLO and Patrick O'SULLIVAN

General Observations

In many countries there is a long-standing requirement to consider decommissioning and dismantling (D&D) aspects of existing and reactor plant from early in the plant lifetime, e.g. this has been a legal requirement in France since 1963. Evidence from this study suggests that this issue is progressively being addressed in a more standardised way, driven by requirements from safety authorities and electricity producers and by general considerations related to public acceptance.

The topical session provided an opportunity for those responsible for the specification and design of new plants to meet regulators working in this field and experts from decommissioning and waste management. There was general recognition that decommissioning should be regarded as an integral phase of the plant lifecycle and should be considered from an early stage of design activity. Such an approach offered the prospect of:

- reduced accumulation of wastes;
- reduced time for eventual dismantling; and
- a more efficient licensing process.

In turn, these benefits should result in a smoother transition to shutdown and less delay in starting decommissioning and, ultimately, lower costs, shorter timeframes and safer D&D.

A particular lesson for assessing the full implications of new build may be drawn from D&D delays in some countries associated with lack of disposal facilities and even, in some cases, lack of any clear policy for disposal.

Main Points from the Presentations by Electricity Producers

Following the difficulties experienced by after the Three Mile Island and Chernobyl accidents in the Eighties, power plant operators resolved to ensure that the next generation of power plants should be designed with greater harmonisation of safety approaches across national boundaries. Within Europe, a group of electricity producers started development in the Nineties of the *European Utility Requirements for LWR Nuclear Power Plants (EUR)*, which aimed to facilitate the development of standard designs usable throughout the European market. Similar requirements for the US market were developed by EPRI, in the *EPRI Utility Requirements Document for Next Generation Nuclear Plants*[1].

An important message from the presentations by the utilities was that the regulation of decommissioning should be proportionate to the risk to the health and safety of the workforce and the public and to environmental safety[2]. In moving from operation, through the transition phase during which spent fuel is removed from the plant and the drainage of equipment containing residual

1. First published in 1995
2. See WPDD report *Regulating the Decommissioning of Nuclear Facilities*, NEA Report No. 6401, 2008

radioactive material, and finally to plant dismantling and removal from the site, the dominant risk focus changes from nuclear safety to normal industrial safety issues.

Utilities are placing significant emphasis on maintaining good records during plant operation. Central to this objective is the regular updating of decommissioning plans, to address changes to the plant configuration and/or to take account of any contamination incidents that occur. This updating is also important for estimating future dose commitments, D&D costs and for apportioning funds proportionately.

Main Points from the Presentations by Designers

Designers indicated that specific consideration was being given to design features (including civil structures, material selection, process design, and maintenance provisions) to facilitate decommissioning and dismantling of the plant, particularly in relation to:

- the choice of materials, such that eventual quantities of radioactive waste are minimised and decontamination is facilitated;
- reducing the potential for contamination by leaks and spills, e.g. lower sections of walls and floors are sealed and the sealing medium is reinforced where wear and tear is expected. Sumps and trenches constructed in concrete floors are lined with sheet steel to protect the concrete from contamination and thus to facilitate final cleanup;
- reducing the time taken for dismantling, e.g. providing access arrangements for removal of large equipment items such as steam generators through special hatches or through use of a heavy lift crane operating through a hole in the concrete containment dome, using open top construction and silos and greater use of modular design;
- facilitating decommissioning sequences that represent the construction sequence in reverse, providing piping/valve modules that are pre-assembled on skids;
- reserving properly furbished space on site for decontamination and disassembly of components;
- accommodating deferred decommissioning through consideration of long-term integrity of structural components; and
- better waste management, e.g. plant layout and zoning, waste segregation, and provision storage facilities for radioactive waste generated both during operation and decommissioning of the plant.

Main Points from the Presentations by Safety Authorities

The primary focus of the safety authorities is the reduction of radiation doses to the workforce and minimisation of the quantity of hazardous materials including radioactive waste. Requirements to be addressed in plant design typically include:

- selection of materials and use of barriers to limit activation and contamination of materials, including facilitating easy decontamination of contaminated surfaces;
- design of access areas and handling devices to minimise direct radiation exposure; and
- selection of equipment for ease of maintenance and replaceability and removal.

In line with the general objective of waste minimisation, some authorities (e.g. in the UK) demand that the waste management and decommissioning strategy should implement a ‘waste hierarchy’ which recognises the interdependence of D&D operations and the design, construction and operation of the plant, e.g.:

- minimise the use and production of materials that increase waste and doses to the workforce;
- obtain a balance between doses received during operation and decommissioning and those subsequently received by those treating residual waste; and
- make provision for onsite treatment of material and seek to reuse existing facilities (e.g. for waste management) rather than installing new facilities.

A case study on the design of the new EPR at Flamanville in France indicated that these requirements were being addressed as follows:

- dismantling of main components of the reactor coolant system is taken into account in their design (core instrumentation, steam generators, reactor coolant pumps, pressuriser etc.);
- the opportunity to remove these components without any segmentation is also considered for the design of the handling systems, specific openings and pathways. If necessary, these components will be dismantled in an appropriate area;
- the design of the reactor pit will include a metallic liner in order to enable the dismantling of the reactor vessel and internals under water; and
- the sequences of the construction of the reactor will be used to organise the dismantling scenario sequence by sequence.

The safety authorities also highlighted the importance of maintaining up-to-date information on the status of the facility, including the systematic collection of information:

- required for decommissioning throughout facility design, construction, operation and final shutdown stages; and
- during the construction stage, properties of the construction materials likely to be activated.

Just as the electricity producers are seeking to encourage more uniformity in design requirements for new generation power plants across national boundaries, the safety authorities (in Europe) are developing common *Safety Reference Levels (SRLs)* for assessing hazards from activities related to decommissioning. These requirements are being developed by a special Working Group of the Western European Nuclear Regulators' Association (WENRA). The SRLs are structured according to radiological safety management aspects, decommissioning strategy and planning aspects, decommissioning operations and safety verification. Important provisional levels include:

- *D-12: Account shall be taken of the need to decommission a facility at the time it is being planned, designed, constructed and operated. Measures, including design features, contamination and activation control, shall be described and justified in the safety documentation of the facility.*
- *D-21: The initial decommissioning plan shall be established in the design phase of the facility.*
- *D-20: In accordance with the decommissioning strategy, the licensee shall establish and maintain facility decommissioning plans, the details of which are commensurate with the type and status of the facility (graded approach).*

Finally, some safety authorities, e.g. the USNRC in particular, are encouraging electricity producers to follow a systematic approach to collecting lessons from decommissioning experience and to ensuring that these are addressed in the designs of new plants, especially in the area of contamination release to the surrounding site. In the case of the USNRC, a dedicated website provides a compilation of lessons learned by the Commission, which includes links to relevant reports on specific issues (http://www.nrc.gov/about-nrc/regulatory/decommissioning/lessons-learned.html). It is understood that Japan is considering making a compilation of similar information which will also be made widely available to plant operators.

Main Points from the Panel Discussions

During the panel discussions the following issues were discussed in particular:

- Overlap between requirements for operation and maintenance (O&M) and for decommissioning

It was suggested that 80% of the design features introduced to facilitate O&M will also directly serve decommissioning needs. Designers were advised that, as well as the consideration being given to the nuclear island plant, attention should also be given to the balance of the reactor plant, on the basis that areas which are difficult to access will give rise to later problems during decommissioning. It was suggested that the whole plant should be submitted to a review from the perspective of decommissioning.

- Plant configuration management

Plant configuration management was identified as one of the areas about which the regulators should consider providing additional guidance. The issue is concerned with maintaining records of the physical configuration of the facility, and is therefore broader than keeping a record of leaks. A risk to be borne in mind is that contamination may become fixed, painted over and eventually forgotten. It was noted that design tools can be used to show how configuration control can be maintained during sequential dismantlement.

- Plant monitoring systems

The importance of developing monitoring systems for early detection of leaks and contamination, including leaks from underground piping (environmental monitoring), was stressed. Regulators noted that the avoidance of future legacy sites was an important priority. A related issue is concerned with monitoring of plant chemistry parameters, against an objective of minimising corrosion of metallic components.

- Estimating the inventory of contaminated materials

Although it was accepted that efficient decommissioning is closely linked to having undertaken extensive prior characterisation of the plant materials, the necessary extent of this can nonetheless be managed. Records of the composition of steel and concrete materials used (including technical specifications) should be retained as knowledge of any impurities may be important for the future decommissioning and can reduce the extent of material characterisation that is ultimately needed. The importance of understanding the properties of materials used in neutron shields were mentioned specifically. It was noted in particular that:

  - it would be generally beneficial to specify the allowable range of cobalt levels in steel, i.e. as well as seeking reduced cobalt levels in absolute terms as estimated quantities of certain other radionuclides are often linked to the cobalt level; and

  - o the development of 3D models as part of the design process provide a useful management tool throughout plant operation, including for recording the locations of sources of activity to help assess where samples should be taken for radiation monitoring.

- Embedded piping

There was broad agreement that the use of embedded piping should be avoided, due to the increased difficulty in locating any leaks which do occur. As well as the implications of any such leaks for decommissioning, e.g. greater amounts of contaminated waste material, there was also the risk of longer outages during plant operation. At the same time, potential radiation doses from unshielded piping need to be addressed in designing the provisions for radiation protection.

- Modular design of the biological shield

Although the erection of the biological shield in modules offered potential advantages during decommissioning, as the construction sequence could then be reversed, it was argued that safety considerations currently favoured a massive, non-modular, shield. For the present, the option of a modular shield was not envisaged as being part of current designs.

- Decommissioning Plan

It was generally agreed that the decommissioning plan should be available in preliminary form prior to the granting of an operating licence and should evolve, in tandem with the safety assessment for decommissioning, throughout the lifetime of the facility and during the decommissioning phase. The plan must reflect the envisaged end state for the installation. Most countries envisage that decommissioning plans will be formally updated on approximately 5-year cycles (with a range of 3-10 years being mentioned), with a key update taking place prior to the granting of permission to proceed with decommissioning. It was noted that the development of the plan required close collaboration with other interested parties, including those responsible for waste management activities.

- Managing feedback from operators/decommissioners to designers

The design guidelines provided the essential link between past experience and the design process; these needed to be developed taking account of discussions with designers about what features can reasonably be delivered. Setting up an iterative loop between decommissioners and designers was complicated by the fact that decommissioning was generally managed as a national business whereas reactor designers tended to operate on an international basis. It was noted that the WPDD or other international organisations may be able to help in terms of identifying different sources of information about lessons learned from decommissioning and perhaps by summarising available information on particular topics.

A.2 RAPPORTEURS' REPORTS

SESSION 2 –DESIGN AND OPERATIONAL ASPECTS

Chair: Gérard Laurent (EdF CIDEN)
Rapporteur: Harri Tuomisto (FORTUM)

I listened to the session contributions as the representative of a licence holder. Thus, I give my remarks from the viewpoint of the nuclear power plant owner and operator.

As a starting point, the European Utility Requirements (EUR) list very well the general design requirements for decommissioning:

- feasibility (with current technologies);
- cost estimation;
- safety;
- waste quantities; and
- doses.

The main question is: what level of detail is expected in information provided during the plant design phase? There seem to be attempts to regard decommissioning and dismantling (D&D) as a separate design criterion or even as a design basis. Apparently, good D&D design solutions bring many benefits for the utility during plant operation and maintenance (O&M) activities. It is now common practice to design new plants for 60 years operation. As the lifetime extension will likely take place, the new plants could be operated even for 100 years. From the licensee viewpoint, it is crucial that there is an overriding priority for smooth and optimal O&M activities of the plant. Therefore, the design priority has to be on the best available and feasible O&M solutions. Fortunately, the successful O&M solutions are in line with facilitating the D&D works and they will support directly the success in D&D. Good design practices for both are ample space for the actions, minimization of the doses during the actions, minimization of waste quantities, provisions for the component changes. The availability of detailed 3D models for all the plant will be extremely useful.

Since the funds have to be collected for the D&D already quite early of the plant operation, at least in some member countries, it is very important to get reliable and credible estimates of the D&D costs. Therefore, D&D plans should be adequate for cost estimation already during the design and construction phase. To this end, the availability of the final repository for the low and intermediate level radioactive waste in the vicinity of the power plant will very valuable.

It is good practice to minimize the waste quantities, by several means. But, also in this case, the availability of the final repository would be helpful, since it would provide several possibilities to seek optimized solutions.

Embedded piping should mainly be avoided, but the design requirements for this should also be reduced from the O&M requirements rather than from the D&D point of view. The modularization of massive concrete structures, such as the biological shield would be desirable for the D&D, but any potential implications on the reactor safety should be considered properly.

To conclude, I want to emphasize the importance of the good O&M design solutions. When these are properly done, the D&D will be essentially easier as well.

Harri Tuomisto

SESSION – 3
‘POLICY AND REGULATORY ASPECTS’

Chair: Doug Metcalfe (Natural Resources, Canada)
Rapporteur: Allan Duncan (Former UK Chief Inspection of Pollution Control)

The following were the key points which I noted from this session, including the panel discussion:

- The idea of looking ahead to the D&D aspects of existing and new plant is not new. Various national laws, decrees and regulations have required consideration of this since at least 1963 (in the specific case of France).
- In general, however, it is only relatively recently that the requirements of decommissioning plans have made specific reference to the management of waste arising from D&D operations, about site end-states and environmental issues, and about proof of financial provision for D&D.
- Design rules now relate to materials of construction, ease of maintenance and dismantling, limitation of contamination, definition of clearance levels, etc. and, in Finland for example, specific information about waste management is required.
- Despite the various laws and regulations, there does not appear to be any substantial national guidance or policy on the choice between immediate or deferred dismantling.
- In the US the process of decommissioning allows for termination of the site licence and release of site under separate conditions, i.e. no longer subject to the provisions of a nuclear site licence, even if the site still needs regulation of residual radioactivity.
- The list of D&D projects that have been completed, or are well under way, shows that D&D activities are already mature technical processes and that for new plants we need to learn from the extensive current experience and focus further developments on increased efficiency and reduced costs.
- The US presentation listed the lessons learnt from their experience and referred to a Web Page that gives details relevant for application to new plants (http://www.nrc.gov/about-nrc/regulatory/decommissioning/lessons-learned.html).
- In D&D the balance of regulatory emphasis changes from nuclear safety (as in operating plant) towards the environmental and conventional safety aspects of what is effectively a waste management operation. There is evidence (e.g. in UK presentation) that the various regulatory bodies are already co-operating in respect of this changing regulatory emphasis. This is something to note for full assessment of the implications of new plant.
- There is general agreement that international co-operation and exchange of experience is valuable in the regulatory as well as in the operational context. A particular, common concern was about the availability of suitably qualified and experienced personnel.

Allan Duncan

Part B

SUMMARY OF RESPONSES TO QUESTIONNAIRE ON:

APPLYING DECOMMISSIONING EXPERIENCE TO THE DESIGN AND OPERATION OF NEW PLANTS

B.1 BACKGROUND INFORMATION ON QUESTIONNAIRE SURVEY

A survey on current practice in applying lessons from decommissioning to the design and operation of new reactor systems was undertaken between May and September 2008 by the WPDD, as part of a study aiming to assess the added value that may be provided to the life cycle management of new plants by taking into account lessons from decommissioning experience. The questionnaire was sent to regulatory authorities, electrical utilities and reactor design organisations concerned with the development and implementation of new reactor systems. A synthesis of the survey results provided a basis for the discussions at a topical session held at the annual meeting of the WPDD on 12-13 November in Senec in the Slovak Republic.

Responses to the survey were received from five utilities (EdF, Fortum, British Energy, Vattenfall, KKG), as well as the Foratom/ENISS utility working group and from the European Utilities' Requirements (EUR) grouping; from the decommissioning and waste management organisation SOGIN and the Slovak nuclear engineering organisations Decom and VUJE; from four vendors of reactors or associated systems (AREVA-NP, Westinghouse jointly with Ansaldo, AECL), and from five regulatory authorities (CNSC, STUK, HSE (UK) jointly with the Environment Agency for England and Wales and UJD-SR, the Nuclear Regulatory Authority of the Slovak Republic).

A summary version of the survey responses is provided in the Section B.2 of this report.

B.2 SUMMARY OF QUESTIONNAIRE RESPONSES

B.2.1 DESIGN CONSIDERATIONS

The following design organisations responded to the questionnaire: AREVA-NP, AECL, Westinghouse/Ansaldo (abbreviated to Westinghouse), VUJE/DECOM (in the Joint Slovak Response – abbreviated to JSR).

B.2.1.1 Dismantling Programme

Question D1: *Did you identify at the design stage a dismantling plan, i.e. the sequence of actions needed to remove all radioactive material and dismantle equipment, systems and structures?*

Westinghouse believes the decommissioning experience accumulated thus far all indicates that the most appropriate philosophy for decommissioning is the same as that embodied in the AP1000 construction plan which is to remove components/modules as complete units.

AREVA-NP states that due to the long service life of the EPR it is anticipated that large components may have to be replaced. That is, dismantling/replacement is already considered in the design. In response to Q7 AREVA-NP says that the Decommissioning Plan is largely a matter for the utility.

AECL has developed a decommissioning strategy for the ACR-1000. This decommissioning strategy is not site specific, and will be developed into a preliminary (or interim) decommissioning plan by the utility. The ACR-1000 decommissioning strategy includes a provisional sequence for the dismantling of radioactive portions of the ACR-1000 (e.g., the nuclear steam plant), and sections of the plant which are not expected to contain any significant contamination at decommissioning (e.g. the balance of plant).

AECL has prepared guidance to Advanced CANDU Reactor (ACR) designers on design features that will facilitate decommissioning of the reactor and its ancillary buildings and structures at the end of their operational life.

The JSR states that Slovak law requires that preliminary decommissioning documentation, a dismantling plan and preliminary RAW (and spent fuel, where appropriate) management documentation must be prepared at the design stage.

Question D2: *Are auxiliary systems that may be used in decommissioning being designed to ensure that their routing and layout is such as to minimize the need for modifications?*

Westinghouse states that air and water services can remain functional for a major part of the removal of the main components but, once the systematic removal of the buildings begins, alternative means for providing these services will need to be provided. The provision of such services through the existing penetrations is envisaged for the latter stages of decommissioning.

AREVA-NP states that no special attention is paid to non-radioactive service systems. The nuclear ventilation system has been designed into sub-systems such that few or no modifications will be required in step with dismantling.

AECL states that auxiliary systems that will be needed during decommissioning (e.g. during storage to allow for radioactive decay) are designed such that during decommissioning they are available and will only require isolation from structures, systems and components that will have to be taken out of service and dismantled early in the decommissioning project.

The JSR states that the need for modifications to auxiliary systems is generally minimised but cannot be altogether excluded.

Question D3: *Did you estimate the amount of radioactive wastes that may be produced in decommissioning?*

Westinghouse states that an initial estimate of quantities and nuclides has been developed. It is anticipated that a further more accurate estimate will be generated as the final detail design is completed and final component manufacturers are selected.

AREVA-NP confirms that the amount of waste is estimated as part of the design process.

AECL states that the quantities of high-, intermediate- and low-level radioactive wastes generated during decommissioning of a two-unit ACR-1000 were estimated from design information. Also, the amount of concrete/structural steel wastes as well as non-radiological wastes (i.e., wastes suitable for free-release or management in conventional waste management facilities) were also estimated.

The JSR states that the amount of radioactive waste that may be produced in decommissioning is estimated in the conceptual decommissioning plans. The first such plan is elaborated before obtaining the operational license. The Plan is updated during nuclear power operation regularly, either on 10 years basis or when a significant change in technologic or safety system is made. A part of the Plan update is also the radioactive waste amount and management update.

Question D4: *Did you identify and reserve sufficient space on the site for on-site temporary storage, characterization and treatment of equipment and radioactive materials?*

Westinghouse states that the current decommissioning plan envisages a facility, custom designed to handle the volume reduction of the large components within the site boundary fence. This will be custom built according to individual site or national circumstances and will be designed to minimize worker exposure and capture contaminated dust.

AREVA-NP states that this subject has not been considered since it depends on the utility and site. The design does provide set-down spaces for dismantled radioactive parts within the buildings. A hot workshop and a decontamination facility are also included in the design.

AECL states that sufficient space has been identified and reserved in the ACR-1000 design for on-site characterization, treatment and temporary storage of radioactive materials and equipment. More specifically, the ACR-1000 design includes areas for radioactive material characterization and storage. There is a radioactive waste management facility and a hazardous chemical storage building in the ACR-1000 plant design.

The JSR states that this space is identified.

Question D5: *Have you access to systematic decommissioning lessons learned? Do you believe that such an activity to be carried out by NEA could be useful for your designs?*

Westinghouse states that access to detail lessons learned on a correlated basis does not appear to be available. Information has been provided by personnel involved in such efforts and the various reports issued by the Plant Owners. Westinghouse has experience in the decommissioning of Fort St Vrain. It would very helpful if the NEA could develop such a list. Westinghouse is very open to ensuring the use of the best available information.

AREVA-NP feels it would be difficult for NEA to help in the design because other design aspects may be in conflict with decommissioning. Were NEA to take up this suggestion then all disciplines should be involved to address such issues.

AECL has access to systematic decommissioning and mid-life refurbishment projects (or life extension) lessons learned in Canada and decommissioning projects globally. AECL also keeps abreast of decommissioning lessons learned/information made available by operators of nuclear power plants currently being decommissioned around the world. AECL would welcome an NEA initiative.

The JSR states that information comes through IAEA, professional activities of individual companies, regional and national technical cooperation programmes in the fields of decommissioning and RAW management. NEA could do useful work in this area.

B.2.1.2 Operational Maintenance Related Features

Questions D6-12: *Did you consider the following design areas for improved maintenance that could be useful as well for plant maintenance and life extension? Have you considered additional areas in your designs*?

The JSR gave a general response to questions D6-12 stating that all the named areas were, or will be, considered when designing decommissioning and RAW management activities.

None of the respondents indicated that there were any other areas, i.e. in addition to those listed below, where improvements could be made.

Question D6: *Easier access to components equipment in normal and accident conditions*

The Westinghouse AP-1000 design incorporates requirements for constructability and ease of maintenance. The focus is on the removal of components and associated egress and access routes. The removal and replacement for major components was considered due to the design life of the plant. This included the replacement of steam generators.

AREVA-NP states that sufficient clearance around the components is ensured. Facilities for accident management are installed. Safety-related components can be drained and flushed remotely after an accident to enable access for their repair. In addition, as for question D1, AREVA-NP states that due to the long service life of the EPR it is anticipated that large components may have to be replaced. That is, dismantling/replacement is already considered in the design.

The ACR-1000 plant design, layout and access routes are optimized to facilitate easy access and removal of large components, and easy detachment and remote removal/replacement of significantly activated components. This also facilitates future installation of decontamination and waste handling equipment.

Question D7: *Development of specific tools and robots for component disassembly*

Westinghouse states that the development of such tools is part of the detailed plant design. Examples range from lifting equipment for large composite modules to tools for the disassembly of small components.

AREVA-NP states that all rooms with large pumps etc. are provided with a means of lifting. Components are designed to enable easier removal for radiation protection reasons. Robots are not required if decontamination is planned (see below). This question is very much directed to a decommissioning plan which is a matter for the utility.

AECL has developed remote-controlled equipment and control systems for retube projects at Bruce and Point Lepreau Nuclear Generating Stations (both in Canada) to minimise dose to workers. Lessons learned from these projects will be used in carrying out component disassembly remotely during the decommissioning of the ACR-1000.

Question D8: *Handling means and paths for removal of all components, including large and heavy ones (reactor vessel, steam generators etc.)*

Westinghouse states that the polar crane main beams have been sized such that, with the installation of a temporary heavy lift trolley, a steam generator can be lifted and will pass between the beams. Routes for removal have been established and conceptual designs established to maintain containment integrity.

AREVA-NP states that due to the necessity to install and maybe replace large components handling means and paths have been considered in the design. Openings sealed after installation can be re-opened, if necessary.

Provisions are made in the design of the ACR-1000 to allow sufficient space and dedicated path for easy and quick transport of large components during maintenance and decommissioning. See response to question D6. In addition adequate provisions are made for material handling, and replacement or removal of components throughout all buildings by providing cranes, hoists and monorail as required (see Question D11).

The EUR document requires that all components, except the vessel, should be removable using permanently installed means of handling.

Question D9: *Separation of radioactive and non radioactive equipment and minimization of radioactive systems*

For Westinghouse there are a range of criteria which influence the separation and segregation of equipment over and above the separation required for safety train requirements. Equipment which is carrying radioactive fluid is generally installed in separate areas and rooms for maintenance and ALARA considerations. This includes separation of redundant equipment in the same system.

AREVA-NP states that separation is a sound radiation protection principle and is implemented in the design. Separation is by means of shielding. (If a system is required it cannot be minimised, it must function.)

The ACR-1000 design has taken into consideration and benefitted from lessons learned and operational feedback from existing CANDU® plants. For example, in order to minimise cross-contamination, atmospheric separation is used between high and low activity areas, with adequate leak tight barrier, pressure differential and negative pressure control in high activity areas. Waterborne contamination is minimised through extensive use of sealants.

EUR states that separation of radioactive and non-radioactive equipment is required by dose reduction obligations.

Question D10: *Proper layout and shielding to minimize activation and contamination of structures and equipment*

Radioactive areas of the AP-1000 plant are designed to ensure that radioactive equipment and components are shielded. Of particular significance is the extensive use of composite steel plate and concrete modules. Such modules present a steel plate face in much of the areas susceptible to contamination. In addition many of the surfaces which will be subject to neutron bombardment will also be faced with steel plate reducing activation of the concrete behind the plate. Avoiding activation in neutron fields is a primary design requirement.

AREVA-NP states that the controlled area is divided into shielded areas, staggered by dose rate. This means that the potential in contamination scope is also strictly limited to the local area of occurrence. But here the ventilation system is designed to remove air-borne contamination if it occurs. With regard to liquid contamination the rooms of potential contamination are provided with a drain system The reactor shielding is sufficient to limit the main activation to the immediate vicinity of the RPV at core level.

The material of construction for ACR-1000 systems and components in high-neutron flux regions are carefully selected to minimize formation of activation products. Internal walls of ACR-1000 containment structures in highly radioactive regions of the reactor are steel-lined to minimize contamination of the concrete structure to a minimum. Tools and equipment used in radioactive areas of the plant are stored in dedicated facilities to prevent cross-contamination. In addition whenever possible the ACR-1000 design segregates the routing of contaminated process systems from non-contaminated systems to minimize possibility of cross contamination during operation and decommissioning.

Question D11: *Potential for on-site decontamination, cutting and conditioning of large components for off-site transportation*

Westinghouse considers the most effective way to decommission the plant is to provide a decontamination and volume reduction facility. The design and engineering of such a facility should be undertaken when the site has been selected and the final layout defined. Decisions at national level regarding the provision of final long term storage facilities will also affect the provision of this facility. In addition to this facility the proposed decommissioning plan envisages the use of the Spent Fuel building and the Spent Fuel Pit as areas where smaller components may be decontaminated and cut up to suit the local regulations regarding size for the transport of active waste.

AREVA-NP states that decontamination facilities and a hot workshop are provided in the buildings.

ACR-1000 lay down areas are provided within the containment, in low radiation field regions of the plant, for radiological inspection, decontamination and dismantling.

Question D12: *Considerations for plant recovery after serious accidents and subsequent plant decommissioning*

Westinghouse considers this is covered in the design to meet the ALARA considerations.

Since the EPR is designed to take account of core meltdown and RPV failure, the high radioactivity is constrained by design and wash-out effects to a very limited area beneath the RPV in the reactor building. Safety related components can be drained and flushed after an accident to allow access for their repair. Thus at a later time access to the containment can be regained to enable surveying and decommissioning decisions. The remaining structures can be decommissioned according to plan since, by design, they are not impacted by the accident.

In the event of a serious accident, which results in core degradation, the ACR-1000 plant has multiple systems, which can remove decay heat from core debris. In addition ACR containment system is designed to limit the release of radioactive materials to the environment in case of severe core damage. It includes the containment structure, provisions for containment atmosphere control and post-accident containment cooling, fluid and electrical systems and components that form part of the extended containment boundary, and isolation provisions to ensure an acceptably leak-tight containment envelope during and following an accident. Hence, a decommissioning strategy similar to the one used for normal plant shutdown will be used in the event of a forced shutdown, e.g. due to a severe accident).

B.2.1.3 Dose Reduction - System And Building Design Related Features

Questions D13-20: *Did you consider the following systems and building design areas for reduced operator doses and waste minimization? Have you considered additional areas in your designs?*

For questions D13, D14, D16-21, D24 and D25 the JSR states that, in general, issues relating to dose reduction are taken into account in the designs, e.g. low content of cobalt and silver, passivation of internal surfaces, smooth-faced surfaces suitable for easy decontamination, special coatings certified for decontaminability etc. Some questions (e.g. D15, D22, D23, D26, and D27) were not relevant to the respondent.

Question D13: *Connections for decontamination of systems and components*

For the AP 1000 the piping detailed design for many systems is being completed and provision for such connections will be made. Such provisions often create potential crud traps, thus the design has limited their inclusion. The primary circuit decontamination operations described in the Decommissioning Plan will be an operation which will be aimed at both Inconel and stainless steel decontamination. Since plant operations will no longer be a factor, decontamination can be a more aggressive process.

AREVA-NP states that large radioactive components are provided with shielded decontamination connections.

The ACR-1000 design includes a decontamination centre.

EUR requests permanent connections and space to install decontamination equipment.

Question D 14: *Minimization of potential traps for radioactive contamination*

For the AP-1000 the piping routing and layout for systems containing radioactive fluids are designed to minimize contamination traps. Valves such as plug or ball type and butt welded connections are used wherever practicable. In addition the selection of diaphragm type sensor isolators, diaphragm air driven pumps, etc. are employed in the design

For the EPR radiation protection design ensures that no bucketing or dead zones are in the layout. Low flow rates are avoided.

For the ACR-1000 is considered, for example, piping layout is designed to eliminate crud traps wherever possible.

Question D15: *Improved primary coolant and spent fuel pool contamination filtration*

The AP-1000 CVS purification process provides for mixed-bed, cation demineralisers and filters. The nominal, continuous purification flow rate was increased compared to operating plants. This arrangement, in concert with the enhanced chemistry requirements, will provide a much cleaner reactor coolant medium. In addition the additional chemical control of the primary circuit utilizing the zinc regime will significantly reduce active corrosion products. The SF Pit (pool) cooling system also incorporates filters and demineralizers appropriately sized to ensure reduced activity levels in the fluid.

AREVA-NP states that mesh sizes have been reduced on comparison with earlier designs. Filter changing is performed semi-remotely using a shielded machine and resin exchange is performed remotely by back-flushing.

For the ACR-1000 sub-micron filters are added to the coolant purification to improve efficiency in particulate removal. A vacuum cleaning circuit (a filter and a pump) is provided to reduce the concentration of solids debris in the spent fuel bay. This, along with the addition of a biocide to control of the growth of biological matter in the spent fuel bay, will prevent the accumulation of contaminants in the spent fuel bay. Removal of activated solid contamination prevents their transport around the system and the build-up of local high radiation fields in the accessible areas.

Question D16: *Minimization of the potential of spills and leakages and provisions for their early identification and clean-up*

The design and layout of the AP-1000 is intended to minimize leakages and spills by the judicious placement of vents and drains. All slabs containing radioactive equipment is enclosed within rooms which have decontaminable surfaces and which are equipped with floor drains connected to the waste process systems. A record will be kept of radionuclide releases relevant to decommissioning.

EPR have the same provisions but in addition AREVA-NP states that leakages in the primary system are detected at an early stage by means of humidity sensors.

AECL states that where the potential exists for leakages that could result in release of radioactive material, welded construction is used. Collection systems are provided to collect, in a controlled manner, leakages from known paths (i.e. from pump seals, valve packing, etc.). In addition various means are provided to detect leakages.

In addition all designers state provisions to ease clean-up.

Question D17: *Limited use of embedded piping*

For the AP-1000 the use of embedded pipes has been minimized to the extent possible, consistent with maintaining radiation doses ALARA. To the extent possible, pipes have been routed in accessible areas such as dedicated pipe routing tunnels or pipe trenches, which will provide good conditions for decommissioning.

AREVA-NP is basically on the same position no embedded radioactive piping is installed where possible. Exceptions to this can be drain lines, depending on utility requirements.

Also ACR-1000 design minimizes the use of buried or embedded piping. In addition, AECL states that where pipes are embedded, materials used are designed to last the lifetime of the plant.

Question D18: *Improved design of sumps and drains*

Westinghouse states that the design and location of the active drains system and associated sumps reflects the requirements of the URD (Utilities Requirements Document) and the Westinghouse experience in this area. All sumps are plate lined, welding is minimized and surfaces treated to limit crud retention.

AREVA-NP states that the drainage system is designed to keep the liquids separated from potential radioactivity. For example, drains for process components are kept separate from building drains. The component drain system is enclosed. Likewise a separate enclosed system accommodates primary system drainage.

For the ACR-1000 sumps and drainages in concrete floors are designed with sheet steel lining to protect the concrete from contamination and to facilitate final clean-up. This is particularly important for systems containing radioactive fluids. Floor drains in the ACR-1000 are equipped with sealed covers to prevent any spills of oils or chemicals from escaping to the environment.

Question D19: *Smooth, non-porous, and free of cracks and crevices*

Westinghouse has made a particular improvement on this issue because the modular construction. Actually a large part of the structural design incorporates composite structural modules. These are steel plate structures which are installed and then filled with concrete. These replace much of the traditionally placed concrete with the outer steel plates doubling as formwork in addition to their structural function.

Without providing any detail AREVA-NP states that surfaces are designed to be decontaminable.

Where radioactive fluids are expected, ACR-1000 process systems and concrete surfaces are kept impenetrable to minimize fixed-contamination from penetrating the surface. This is achieved by surface pre-treatment, painting or lining the surface with suitable materials.

Question D20: *Smoother surfaces for floor and walls with no sharp corners*

The responses were much the same as for Question D19: provisions are taken to facilitate decontamination. Only Westinghouse appears to make provision to avoid sharp corners by adopting a modular design that eliminates many of the sharp corners associated with traditional construction, e.g. fillet welds at plate junctions.

B.2.1.4 Dose Reduction – Materials Selection Related Features

Question D21: *Selection of materials for systems that will minimize activation products (for example lower cobalt content)*

It is noted that improvements made to improve operation will be beneficial also for decommissioning. Actually the major source of personnel exposure is from cobalt-60 thus every effort to minimize its production is employed in the design. This includes all materials in contact with the reactor coolant and or which may be subject to neutron bombardment. In the latter case this includes such items as hard facing materials for valves. For in-core components the use of stainless steel and Inconel are avoided wherever possible, zircaloy being the most favoured replacement. In addition the incorporation of zinc in the reactor coolant chemistry will result in a more stable corrosion layer on primary surfaces, minimizing transport and subsequent activation of corrosion products.

Also AREVA-NP points out that the use of cobalt is restricted by design. This has been analysed to achieve the optimal reduction. Use of antimony and silver in gaskets has been minimised.

Material used in ACR-1000 systems, components and structures in high neutron flux regions are carefully chosen to minimize activation products. For example, stainless steel with as low as possible cobalt content is used in the highly radioactive reactor core. This also applies to other regions of the plant where neutron activation is expected.

The EUR document states that limits will be imposed on cobalt levels but the limiting values are still being discussed. The Westinghouse response indicates that the URD will have similar requirements.

Question D22: *Finishing processes for internal surfaces of components in contact with primary coolant to minimize crud production*

Electropolishing of surfaces exposed to reactor coolant will be required for the AP1000. Similar treatment of the reactor cavity and the spent fuel pit surfaces will also be required. The benefits of passivation and a selection of the most effective process are still being evaluated for the AP1000.

For EPR electro-polishing can be utilised as well as polishing by other means, especially at weld junctions.

As part of an effort to reduce worker dose and emission, the ACR-1000 project is currently assessing various surface treatments to minimize corrosion and crud production.

Question D23: Improved leak tightness of fuel

Westinghouse fuel is under continuous and aggressive development toward a 'zero leakage' goal.

AREVA-NP fuel is already improved and leaks are few.

AECL points to low CANDU fuel defect rates and advantages of CANDU reactors with respect to detection and on-power removal of defective fuel.

<u>Question D24:</u> *External surface finishing of equipment and piping*

The AP-1000 design has incorporated many innovative features which support the ALARA principles for ease of maintenance and decontaminability. Piping surfaces in areas where piping could become contaminated will be specified to facilitate decontamination.

AREVA-NP states that equipment and piping within the controlled area are designed to avoid cracks and nooks and ensure their surfaces are smooth to enable cleaning.

For ACR-1000 standard industrial instruments and materials of suitable types are used in general. Special materials, treatments, finishes, and dust-tight and air-conditioned enclosures are employed where necessary.

<u>Question D25:</u> *Selection of insulation materials to minimize the production of radioactive and even mixed wastes*

For AP-1000 the insulation within the containment and the auxiliary buildings is generally of the stainless steel reflective type which can be decontaminated.

AREVA-NP plan to use mineral wool protected by stainless steel covers so to reduce the potential for radioactive waste production from activation or contamination.

For ACR-1000 the focus is on separation of active and non-active systems. Also, thermal insulation materials enclosed in metallic jackets minimize surface contamination and the quantity of radioactive waste that will be disposed during decommissioning.

The JSR states that insulating materials should be selected from those that are commercially available.

<u>Question D26:</u> *Selection of materials for structures that minimize activation products*

As said previously Material used in ACR-1000 systems, components and structures in high neutron flux regions are carefully chosen to minimize activation products.

For the AP-1000 the design of the concrete mix is not yet finalized but will reflect the need to minimize activation products.

For AREVA-NP see question D27.

<u>Question D27:</u> *Improved biological shield design to minimize activation*

For AP-1000 the biological shield is designed such that all sections facing the reactor vessel are part of a structural module and thus present a steel decontaminable face. The material used will meet the cobalt free/low criteria.

For the EPR the concrete surrounding the RPV is designed to withstand a severe accident and therefore this design has precedence. However, the concrete is analysed to ensure that long-lived nuclides are present only as traces. The concrete composition is, however, dependant on site aggregates. Furthermore any additives in the concrete to reduce the neutron activation also have negative affects in other disciplines.

As part of the ACR design process, the expected dose from the different systems and components are used as input in the layout in various rooms. Proper shielding is provided to minimize worker dose and activation of surrounding equipment.

B.2.2 REQUIREMENTS OF ELECTRICITY PRODUCERS

The following electrical utilities responded to the questionnaire: British Energy, EdF, Fortum, KKG, and Vattenfall. Other responses included in this section are from SOGIN and the Joint Slovakia Response (JSR)

Question U1: *Did you include specific requirements for decommissioning in your recent procurement specifications or do you intend to do it?*

EDF states that certain specific requirements are included.

FORTUM states that they intend to include specific requirements. The draft regulatory guide STUK-YVL5.5 already requires that the plant design has to provide for decommissioning. FORTUM considers that EUR Chapter 2.16 may be used as a basis for requirements.

Vattenfall states that environmental aspects are included in the specifications. They have requirements for chemicals with a focus on reactor safety but there will also be benefits in relation to waste treatment.

KKG responds in the context of decommissioning of existing plant.

The JSR responds mostly in the context of an ongoing decommissioning project but suggests that VUJE will include specific requirements for decommissioning when ordering new waste treatment plant.

SOGIN states that specific requirements for decommissioning, such as easy decommissioning of the NPP in terms of feasibility, cost and occupational doses for workers, are requested at the time of NPP or other nuclear facility procurement.

Question U2: *Have you performed or do you intend to perform an initial baseline characterization of the site and buildings?*

EDF states that an initial baseline characterization of the site is performed.

Vattenfall responds in the context of characterisation of shutdown or still-operating plant.

Fortum states that there is no current plan to do so. However, they feel that this may be beneficial and, if so, they will elaborate on it in due course.

For KKG this matter is to be decided later. All data available today are based on the *Stilllegunsstudie* and on Nagra's *Modellhaftes Abfallinventar*.

SOGIN states that no baseline characterization of site end materials was performed. Later facilities underwent Environmental Impact Evaluation which provides an exposition of hydrogeology. SOGIN believes that collected data should be sufficient to identify migration paths.

The JSR response is written solely in the context of ongoing decommissioning or planned decommissioning of already operating plant. It should be noted that, for the Bohunice A-1 plant, an initial characterisation of the site was performed after the accident that caused its closure.

Question U3: *Do you develop initial decommission plans on which you assess the funds to be accumulated? Do you periodically update these on the basis of operating experience or do you intend to do so?*

British Energy develops the plans and these are maintained and updated to ensure that the cost estimates are current and that the funds available to manage and discharge the decommissioning liabilities are adequate.

EDF states that the 2007 French regulations now require a decommissioning plan to be produced at the start of the licensing process.

Vattenfall states that the decommissioning fund for all NPPs in Sweden is managed by an independent entity, SKB.

FORTUM states that the funding is based on the decommissioning plans. According to the Nuclear Energy Act the decommissioning plan shall be presented every sixth year.

KKG develops the decommissioning plan. The update period is 10 years according to *Kernenergieverordnung, Art. 42.*

SOGIN states that, when the nuclear plants were built, there was no decommissioning plan and costs were based on international practice. Future cost estimates will require regulatory approval and will be based on a detailed decommissioning plan.

The JSR states that the decommissioning plan (including a funding estimate) for A-1 NPP has five stages and is updated every 5 years or less (a legal requirement). Initial decommissioning plans for VUJE's waste management facilities have been developed and funding is likely to come from the Slovak National Nuclear Fund.

Question U4: *Did you identify design and operational information relevant to decommissioning and do you assure proper record keeping of them?*

Decommissioning plans of British Energy now specifically address the issue of knowledge management for decommissioning.

EDF states that Information relevant for decommissioning will be properly recorded.

Vattenfall indicates that there was no gathering of information-relevant-to-decommissioning prior to shutdown (at Barsebäck). The task of information gathering started after shutdown and was aided by a good records management system.

Fortum states that the relevant design documentation was identified when preparing the decommissioning plans. The periodical revisions of the decommissioning plans as well as the contamination development follow-up provide assurance that the operational experience will be taken into account.

KKG refers to *Stilllegungsstudie*.

SOGIN states that, for the plant currently being decommissioned, there were no requirements to keep records specifically for this purpose. Before starting any dismantling activity it has been found necessary to verify that the design and other information tallies with the actual configuration of the plant.

The JSR states that operational records have been used for A-1 NPP decommissioning but more essential is the information on post-accident conditions and the design of the plant. Record keeping is ensured by the operator of the facilities.

<u>Question U5:</u> *Have you a configuration management program to assure proper record keeping of modifications to the plant?*

For British Energy the modifications to plant are subject to a strict change control procedure which includes identification of any which have an impact upon decommissioning liabilities. If significant, these can be immediately evaluated, otherwise they are incorporated into the subsequent update of the decommissioning plan for the power station concerned.

EDF states that the proper record keeping of the modifications of the plant will be ensured by the management system.

Vattenfall and FORTUM state similar provisions.

For KKG plant modifications are part of the management programme.

According to SOGIN experience in Italy, proper procedures were in place to record f modifications but, in practice, not all the modifications were recorded in the archive copy. Consequently the information must be checked as described in response to question U4.

The JSR responds in the context of modifications in the course of A-1 NPP decommissioning where two accidents occurred prior to shutdown. The configuration management programme has been extended also to the decommissioning phase. The documentation showing the layout and configuration of the A-1 NPP buildings and facilities is continually updated.

<u>Question U6:</u> *Do you perform (or intend to perform) periodic integrity verification of embedded piping potentially contaminated?*

For British Energy extensive NDT of vessel penetrations is undertaken to support the operational safety case.

FORTUM performs periodic integrity verification, the scope of which depends on the safety class of the piping. Thus all piping is not covered.

Vattenfall and KKG provide the same response: “yes and no”: yes, because verification is included in the control programme; no, because they do not perform it for all of the embedded pipes – it depends on the classification.

According to SOGIN (referring to decommissioned plant) such verifications were not envisaged during operation and there is no need for such inspections once the pipes have been drained after shutdown.

The JSR states that during operation of the experimental bituminisation facility (from 1985 to 1999) periodic verifications of integrity of embedded piping were done. With respect to decommissioning of A-1 NPP, the response does not say whether such inspections were performed during the operational period, which ended in 1977 (decommissioning started 1999).

Question U7: *Have you access to systematic decommissioning lessons learned? Do you believe that such an activity to be carried out by NEA could be useful for your plants?*

According to British Energy, access to decommissioning lessons learned tends to be opportunistic, coming from personal contacts, conferences and publications. Invariably the information is incomplete and requires follow-up. They suggest that the national Decommissioning Authority (NDA) could help to spread best practice by systematising and circulating the information.

EDF has access to specific decommissioning lessons learned by bilateral agreements with other organizations involved in decommissioning. Nevertheless, an activity carried out by NEA could be useful.

Vattenfall says that Barsebäck has access to the EPRI decommissioning programme. NEA could develop a broader programme, which would definitely be useful.

Fortum believes it could benefit from better access to such experience.

KKG has access via WNA (World Nuclear Association) to lessons learned. At the time being no further access is needed.

SOGIN has little access to such information and encourages exchange of experience along the lines of WANO or IDN (IAEA International decommissioning network).

The JSR states that the A-1 Nuclear Power Plant was built as an experimental plant; is non-standard and operated for a short period only and, accordingly, the opportunity for learning lessons applicable to other plant or for applying lessons from other plant is limited. Activities carried out by NEA could be useful, but should not duplicate those provided by the IAEA (e.g. VUJE already participates in regional and national technical cooperation programmes in the fields of radioactive waste management and decommissioning).

Question U8: *Do your safety authorities provide sufficient guidance on what is expected in terms of the use of experience gained from decommissioning projects?*

British Energy believes that safety authorities provide sufficient guidance.

EDF believes they do not need more guidance from the safety authority for this topic. It also notes that, at the request of the French Safety Authority, one chapter of the preliminary safety analysis report is devoted to decommissioning and describes different arrangements taken to make further decommissioning easier.

Vattenfall states that the regulatory authorities do not provide sufficient guidance.

According to FORTUM they have some guidance from the safety authorities.

KKG say this is difficult to answer because it is not yet involved in a decommissioning programme.

SOGIN states that in Italy non-specific guidance has been developed to address decommissioning activities. The authorisation process is currently the same as for construction of an NPP so that decommissioning activities are proceeding through case-by-case agreements with the regulatory body, which is time consuming.

The JSR indicates that the regulatory authorities provide sufficient guidance.

B.2.3 REQUIREMENTS OF THE REGULATORY AUTHORITIES

The following regulatory bodies responded to the questionnaire: CNSC (Canada), HSE/EA (United Kingdom/England and Wales), STUK (Finland) and UJD-SR (Slovak Republic)

Question R1: *Do you consider it necessary to develop decommissioning requirements and review criteria for the licensing of new nuclear power plants? How detailed is the information you require?*

CSNC responded in the affirmative but did not provide details.

HSE/EA issued guidance[3,4] to the reactor vendors on "generic design assessment" (GDA), which relates to pre-licensing and pre-authorisation assessments of candidate reactor designs. The GDA requires estimates of annual waste and spent fuel arisings (both character and volume) plus details of spent fuel and radioactive waste management, and decommissioning. The depth of the information required may vary according to the significance of each issue to the design acceptance. Requesting parties should demonstrate

- that the design and the proposed operation will avoid or minimise the generation of radioactive waste
- that radioactive wastes will be safely stored pending disposal; and
- that wastes are disposable.

HSE will also use existing criteria for licensing and decommissioning, which have recently been revised and published[5,6].

STUK states that the application for a construction licence shall be supplemented with the description of the applicant's plans and available methods for arranging nuclear waste management, including the decommissioning of the nuclear facility and the disposal of nuclear waste, and a description of the timetable of nuclear waste management and its estimated costs. The description shall particularly include information on:

- how the decommissioning is taken into account in the plant design,
- radiation protection optimization during decommissioning, and
- minimisation of the decommissioning waste.

The application for an operating licence shall include all the above plus the decommissioning plan, which shall be detailed enough to serve as a basis for the estimation of the assessed liability.

UJD SR requires decommissioning to be addressed in increasing detail through the licensing process:

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3. See "Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs", Environment Agency, version 1 January 2007, available at http://publications.environment-agency.gov.uk/pdf/GEHO0107BLTN-e-e.pdf
4. See "Nuclear Power Station Generic Design Assessment – Guidance to Requesting Parties", Health & Safety Executive, Version 2, 16 July 2007, available at http://www.hse.gov.uk/nuclear/reactors/design.pdf
5. http://www.hse.gov.uk/nuclear/notesforapplicants.pdf
6. http://www.hse.gov.uk/nuclear/decomm1.pdf

- a Reference Report on the Decommissioning Method attached to the written application for permission for siting of a nuclear installation;
- a Preliminary Conceptual Decommissioning Plan attached to the written application for building permission for the construction of nuclear installation
- a (detailed) Conceptual Decommissioning Plan attached to the written application for authorisation for the commissioning and operation of nuclear installation; this is to be updated every 10 years.

These reports cover all aspects of decommissioning including methodology, waste generation (both radioactive and conventional), cost estimation, securing of funds, re-use of cleared materials.

<u>Question R2:</u> *Do you require that decommissioning plans for new plants take any account of possible future developments in terms of clearance and release criteria?*

CSNC responded in the affirmative but did not provide details.

HSE/EA states that this requirement would be reflected in the periodic reviews that operators of nuclear facilities would be required to carry out of their decommissioning and waste management plans (see response to question R3).

STUK states that regulatory guidance for clearance exists (Guide YVL 8.2) and it is upgraded regularly. It is generally required in the legislation that the amount of the decommissioning waste is minimized, and also waste management schemes must be updated regularly taking into account technological and other developments.

UJD-SR requires clearance and release criteria to be included in the Conceptual Decommissioning Plan which is updated every ten years. The update reflects, inter alia, amendments of generally binding legal regulations including conditions for release and clearance of radioactive materials.

<u>Question R3:</u> *What is your role in defining decommissioning costs and controlling that fund accumulation is constantly updated, as necessary?*

CNSC states that Class I and Class nuclear facilities in Canada require a decommissioning plan and a financial guarantee. The licensee (applicant) defines the decommissioning costs in support of the financial guarantee. CNSC provides guidance on financial guarantees. The decommissioning plan forms the strategic basis for establishing a financial guarantee and provides the outline for the subsequent detailed planning; it is reviewed and updated periodically, as necessary and this may change the amount of the guarantee.

Almost all existing UK nuclear facilities are owned either directly or indirectly by the state, which has responsibility for ensuring adequate funding for decommissioning. Operators of new nuclear power stations are required to have secure financing arrangements in place to meet the costs of decommissioning and waste management. A Funded Decommissioning and Waste Management Programme must be approved by the relevant Secretary of State before construction of a new nuclear power station can begin. Operators must comply with this programme thereafter and review it regularly. Funded Decommissioning and Waste Management Programmes have two main parts: technical and financial. The regulators are statutory consultees of the Secretary of State for approval of the programme and for any subsequent modifications. Further guidance on the content of such programmes is being prepared.

STUK gives its opinion to the Ministry of Employment and Economy on the safety of the decommissioning, dismantling and disposal techniques in the waste management scheme presented and upgraded regularly by the licensees. The Ministry confirms the assessed liabilities and sets the annual amounts to be paid to the National Nuclear Waste Management Fund based on the waste management schemes. Key points are:

- The licensee is responsible for all nuclear waste management measures and costs. The financial obligation is met through annual payments into the National Nuclear Waste Management Fund. Securities must be provided as a precaution against insolvency.
- The National Nuclear Waste Management Fund is controlled and administered by the Ministry of Employment and Economy and independent of the State budget.
- Estimation of the liability is made by the licensee based on the proposed waste management scheme and current prices and costs with allowance for reasonable uncertainty.
- The waste management scheme must be sufficiently detailed for the calculation of the assessed liability. The scheme must be approved by the Ministry before beginning the operations that produce nuclear waste.
- The licensee must regularly update the scheme, waste estimates, prices, costs and calculations and submit them to the Ministry.
- Before approving the waste management scheme and confirming the assessed liability the Ministry must obtain a statement from the Radiation and Nuclear Safety Authority (STUK).

The Slovak Atomic Act requires the authorisation holder to ensure that the earmarked funds can cover the decommissioning costs. The rules for creation and use of the resources of the decommissioning fund are established by law. The same law requires a ‘back end strategy’ to be prepared by the Ministry of Economy and approved by the Government. The strategy is updated every five years and aims to ensure that the needed ‘back end’ activities do actually take place and that the appropriate financial arrangements are in place. UJD-SR reviews the strategy and issues a public statement of its findings. UJD SR is also represented on the nuclear decommissioning fund board of governors and its advisory committee. Finally, the decommissioning licence holder requires a statement of support from UJD-SR when applying for funding from the nuclear decommissioning fund.

<u>Question R4:</u> *Have you access to systematic decommissioning lessons learned? Do you believe that such an activity to be carried out by NEA could be useful for your responsibilities?*

CNSC responds to both questions in the affirmative.

The UK Regulators do not have direct access to such a system. However, the nuclear industry operates various LFE systems which we are able to access. They welcome developments of systems that share experience and enable learning.

STUK responds “no” to the first question and “yes” to the second.

UJD SR has access to systematic decommissioning lessons learned through interactions with IAEA (WASSC, SADRWMS, DeSa/ FaSa), OECD/NEA and WENRA.

Question R5: *Please give references to regulations and/or guidance documents that address the above issues.*

Canada

Canadian Nuclear Safety Commission (CNSC)

- Nuclear Safety and Control Act (NSCA)
- Class I Nuclear Facilities Regulations
- G-219: Decommissioning Planning for Licensed Activities
- G-206: Financial Guarantees for the Decommissioning of Licensed Activities

Canadian Standards Association (CSA)

- Standard N294 (currently in development)

International standards on this topic, to which the Canadian documents are aligned.

United Kingdom

- "Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs", Environment Agency, version 1 January 2007, available at http://publications.environment-agency.gov.uk/pdf/GEHO0107BLTN-e-e.pdf
- "Nuclear Power Station Generic Design Assessment – Guidance to Requesting Parties", Health & Safety Executive, Version 2, 16 July 2007, available at http://www.hse.gov.uk/nuclear/reactors/design.pdf
- CM 7296 "Meeting the Energy Challenge: A White Paper on Nuclear Power", January 2008 Department for Business, Enterprise & Regulatory Reform. January 2008. See http://www.berr.gov.uk/energy/nuclear-whitepaper/page42765.html
- Energy Bill 2008
- Health and Safety Executive, Nuclear Safety Directorate, The Licensing of Nuclear Installations, http://www.hse.gov.uk/nuclear/notesforapplicants.pdf
- Health and Safety Executive, Guidance for Inspectors: Decommissioning on Nuclear Licensed Sites, http://www.hse.gov.uk/nuclear/decomm1.pdf

Finland

Regulatory guides:

- YVL 7.18 Radiation safety aspects in the design of a nuclear power plant, 26.9.2003
- YVL 8.2 Premises for removal of regulatory control from nuclear waste and decommissioned nuclear facilities, 18.2.2008
- STUK YVL 5.5 Management of low and intermediate level nuclear waste and decommissioning of nuclear facilities (draft)

Slovak Republic

- Act no. 541/2004 Coll. on Peaceful use of nuclear energy (‘Atomic Act’),
- Regulation no. 58/2006 Coll. on details concerning the scope, content and method of preparation of nuclear installation documentation needed for certain decisions,
- Regulation no. 53/2006 Coll. on details concerning requirements for management of nuclear material, radioactive waste and spent fuel,
- Act no. 238/2006 Coll. on National decommissioning fund for decommissioning of nuclear facilities and spent fuel and radioactive waste management (“national decommissioning fund”),
- Act no. 355/2007 Coll. on The protection, promotion and development of public health,
- Government Regulation no. 345/2006 Coll. on basic safety requirements for health protection of workers and population against ionising radiation.

Part C

AGENDA OF THE TOPICAL SESSION ON:

APPLYING DECOMMISSIONING EXPERIENCE TO THE DESIGN AND OPERATION OF NEW PLANTS

12-13 NOVEMBER, 2008

12 NOVEMBER 2008

Topical Session

'APPLYING DECOMMISSIONING EXPERIENCE TO THE DESIGN AND OPERATION OF NEW PLANTS'

INTRODUCTORY SESSION

14:00	**1.**	**INTRODUCTION TO THE PROJECT AND TOPICAL SESSION** *Ivo Tripputi, WPDD Chair* • *The introductory remarks will describe the origin and aims of the project, and its relevance for WPDD and for NEA, and the overall aim of the topical session.*	
14:10	**2.**	**SYNTHESIS OF RESPONSES TO THE QUESTIONNAIRE SURVEY** *Luigi Noviello, Consultant to the Secretariat*	*NEA/RWM/WPDD(2008)9*

SESSION 2 –DESIGN AND OPERATIONAL ASPECTS

Chair: Gérard Laurent (EdF CIDEN)
Rapporteur: Harri Tuomisto (FORTUM)

14:30	**3.**	**INTRODUCTION TO SESSION 2** *Gérard Laurent* • *The Chair will introduce the issues for discussion and will outline the planned scope and objectives of the session*

14:50	**4.**	**EUROPEAN NUCLEAR INSTALLATIONS SAFETY STANDARDS (ENISS) GROUP** *Ivana Davidova* • *ENISS has been actively interacting with the Western Europpean Nuclear Regulators'Association (WENRA) on decommissioning requirements and on requirements for operating plants playing the role of industry counterpart. The view of ENISS on the relevance of decommissioning lessons learned for new designs, not only in the context of future dismantling but also throughout the plant lifecycle, will be given.*
15:10	**5.**	**ATOMIC ENERGY OF CANADA LIMITED (AECL)** *Serge Julien* • *The extent to which AECL takes account of decommissioning experience in the design of new plant will be described. The process by which such experience should be captured in a systematic way and made available to reactor designers will be discussed in particular. Potential linkages between provisions for improved decommissioning and improved maintenance should also be discussed.*
15:30	**6.**	**COMMENTARY ON THE RESPONSE FROM THE EUROPEAN UTILITIES' REQUIREMENTS (EUR) GROUP** *Luigi Noviello* • *The EUR response on requirements for decommissioning (as also set out in chapter 2.16 of the EUR document) will be described, together with any plans for revision of the current requirements. Potential benefits for utilities of incorporating decommissioning lessons learned into new designs will be outlined, with reference also to possible lifetime cost reductions*
16:00		*Break*
16:30	**7.**	**INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)** *Paul Dinner* • *IAEA activities aimed at assisting the transfer of decommissioning experience to the design of new reactors (e.g. as described in TECDOC 460) will be discussed. The relevance of such information for nuclear installations other than NPPs (Laboratories, research reactors, other research installations) will also be discussed.*

16:50	**8.**	**PANEL-BASED DISCUSSION** *Gérard Laurent*
		Relevant questions include: • *Is ease of decommissioning mainly related to features that improve operation and maintenance provisions? Which aspects that are specific to decommissioning only, i.e. which are not related to operation and maintenance activities?* • *Is the decommissioning sequence specifically addressed at the design stage, i.e. promoting the use of modular approaches so that parts of a system may be removed whilst another part may still be operating?* • *Is there a need to improve the information flow between decommissioning implementers and vendors? Could international organizations such as the WPDD facilitate this?* *Panellists: Ivana Davidova (CEZ); Serge Julien (AECL); Paul Dinner (IAEA); Ian Terry (AREVA-NP); Giuseppe BITETTI (Ansaldo Nucleare S.p.A.)*
17:45	**9.**	**RAPPORTEUR'S REMARKS AND AUDIENCE FEEDBACK** *Harri Tuomisto*
18:00		*Adjourn*

13 NOVEMBER 2008

SESSION – 3
'POLICY AND REGULATORY ASPECTS'

Chair: Doug Metcalfe (Natural Resources, Canada)
Rapporteur: Allan Duncan (Former UK Chief Inspection of Pollution Control)

09:00 **10. INTRODUCTION TO SESSION-3**
Doug Metcalfe

- *The Chair will introduce the issues for discussion and will outline the planned scope and objectives of the session*

09:10 **11. FRENCH NUCLEAR SAFETY AUTHORITY (ASN)**
Vincent Ridard

- *The licensing approach for Flamanville-3 will be described, with particular reference to considerations of facilitated maintenance, decommissioning and reduced waste and operator doses.*

09:30 **12. FINNISH NUCLEAR SAFETY AUTHORITY (STUK)**
Arto Isolankila

- *The licensing approach for Olkiluoto-3 will be described, with particular reference to considerations of facilitated maintenance, decommissioning and reduced waste and operator doses.*

09:50 **13. US NUCLEAR REGULATORY COMMISSION (NRC)**
Boby Abu-Eid

- *NRC's important programme on decommissioning experience collection and use for current and future decommissioning projects will be discussed, including – to the extent compatible with its mandate – NRC's views on the extent to which this information is influential in the licensing of new plants.*

10:10	**14.**	**UK NII/UK ENVIRONMENT AGENCY (JOINT PRESENTATION)** *David Glazbrook/Ian Streatfield* • *The presentation will address the UK approach to the assessment of designs of new plants with specific reference to the role and aims of the generic design assessment process, and in relation to the significance of decommissioning to the process.*
10:30		*Break*
11:00	**15.**	**PANEL-BASED DISCUSSION** *Doug Metcalfe*
	15.a	Introductory remarks by Stefan Theis (HSK), Chairman of WENRA's Working Group on Waste Disposal (WGWD) on the work of the WGWD, in general, and on Swiss plans for licensing new plants.
	15. b	Panel Discussion *Relevant questions include:* • *The role of decommissioning (or decommissioning related requirements) in new plant licensing process from the policy and regulatory standpoint: how has it evolved and what may be expected in the future?* • *What could be expectations on the contribution from international groups, such as WPDD?* *Stefan Theis (HSK), Vincent Ridard (ASN), Arto Isolankila (STUK), Boby Abu-Eid (NRC), David Glazbrook (NII) and/or Ian Streatfield (UK Environment Agency) and Marta Ziakova (UJD-SR, Slovak Nuclear Regulatory Authority)*
12:00	**16.**	**RAPPORTEUR'S REMARKS AND AUDIENCE FEEDBACK** *Allan Duncan*
12:15	**17.**	**DISCUSSION ON FURTHER STEPS** *Ivo Tripputi*
12:30	**18.**	**CLOSING REMARKS** *Doug Metcalfe*
12:45		*Adjourn*

Part D

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APPLYING DECOMMISSIONING EXPERIENCE TO THE DESIGN AND OPERATION OF NEW PLANTS

12-13 NOVEMBER, 2008

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