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NUCLEAR ENERGY AGENCY
COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

REPORT ON THE CSNI WORKSHOP ON NUCLEAR POWER PLANT TRANSITION FROM OPERATION INTO DECOMMISSIONING: HUMAN FACTORS AND ORGANISATION CONSIDERATIONS

May 17-18, 1999
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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter; Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996) and the Republic of Korea (12th December 1996). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1st February 1958 under the name of OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full Member. NEA membership today consist of all OECD Member countries, except New Zealand and Poland. The Commission of the European Communities takes part in the work of the Agency.

The primary objective of the NEA is to promote co-operation among the governments of its participating countries in furthering the development of nuclear power as a safe, environmentally acceptable and economic energy source.

This is achieved by:

- *encouraging harmonization of national regulatory policies and practices, with particular reference to the safety of nuclear installations, protection of man against ionising radiation and preservation of the environment, radioactive waste management, and nuclear third party liability and insurance;*
- *assessing the contribution of nuclear power to the overall energy supply by keeping under review the technical and economic aspects of nuclear power growth and forecasting demand and supply for the different phases of the nuclear fuel cycle;*
- *developing exchanges of scientific and technical information particularly through participation in common services;*
- *setting up international research and development programmes and joint undertakings.*

In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has concluded a Co-operation Agreement, as well as with other international organisations in the nuclear field.

COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

The Committee on the Safety of Nuclear Installations (CSNI) of the OECD Nuclear Energy Agency (NEA) is an international committee made up of senior scientists and engineers. It was set up in 1973 to develop, and co-ordinate the activities of the Nuclear Energy Agency concerning the technical aspects of the design, construction and operation of nuclear installations insofar as they affect the safety of such installations. The Committee's purpose is to foster international co-operation in nuclear safety among the OECD Member countries.

The CSNI constitutes a forum for the exchange of technical information and for collaboration between organisations, which can contribute, from their respective backgrounds in research, development, engineering or regulation, to these activities and to the definition of the programme of work. It also reviews the state of knowledge on selected topics on nuclear safety technology and safety assessment, including operating experience. It initiates and conducts programmes identified by these reviews and assessments in order to overcome discrepancies, develop improvements and reach international consensus on technical issues of common interest. It promotes the co-ordination of work in different Member countries including the establishment of co-operative research projects and assists in the feedback of the results to participating organisations. Full use is also made of traditional methods of co-operation, such as information exchanges, establishment of working groups, and organisation of conferences and specialist meetings.

The greater part of the CSNI's current programme is concerned with the technology of water reactors. The principal areas covered are operating experience and the human factor, reactor coolant system behaviour, various aspects of reactor component integrity, the phenomenology of radioactive releases in reactor accidents and their confinement, containment performance, risk assessment, and severe accidents. The Committee also studies the safety of the nuclear fuel cycle, conducts periodic surveys of the reactor safety research programmes and operates an international mechanism for exchanging reports on safety related nuclear power plant accidents.

In implementing its programme, the CSNI establishes co-operative mechanisms with NEA's Committee on Nuclear Regulatory Activities (CNRA), responsible for the activities of the Agency concerning the regulation, licensing and inspection of nuclear installations with regard to safety. It also co-operates with NEA's Committee on Radiation Protection and Public Health and NEA's Radioactive Waste Management Committee on matters of common interest.

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EXECUTIVE SUMMARY

The Senior Expert Group of the Committee on the Safety of Nuclear Installations (CSNI) proposed to Principal Working Group 1 (PWG1) of CSNI that a workshop be held to identify and discuss issues related to the impact of human factors and organisational aspects on decommissioning. This workshop was held in May 1999 in conjunction with the Joint NEA/IAEA/EC workshop on The Regulatory Aspects of Decommissioning. The workshop goals, as stated in the NEA *Research Strategies for Human Performance*, were "to convene an information exchange meeting with interested Member countries in order to discuss areas of concern in this respect and identify possible areas that merit further research and their priorities." [NEA/CSNI/R(97)24]

Professionals from regulatory agencies, utilities, and research organisations from 11 countries participated; a total of 23 people attended the workshop. Several formal papers provided an initial platform for informing working group discussions. The consensus of the participants is that the workshop provided a valuable set of insights into the organisational issues that affect the transition from operations into decommissioning. The workshop also highlighted a comparative lack of developed work in this area concerning the way in which organisational weaknesses can manifest themselves and how best to prevent or mitigate their effects.

Eight key issues were identified and discussed by the participants. For each of the eight issues discussed by working groups, the potential risks of failing to address the Issue were identified. These potential risks formed a focal point for generating discussion about current experience and for drawing out gaps in current knowledge and understanding. From this base, participants then focused on specific types of information and questions that need further research in order to improve understanding and successful implementation of the transition from operations to decommissioning.

The eight issues and suggested high priority needs for each issue area are presented below.

Creating a system to share international experience

- Establish improved methods for obtaining and sharing information and experience on a regular basis in order to identify organisational and human factors issues, good practices and lessons learned as regulators and utilities deal with decommissioning.

Organisational memory and competence

- Identify effective approaches to retain expertise during the transition from operations to decommissioning. This information could be obtained through comparisons of different plant strategies (e.g. alternative incentive systems).
- Develop methods for enhanced preservation and transfer of information about plant status to workers carrying out decommissioning.

Organisational functions and management skills during transition from operations to decommissioning

- Identify what organisational processes used at operating plants can transfer successfully to decommissioning plants and what processes do not transfer successfully or are not appropriate under decommissioning.
- Compare plants using operating plant management for transition with plants using separate decommissioning team to determine effective practices. (While both approaches can be effective, it is useful to identify different advantages and problems associated with each strategy.)
- Identify and evaluate different approaches to using contractors compared to retaining permanent workers.

Safety culture and morale

- Study measures that have been used by plants to sustain safety culture to identify both effective and ineffective approaches.
- Compare measures plants use to sustain safety culture across transition periods during decommissioning.
- Identify periods of greater vulnerability to lowered safety culture and morale.

Contractor reliance

- Identify generic experience transferable across sites and site-specific issues that require plant staff participation based on the experiences of contractor organisations that specialise in decommissioning and plants that have used these types of contractors.
- Compare plants relying primarily on plant staff to plants relying primarily on contractors. This study could identify both effective methods and types of difficulties encountered under these alternative strategies.

Multiunit sites

- Identify effective methods and specify problems and mitigation strategies used by multiunit sites that have decommissioned one unit while another is operating.
- Compare the advantages and disadvantages of alternative staffing methods (e.g. using a dedicated, separate staff for shut down and operating units as compared to rotating staff responsibilities between the two types of units).

Delayed dismantlement

- Identify methods to sustain competence and resources over extended periods of several generations.
- Identify the organisational and human factor aspects likely to affect release and exposure risks under delayed dismantlement compared to early dismantlement.

Reconciling differing regulatory and government policies and requirements

- Identify areas of overlap and contradiction among agencies and policies within agencies that affect the ability of organisations to effectively decommission.

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1. INTRODUCTION

The Senior Expert Group of the Committee on the Safety of Nuclear Installations (CSNI) proposed work on the human factors (HF) aspects of the transition from operation into decommissioning. A workshop was proposed to Principal Working Group 1 (PWG1) of CSNI. Preparation for the meeting included numerous discussions by the Senior Expert Group and a preliminary workshop in Sweden to better define the agenda. The workshop was planned for May of 1999 in Rome, Italy. The timing and location were selected so that the workshop could be held in conjunction with the Joint NEA/IAEA/EC workshop on The Regulatory Aspects of Decommissioning.

1.1 Background

While a great deal of work has been done on the technical aspects of decommissioning, far less attention has been given to the human factors and organisational aspects of decommissioning. Human factors and organisational aspects of decommissioning are fundamental to any successful decommissioning process. Organisations must provide support for the management of change during the transition from operations to decommissioning. In addition, they must assure that resource and competence needs are appropriately specified, that uncertainty is minimised and staff morale is maintained. Furthermore, many new technical challenges must be met. The organisation often has to address all these challenges with little guidance or experience and with reduced resources.

Following the recommendations of the senior experts expressed in August 1997, a workshop to identify and discuss issues related to the impact of human factors and organisational aspects on decommissioning was proposed to Principal Working Group 1 (PWG1) of CSNI. This workshop was held in May 1999 in conjunction with the Joint NEA/IAEA/EC workshop on The Regulatory Aspects of Decommissioning. The workshop goals were to provide an initial attempt to identify the issues associated with this stage in the life cycle of a nuclear facility, and to draw out the areas where further attention—be it research, analysis, or sharing of experience—is warranted. Or, as stated in the NEA *Research Strategies for Human Performance*

> C.3 Decommissioning
> *The groups propose NEA to convene an information exchange meeting with interested Member countries in order to discuss areas of concern in this respect and identify possible areas that merit further research and their priorities (NEA/CSNI/R(97)24).*

In preparation for the CSNI workshop, a meeting in Sweden was held in the spring of 1998 to define the agenda for the workshop. This meeting included a workshop organised by SKI to address organisational and human factor issues during decommissioning of nuclear power plants. SKI invited a broad range of experts on organisational and technical aspects of decommissioning, including regulators, nuclear utility and plant management, and researchers. The SKI workshop provided input on potential areas for decommissioning research for SKI to consider in its development of a research agenda to address decommissioning.

The aim of the workshop planned for the spring of 1999 was to identify and discuss issues related to the impact of organisational aspects on decommissioning. Professionals from regulatory agencies, utilities, and

research organisations from 11 countries participated; a total of 23 people attended the workshop. The workshop format included presentations, discussion, and small group meetings to identify and discuss key human factors and organisational issues that arise during decommissioning. The results of this workshop are presented in this report.

1.2 The Challenge

Decommissioning is essentially the transition from operations to waste storage - it is made up of a series of smaller transitions (from operations to cold shutdown, from shut down to defueling, to dismantling and site release - with management of waste streams from these transitions throughout the decommissioning process). Transitions are usually periods of greater safety risk for organisations for a number of reasons. First, the organisation is managing at least two major systems at one time (e.g. operating the plant to produce power while preparing for and implementing a reorganisation of staff and functions to shut down the plant). Second, uncertainty is increased by lack of experience with the new roles and responsibilities needed for the new phase the plant is moving to. (This greater vulnerability is true technically as well as organisationally - e.g. start up and shut down evolutions at nuclear power plants have more uncertainties and risks than running continuously). Furthermore, decommissioning, like all plant closures, has the challenge of dealing with the termination of many employees and the loss of the production mission for the facility. However, decommissioning is more difficult than a typical industrial plant closure because it is a long, complex process that takes years to complete.

While there are many technical and organisational challenges of decommissioning, the main focus, to date, has been on the technical issues. However, organisational support is critical for the accomplishment of technical activities. The organisation determines and implements:

- change management,
- work management,
- safety management, and
- allocation of the resources and staff to carry out the technical work.

While there is little guidance currently available, experience with decommissioning has been building. Now is the time to consolidate lessons learned from recent experience and to identify key issues that need to be addressed to assure safe decommissioning of nuclear power plants in order to demonstrate to the public that the nuclear industry is able to safely manage all the phases of its life.

This workshop has provided the beginning of consolidation of current knowledge about organisational factors in decommissioning, focusing on organisational aspects fundamental to a safe decommissioning process:

- management of change;
- resource and competence specification;
- dealing with uncertainty and staff morale; and
- managing new technical challenges.

1.3 Organisation of the Report

The next section, Section 2, of this report provides more detail on the methodology used for the workshop. Section 3 presents the results of group discussions of each of eight issues identified by the workshop participants as most significant, and Section 4 discusses conclusions and suggestions regarding organisational approaches to decommissioning and future work in this area.

2. WORKSHOP METHODOLOGY

The structure and organisation of the workshop were established at a planning meeting attended by the workshop organising committee. It was agreed that the workshop should be arranged so that it could operate in tandem with a related NEA/IAEA/EC meeting on regulatory aspects of decommissioning. A session was booked on the final day of that meeting for the organising committee to present the findings of the CSNI workshop.

It was agreed that the workshop should be separated into two discrete parts operated over two days:

- A selection of presented papers describing approaches to decommissioning and organisational change adopted by regulators, utilities and researchers.
- A "workshop" element, in which issues were generated and discussed.

2.1 Presentations

The presented papers were intended to stimulate awareness of issues amongst the workshop participants, and to inform discussion and debate. Eight presentations were prepared. A list of the presentations and the authors is provided in Table 1. The full text of each paper is presented separately.

2.2 Workshop Sessions

The participants were assigned to one of four groups. Each group was balanced to include regulators, researchers and utility representatives, plus one member of the workshop organising committee. The workshop participants assigned to each topic area are provided in Appendix 1.

The group work comprised two stages:

Stage 1: Issue Generation

Each group was asked to generate issues relevant to organisational aspects of decommissioning. Participants were encouraged to "brainstorm" rather than to discuss points in detail. A representative of each group subsequently presented the outcome of that group's discussions to the workshop.

At the conclusion of the first day of the workshop, the organising committee gathered the outputs of each group, and analysed these to distil a number of key issues. There was, not surprisingly, considerable overlap between the issues generated by the different groups. Nonetheless, each group provided a slightly different perspective, and it proved possible to extract eight Issues to be the subjects for in depth discussion the following day. The Issues were:

1. The impact of delaying dismantling of decommissioned nuclear power plants
2. The use and control of contractors during the decommissioning
3. Sustaining safety culture and morale during the transition from operation intodecommissioning
4. Identifying key organisational functions and management skills that are critical during the transition
5. Reconciling regulatory and government policies and demands regarding decommissioning

6. Sustaining organisational memory and obtaining and retaining staff competence during decommissioning
7. Decommissioning multiunit sites when one unit continues to operate
8. Developing an experience feedback system on organisational and human factors aspects of decommissioning

***Stage 2*: Issue Discussion**

The four working groups were each assigned two Issues for in depth discussion. Groups were asked to prepare short presentations on the findings of each discussion. The presentations were structured against a common framework using the following headings:

1. Risk of failure to address issue
2. Experience and knowledge
3. Gaps in knowledge and understanding
4. Conclusions and suggestions

Each group reported back that it found the discussions stimulating, and that in several instances novel concerns or suggestions were generated which proved the worth of conducting this sort of exercise in a workshop environment. Use of a single reporting format allowed a degree of comparison between the points raised against each of the eight Issues. Pressure of time allowed only limited discussion and debate following each group's presentation. Although this was unfortunate, the use of time had been considered by the organising committee, and a decision made to focus resources on generating issues and discussing them in the small group sessions. The feedback from group members supported this decision.

The outputs of the groups' detailed reports were collated by the organising committee and analysed. The results of these analyses are presented in Section 3 below.

LIST OF PRESENTATIONS AND AUTHORS

Decommissioning as an Organisational Process
by Karin Lundqvist, Ph.D. (Castor A.B., Sweden)

Safety Assessment of Decommissioning in IPSN
by Marie Catherine Piorier (IPSN, France)

Regulating Organisational Change on Nuclear Licensed Sites and at Corporate Headquarters
by Craig Reiersen (NII, UK)

The Approach of SKI to the Transition from Operation into Decommissioning
by Anna Lekberg (SKI, Sweden)

Trawsfynydd Power Station - The Transition from Operations to Defuelling and Defuelling to Decommissioning
by Alan T. Ellis (BNFL, UK)

Regulatory, Organisational and Technical Processes of Decommissioning
by Barbara Melber (Melber Consulting, USA) and Nancy Durbin (MPD Consulting, USA)

The Management of Contractors During Decommissioning Activities in Nuclear Facilities
by Felicity Harrison (AECB, Canada)

Decommissioning of the Dodewaard Nuclear Power Plant
by M.J.J.M. Ruesen (N.V. GKN, The Netherlands)

3. FINDINGS REGARDING THE KEY ISSUE AREAS

In this section the findings regarding each of the eight issue areas are discussed in the same format that was used for the presentation of the findings by each of the groups, that is, after a brief overview of the issue, each section provides a discussion of:

1.Risk of failing to address the problems
2.Experience and knowledge of the area
3.Gaps in knowledge
4.Conclusions and suggestions

3.1 The Impact of Delaying the Dismantling of Decommissioned Nuclear Power Plants

Numerous plants are considering or already planning to delay dismantlement for very long periods, ranging from 40 to over 100 years. Currently there is no significant experience with the implications of extended periods between decommissioning and dismantling—commercial nuclear-powered generation of electricity itself is less than 50 years old. The lack of direct experience with managing such long delays makes it difficult to identify specific impacts. The group discussed potential impacts by extrapolating from current experience with decommissioning and by considering the implications of different assumptions about the status of nuclear power in the future.

Risks

A major reason given for delaying dismantlement is that the radioactive decay over time will lead directly to a reduction in the overall level of the risk of dismantlement to the public and to the workforce.

However, knowledge and understanding of the level of risk also degrades over time. The level of remaining risk may not be known several decades after plant closure. Of greater concern is that future generations may "not know that they don't know," and make wrong assumptions about risk which could increase the potential for radiation releases to the environment and for worker exposure and contamination. Even after a significant delay, radiological risks are not negligible.

Experience and Knowledge

<u>Assumptions about the future favourable to delayed dismantlement</u>

- Experience from decommissioning and dismantling other sites will lead to continued development and improvement of competence for dismantlement.

  A large number of plants will be decommissioned in the near future, and many of these will be dismantled early. Plants that delay dismantling will have the advantage of the experience gained by plants that have already been dismantled. The competence of workers carrying out dismantlement will improve as they have experience with more plants. Contracting organisations that specialise in decommissioning and dismantlement are likely to emerge, and they will have substantial expertise.

- There will be significant technological advances in the methods available for dismantlement.

  Current experience with decommissioning has demonstrated that new methods are developed as more plants undergo the process of decommissioning. Significant technological breakthroughs can be expected especially over the long time periods planned for delayed dismantlement.

- The issue of nuclear waste disposal will be resolved.

  Over the long term, both low and high level waste repositories will be available. Plants that delay dismantlement will not have to deal with the current uncertainty regarding waste storage and disposal that adds complexity to the conditions under which dismantling of the site is carried out.

- Financial resources available will increase substantially over time.

  Setting aside money now for dismantlement in the future will allow the funds to be invested, thereby providing greater resources for carrying out the work.

Assumptions about the future unfavourable to delayed dismantlement

- There will be a general loss of competency in nuclear power.

  It is possible that there will not be an active nuclear industry several decades in the future. This situation is likely to lead to a progressive loss of competence both in licensee and regulator organisations. Thus a significant loss of the knowledge base necessary for dismantlement would be expected.

  Furthermore, there may be little or no infrastructure for nuclear power activities. The loss of infrastructure means a loss in organisational competency for conducting or overseeing dismantlement activities.

- The licensee organisation may no longer exist.

  Companies may disband or be absorbed into other organisations over time. In particular, utilities with small nuclear operations (e.g. having only one shut down nuclear unit) are not likely to continue. It may be unclear who has responsibility for dismantlement when the original licensee has closed down.

  This situation will lead to dependence on organisations other than the licensee to dismantle. The government could become the responsible organisation by default.

- The regulator organisation may no longer exist.

  A shrinking nuclear industry reduces the population of plants overseen by the regulator. The likely result is a significant reduction in resources provided for regulation and possibly the transfer of nuclear regulatory responsibilities to other government agencies with limited expertise in nuclear power. There may be a loss of public and government interest and concern. This is a particularly important issue in countries with very few plants (there are currently some countries that have only one or two nuclear power plants).

- There will be a loss of site-specific and plant-specific knowledge by the licensee.

  Because there will be a loss of the staff's personal experience and knowledge of the plant and the site, those responsible for final dismantling will need to rely heavily on the accuracy and quality of plant documentation and records. Reliance on only one source of information (e.g., written documentation) rather that multiple sources (e.g., written documentation combined with staff knowledge and industry support) is much weaker.

  Plants undergoing decommissioning have already encountered problems with inadequate documentation. In many cases it was necessary to obtain information from workers who were at the plant at the time of construction and start up. Accurate documentation will be a much greater problem decades later when no such workers can be contacted. (See the detailed discussion under the issue of retaining organisational memory).

- There will be insufficient financial resources for dismantlement.

  Costs may be higher than expected (e.g. due to minimal activities needed during the intermediate period such as monitoring the site over several decades or due to difficulty in obtaining and training staff to carry out dismantlement).

  In the case of early decommissioning, the licensee may not have set aside enough resources for decommissioning since the calculation of the savings rate for the decommissioning fund is usually based on the assumption of full plant life.

  There may be no recourse for obtaining additional funds if there are escalating costs.

  There may be a loss of licensee motivation to provide sufficient resources for appropriate monitoring and, ultimately, dismantling of the site. Current experience indicates significant pressures from corporate headquarters on decommissioning plants to reduce costs quickly.

  Again, the government could become responsible for providing financial resources by default.

- There may be major world changes, such as an economic depression, a major political change or a war that will jeopardise the final dismantlement of the plant.

Gaps in Knowledge

- Extent of difference in predicted worker exposure to radiation under immediate dismantlement compared to delayed dismantlement.

  The consequences of immediate versus delayed dismantling for worker exposure are not known. A comparison of worker exposure under these two alternatives is needed to inform strategic decision-making.

- Strategies to maintain or rebuild competency for dismantlement.

  How to maintain the competencies needed for dismantlement over extended periods of delay is not known.

- Methods for maintaining accurate plant documentation over extended periods.

  It is necessary to identify steps and methods that have been or could be developed to ensure that the history of the plant is suitably documented, such that information can easily be accessed in the future.

- Impacts of using specialist contractor organisations for delayed dismantlement.

  Information about the effects of reliance on external groups (i.e. contractors) for delayed decommissioning is also needed. For example, is it appropriate to assume that a different organisation - perhaps one which is not even based in the licensee's country – will manage and implement the decommissioning/dismantling process at some later date? While a specialist organisation might bring the advantage of having accrued considerable expertise and understanding of these activities over the period of delay, the licensing implications of such arrangements need to be determined.

Conclusions and Suggestions

Regulators

Requirements should be developed for licensees to develop long-term plans to address any period of delay prior to dismantling. Those plans should embrace human factors and organisational issues as well as the technical and financial aspects of decommissioning. For example, they should address how the licensee will establish and maintain a critical mass of competence in order to dismantle the plant (bearing in mind that the dismantling may not start until one or more generations after plant shutdown).

Requirements that the licensee carry out periodic safety reviews of the shutdown plant throughout the period prior to dismantling are needed. Those reviews should examine and validate the organisational assumptions made in the initial long-term plan (e.g., are there staff dedicated to the shutdown plant ?).

It is probably desirable that the site remain licensed throughout the decommissioning and dismantling period in order to assure continued regulatory oversight. Regulators will need to evaluate:

- how they can ensure that the licensee will sustain the requisite resource and competence,
- how expertise needed for dismantlement can be developed when it is called for in the future, and
- whether it is acceptable for the present generation to defer such decisions for future generations.

Future work

A system to share decommissioning and dismantling experience is needed to better plan for dismantlement and to better understand the pros and cons of immediate dismantlement compared to various periods of delay. Such a system should note that there are diminishing incentives to licensees to continue to invest in sharing experience compared to the incentives during operations.

3.2 The Use and Control of Contractors During Decommissioning

Licensees often reduce staff significantly when they begin decommissioning. This leads to a reliance on contractors to perform many decommissioning activities at the same time that the licensee has

fewer personnel to oversee work. The reduction in licensee staff relative to contractors raises a number of concerns regarding the ability of the licensee to maintain safety when relying heavily on contractors during decommissioning. On the other hand, contracting organisations that specialise in decommissioning and dismantlement are likely to emerge, and they would have substantial expertise that may increase safety during decommissioning.

A number of areas of concern were raised in the workshop with regard to the use of contractors during decommissioning. These included:

- The need for licensees to retain sufficient competent resources to act as the "intelligent customer" for contractors' activities and to maintain adequate oversight of contractor performance.
- The need to assure that contractors used during decommissioning have nuclear experience and a nuclear safety culture.
- The need to assure clear communication among regulators, licensees, contractors and subcontractors.
- The potential role of "super-contractors" who may specialise in decommissioning/ dismantling, and operate internationally.

Risks

The major risks are that the work will not be done appropriately leading to incidents that could cause radiation release, and that workers may be at a higher risk of exposure and contamination.

A further risk is that those ultimately responsible for the safety of the plant - the licensee and the regulator (from an oversight perspective) - will loose some of their ability to adequately assure safety. Thus, incidents may be more likely to occur. Any incidents that occur, even those that pose little threat of contamination, can result in media and public attention and the perception that the nuclear industry lacks control over the process. Transport contamination events have demonstrated this risk.

Experience and Knowledge

In many cases there has been an increased reliance on contractors during decommissioning. This has created the potential for problems associated with the oversight of the decommissioning activities by the licensee; the knowledge and experience of those doing decommissioning work; and communication among the regulator, the licensee and the contractor and the subcontractor (those actually doing the work).

<u>Supervision of contractor work</u>

It is important that the licensee responsible to the regulator has complete knowledge and control over the work being performed. A number of examples were given in which extensive use of contractors was successfully managed. The keys to success were identified by the discussants as the provision of adequate measures to retain competence within the licensee organisation such that the licensee could act as an informed customer and manage the contractors.

Other examples were discussed in which the control of contractors was inadequate—specific examples of contractors being responsible for reportable events in the UK, Canada and France were cited.

The extensive use of contractors makes it difficult for licensees to maintain control over the quality and safety of the work performed. In some cases licensees have reduced staff to the point that there is not sufficient staff with the competence to supervise the work of the contractors and subcontractors.

Licensee staff must also be adequate—both in number and competence—to clearly define the work that the contractors will perform. If work is not defined correctly, the contractors and subcontractors will not be able to perform well.

In one case discussed at the workshop, contractors filled several key plant management and supervisory posts. This meant that the work actually was being both managed and conducted by contractors and subcontractors. The regulator was not convinced that the utility had the capability to maintain knowledge and control over the work being performed, that is, the licensee did not remain an intelligent customer throughout the decommissioning**.**

Recognition of the hazards, communication to contractors, supervision of work and compliance with licence were seen as key competencies for managing contractor work according to the experiences at one plant.

Good practices mentioned included keeping policies regarding contractors during decommissioning the same as during operation (e.g. work authorisation, promotion of ALARA-principles, training) and integrating contractors into the licensee culture, especially a nuclear safety culture. Long-term partnering arrangements with selected contractors may be desirable and reduce difficulties with managing contractors. Finally, ALARA practices have to be promoted to reduce contractor employee doses and increase public safety.

Contractor Knowledge and Experience

While plants will often use those contractors that have been used in plant outages, the pool of contractors with nuclear experience is limited and there are other competencies that will be needed during decommissioning (e.g., particularly during demolition) that may require workers who do not have nuclear experience. Hence, contractor employees without nuclear experience and awareness of standard safety practices in the nuclear arena may be used extensively.

Contractors (even those with nuclear experience) will not have the knowledge of plant history and operating experience of the plant staff.

Licensees need to verify the competence of the individuals actually doing the work for the contractor and subcontractors. This is difficult because extensive licensee expertise (which may have been lost during downsizing associated with decommissioning) is required for the effective identification and selection of competent contractors.

Contractors and subcontractors are also less likely to be integrated into experience feedback systems - which affects both the level of knowledge of the contractor and the information from the contractor’s experience to the licensee.

Communication difficulties

There is the likelihood that communication will be weaker between the licensee and the contractor employees than it is between the licensee and the licensee’s employees (a problem reported by operating as well as decommissioning plants). It is particularly important that the hazards and uncertainties associated with decommissioning work are effectively communicated to contractors and their employees.

Communication systems will need to effectively integrate contractors and assure two-way communication. That is, that there is clear and complete hand-over of information from the licensee to the contractor, from the contractor to the subcontractor and, in turn, from the subcontractor to the contractor, and from the contractor to the licensee.

Gaps in Knowledge

While examples of successful and unsuccessful use of contractors were discussed at the workshop, there is limited understanding about:

- what elements assure the successful use of contractors,
- the "warning signs" that regulators need to attend to regarding the use of contractors,
- the pros and cons of different approaches to using contractors,
- whether an accreditation body would be of value,
- whether long term partnering arrangements are desirable, and
- what difficulties are encountered with the use of foreign contractors and with contract vendor companies that are emerging to work in the decommissioning area.

Conclusions and Suggestions

Plants

The licensee should make adequate arrangements for maintaining control and supervision of contractor personnel, for assuring that contractor personnel are adequately trained and experienced to do the work, and maintain communication across regulators, themselves, contractors and subcontractors.

In order to do this the licensee should have sufficient competent personnel to understand, own and use the plant safety case and to act as an intelligent customer for work by contractors.

The licensee should within its own organisation have enough competence to:

- know when to bring in expertise from outside and to order the kind of expertise needed,
- ensure adequate control and supervision of the contractor, and
- make informed judgements about the contractor's work, and to process and implement the outcome of that work.

Capability to provide training should be retained due to the need both among the licensee's own staff and contractors to understand both site-specific safety-related issues, safety culture of the plant and the roles and authorities of plant staff and contractors.

In order to facilitate safe work when using contractors a well thought-out contractor management process is essential, including such areas as policy and procedures for using contractors, contractor pre-qualification and selection, contractor training, project and work planning and supervision, work documentation and experience feedback. This is particularly important during decommissioning where there will be unique and unexpected factors not normally encountered during operations.

Contractors need to be integrated into the licensee culture, especially a nuclear safety culture. The ALARA practices have to be promoted to reduce contractor employee radiation doses.

3.3 Sustaining Safety Culture and Morale During Transition from Operation to Decommissioning

Safety culture and staff morale have for some time now been recognised to make an important contribution to the nuclear and industrial safety of nuclear installations. The workshop emphasised the threat that can be made to these factors by the change and uncertainty associated with the move from operations to decommissioning. It was noted that utilities had developed a range of different approaches to dealing with this problem - from guaranteeing employment for a certain period through to emphasising that decommissioning can present new and important technical challenges to staff, and should be seen as an opportunity rather than a threat. Good and timely communication was seen to be a major tool in the attempt to sustain a positive safety culture, and more sharing of international experience on utilities' successful and not so successful strategies was recommended.

Risks

During the transition period the risk from operations remains and there may be increased risk due to degradation of safety culture and staff morale, which may reduce safety performance and lead to accidents.

In addition, once the plant has made the transition to cold shutdown, workers may assume there is little or no risk. However, some safety risks remain. Workers may relax their safety vigilance because of this false assumption, which could lead to incidents.

Experience and Knowledge

Decision-making period

The early stages of decommissioning - in particular the pre-decision period, when there are rumours of a possible shut down, and the post-decision period, when the decision to shut down has been made but the plant is still operational - are significant periods of potential staff demoralisation and uncertainty.

If the plant is facing rumours or discussions of a near-term permanent shutdown there can be consequences of uncertainty like apathy, stress and lack of commitment to the future. There might be a deterioration of safety culture.

The organisational context of the plant changes dramatically during the post-decision period. When the plant loses its mission the staff lose their life's work. This presents management with a considerable challenge. The plant must be operated safely during a time of uncertainty. Unless handled carefully this uncertainty may affect staff morale and commitment.

A sudden announcement of shutdown causes distrust in management. Even if the decision is expected the announcement will cause grief and uncertainty among the staff. They are likely to enter a shock phase that might last for half a year. If the decision is unexpected the staff often feels betrayed. Faith in management will then be difficult to regain.

Safety culture of contractors

Contractors may have a different safety culture. The safety culture of the construction industry often differs from that of the nuclear power industry. A strong safety orientation, supported by strict policies, procedures and practices is deeply rooted in the culture of work in most nuclear power plants. The

construction industry, on the other hand, does not have the history of as well-established and well-enforced safety rules and procedures; risk-taking is traditionally a part of the work culture of this industry.

Management role

Decommissioning consists to a large extent of tough, complicated and time consuming physical work tasks and is often perceived as boring, demoralising and destructive by the workers. The interest of top-management in the proceeding of the work is of vital importance for the staff's motivation. It must be made perfectly clear to everybody involved that decommissioning is as important as operation.

Safety culture does not change overnight. The existing strong emphasis on safety culture at most operating plants is likely to counteract (at least in the short run) some of the risks of lower staff morale. A well-managed company with established routines and safety and quality assurance systems is generally better prepared to maintain a strong safety culture during the transition to decommissioning.

All management levels are involved, but middle management is under extraordinary strain because they are both victims of the shutdown as well as being seen as responsible for it. They are vulnerable to losing their jobs with downsizing, but, from the perspective of the workers, it is middle management that implements decisions regarding terminations and changes in roles.

Gaps in Knowledge

Very little is known about the specific impacts of decommissioning on safety culture and morale. Decommissioning is a relatively new area and experiences of decommissioning until recently have been limited to a few plants. While there has been considerable research on the effects of shutdown in other industries, and this can be useful in predicting potential effects in the nuclear area, actual experiences of different decommissioning outcomes and the effects on the staff have rarely been studied.

In particular, there is little knowledge of measures that have been taken at plants to sustain safety culture and morale during the transition to decommissioning.

Furthermore, we need to determine how safety culture will be affected in the long run. It is not known if measures taken in the transition period will remain effective during later stages of decommissioning.

The conditions concerning decommissioning differ considerably across plants, e.g. due to reasons for shutting down, the labour market, culture of the country. What specific measures for maintaining safety culture and morale are effective under these differing conditions needs to be identified.

Conclusions and Suggestions

Plants

The safety and quality assurance systems already in place during the operational life of the plant can be continued during decommissioning to sustain the emphasis on a strong safety culture (although some changes to simplify and streamline procedures may be appropriate when the staff size has been significantly reduced).

Management that is trustworthy and in a continuous dialog with the staff can help sustain a positive company culture. Openness in the relations between management and staff is required. Proper information must be given during the process of decommissioning.

Involving employees in the planning and preparations for transition to decommissioning provides them with at least some measure of control of their own situation.

Staff should be aware that there is significant work to be carried out after shutdown, although the size of the staff will be lower than during operations.

Both the organisation and the individuals lose their missions which might cause uncertainty and despair. New orientations must be gained and new targets set in order for staff to believe in the future.

Future work

Shared experiences regarding the effects of decommissioning on safety culture and staff morale are needed. Experiences of the change process, especially on human and organisational issues have rarely been studied systematically. International and comparative research are needed so that experiences can be analysed and shared across a wide network of countries dealing with decommissioning.

In particular, studies are needed of measures plants have used to sustain safety culture and morale in order to identify approaches that have been successful and those that have been ineffective or counterproductive.

Longitudinal case studies of plants undergoing decommissioning are also needed to identify ways to sustain safety culture over the long term as the plant goes through several transitions and major staffing changes throughout the various stages of decommissioning.

3.4 Organisational Functions and Management Skills Critical for Transition

Decommissioning may call for a radical change to the way in which the utility is organised and structured. There is a strong case for sharing experience on the suitability of different organisational arrangements for decommissioning and also for the period between the announcement of plant closure and the final shutdown, where potentially competing activities need to be organised and scheduled. Underpinning all the above points is the need to ensure that comprehensive planning of decommissioning is carried out in a timely manner. The challenge to both licensees and regulators is to ensure that the planning process takes due account of organisational matters, such as those identified in this workshop, as well as purely technical issues. There was discussion over the management skills and competencies that are needed during the transition from operations to decommissioning. Participants raised the question of whether project management skills were more suitable than those typically possessed by managers during the utility's operational life. Management has a key role in ensuring the success of decommissioning, and the skills they need should be analysed.

Risks

During the period of transition from operations to decommissioning the risk level of operating a plant continues as usual. There is also the possibility of some additional risk due to both 1) the increased workload on management and workers to prepare for decommissioning while continuing to run the plant and 2) increased uncertainty about future employment for plant staff. Failure to address the issue of different organisational functions and management skills needed for this transition potentially could lead to incidents if the special conditions of the transition are not recognised.

Experience and Knowledge

The group discussion identified 1) conditions that are typical when a decision is made to close a plant, 2) demands on management during the transition from operations to decommissioning, and 3) some specific organisational functions during this transition period. The group used the findings of the papers presented as well as personal knowledge and experience in decommissioning in developing these points.

Conditions

- Limited resources
  Because the plant will no longer be producing electricity, there is often pressure to reduce expenditures. This pressure can affect both current operations (e.g. reluctance to continue usual maintenance and training activities) and preparation for decommissioning (e.g. limited budget for planning and pressure to terminate employees quickly after cold shut down of the plant).
- Short time frame for planning
  It is increasingly common for plants to shut down "prematurely" (i.e. prior to their end of life or license expiration). This situation generally means that plants have limited time for planning for the transition to decommissioning.

Management Skills

- Ability to manage several parallel but competing processes
  During the transition phase plant management is 1) operating the plant, 2) changing the mission of the plant from production to decommissioning, and 3) preparing for plant closure.
- Flexibility to lead major site mission change

  The plant manager has to be able to change goals for the organisation from production to safe decommissioning and to motivate staff to accept and work for the new mission.
- Ability to deal with new corporate demands
  The manager now has to obtain resources for a function that is a drain rather than a contributor to corporate finances. He or she also will have to justify staffing levels and time frames for terminating staff to assure a safe and orderly transition to decommissioning.
- Prepare and implement staff reduction

  The transition phase is usually the period of the most significant reductions in staffing. A difficult task in any situation, it is more difficult under transition to decommissioning because some staff will be selected to stay and carry out decommissioning work while others will be terminated.
- Acquiring skills for managing decommissioning activities

  Because many of the activities carried out under decommissioning are different than operating activities, the manager will have to determine how to assess performance of these new activities (e.g. through reliance on specific experts, independent reviews).

Organisational Functions

- Mission change from production to decommissioning

  The organisation has to provide a management of change strategy, special communication mechanisms and motivation for staff during a period of considerable uncertainty and a sense of a loss of purpose for the organisation and the individual.

- Plan for a decommissioning organisation

  Key activities include identifying tasks and associated roles and responsibilities. In addition, planning for a flexible organisation that will be changing throughout the many phases of decommissioning is important, since tasks, risk levels and expertise will be different during various stages of decommissioning.

- Identification of increased demands in support areas

  Some areas with increased demands include:

  – Human resources - large number of terminations due to shut down, strategies for retaining staff expertise needed for decommissioning work, specifying roles and responsibilities for decommissioning positions;

  – Training - technical training for new techniques, skill broadening as individual positions cover more areas due to reduced number of staff;

  – Radiological Protection - many tasks involve the increased possibility of worker exposure to radiation.

- Preparation for potential extensive use of contractors

  At certain periods it has been common to use contractors for major work (e.g. dismantlement). The organisation needs to develop policies for contractor use and oversight that may be different than under operations, when a much larger plant staff was available to oversee contractor work.

- Increased contact with and scrutiny by regulatory bodies

- Greater contact with and scrutiny by the public

Gaps in Knowledge

While many of the new demands on the organisation and management have been identified, there is little knowledge of the relative advantages of different strategies plants have used. It would be useful to identify what skills and organisational processes that are used at operating plants can transfer successfully to decommissioning plants, and what processes do **not** transfer successfully.

Conclusions and Suggestions

The group concluded that the primary way to address gaps in knowledge was to learn from international experience. Systematic comparisons of lessons learned from different approaches to addressing key organisational functions during the transition period would help to identify advantages and

disadvantages of alternative strategies. Sharing of successful practices (for example: communication mechanisms, staff retention incentives, determining staffing needs for specific decommissioning phases) as well as difficulties (underestimating needs for particular kinds of expertise) can help improve the transition to decommissioning.

3.5 Reconciling Differing Regulatory and Government Policies and Requirements

A recurring theme of the workshop was difficulties in dealing with regulations and regulators during planning for and carrying out decommissioning, including preparations for waste storage. The working group noted that there are often overlaps and/or gaps in government and regulatory authorities - and in the regulations they are responsible for enforcing. As a result, the regulation of decommissioning activities is often less effective and slower than desirable. The message given to the decommissioning organisation is often contradictory. In some cases there is no clear government or regulatory agency responsible for some or all of the decommissioning process - leaving the decommissioning body without guidance and sometimes preventing decommissioning from commencing. In particular, it is very difficult to plan and define the waste aspects without clear national decisions in this area.

Risks

Failing to address this issue could result in:

- long term delays in decommissioning;
- potential safety risks associated with lack of coherent oversight of activities;
- loss of opportunities to assure safe decommissioning and waste storage;
- loss of resources because money is spent on the redefinition of strategy, planning, and methods to respond to shifting regulations;
- distractions to management focus on important safety issues during decommissioning because they are devoting their energies to regulatory aspects (e.g., to find the rules, or interpret the rules or cope with their complexity);
- added expense for both the regulator and the utility - which will eventually accrue to the public

Experience and Knowledge

The group discussed a number of reasons that the regulation of decommissioning has been difficult. These included that

- Decommissioning is a new activity and regulations written for operating reactors may not apply appropriately.
- Regulators (and governments) were not prepared for early decommissioning. Therefore the infrastructure for decommissioning (both in terms of the assignment of tasks and staff to decommissioning and in terms of building waste repositories etc.) was not in place when utilities began to decommission.
- Decommissioning has not been considered an important - or core - activity by regulators and hence there has been little or no resource allocation

- The regulations concerning financial planning for decommissioning funds were based on full life for the plant - hence, there may be inadequate build-up of funds when plants decommission early.
- The major concerns regarding nuclear power were with regulation of operations and waste management. Decommissioning, which represents the transition from operations to waste management, is an element that creates special problems that were not appreciated.
- Planning and analysis by government and regulators were hindered by lack of experience with decommissioning. There were (and continue to be) many unknowns and uncertainties.
- Contradictions can exist between regulations and among regulatory agencies.

Gaps in Knowledge

Basically, there is no coherent picture of regulatory and government requirements for decommissioning within or across nations.

Conclusions and Suggestions

Communication and dialogue across national agencies, industry, public must occur.

Comparisons/information across countries on effective national policies and regulatory practices would be useful.

It is important that each country prioritise safety and environmental goals relative to social and economical costs at a national level.

Funding for regulation of decommissioning is critical to the process.

Collection and analysis of all policies and regulations that apply to decommissioning in order to identify overlaps, gaps and contradictions.

Examples of areas where conflicts may occur:

- Operating reactor requirements
- Waste management
- Transportation
- Environmental protection
- Worker protection
- Financial accountability and requirements

3.6 Organisational Corporate Memory and Competence

Successful decommissioning requires a great deal of knowledge about the history of the plant and the operation of the plant. Various characteristics of decommissioning - rapid reduction in staff and long delays in dismantlement - result in the loss of organisational memory and increase the reliance on documentation. The same characteristics in decommissioning result in the loss of highly trained and experienced staff - maintaining adequate competence during decommissioning is therefore also a problem. Participants recognised the importance of identifying the skills and competencies needed throughout the decommissioning process at an early stage. They also expressed concern at the challenge that the nuclear

industry faces in maintaining a sufficient competence base throughout extended periods, especially if/where the industry is in a process of decline.

The information that is needed to ensure a safe and smooth transition throughout decommissioning is vested not only in individuals, but also in the plant records, procedures and other documentation such as design statements. The workshop considered that utilities needed to recognise their information needs well in advance of decommissioning in order to ensure that these needs can be met. It will be increasingly difficult to sustain a sound and comprehensive organisational memory if the people with experience have retired and a proper and thorough set of documentation has not been secured.

Risks

The primary risk of the loss of organisational memory and competence is that an accident may result from lack of information about the plant or lack of competence to safely perform the work.

Experience and Knowledge

Information about the condition of the plant and its operation and competent staff provide a necessary basis for decommissioning planning. A good design basis reduces surprises during decommissioning. Incidents due to lack of documentation and organisational memory have been reported in several countries (Canada, France, UK) especially when contractor personnel have been involved. Loss of competent personnel when their skills are still needed has also been documented.

In order to assure that organisational memory and competent staff are retained, staffing issues need particular attention early in the decommissioning decision process. There is a significant risk of losing key personnel and with them both competence and the “organisational memory” while the plant is still operating. The loss of staff memory is a particularly difficult problem if there is a danger that changes in the facility have not been properly documented. Even if there is documentation, the general consensus is that no matter how good the drawings and documents are, there is a critical organisational memory lodged in the staff that must be documented before they leave.

Because there is the possibility of long delays before plants are dismantled, methods to retain useful documentation for long periods are necessary.

When the decommissioning work is being performed by contractors measures have to be taken to transfer the organisational memory. This means that documentation and debriefing of key persons leaving will be of utmost importance. It is also difficult to assure that contractor staff have adequate competence to perform the work if the licensee has lost staff required to make these assessments (see the discussion of contractors for a more detailed discussion).

There is the potential of designing advanced computer systems for maintaining documentation and transference of knowledge about the plant given the state of current technology.

Gaps in Knowledge

In terms of retaining staff competence, while some information on both successful and unsuccessful methods for retaining staff has been made available, more experience has been gained recently but not yet documented or analysed. There is less known about other problems (and solutions) for maintaining organisational memory. For example, some plants have brought former staff back to the plant to address questions that have arisen during decommissioning (e.g. retirees) but this option will not be available to all plants or for very long in the future.

Alternative methods for documenting the plant should also be explored. For example, it is not known whether the kinds of computer systems that are currently being developed to support maintenance, safety and quality assurance systems for operating plants will be appropriate for sustaining and transferring organisational memory for plants undergoing decommissioning.

The question of how the organisational memory shall be transferred to those who are to do the demolition work in the future when dismantling has been delayed for an extended period has not yet been addressed.

Conclusions and Suggestions

Plant

It is important to have a plan for retaining key personnel early in the decommissioning process in order to avoid losing critical competencies. It is also important to document 1) the original design of the plant, 2) all changes that are being made (the latest version is to be saved) 3) what is happening during the lifetime of the facility.

Computer systems also have to be adapted to the needs of those who are to use them. This means that the systems should be structured to present both a holistic view and more detailed information about functions and events. Drawings, photos and visual models of the facility can be included.

Decommissioning has not traditionally been integrated in the original design of the facilities (although there is hope that in the future this will be done). Issues of organisational memory have to be included in the original design basis as well.

Future work

A study is needed to determine the types of computer systems that are currently available to help assure that organisational memory is sustained. Questions to be addressed include: Do they answer the right kind of questions? Are they focused on the users? Are they structured for keeping and transferring the organisational memory as well as for learning and competence development from the point of view of the users?

Methods for transferring organisational memory to new workers need to be identified. Case studies of problems that already have been encountered by plants undergoing decommissioning would be useful to identify critical areas that need to be addressed.

3.7 Decommissioning Multiunit Sites When One Unit Continues to Operate

Some plants will decommission one unit while one or more other units are operating at the same site. The risk here is that safety significant incidents may occur either due to neglect of the shut down unit and/or due to difficulties with shared systems between decommissioning and operating units. Information about approaches used by sites that have shut down one unit while other units continue to operate would provide useful insights to both regulators and licensees.

Risks

- The decommissioning unit may be given a lower priority than the operating unit and safety might be taken less seriously at the decommissioning unit.

- There might be risks to the operating and to the decommissioning units if the management and organisation do not effectively organise the work and retain staff across both units.

- There might be risks to the operating unit due to shared systems.

- Dismantling activities could result in accidents (e.g. fire hazards) that could pose safety threats to both the operating and the dismantling unit.

- Events at the decommissioning unit might affect public perception of safety at the operating unit.

Experience and Knowledge

Potential difficulties

There is the possibility that neither the staff nor management will take full ownership of the decommissioning unit. The operating unit is seen as more important because the risk of a catastrophic accident remains and there may be perceptions of low or non-existent risks at the decommissioning unit. In addition, work at the decommissioning unit is not seen as contributing to the main business of the utility.

Although an initial impression was expressed that there is no difference between operating one unit while constructing another and operating one unit and decommissioning another, further discussion indicated that they are not the same. A major difference is that the material being handled during decommissioning is contaminated. In addition, at multiunit sites there is the risk of damaging shared systems.

Prior to final decisions about all units at sites that will have both operating and decommissioning units, staff will face a great deal of uncertainty about the management strategy for organising work and retaining staff. Particularly at a dual-unit plant there might be uncertainties and rumours about who will lose their positions, only those working at the plant to be closed or also staff at the operating units. These uncertainties and rumours may decrease communication within and between groups, potentially lowering safety culture and morale also at the unit that will still operate. In addition, some key personnel may leave - making it more difficult to manage both operations and decommissioning.

Workers at the decommissioning unit may not perform up to standard or maintain safety if top management does not have a strategy to motivate the staff at the decommissioning unit and does not monitor and analyse the working climate and management interest at that unit. Thus, workers at the shutdown unit potentially could feel they are ”second class” employees, which could create problems for the site as a whole.

Experience from at least one U.S. plant with joint staffing of shut down and operating units, showed that less than adequate attention might be paid to the shut down plant. This was considered a contributing factor to an incident at the shut down plant. Management of the operating units also had a tendency to borrow staff from the shut down unit for operating unit tasks. Staff at the shut down unit found it difficult to conduct work efficiently and to maintain schedules at the shut down plant while in the ”shadow” of operating nuclear units.

Observations have been reported of lack of communication and poor quality assurance at some shut down units with incomplete audits. Audits which were supposed to cover the whole site were only done at the operating unit.

Potential advantages

While there were a number of difficulties discussed regarding decommissioning one unit while another is operating, there were also some acknowledged benefits. The strong emphasis on safety within the plant organisation when there is an operating unit could have a positive impact on the decommissioning unit.

Staff at the decommissioning unit might have the opportunity to work some of the time at an operating unit. One plant with an integrated, collateral responsibility organisation established special projects (similar to outage) when facing problems at the shut down plant. In addition, training would still be in place for all staff if one unit is still operating while at most decommissioning units the training staff are gone.

Good practices

Experience was presented showing that a separate management team with responsibility for the decommissioning unit can be an effective strategy. Decommissioning was seen as differing from operation in terms of the mission, goals and objectives of the organisation and the skills and attitudes needed in the staff. By providing a separate management team, the managers have clear ”ownership” of the decommissioning facility and can focus on the decommissioning activities. The team should have direct access to top plant management.

Gaps in Knowledge

Utilities that have both operational and shut down units at the same site have used various approaches to organising decommissioning. Some have used integrated organisations, where management and staff have responsibilities at both the shut down and operating units, while others have used dedicated staffing, with separate organisations responsible for the shut down versus the operating units. There is much to be learned from the experience of utilities that have used different strategies in terms of the specific issues they have faced and how they resolved them under each of the approaches. There are plants where one unit has been shut down and other units are operating (e.g. Hunterston A and B, Grundremmingen A and B, Chernobyl, TMI, Saint Laurent, Choose and Vandelles). However no systematic comparison has been done of their experiences using joint versus separated staffing of the units.

There is little known about the differences in skills profiles needed for decommissioners versus operators.

The extent to which plants have faced problems of workers from shut down plants perceiving the workers at the operational units as having more status or better treatment is not known.

Methods to maintain the experience and knowledge gained from decommissioning work at one unit for later use by the other units on site have not yet been identified.

Conclusions and Suggestions

Plants

There was a general consensus that although it might be possible to dismantle one unit while another unit is operating, due to potential problems (e.g., with shared systems), dismantling dual units at the same time creates fewer problems.

Management should assure that adequate attention is be paid to the shut down plant

The ”messages” of the shut down plant should be listened to. Examples were given where data from the shut down unit was used to support other operating units.

Management should develop and implement a strategy for organising work and retaining staff for both the operating and the decommissioning unit(s).

Management should assure that there are staff and management who take ownership of the decommissioning unit. The management needs to assure that decommissioning is not constantly postponed to accommodate the needs of the operating unit.

Top management should have a strategy to motivate the staff at the decommissioning unit and monitor and analyse the working climate and management interest at that unit.

Regulators

Regulators need to assure that their activities include adequate attention to the shut down plant (both by plant management and by the regulator).

Regulators should attend to the successful completion of decommissioning tasks and that the planning for decommissioning assures that the safety of the operating plant will not be jeopardised.

Regulations should assure that there are no disincentives for waiting to dismantle the decommissioned unit until all units on site are shut down because dismantling dual units at the same time is likely to create fewer problems.

Future work

More information should be gathered on plants that have successfully decommissioned one unit while operating one or more other units. In particular this research could help to determine the skill profiles for decommissioning staff versus operations staff – how do they differ? How can staff at both decommissioning and operating units be given equal status?

Sharing of international experience can also help to determine how to transfer the experience and knowledge from decommissioning work at one unit to other units on site that decommission at a later date.

3.8 Decommissioning Experience Feedback

The participants at the workshop brought and shared extensive knowledge and experience with decommissioning. The need for improved methods for obtaining and sharing information on a more regular basis was acknowledged and discussed. For most utilities, experience in decommissioning is still comparatively small and it would appear sensible and practicable to develop improved means of sharing experience internationally. Currently, working groups such as PWG1 of the OECD/CSNI focus on sharing experience derived from operating reactors. There is a strong case for establishing a suitable forum for sharing decommissioning experience. The workshop identified a number of obstacles to such a forum, but also emphasised the positive benefits which could accrue - not least, the development of a common “language” for decommissioning and a clear message that decommissioning is an important phase in a nuclear facility’s life cycle.

Decommissioning experience feedback was identified as an important process for assuring safety in operating nuclear power plants that could play an important role in increasing safety during decommissioning. Because decommissioning occurs only once at each unit, there is limited opportunity to

develop experience with decommissioning at a particular site. Hence, obtaining experience from other sites is critical.

Risks

The major risk of failing to address the lack of decommissioning experience feedback is the repetition of errors and the loss of opportunities to share good practices across the industry. Repetition of errors increases the risk of radiological and other accidents.

Experience and Knowledge

The group discussion identified specific periods of increased risk during decommissioning when experience feedback would be most relevant. These included:

- During transitions from one phase to another (e.g. from operations to cold shutdown) risk is increased.
- During specific activities (e.g., fuel handling and storage) risks are high.
- Recognition and handling of the combined risks of increased risk of an industrial accident when there are also radiological hazards was considered important.

The group agreed that decommissioning information might be particularly hard to obtain and identified problems with developing and disseminating decommissioning experience feedback. These included:

- Tasks are not repetitive at a particular site - there is little opportunity to develop experience.
- A plant will be leaving the industry after decommissioning and will therefore have little incentive to devote time and resources to identifying and sharing lessons learned.
- Collecting data is difficult in all situations, it is particularly difficult at decommissioning plants.
- Resources are limited at decommissioning plants and are supposed to be devoted to decommissioning - not to sharing information with the industry.
- In cases where contractors specialising in decommissioning do much of the decommissioning work, the experience may be considered proprietary and would not be available.

Gaps in Knowledge

The major point of the discussion is that the gaps in knowledge are very wide and that they are unlikely to be filled without active involvement by regulatory and research organisations. Unlike operating experience feedback, decommissioning experience feedback often does not provide obvious advantages to the organisations with the experience.

Conclusions and Suggestions

The conclusion of the workshop was that new techniques may be required to obtain information on decommissioning experience feedback. International and national regulatory groups will need to take the lead and develop new strategies and tools for supporting sharing of experience in decommissioning if this important area is to be developed.

4. CONCLUSIONS

This CSNI workshop was stimulated by a growing awareness of the need to consider the impact of human and organisational factors on a nuclear installation's transition from an operating to a decommissioning facility. The workshop did not seek to identify specific solutions to problems or to recommend a particular model or approach. The task of the workshop was to discuss issues of concern during this stage in the life cycle of a nuclear facility and to identify areas that merit further research and analysis.

The workshop highlighted three things - how much is already known about the organisational and human factors issues of decommissioning, the need for more and better opportunities to share that information in this area, and how many questions still need to be answered.

4.1 Creating a System to Share International Experience

The participants at the workshop brought and shared extensive knowledge and experience with decommissioning. The need for improved methods for obtaining and sharing information on a more regular basis was acknowledged and discussed. For most utilities, experience in decommissioning is still comparatively small and it would appear sensible and practicable to develop improved means of sharing experience internationally. Currently, working groups such as PWG1 of the OECD/CSNI focus on sharing experience derived from operating reactors. There is a strong case for establishing a suitable forum for sharing decommissioning experience. The workshop identified a number of obstacles to such a forum, but also emphasised the positive benefits which could accrue - not least, the development of a common "language" for decommissioning and a clear message that decommissioning is an important phase in a nuclear facility's life cycle.

Developing such a forum is useful for identifying issues, good practices and lessons learned as regulators and utilities deal with decommissioning. Overall increased attention to these issues through continued workshops specifically on this issue, increased attention to this issue at all decommissioning workshops and conferences, and, most importantly, a system for sharing international experience on organisational aspects of decommissioning were considered an important next steps. The participants also identified specific issues and kinds of information where more research is needed.

4.2 Areas for Further Research and Consideration

The workshop participants discussed the current level of knowledge and experience for each of the critical issue areas they identified. From this base, they then focused on specific types of information and questions that need further research in order to improve understanding and successful implementation of the transition from operations to decommissioning. Below are some of the high priority areas suggested for further research.

Organisational memory and competence

During decommissioning significant numbers of experienced workers are let go. These workers have knowledge of the plant as well as experience and areas of competence that may be needed during decommissioning. The risk posed by this issue is that safety may be jeopardised by inadequate knowledge of plant status and inadequate expertise to conduct work safely.

Specific research needs are to:

- Identify effective approaches to retain expertise during the transition from operations to decommissioning. This information could be obtained through comparisons of different plant strategies (e.g. alternative incentive systems).

- Develop methods for enhanced preservation and transfer of information about plant status to workers carrying out decommissioning.

Organisational functions and management skills during transition from operations to decommissioning

Organisations must deal with additional tasks and new requirements during decommissioning—often with decreasing resources. Managers are often faced with dealing with planning for decommissioning while still operating a nuclear power plant. The risk in this area is an increased potential for incidents due to management and worker overload. Overload which could be caused by the pressures of running an operating plant while planning for closure and decommissioning, operating under the uncertainty, increased stress, and/or loss of mission and jobs. The key research need in this area was the identification of effective practices. This included:

- Identify what organisational processes used at operating plants can transfer successfully to decommissioning plants and what processes do not transfer successfully or are not appropriate under decommissioning.

- Compare plants using operating plant management for transition with plants using separate decommissioning team to determine effective practices. (While both approaches can be effective, it is useful to identify different advantages and problems associated with each strategy.)

- Identify and evaluate different approaches to using contractors compared to retaining permanent workers.

Safety culture and morale

A number of participants expressed concerns about the loss of safety culture and morale at plants prior to a decision to decommission and after such a decision. The risk created here is a potential for relaxed vigilance or distractions that might lead to unsafe actions. For example, workers may assume that a shut down plant has minimal risk and this may increase the likelihood of a radioactive release. Specific research needs identified include:

- Study measures that have been used by plants to sustain safety culture to identify both effective and ineffective approaches.

- Compare measures plants use to sustain safety culture across transition periods during decommissioning.

- Identify periods of greater vulnerability to lowered safety culture and morale.

Contractor reliance

Many decommissioning activities are expected to rely on contractor labour. There are both advantages (e.g., some contractors or contracting organisations may have more experience with decommissioning than long-term plant employees) and disadvantages (contractors or contracting organisations may be less familiar with the specific installation than long term employees). The risks posed by the use of contractors include limited expertise, inadequate resources of licensee for oversight, or the lack of site specific knowledge by contractors could lead to safety significant incidents. Specific research programs identified included:

- Identify generic experience transferable across sites and site-specific issues that require plant staff participation based on the experiences of contractor organisations that specialise in decommissioning and plants that have used these types of contractors.

- Compare plants relying primarily on plant staff to plants relying primarily on contractors. This study could identify both effective methods and types of difficulties encountered under these alternative strategies.

Multiunit sites

Some plants will decommission one unit while one or more other units are operating at the same site. The risk here is that safety significant incidents may occur either due to neglect of the shut down unit and/or due to difficulties with shared systems between decommissioning and operating units. Potential studies that could provide useful insights in this area included:

- Identify effective methods and specify problems and mitigation strategies used by multiunit sites that have decommissioned one unit while another is operating.

- Compare the advantages and disadvantages of alternative staffing methods (e.g. using a dedicated, separate staff for shut down and operating units as compared to rotating staff responsibilities between the two types of units).

Delayed dismantlement

Many sites are considering delaying dismantlement for a significant period. Although there are potential benefits of this delay (e.g., reducing the radiation levels prior to dismantlement) there are also risks. These risks include that the loss of expert competence and experience during the period of delay combined with a shrinking regulatory and utility nuclear infrastructure will increase risk of releases to the public and to workers. Specific research questions considered important included:

- Identify methods to sustain competence and resources over extended periods of several generations.

- Identify the organisational and human factors aspects likely to affect release and exposure risks under delayed dismantlement compared to early dismantlement.

Reconciling differing regulatory and government policies and requirements

There was a discussion of difficulties in dealing with overlapping and sometimes contradictory national policies and regulations that affect decommissioning. Potential risks of this issue include delays in decommissioning activities, potential safety risks associated with lack of coherent oversight by regulators, loss of opportunities to assure safe decommissioning and waste storage, and ineffective use of decommissioning resources. This issue can have significant effects on the success of organisations to decommission and should be further explored.

4.3 Summation

In sum, there was a confirmation of the reason for the workshop—an increasing need for attention to the organisational and human factors issues that arise in the transition from operations to decommissioning. The workshop concluded that it would be desirable to have

- additional research in specific areas identified, and
- a system for encouraging and sharing information in the organisational and human factors issues of decommissioning.

5. APPENDIX 1

5.1 The Working Groups

Group 1

The impact of delaying dismantlement
Organisational functions and management skills during transition

- Reiersen, NII, UK (Facilitator)
- J. Laaksonen, STUK, FIN
- Zellbi, SKI, SWE
- J. Iqbal, WANO, JAP
- B. Melber, Melber Cons., USA

Group 2

Developing an experience feedback system on organisational and human factors aspects
Reconciling regulatory and government policies and demands during decommissioning

- G. Baumont, IPSN, FRA (Facilitator)
- S. Suksi, STUK, FIN
- Lund, SRPI, SWE
- N. Durbin, Durbin Cons. USA

Group 3

Decommissioning multi-unit sites when one unit continues to operate
The use and control of contractors during decommissioning

- G. Svensson, SKI, SWE (Facilitator)
- A.T. Ellis, BNFL, UK
- M. Maqua, GRS, GER
- J. Carlsson, SKB,SWE
- K.J. Jung, KAERI, KOR

Group 4

Sustaining organisational memory and obtaining and retaining staff competence
Sustaining safety culture and morale during the transition

- L. Carlsson, NEA (Facilitator)
- R. Olsson, SKI, SWE
- C. Temple, NII, UK
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