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Organisation de Coopération et de Développement Economiques
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NUCLEAR ENERGY AGENCY
COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

NEA/CSNI/R(2002)9
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Principal Working Group 1 on Operating Experience and Human Factors

APPROACHES FOR THE INTEGRATION OF HUMAN FACTORS INTO THE UPGRADING AND REFURBISHMENT OF CONTROL ROOMS

SUMMARY AND CONCLUSIONS

Halden, Norway, 23-25 August 1999

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English text only

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), Korea (12th December 1996) and the Slovak Republic (14 December 2000). 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 the 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 consists of 28 OECD Member countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, Republic of Korea, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities also takes part in the work of the Agency.

The mission of the NEA is:

- to assist its Member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information. The NEA Data Bank provides nuclear data and computer program services for participating countries.

In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has 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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1. BACKGROUND

During the 23th-25th August, 1999, under the auspices of Principal Working Group 1 (PWG1) on Operating Experience and Human Factors, the Committee on the Safety of the Nuclear Installations (CNSI), and the OECD Nuclear Energy Agency (NEA), a Workshop/Specialists meeting was held dealing with "Approaches for the Integration of Human Factors into the Upgrading and Refurbishment of Control Rooms." The meeting was organised in co-operation with IAEA, and was hosted by the Halden Reactor Project, Norway.

2. INTRODUCTION

A modern approach to control room design, be it for upgrading or complete refurbishment, requires the integration of many disciplines and approaches. The integration of human factors into such a process continues to present challenges. How such a process should be conceived, planned, and carried out is of considerable interest to designers, operators and regulators.

Many NPPs around the world have been, or will be faced with decisions concerning modernisation of their control rooms. Such changes can be driven by a range of issues including; the need to replace outdated control and instrumentation systems; increasing regulatory concern about human performance; or the need to provide a better process control environment for NPPs whose life cycles extend beyond that originally intended. Considering the importance of operator performance for safe and profitable operations, a process for ensuring that human factors issues are properly addressed could be central to the success or failure of such a project. Human factors is of particular importance when a combination of existing and new systems are to be used, resulting in a so-called 'hybrid' control room.

The workshop addressed this topical area by providing a forum where a number of important areas could be discussed and experiences and lessons shared. Topics identified before hand as important and worthy of discussion included:

- Exploration of how human factors issues can be identified.
- Consideration of those processes and techniques necessary to ensure that appropriate requirements are specified, and that suitable data is gathered and analysed.
- Identification and discussion of issues related to the above topics together with lessons from utilities, vendors and regulators which have faced, or are currently facing, these challenges.

The meeting itself focused on the state of knowledge and current best practices within these areas and provided a forum for the open discussion of the human factors issues, as seen by a broad range of interested parties, in relation to the upgrading and refurbishing of control rooms. The workshop attracted 16 contributions from 13 different countries and provided a range of insights and lessons based on design experience, practical experience, research and regulatory needs, and an opportunity for the exchange of experiences and approaches on a range of important topics. The workshop also sought to identify and prioritise areas meriting further consideration and research.

The 34 participants shared their experiences and perceptions on a broad number of aspects including:

- The identification of human factors issues from the utility, vendor, and regulatory perspectives.
- Ensuring the inclusion and implementation of human factors issues within the upgrade or refurbishment process.
- How this change process should be managed.
- Feedback from practical experience and real concerns.
- Meeting modern human factors requirements.
- These proceedings document the papers presented at the workshop, the result of the group work conducted during the meeting, and concludes with a summary of the conclusions and recommendations from the workshop.

The members of the Programme Committee were: Mr. R. Montmayeul (EdF), Mr. J. Wachtel (US NRC), Mr. M. Green (HRP), Mr. D. Tasset (IPSN), Dr. W. Fassmann (GRS), Mr. B. Fitzpatrick (WANO), Dr. M. Dusic (IAEA) and Mr. L. Carlsson (NEA). The committee would like to express its thanks for the valuable support provided both before and during the workshop by Elisabeth Mauny from the NEA and to Marit Larson from the Halden Reactor Project.

3. SUMMARY OF GROUP DISCUSSIONS

The Basic issues, themes and questions to be discussed in the group work were as follows:

- What has been achieved so far, e.g., experiences, design principles, lessons, and findings, that we can rely on and apply successfully?
    - What issues were they trying to address?
    - What problems were they trying to solve?
    - What difficulties were identified, or were overcome?
    - What lessons have been learned from the project that might be useful to others?
    - What knowledge/information have they gained that means certain research need not be repeated by others?
    - How might the human factors aspects differ for existing plants/upgrades as opposed to new designs?

- What aspects are missing?
    - What do they still not know that requires more research, discussion, assessment, or better tools?

- Which aspects should be investigated in future research, to efficiently support regulatory authorities, utilities, designers and expert organisations?
    - What are the most important human factors issues in this area facing your plant(s) in your country over the next several years?

- How can we structure future practically orientated activities in the area? Indicate a priority.
    - What unique issues are faced in conducting such human factors studies within the nuclear environment?
    - Where should human factors research and testing be focused in the foreseeable future?

- What conclusions do you draw from the papers presented in this area?

3.1 Discussions presented by Group 1

- The main areas for discussion in group 1, were:
    - Need for human factors programme from the start.
    - Use of operator and other input.
    - Test and evaluation important.

- While common human factors programme activities have been identified, tools to support designers and evaluators to perform activities are needed. Tools should help tailor available information to projects. Example presented at the workshop include,
    - HIBISCUS
    - DIMS (design issue management system)
    - NREAL
- One cannot consider one human system interaction resource or system as independent from the total human system interaction, the procedures and training. It is important that design changes are considered in relation to each other.
- Upgrades can enhance or detract from human performance. The impact of changes on crews and crew performance need to be carefully assessed and addressed in upgrade projects.
    - Use operational experience and knowledge about technology.
    - Look for broader impact of the technology itself.
    - Good human factors can help realise the benefits.
- We tend to take a "top-down" view, but we also need the "bottom-up" view. The 'bottom-up' approach has many merits and should not be neglected.
- The benefits and drawbacks for digital verses conventional systems should be carefully considered. Conventional systems have served well and have benefits which should not be overlooked. Benefits include: considerable operating experience; meet needs of the operators; match the characteristics of the plant, age; cost; maintainability.
- Plants change continuously. The upgrade must include design for change and maintainability – as change will occur so must the design. Maintain configuration management. Computers are replaced, e.g. we don't want a new system depending on a computer system that may be replaced in 3-4 years.
- It is important to have the ability to monitor the health of new support systems. Is the computerised process system doing what it is supposed to do? There is a need for health and performance monitoring of the system itself.
- *What has been achieved so far?*
    - There has been a convergence of human factors methods in recent years leading to roughly similar processes which consider similar analyses as important.
    - It is important that the human factors programme must be adapted to the size and scope of the upgrade project.
    - The human factors programme should be part of the design process from the early stages of the design to be most effective.
    - It is important that the justification for the change should be clearly understood, i.e., why is the modernisation being performed.
    - Plant changes are often continuous and can result in diverse control room systems if not attended to.
    - A clear concept of operations is needed to structure the upgrade processes and ensure continuity of operations as changes are introduced into the control room.

- The upgrade should be analysed for impact on test and maintenance as well as operations (especially software).
- Obtaining operations input is an important aspect of design and should be obtained from the start.
- Analysis of operating experience is important in designing upgrades - fix what is bad, not what is good.
- Test, evaluation, and V&V are essential and are best when performed throughout the design process to detect and resolve issues as early as possible.

➢ *Validation considerations.*

- Greater standardisation has been observed.
- Validation methods need to be tailored by the scope of the upgrade.
- Validation methodology is an issue needing careful consideration.
- Validation is different from verification and can be a large effort.
- Validation needs to consider realistic operation conditions.

➢ *What needs to be done/missing*

- While the importance of operator input is recognised, how and where to best incorporate operator input needs to be explored.
- Methods to account in design for varying psychological states known to be associated with human error, such as stress, are needed.
- Methods to justify human factors activities as cost effective are needed.
- Methods to link control room upgrades with PSA/human error for safety impact analysis are needed.

3.2 Discussions presented by Group 2

➢ *What has been achieved so far?*

Methods for H.F. input in design / upgrades:

- Guidelines (all sorts of them!)
- Including operators in design process
  - Lego control room mock-ups
  - Discussion
  - SW techniques, VR methods
  - Realise the subjective nature of individual operator input + attempt to gather diverse data
- Validation techniques

- Recognition of common issues
  - Difference between upgrades + new designs
  - Need for diverse, broad-spectrum approach
  - Need to determine priorities – where do we devote our efforts
  - Need for cost / benefit – bottom line value
  - Need for V&V throughout the process rather than at the end (early, while you can do something)

- Advanced technology – issues:
  - Affects teams
  - Navigation – keyhole effect (hiding info)
  - Advantages for human performance
    - identify if there are
    - what they are
    - what would need improving?
  - Configuration control

- In the nuclear industry there is a trend towards more upgrades, fewer new designs, going towards computerised control rooms
  - alarm reduction
  - info hierarchies, graphic displays
  - computerised displays (rather than tiles)
  - soft controls
  - computerised procedures
  - COSSs
  - crew sizes
  - cockpit workstations
  - large screen overview

- Potential benefits
  - ↓ WL
  - ↑ Integrated info (not data)
  - ↑ Configuration control
  - ↑ Flexibility
  - ↑ Integration of systems (unified interface)

- Potential problems to investigate
  - Measures of effectiveness / complexity
  - Information overload
  - Keyhole effect / secondary tasks
  - Time delay + "fly by wire" issues
  - Sufficient display area
  - Effects on team performance / co-ordination, communication
  - Poor integration

- *What is missing/ what needs to be done?*

  - "State of the art" appears to vary in countries with respect to advanced vs. conventional upgrades, use of guidelines and recognising the value of human factors. A standardisation process would be of great value.
  - There is a need to share information on common issues regarding:
    - quantifying human factor value
    - showing cost benefits
    - need for clear criteria to evaluate upgrades

  - Help on using the guidelines

  Guidance needed on /for:

  - making trade-offs (in design, in H.F. input)
  - applying guidelines
  - designers
    - to make usable interfaces, control rooms, procedures, alarm systems
  - regulators
    - so they can evaluate designs / upgrades using consistent, objective criteria

Need criteria

- to determine if a design / upgrade is "good enough"
- benchmarking
- identifying relevant performance criteria
- establishing standards of acceptability

Need more consideration of team performance

- operators work in teams
- experience shows that advanced plants change the ways team interact
- need to evaluate / characterise team interaction

3.3 Discussions presented by Group 3

- *What have been achieved so far?*

  - Guidelines
    - There are many guidelines, standards, references which are useful for design and for safety review. It is possible to consider this kind of document as a minimal set of requirement, some kind of frame used by the safety authority to examine the design process. For example, such a document (NUREG-711) has been used by IPSN for analysing the design of the MMI of the European Pressurized Reactor (EPR).

  - Economical aspects
    - Presentation of Borselee plant upgrade include some way to quantify aspects of costs and benefits of human factors integration in the process. It is a promising issue, which should be important to develop in further research.

  - Share experience
    - V&V process : discussion about research versus practical aspects of this process. Experience of Borssele plant upgrade seems very practical. In industrial programs, there are very much constraints (schedule, cost, availability of people, simulators, etc.) that are not so strong in research programs.

- *What aspects are missing?*

  - Guidelines
    - Application of NUREG needs some adaptation. It is impossible to follow every detail. It is only some general frame to help the design.
    - Design and review guidelines should have to be distinguished.
    - Need more requirements for designers.
    - How to use the kind of tools provided (standards, validation tools, handbooks, etc.) in the design process. Standardisation can provide some more consistency between plants.

  - Economical aspects
    - The economical factors related to HFE: can we better show cost-benefit when integrating human factors into the design process - both for hybrid CRs and total modernisation's.
    - In quantification of costs/benefits: to take into account the entire system and plant, not only the control room.

  - Share experience
    - Need to share experience on difficulties we have in human factor projects.
    - Need more practical and experimental data,
    - Need good examples of success stories and things we could learn. We spend a lot of money and resources developing things, but not enough on post-hoc evaluation.
    - Continue the discussion/share more applied experiences – go into more detail. How to apply experience/information we all have in future work. Possibility of a future internet connection between people at this workshop and others interested.

- Holistic perspective
  - Important to consider the entire environment - not only the installation but also the operational area in the control room, training, maintenance, local stations, etc.
  - What also is missing is studying the interaction and communication aspects in the control room, and the role of team members in them.

3.4 Discussions presented by Group 4

- Two main areas were discussed:
  - *The design process* with the question of the integration of Human Factors (HF) in this process, and,
  - *The design product* with the question on how to provide a good design and what kind of information we need.

- *The design process*

  - The methods for the integration of HF in the design process are based on a structured approach; they are now well known. They need to mix top down and bottom up approaches.

  - Major changes such as change in alarm systems did not come from operators needs but were imposed by technology changes. This led to HF problems due to late implication of operation personnel, maintenance personnel, HF specialists, regulatory bodies, and other interested parties.

  - The group came to the conclusion that it is needed to emphasise the as early as possible participation of all the end users in the design process in order to base requirements on real users' needs. Also the design team should be interdisciplinary and the development team should have sufficient experience.

  - Managers should be made aware of the proper approaches, and rules for applying them should be established clearly at the beginning of the project.

  - Everybody speaks of HF but it is difficult to understand what it includes. It is also difficult to talk with HF specialists who have their own language. If application progress is to be made, HF should be made easier to understand by plant personnel and managers. In addition HF specialist should also have operational experience.

  - There is not a unique HF approach and HF approaches have to be considered broadly since there is not a unique solution to a design problem. Anyway new designs should always be assessed and operation feedback collected to serve as a basis for improvements.

- *The design product*

  - The question here is more on how to do the job of designing, how to make a good design. There is a lot of knowledge you need to get in order to design; among them standards, bad stories of designs that failed, experience return of previous designs, guidelines, and other more dedicated data as operators population profile, company operation and cultural habits, etc.

  - A certain guidance is needed there on issues, questions to ask, what you should do and not do.

- A lot is known but information is scattered among various guidelines or other information sources. An effort should be made to put information together in a systematic way and to guide on how to use it (information can be context dependant). Exchange of experience is also deeply needed, as control room upgrade or refurbishment experience is still rare.

- An important point is to be able to measure and if possible quantify the benefit of implementing a change in terms of cost and benefit

- Upgrading is not replacing but there can be overlapping. It is a complex process as it can be done in many different ways. Major HF problems or factors influencing the process have to be taken into account. The operating philosophy should be kept consistent particularly as the level of information and automation are concerned but you have also to take advantage of the potential of the computer system to provide new information.

- There are two ways to consider the design: either to start from technology, or to start from the cognitive and social aspects. Unfortunately upgrading is more often technology driven than HF driven and this leads to problems. One of the problems is that computerised new systems tend to cover normal operation which operators know well already, and much less disturbed operation where operators would like to have support. Side effects of a new system are often overlooked by designers and the impact of the new system on the whole work system has to be considered (not only for operation tasks but also maintenance tasks, testing tasks, etc.).

- The main issue is that operators can rely on the system; it can be able to detect malfunctions and have back up. Technology is mature enough to provide good systems.

- How to license a computerised system is still an issue. There are too many standards. The regulator has his own view and the industry (which progresses) has another one. Discussions of both parties are strongly needed to define a licensing process. It is really needed to consider the regulatory issues at the beginning of a project.

➢ *Future research areas:*

The Group identified key areas for R&D in order to know better how to support the following points:

- Team co-operation and team work (groupware)
- Information processing (diagnosis and decision making at high cognitive level)
- Measurement of the performance of the work system (preferably quantitatively)
- Overall consistency of the work system (and look at side effects).

4. PLENARY DISCUSSION

The plenary discussion agreed that there are generally three main areas to follow regarding control room upgrades:

1. Follow up lessons learnt on control room upgrades and licensing issues

We need a philosophy of design to ensure consistency. Training for operators (teamwork) involves shared cognition. The same is true for the design team and the design process. We need a shared understanding of the design process. H.F. people need process knowledge, operations people need H.F. knowledge.

There should be a systematic follow-up of lessons learnt including how regulators treat upgraded control rooms. Different approaches, good practices, success stories, and failures should be collected. This systematic knowledge acquisition should focus on good practices.

It is important to know why certain designs fail so that we don't make the same mistakes again. When it has been established what is wrong, this can be compared with what you are doing. If the system is a success, the pitfalls should be avoided in other systems. Some plants involve operators at an early stage. One should be careful involving too many participants in developing a new system.

Also, one should be careful when taking lessons from other design experience. It is not sure that the experience acquired in one project can be generalised to other projects, because the context is different, the situation, objectives, people involved, history, culture, and the socio-economical aspects, will probably vary.

Lessons learnt from plant upgrades should not simply focus on operating experience. It should also include licensing issues. At Beznau the big upgrade came very late in the process. This knowledge can help researchers and other plants to get a sense of costs, etc. The utilities have difficulties to know what the regulatory shall request; they have no knowledge what the regulatory shall require as validation. In the example of the Beznau NPP, the V&V arrived late in the design process.

2. Develop and co-ordinate methods and tools to support evaluations and comparisons

Human factors basis are not well known. There was an expressed hope by the participants in the workshop that human factors will be more involved in CR upgrades in the future. Human factors should be independent on technology, and try to stay on the same system basis. The human function in a control room is always the same.

Purchasing computers is a tough issue which lasts for a while. And it would be difficult to purchase a similar computer after three years. Therefore hybrid control rooms are being developed - we have no choice. More technology is brought into the control room because we can do it, not necessarily because it

represent the best solutions. There should exist guidelines for utilities on how to change, they should know the context and specify any change with consistency.

There is a need for more detailed guidelines or solutions. E.g. shall a new alarm display be organised on the basis of a functional or an organic structure. Consistency, i.e. impacts on existing design, should be assessed in such a situation. Suitable guidance is needed. A broad approach should be followed to ensure consistency, i.e. the philosophy behind design and change should be clear. Guidance, i.e. questions to be asked, should be provided on how to detect the philosophy behind design and change.

Methods and tools for upgrading and for tailoring human factors programmes should be better coordinated. This is the weakest area of knowledge. One should focus the efforts on ”how to do an upgrade”. Perhaps we need clearer ”requirements,” but many different designs can come out of the same set of requirements. Development and application of suitable criteria are needed.

Performance measures are needed. People’s needs & uses should be considered, and design should improve performance. One should evaluate the changed design and provide and use information about lessons learnt also in licensing. Criteria and coherent, easy-to-apply guidance supporting design, assessments, and evaluations should be developed.

There was a consensus among the workshop participants that one of the largest challenges in this area is co-ordination of methods and guidelines to make it easier. Tools on functional analysis need to be developed. Also, there is a need to co-ordinate efforts to put human factors into effect, and how to use tools in a cost effective way and include human factors. An interdisciplinary design team with a shared understanding of what, why and how to change should be used in upgrades. This interdisciplinary design team will develop a shared understanding of what to do and how to proceed.

3. Ways of analysing progress of cost benefits and risks

It is important to analyse upgrade programs in terms of costs/benefits and also in terms of risks. In this respect risk should not bee seen as a negative impact. How do you show that upgrades don’t increase risk? In order to assess cost and benefit appropriately, there is a need for a clear baseline. What is important is to find see where you start from and what to change. Aspects of operation and maintenance as well as functions allocated to automation and personnel should be considered.

In Sweden, work has started with regard to develop a baseline. This should be finished by spring in 2000. Halden has collected data to prepare a baseline situation for Ringhals. ISO and different IAEA documents can also serve in this task. It would be useful to gather and compare all available baseline documents.

Upgrades must be based on the status of existing designs. In this way it is possible to link upgrades to risk and to cost-benefit. It is not improvement, if what we have is already ”good enough.” Upgrades should thus assess the usefulness, costs, benefits, risks, side effects, and consistency of changes with respect to the previous design and design concepts. This needs to be done, as far as possible, *prior to* and *during* the design process.

5. WORKSHOP CONCLUSION - AREAS FOR FUTURE WORK

The workshop was adjourned and concluded by the Chairman in that he summarised five main points considered by the participants in the workshop as important areas for future work or research:

- **Lessons learnt.** There is a need to collate a 'lessons learnt' database relating to human factors and control room upgrades. This should include results or lessons from upgrade projects relating to: effect on the plant; implications of the change; costs and justifications; regulatory aspects; etc. Such a resource would help to:
  - Identify pitfalls in order for designers/utilities/regulators to avoid mistakes made by others.
  - Help to identify significant issues for research
  - Help other plants to assess costs/implications of upgrade programmes.
  - Help to collect success stories, examples and case studies demonstrating the use of human factors principles.

- **Methods & Tools.** There is a need to co-ordinate the method/tool development and use in order to better support evaluations and comparisons.
  - What methods should be used and how they should be applied.
  - How to tailor the tools to the scope of the project.
  - What performance measures to use, how to adapt and apply the guidelines themselves.

- **Need to consider regulatory implications.** What are the regulatory implications – there is a need to show how to establish a **performance baseline** before change in order to demonstrate that performance is at least as good, or better, that prior to the change.

- **Control room philosophy.** It is important to support the use of a 'control room philosophy' prior to, during, and after the upgrade. This will help maintain the integrity of the control room across numerous changes, for example, the requirements for a unified MMI throughout the control room.

- **Interdisciplinary appreciation.** There is a need to have a better-shared understanding of the design process and how the different disciplines involved contribute to it. One should also appreciate what, and how each of the disciplines can contribute to improving the final product.

6. APPENDICES

APPENDIX 1: LIST OF PARTICIPANTS

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APPENDIX 2: PROGRAMME FOR NEA/IAEA WORKSHOP

Park Hotel, Halden,
Monday 23rd –Wednesday 25th August 1999

Day 1

Time	**Item**
9:00-9:45	Welcome from Halden Reactor Project (F. Øwre) Introduction from Chair (J. Wachtel) Participants introduction
	Session 1: Lessons from current control room development and evaluations
9:45-10:10	Mark Feher (AECL) *Application of Human Factors to the CANDU 6 Control Room Upgrade*
10:10-10:35	Dezsö Sarkadi (HAEC) *Human Side Preparedness before the Refurbishing Reactor Protection System in Paks-NPP*
10:35-10:55	*Coffee*
10:55-11:20	J.W. de Vries (Borsselle NPP) *The Borssele NPP New Control Room Based on a Human-Factored Operational Concept*
11:20-11:45	Alfonso Jiménez (Tecnatom, s.a.), H: Deutschmann (HSK), & L. Lot (NOK) *Verification and Validation of New Operation Support Systems for Beznau NPP*
11:45-12:30	Group Discussions
12:30-12:45	Group Preparation for Presentations
12:45 – 13:30	*Lunch*
	Session 2: Approaches to and lessons from assessment
13:30-14:10	John O'Hara, William Stubler, James Higgins and William Brown (BNL), Jerry Wachtel and J.J.Persensky (USNRC) *Human-Factors Guidance Development for Control Room Modernisation*
14:10-14:35	Angelia Sebok, Steven Collier and Per Øivind Braarud (Institutt fur Energiteknik) *Incorporating Human Factors in Control Room Upgrades : Theory and Practical Experience*

14:35-14:55	*Coffee*
14:55-15:20	Daniel Tasset (IPSN) *Human Factors and Operation Aspects in Computerisation of the Control Room: a French Safety View based on N4 experience*
15:20-15:45	Kent Bladh (SwedPower) *Validation of Control Room Upgrades*
15:45 – 16:30	Group Discussions
16:30 – 16:45	Group Preparation for Presentations
16:45	Close of day
	Cruise on the fjord (Bus from Park Hotel at 17:45 - return 23:00)

Day 2

Time	**Item**
9:00-9:45	Opening from Chair (J. Wachtel) Plans for the day Individual Group Presentations of Day 1 Summaries
	Session 3: Lessons from COSS's & specific issues
9:45-10:10	John O'Hara, William Stubler and James Higgins (BNL), Joel Kramer (USNRC) *Human Performance Issues in Control Room Modernisation*
10:10-10:35	Jun-ichi Tanji, K. Monta, & J. Kawai (NUPEC) *Electronic Handbook on Human-Machine System Interface Evaluation Method for Nuclear Power Plants*
10:35-10:55	*Coffee*
10:55 - 11:20	Yong H. Lee (KAERI) *An Experience on Human Factors Evaluation of a Safety Parameter Display System in Korea*
11:20-11:45	Øivind Berg, Thorbjørn Bjørlo (Institutt fur Energiteknik) *Experience from Integration of Operator Support Systems to Enhance Human Performance*
11:45-12:30	Group Discussions
12:30-12:45	Group Presentation Preparations
12:45 – 13:30	*Lunch*
	Session 4: Lessons from training, test and research facilities

13:30 – 14:10	Eberhard Hoffman (KSG/Gfs) *Control Rooms in German Nuclear Power Plants*
14:10-14:35	Jean-Marc Fourneron, B. Papin, C. Germain (CEA) *Integration of Human Factor and Experience Feedback in the Design of the Future French Irradiation Reactor*
14:35-14:55	*Coffee*
14:55 – 15:20	Carlos Chávez-Mercado (Universidad Nacional Autonoma de Mexico) *Human Factors and the Nuclear Reactor Engineering Analysis Laboratory*
15:20 – 15:45	Gregor Eberle (Philippsburg NPP) *Approaches for the Integration of Human Factors into the Upgrading and Refurbishment of Control Rooms*
15:45-16:30	Group Discussions
16:30-16:45	Group Presentation Preparations
16:45-17:00	Presentation from Joaquin Martin-Bermejo CEC. *European Research Programme*
17:00	Close of day
	Guide tour to Halden Fortress (Bus from Park Hotel at 17:45 return 19:00)

Day 3: Recommendations/Future work

Time	**Item**
9:00-9:45	Opening from Chair (J. Wachtel) Plan for the day Individual Group Summary Presentations from Day 2
9:45 – 10:00	*Coffee*
10:00-11:00	Group discussions; prepare charge to committee
11:00-12:00	Group presentations; charge to committee Closing Remarks: Chair (J. Wachtel) Invitation to demonstrations – Mark Green
12:00 – 13:00	*Lunch*
13:00 – 16:00	Visit to Halden Reactor Project: HAMMLAB, Virtual Reality Centre, demonstrations of operator support systems

APPENDIX 3: THE WORKING GROUPS

Group 1

Mr. Mark GREEN *(Secretary)*
Mr. Mark FEHER
Dr. John O'HARA
Dr. Eberhard HOFFMAN
Mr. S. SMEATON
Mr. Jung Chang Na
Mr. Steve COLLIER

Group 2

Mr. Jerry WACHTEL *(Secretary)*
Mr. Dezso SARKADI
Mrs. Angie SEBOK
Mr. Jun-ichi TANJI
Mr. Jean-Marc FOURNERON
Mr. Dietmar ASSE
Ms. Anna Maria OLSSON
Mr. Anders JOHANSSON
Mr Seong-Nam CHOI

Group 3

Mr. Daniel TASSET *(Secretary)*
Mr. J.W. DE VRIES
Mr. Yong H. LEE
Dr. Carlos CHAVEZ MERCADO
Mr. Thorbjorn BJÖRLO
Mr. Conny HOLMSTROM
Mr. Lars-Göran SJÖSTRÖM
Mr. Hans EDVINSSON

Group 4

Mr. René MONTMAYEUL *(Secretary)*
Mr. Alfonso JIMENEZ
Dr. Kent BLADH
Mr. Øivind BERG
Mr. Gregor EBERLE
Dr. FASSMAN
Mr. Joaquin MARTIN-BERMEJO
Mr. Lennart CARLSSON
Mr. Kjell HAUGSET

APPENDIX 4: CALL FOR PAPERS

OECD NUCLEAR ENERGY AGENCY
AGENCE DE L'OCDE POUR L'ENERGIE NUCLEAIRE

COMMITTEE ON THE SAFETY OF NUCLEAR INSTALLATIONS

PRINCIPAL WORKING GROUP No. 1

ORGANISED IN CO-OPERATION WITH

INTERNATIONAL ATOMIC ENERGY AGENCY
WORL ASSOCIATION OF NUCLEAR OPERATORS

CALL FOR PAPERS

FOR A

WORKSHOP/SPECIALISTs MEETING

ON

APPROACHES FOR THE INTEGRATION OF HUMAN FACTORS INTO THE UPGRADING AND REFURBISHMENT OF CONTROL ROOMS

HOSTED BY
The OECD Halden Reactor Project

Halden, Norway

23rd – 25th August, 1999

ORGANISATION

An OECD/NEA Workshop/Specialists meeting is to be held on "Approaches for the Integration of Human Factors into the Upgrading and Refurbishment of Control Rooms." It will be organised by the Principal Working Group 1 (PWG1) on Operating Experience and Human Factors, of the Committee on the Safety of the Nuclear Installations (CSNI), of the OECD Nuclear Energy Agency (NEA). The meeting will be organised in co-operation with the IAEA, and will be hosted by the Halden Reactor Project, Halden, Norway on the 23rd-25th August, 1999.

BACKGROUND

A modern approach to control room design, be it for upgrading or complete refurbishment, requires the integration of many disciplines and approaches. The integration of human factors into such a process continues to present challenges. How this process should be conceived, planned, and carried out will be of considerable interest to designers, operators and regulators.

Many NPPs around the world have been, or will be faced with decisions concerning modernisation of their control rooms. Such changes can be driven by a range of issues including; the need to replace outdated control and instrumentation systems; increasing regulatory concern about human performance; or the need to provide a better process control environment for NPPs whose life cycles extend beyond what was originally intended. Considering the importance of operator performance for safe and profitable operations, a process for ensuring that human factors issues are properly addressed could be central to the success or failure of such a project. Human factors is of particular importance when a combination of existing and new systems are to be used, resulting is a so called 'hybrid' control room.

The workshop/specialist meeting will:

- Explore how human factors issues can be identified.
- Consider what processes and techniques are necessary to ensure that appropriate requirements are specified, and that suitable data is gathered and analysed.
- Identify and discuss issues related to these questions together with lessons from utilities, vendors and regulators which have faced, or are currently facing, these challenges.

SCOPE OF THE MEETING

The agenda for the meeting will focus on the state of knowledge and current best practices within this area. The purpose of the meeting is to provide a forum for the open discussion of the human factors issues, as seen by a broad range of interested parties, in relation to the upgrading and refurbishing of control rooms. Contributions will be sought based on design experience, practical experience, research and regulatory needs, and the meeting will provide for the exchange of experiences and approaches on a range of important topics. This will enable the identification and prioritisation of areas meriting further consideration and research. It is proposed that the format of the meeting should include presentations on current knowledge and concerns, and small group workshops to identify important issues for designers, utilities and regulators, as well as future research needs.

TOPICS FOR CONTRIBUTIONS

Among topics to be discussed participants are invited to share their experiences and perceptions on a broad number of aspects, including:

- Identification of human factors issues from the utility, vendor, and regulatory perspective.
- Ensuring the inclusion and implementation of human factors issues within the upgrade or refurbishment process.
- How this change process should be managed.
- Feedback from practical experience and real concerns.
- Meeting modern human factors requirements.

PROGRAMME COMMITTEE

The Workshop/Specialists meeting will be organised under the direction of the Programme Committee, whose Members are:

- Mr. R. Montmayeul (EdF)
- Mr. J. Wachtel (US NRC)
- Mr. M. Green (HRP)
- Mr. D. Tasset (IPSN)
- Dr. W. Fassmann (GRS)
- Mr. B. Fitzpatrick (WANO)
- Dr. M. Dusic (IAEA)
- NEA/PWG1 secretariat

MEETING ARRANGEMENTS

Meeting Participation

Participation in the Workshop/Specialist meeting is expected from persons knowledgeable in the technical issues above mentioned. Nominations should be made through national delegates to the CSNI and official government representatives using the attached registration form. The registration form should be sent to the secretariat by 7th May for the authors, together with the abstract, and by 10th June 1999 for the other participants.

Abstract Form

The abstract should indicate the relationship to the scope of the meeting (parts 3 and 4, above). It should be between 200 and 400 words in length. It should submitted to the NEA secretariat whose address is in the registration form.

Schedule

The abstract should reach the secretariat by 7th May 1999. The Programme Committee will meet to select the papers and prepare the provisional programme. The authors of the selected papers will be notified at the latest 10th June 1999.

Authors should send the final version of the paper to the secretariat no later than 6th August 1999.

Working Language

The working language for the meeting will be English. No translation service will be available.

Meeting Proceedings

The proceedings will be published and will include all accepted papers together with a summary of the overall conclusions of the meeting.

Local Arrangements

Details of local arrangements are being developed and will be sent to authors and participants together with the provisional programme. For questions you may contact the Secretariat:

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AGENCE DE L'OCDE POUR L'ENERGIE NUCLEAIRE
Committee on The Safety of Nuclear Installations
Principal Working Group No.1

Registration Form
to the Workshop Meeting on
Approaches for the integration of human factors into the upgrading and refurbishment of control rooms

In response to the announcement and call for papers we inform you of the nomination of

Name:_____
Ms. ( ), Mr. ( ), Dr. ( ) Prof. ( )

Position:_____

Organisation:_____

Address:_____
_____
_____
_____

Tel:_____ **fax:**_____

E-mail:_____

Title of my presentation:

Please return the form by 7th May, 1999 at the latest to:

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