

**Unclassified**

**NEA/CNRA/R(2001)2**



Organisation de Coopération et de Développement Economiques  
Organisation for Economic Co-operation and Development

**OLIS : 15-Jan-2001**  
**Dist. : 16-Jan-2001**

**English text only**

PARIS

**NUCLEAR ENERGY AGENCY  
COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES**

**NEA/CNRA/R(2001)2**  
**Unclassified**

**REGULATORY ASPECTS OF LIFE EXTENSION AND UPGRADING OF NPPS**

**CNRA Special Issue's Meeting 2000 - Member Countries Responses to the Questionnaire**

**99065**

Document complet disponible sur OLIS dans son format d'origine  
Complete document available on OLIS in its original format

**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) 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.*

© OECD 2001

Permission to reproduce a portion of this work for non-commercial purposes or classroom use should be obtained through the Centre français d'exploitation du droit de copie (CCF), 20, rue des Grands-Augustins, 75006 Paris, France, Tel. (33-1) 44 07 47 70, Fax (33-1) 46 34 67 19, for every country except the United States. In the United States permission should be obtained through the Copyright Clearance Center, Customer Service, (508)750-8400, 222 Rosewood Drive, Danvers, MA 01923, USA, or CCC Online: <http://www.copyright.com/>. All other applications for permission to reproduce or translate all or part of this book should be made to OECD Publications, 2, rue André-Pascal, 75775 Paris Cedex 16, France.

## **COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES**

The Committee on Nuclear Regulatory Activities (CNRA) of the OECD Nuclear Energy Agency (NEA) is an international committee made up primarily of senior nuclear regulators. It was set up in 1989 as a forum for the exchange of information and experience among regulatory organisations and for the review of developments which could affect regulatory requirements.

The Committee is responsible for the programme of the NEA, concerning the regulation, licensing and inspection of nuclear installations. The Committee reviews developments which could affect regulatory requirements with the objective of providing members with an understanding of the motivation for new regulatory requirements under consideration and an opportunity to offer suggestions that might improve them or avoid disparities among Member Countries. In particular, the Committee reviews current practices and operating experience.

The Committee focuses primarily on power reactors and other nuclear installations currently being built and operated. It also may consider the regulatory implications of new designs of power reactors and other types of nuclear installations.

In implementing its programme, CNRA establishes co-operative mechanisms with NEA's Committee on the Safety of Nuclear Installations (CSNI), responsible for co-ordinating the activities of the Agency concerning the technical aspects of design, construction and operation of nuclear installations insofar as they affect the safety of such installations. It also co-operates with NEA's Committee on Radiation Protection and Public Health (CRPPH) and NEA's Radioactive Waste Management Committee (RWMC) on matters of common interest.

## **ABSTRACT**

At its annual meeting in June 1999, the Committee on Nuclear Regulatory Activities (CNRA) agreed to hold a Special Issue Meeting in June 2000 on the topic of “Life Extension and Upgrading”. This report contains the responses by Member countries to the detailed questionnaire issued by the Organising Committee. The results of the Special Issues meeting which includes the synthesis of these responses and the results and conclusions of the CNRA discussions can be found in report NEA/CNRA/R(2001)1.

**TABLE OF CONTENTS**

ABSTRACT .....	4
EXECUTIVE SUMMARY .....	6
RESPONSES TO QUESTIONNAIRE .....	7
BELGIUM.....	8
CANADA.....	12
CZECH REPUBLIC.....	18
FINLAND .....	21
FRANCE.....	29
GERMANY .....	33
HUNGARY .....	41
JAPAN.....	45
MEXICO.....	47
THE NETHERLANDS .....	50
SPAIN .....	52
SWEDEN .....	55
SWITZERLAND .....	61
UNITED KINGDOM .....	72
UNITED STATES .....	78

## EXECUTIVE SUMMARY

### INTRODUCTION

In discussing the special issues topic, Life Extension and Upgrading, the Committee reflected on the meaning of the terms “life extension” and “upgrading”. Differences in the terminologies used, both nationally and internationally, make any definitions difficult but the Committee reached a general consensus on using the following terms to identify the issues:

- Life Extension: Where applicable, continuous operation maintaining an acceptable level of safety of a facility beyond an established licensed term or period established by a safety evaluation.
- Upgrading: Applying measures to enhance the safety level of the plant.

Current information and views on life extension and upgrading were obtained from the regulators by means of a questionnaire. The ten questions on the questionnaire were:

1. Describe the key elements of your legislation (i.e. rules and regulations) relevant to upgrading and continued long-term operation.
2. Do you have a term licence (licences for a fixed period)? If yes, how long and what is the legal basis?
3. If you have a limited term licence, can it be extended and what are the criteria? If you do not have limited term licences, what are the relevant regulatory measures in place to control long-term operation (i.e. periodic reviews, limitations on long-term operation)?
4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included; if no, how do you justify long-term operation?
5. How do you develop and update your rules and regulations (i.e. standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?
6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any additional criteria (i.e. considered financial, public perception).
7. Describe what are the key technical issues related to upgrading and long-term operation you are addressing or plan to address.
8. Describe what key management issues you are addressing (i.e. organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long-term operation.
9. Describe how you apply deterministic and probabilistic methods in your evaluation.
10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long-term operation.

In response to the questionnaire, reports were received from fourteen regulators: Belgium, Canada, Czech Republic, Finland, France, Germany, Hungary, Japan, Mexico, Netherlands, Spain, Sweden, Switzerland, UK and USA. The following sections contain the detailed responses to the questionnaire from these countries.

**RESPONSES TO QUESTIONNAIRE**

## BELGIUM

### **1. Describe the key elements of your legislation (i.e., rules and regulations) relevant to upgrading and continued long-term operation.**

In accordance with the Belgian law, the regulatory body performs a continuous safety review during operation. Tests and inspections, modifications (hardware, procedures, organisation), feedback of national and foreign operational experience are dealt with in this frame.

Additionally, PSRs at ten-year intervals are required by the operating license. The operating license of each NPP states:

“10, 20, 30, ... years after the plant has reached its nominal power, the utility and the Safety Authority jointly proceed to a comparative examination of the design, construction, operating rules and procedures of the existing plant with respect to the current rules and practices in use in the USA and in the European Community at the time of the review”.

The joint report must cover:

- identification of the differences between the present state of the plant and the current safety rules and practices;
- evaluation of the acceptability of these differences;
- proposal for making appropriate improvements;
- schedule for the implementation of the modifications.

The report is sent for approval to the Belgian Safety Authorities. It is not a public document.

### **2. Do you have a term license (licenses for a fixed period)? If yes, how long and what is the legal basis?**

No.

### **3. If you have a limited term licenses, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?**

Continuous safety review during operation and periodic safety reviews according to § 1.

### **4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

Yes.

a) Objectives of the periodic safety reviews

Plant as safe as originally designed?

- no subtle degradations, e.g. due to accumulation of modifications?
- were all scenarios intended to be covered by the design, really considered in all circumstances?

Plant still safe for the next 10 years?

- ageing;
- wear-out.

Comparison to the most recent safety standards:

- identification of improvements (reduction of risks at justifiable expense);
- balanced approach to safety.

b) List of potential periodic safety review subjects:

- all subjects discussed in the standard format and content of the FSAR according to the latest rules, i.e. R.G. 1.70 rev. 3 and related rules, SRP, etc.;
- all rules, standards, norms, practices published since the original licensing or since the last PSR;
- all unresolved safety issues and generic issues;
- all subjects considered for the latest plants licensed in the country;
- the operational experience of the plant itself;
- the operational experience of other plants, nationally and internationally;
- the results from other periodic safety reviews;
- PSA studies and current research programmes topics;
- decommissioning, where appropriate.

**5. How do you develop and update your rules and regulations (i.e., standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

Since Belgium did not develop (besides its basic law on the protection against radiation) its own rules and regulation and adopted the US rules for the design of its last four plants, the safety of the plants is evaluated by using foreign rules and regulations, i.e. mainly the rulemaking of the USNRC and to a lesser extent other rules applied in the European Community (see also definition of PSR in response to question 1). As a consequence, the update of the applied rules and regulations stems to a large extent directly from the update of these foreign rulemaking systems.

The FSAR describes the applicable requirements and their implementation when applied to existing units. The license requires that the FSAR be kept up to date.

There are no specific criteria to evaluate and/or justify the current level of safety in comparison to modern safety standards. However, one should keep in mind that it is the goal of PSRs not only to justify but also to improve the current safety level to the extent practical (this may include cost-benefit considerations).

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception).**

No, as long as the conditions of the license are respected.

**7. Describe what are the key technical issues related to upgrading and long term operation you are addressing or plan to address.**

Key technical issues addressed in the former and on-going PSRs

a) For the 1st PSR of older plants: see Appendix 5 of EUR 15555 report (quoted hereafter):

1. Protection against accidents of external origin and industrial risks.
2. Earthquakes.
3. High energy line breaks.
4. Fire protection.
5. Flooding from external or internal origin.
6. Large winds, climatic effects.
7. Differential settling of buildings.
8. Systems to stop the reactor, cool the core, and remove the residual heat:
  - reactor protection system
  - safety systems: auxiliary feedwater to the steam generators, shutdown cooling, safety injection, spray (ventilation of the reactor containment), control room and auxiliary shutdown panel
  - steam discharge to the atmosphere
  - ultimate heat sink
  - safety related compressed air
  - electrical supplies
  - resistance and integrity of the circuits
  - instrumentation of the safety related systems
  - leak detection of the primary circuit
  - detection of inadequate core cooling
  - qualification (seismic and environmental) of electrical and mechanical systems.
9. Primary circuit integrity:
  - overpressure protection (cold and hot)
  - protection against thermal shock
  - reactor vessel venting
  - integrity of the primary pump seals
  - leak detection
  - corrosion due to boric acid
  - list of transients which have occurred.
10. Nuclear auxiliary buildings: protection against radiation after an accident.
11. Inspection of structures and equipment (electrical, mechanical).
12. Test programme.
13. Technical specifications.
14. Conduct of operation.
15. Quality organisation.
16. Spent fuel handling and storage.
17. Ventilation systems, gaseous waste systems.
18. Isolation and leak-tightness of the primary and secondary containments.
19. Hydrogen control in the primary containment (note: this subject only considered DBA conditions; not severe accident conditions).
20. Operation experience.
21. Accident analysis.
22. Radiation monitoring and ALARA policy.
23. Post accident sampling in the reactor building.
24. Updated documentation, including revision of the FSAR.

b) For PSR of more recent plants:

- a list of similar subjects structured according to table of content of FSAR completed with subjects on operational experience feedback, PSA and severe accidents studies.
- PSA gives complementary viewpoint to deterministic approach.
- covers power and shutdown modes.
- results show the benefit of the diversity offered by the second level of protection (bunkered systems) during power operation.
- contains analysis of containment threats.

As a result of these studies, it was decided to install autocatalytic hydrogen recombiners in all Belgian plants:

- severe accidents taken into account.
- analysis of ultimate strength of containment.
- investigation on ways to vent the containment.
- analysis of dilution scenarios.
- accident management procedures.

**8. Describe what key management issues you are addressing (i.e., organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long term operation.**

Key management issues like major organisation changes, economic deregulation, maintaining competence, use of subcontractors are currently under (still mostly informal) evaluation.

Until now, these issues have been treated in the framework of the continuous inspection activities of the Regulatory Body (and not in the PSRs).

**9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

- For 1st PSR of older plants: mainly deterministic analysis.
- For more recent plants and 2nd PSR of older plants: more emphasis on feedback of operational experience and PSA.
- Defence in depth must remain the basic safety philosophy.
- Interest of global approach: search for mutually consistent solutions.
- Improvements appear to be possible even for systems deeply linked to the design and the layout of the plants: increase of the SSE level, protection against external hazards, new reactor protection system.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

- The concerns to be dealt with in the upcoming Belgian PSRs are currently under evaluation.
- The concerns delineated under § 8 should be dealt with more intensively in Belgium as well as internationally.
- PSA results might be used in a more systematic way, when models and assumptions have been agreed upon.

## CANADA

Note: The questionnaire was answered prior change of the Atomic Energy Control Board (AECB) to the Canadian Nuclear Safety Commission (CNSC).

### **1. Describe the key elements of your legislation (i.e., rules and regulations) relevant to upgrading and continued long-term operation.**

There are no specific rules and regulations in the Canadian regulatory framework relevant to upgrading and continued long-term operation of nuclear power stations. The Atomic Energy Control Board (AECB) recognises, however, that continued long-term operation may be made conditional upon timely and satisfactory completion of safety analyses and some safety upgrades to obtain assurance that the risk to the public and employee health and safety, and to the environment, remains within the bound of the original licensing basis.

The AECB recognises also that the effects of ageing degradation of critical systems, structures and components can result in design safety margins being diminished and safety analyses being invalidated. Consequently, the AECB has embarked on the development of a regulatory position on requirements for the management of ageing.

In 1990, the AECB required that each of its licensees submit a summary of the means by which it is assured of continued safe operation of its nuclear power station as it ages, including the following:

- the continued validity of steady-state and dynamic analyses of the station, where key characteristics, such as heat transfer rates and flow rates, have changed;
- the scope of the review of degradation mechanisms that could impact significantly on safety, and which might therefore require changes to surveillance and testing programs;
- the continued validity of reliability assessments of special safety systems, safety-support, and safety-related systems in the light of known or anticipated changes in component failures rates; and
- the adequacy of the planned maintenance program.

In 1991-92, the AECB issued draft recommendations for a regulatory position on requirements for the management of ageing. It was recommended that the program should be auditable and provide for the effective management of:

- ageing degradation of any component that could increase the probability or consequences of process system failures;
- ageing degradation of any safety-support or other safety-related systems that could render a special safety system less effective or less reliable; and
- ageing degradation that causes key system parameters such as flow rates, heat transfer rates, and pressure drops, to change to the extent that they exceed the limits assumed in the safety report.

In addition, the AECB has recently initiated the development of new regulatory documents to define requirements for Probabilistic Safety Assessment (PSA) as related to the management of ageing.

**2. Do you have a term license (license for a fixed period)? If yes, how long and what is the legal basis?**

The current Atomic Energy Control (AEC) Regulations stipulate two formal licensing steps for nuclear power stations:

- construction approval, and
- operating license.

In practice, formal approval is also given for the site. Proposed regulations to be made under the new Nuclear Safety and Control (NSC) Act would require a site preparation license.

Site and construction approvals are not intended for renewal. They are granted, respectively, once the AECB is assured that the site characteristics important to safety have been identified and accounted for in the design basis of the plant, and once the AECB is assured that the plant design will meet AECB safety requirements and the plant will be built to appropriate quality standards.

An operating license is initially granted for the term of two years provided that the construction of the plant conforms to the design, and that the plans for operation are satisfactory. The operating license is then renewed every two years provided that continued operation of the plant is safe.

**3. If you have a limited term license, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?**

The operating license is periodically reviewed by AECB staff to obtain assurance that the risk to the public and employee health and safety, and to the environment, remains within the bound of the original licensing basis. The review process accommodates a two-year licence renewal cycle and covers all relevant AECB regulatory requirements.

AECB staff, on-site and at the head office, continuously monitor the operation of the reactors and the licensee's compliance with safety and licensing requirements. If the AECB is not satisfied that the licensee fulfils the required commitment to safety, as indicated by the current violation and compliance history, licensing sanctions can be imposed such as, for example, a license for a shorter term or, alternatively, a short term license extension to allow sufficient time for the licensee to make the required improvements before the license is considered for the renewal. License suspension, revocation or non-renewal can be imposed by the AECB in any of the following circumstances:

- licensee is in serious non-compliance,
- licensee has been successfully prosecuted,
- licensee has a history of non-compliance, and
- AECB has lost confidence in the licensee's ability to comply with the regulatory requirements.

**4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

The AECB does not perform a formal periodic evaluation of overall plant design. However, Canadian regulatory practice requires that the safety analysis for each operating stations be reviewed and updated periodically, and the safety report resubmitted to the AECB once every three years, or at another agreed frequency, to account for the following:

- utility operating experience,
- improved analytical techniques, and
- new information arising from research findings.

The AECB requires also the licensees to follow a formal configuration control process for the existing plant designs. The design control process includes:

- the design audit process (vertical/horizontal slice);
- the process of periodically making sure that the system is designed to meet relevant standards and has not been inadvertently modified outside its specifications (for example, by addition, removal or replacement of components, or other changes to its operating environment); and
- the process of periodically making sure that the system is being maintained, inspected, tested and operated to make sure it stays within the required specifications.

In addition, the AECB continuously reviews and monitors reactor operation, and conducts a formal periodic review of plant operation on an annual basis. This includes a review of the information contained in the licensee's annual report as well as that in various event reports submitted throughout the year.

The AECB recognises that the present safety review process, although flexible and efficient in assessing the basis of acceptability of continued operation, does not provide the level of assurance needed in the continued long-term operation of nuclear power stations. Therefore, the use of Periodic Safety Reviews (PSRs) at a 10-year period is now a subject of discussion between the AECB and the utilities. PSRs will bring together all essential elements which contribute to safety at a defined point in time and measures it against current requirements. Care, however, will be taken to preserve the essential features of the operating safety monitoring, that is now taking place, in addition to PSRs.

**5. How do you develop and update your rules and regulations (i.e., standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

In addition to the various legally binding regulations issued pursuant to the AEC Act, the AECB provides guidance and information on these regulations in Regulatory Guidance Documents (RGDs). The RGDs are written statements that describe policies, standards, criteria, procedures or factors that the AECB considers in the exercise of its regulatory authority. They promote compliance approaches or standards acceptable to the AECB, but do not preclude other ways to satisfy the intent of the regulatory requirements. The AECB either develops the RGDs in consultation with licensees and the public, or adopts national or international policies and standards for this purpose.

The RGDs may be incorporated into the regulations of nuclear power stations as binding license conditions. However, in most cases, licensees use the guidance documents to develop their design and/or operating documents, and it is these licensee-produced documents that are incorporated into binding license conditions.

License conditions can also be used to address the issue of changing standards for nuclear safety as technology advances and public expectations increase. With its non-prescriptive regulations and two-year license renewal cycle, the AECB has flexibility to adjust to these changes. For example, modifications have been made to the basic single/dual failure safety analysis requirements to reflect Canadian experience in applying this approach. The Consultative Document C-6, dealing with safety analysis requirements, contains a list of single and dual failures whose consequences are expected to be analysed by the licensees in order to demonstrate the safety of nuclear power stations. The list is not exhaustive but is intended to

include the major failures of concern in CANDU nuclear power stations, as the list was based on more than 20 years of CANDU licensing experience. It is recognised, however, that upgrading and long-term operation of nuclear power stations may either introduce new potential for failures or eliminate some failures from the existing list. In the event that a new failure mode is identified, the failure sequence in C-6 would serve as a frame of reference for the placement of the new failure in terms of the relative likelihood of occurrence.

The requirements introduced in the Consultative Document C-6 represent an increase in both the scope and the rigour of design basis accidents, which operating power plants licensed prior to the publication of C-6 would have to consider. At the present, these requirements have not been readily accepted by the licensees who have proposed an incremental approach to address the scope of the design basis.

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception).**

The overriding regulatory criterion for continued operation of nuclear power plants is the safety of licensees' operations; specifically, compliance with applicable regulations and licenses through which the safety is assessed. The safety of operating nuclear power plants is reviewed for compliance with the following:

- requirements of the AEC regulations,
- relevant regulatory documents,
- industry codes and standards,
- the facility operating licence, and
- pertinent station policies and procedures.

There is a range of possible actions that the AECB can take in the event of non-compliance, including restricted reactor operation or reactor shutdown, and revocation or suspension of the license. The severity of possible actions depends normally on the potential impact of non-compliance on the safety of operating nuclear power plants. Unacceptable reduction in safety margins, standards of operation or in material conditions would normally lead to restricted reactor operation or reactor shutdown.

**7. Describe what are the key technical issues related to upgrading and long term operation you are addressing or plan to address.**

The key technical issues related to upgrading and long-term operation of nuclear power stations are mainly identified through safety assessments of plant design and operation following major international accidents, and following national incidents that occur during the routine operation. The AECB uses Generic Action Items as a method of pursuing concerns that arise through its continuing safety assessment. They are, for example:

- hydrogen behaviour in containment,
- core cooling in the absence of forced flow,
- assurance of continued nuclear station safety,
- post-accident filter effectiveness,
- reactor operation with a flux tilt,
- best effort analysis of ECCS effectiveness,
- impact of fuel bundle condition on reactor safety,
- molten fuel-moderator interaction,
- behaviour of heat transport pumps under two-phase flow condition,
- pressure tube failure with consequential loss of moderator inventory,

- compliance with bundle and channel power limits, and
- void reactor uncertainty allowance in LOCA analysis.

The AECB recognises also that further improvements are required in the standards of nuclear power plant operation and maintenance to arrest deterioration in the material conditions, restore safety margins, and enhance defence-in-depth at Canadian nuclear power stations since they were originally licensed. To achieve these goals, the industry has already committed to various plans and programs. The AECB monitors the execution of these plans to verify that:

- *commitment are being kept;*
- *the desired improvements are achieved within a reasonable period of time;*
- *the improvements are subsequently sustained; and*
- *the level of defence-in-depth is still acceptable and our regulatory requirements are still being met or exceeded.*

**8. Describe what key management issues you are addressing (i.e., organisational, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long-term operation.**

The management of nuclear power stations, for some utilities, has not been given adequate attention by the owners over the last decade. This lack of management has resulted in declining standards of operation and maintenance to the extent that they are now only marginally acceptable. Configuration control has become poor. (To date, programs to compensate for the effects of ageing degradation have not been fully successful.) It is thus now required that the licensee must describe the organisation structure in a license application and seek AECB approval of any significant change.

In an attempt to eliminate these organisational deficiencies, a model of the desired characteristics of effective management (Canadian Adaptive Machine Model) is now being used in Organisation and Management Assessments by the AECB. Also, large remedial programs are being put in place to achieve the necessary standards of excellence, and to justify long-term operation of nuclear power stations. For example, Ontario Power Generation uses a process called Technical Operability Evaluation as the key to determine the acceptability of continued operation as a result of current and future review findings. This is a formal process for documenting and tracking deficiencies from identification through closure, adding also the benefit of an external review to the decision. Ultimately, the process is based on the decision-making capability of plant personnel and increases the involvement of the station's senior personnel in station operation.

In the case of potential privatisation of nuclear stations, the AECB does not see intrinsic problems associated with ownership changes and increased competition, except in the area of financial capacity to maintain the standards of nuclear power plant operation and maintenance, and the standards related to environmental protection. (The NSC Act will give the regulator authority to require financial assurances for decommissioning of nuclear facilities.) The AECB recognises, however, that enhanced awareness of the potential consequences of economic pressure on long-term maintenance of material, infrastructure and processes is required to ensure the licensee's compliance with safety and licensing requirements. The Canadian regulatory practice gives the AECB and the public frequent opportunity to review any negative impact developing as a results of ownership changes and increased competition associated with deregulation of electricity market.

**9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

Deterministic methods are used to provide continued assurance of safety of critical systems, structures and components by developing the understanding of phenomena that can result in design safety margins being

diminished and safety analyses being invalidated. This is achieved through optimised operating conditions, mitigating the effect of degradation mechanisms, improving component defect detection and characterisation, and extending service life of key reactor components. The specific objectives are:

- reliability assessments of critical systems, structures and components;
- assessment of degradation mechanisms that could impact on failure rate of critical systems, structures and components;
- assessment of ageing degradation that causes key system parameters such as flow rates; heat transfer rates, and pressure drops, to change to the extent that they exceed the limits assumed in the safety report;
- development of fitness-for service guidelines;
- development of condition monitoring programs; and
- development of inspection and maintenance techniques.

Regulatory requirements for PSA, including risk-informed regulations, are presently under development. Probabilistic methods, however, were recently used by OPG to justify continued operation of nuclear power stations. Specifically, they were used to assess the importance of some findings of a broad internal assessment that highlighted declining performance of nuclear power stations, and prioritise several recommendations to identify key improvement (upgrade) projects for implementation.

Also, PSA is used for new Canadian power reactor designs (such as CANDU 9) to define system reliability requirements and to confirm the adequacy of the design.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

Additional regulatory issues, associated with upgrading and long-term operation of nuclear power stations, and related to Canadian and international nuclear safety programs can be identified as:

- capability to withstand accidents beyond the design basis,
- measures for severe accident management,
- decrease of nuclear technology knowledge base in design, operation, maintenance, and research and development, and
- complementary use (role) of risk-based assessments.

There are also some issues which de facto are external to Canadian and international regulatory frameworks but could have a significant impact on long-term operation of nuclear power stations. The most important are:

- ownership changes and increased competition associated with deregulation of electricity markets, and
- lack of sufficient economic resources.

## CZECH REPUBLIC

### **1. Describe the key elements of your legislation (i.e.; rules and regulations) relevant to upgrading and continued long-term operation.**

The key elements of the Czech legislation relevant to upgrading and continued long-term operation are the Atomic Act No. 18/1997 Sb. (1<sup>st</sup> level) and implementing mandatory regulations of the SÚJB (2<sup>nd</sup> level), in particular:

- No. 106/1997 Coll., on Nuclear Safety and Radiation Protection Assurance during Commissioning and Operation of Nuclear Facilities,
- No. 214/1997 Coll. , on Quality Assurance in Activities Related to the Utilisation of Nuclear Energy and in Radiation Practices, and Laying Down Criteria for the Assignment and Categorisation of Classified Equipment into Safety Classes,
- No. 195/1999 Coll., on Requirements on Nuclear Installations for Assurance of Nuclear Safety, Radiation Protection and Emergency Preparedness.

In relation to upgrading activities the Atomic Act requires according to § 9 f) a permit/approval issued by the SÚJB for reconstruction and other changes affecting nuclear safety. A permit is issued on the basis of review of documentation submitted by a licensee (description and justification of prepared reconstruction and changes, anticipated time schedule for reconstruction or changes and evidence that the consequence of reconstruction or other changes will not adversely influence nuclear safety, radiation protection or emergency preparedness). Furthermore SÚJB approves up-dated documentation that was approved for commissioning and operation of nuclear installation.

In relation for continued long-term operation a permit/approval issued by the SÚJB is required for restart of a nuclear reactor to criticality following a nuclear fuel reload. The SÚJB can condition its consent with long-term operation by fulfilment of requirements (termination date).

### **2. Do you have a term license (licenses for a fixed period)? If yes, how long and what is the legal basis?**

Under the Atomic Act No. 18/1997 Coll., basic licenses granted by the SÚJB are required for siting, construction and operation of a nuclear installation. No time restriction for operation license is given by the Atomic Act (so it is permanent in the sense of the way of utilisation) but certain individual activities as for instance for restart of a nuclear reactor to criticality following each nuclear fuel reload, reconstruction or other changes affecting nuclear safety etc. require further permits (approvals) for these activities. That means that the licensing procedure, (besides the three basic licenses siting, construction, operation) includes a number of other permits/approvals (“partial licenses”) issued by the SÚJB in accordance with the Atomic Act and implementing regulations during different stages of the service life of a nuclear installation. Documentation required for issue of such permits/approvals is prescribed by the Atomic Act. Both license and a permit/approval issued by the SÚJB can be conditioned by fulfilment of requirements (conditions).

### **3. If you have a limited term licenses, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?**

Please, see item 2

**4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

The first complete reassessment of nuclear safety (innovated Operational Safety Analysis Report - OSAR) was performed after 10 years of operation using advanced state of the art tools and taking into account operational experience and plant modifications. It was prepared by the utility to fulfil one of the conditions of the SÚJB decision (No. 154/1991), which established conditions for continued operation after 10 years. During review process of the OSAR it was checked if using advanced state of the art tools the safety objectives and all of the legal requirements including the requirements of the SÚJB were met. It was also checked if it was accomplished using acceptable analytical methods. The SÚJB also requires for review periodically (once a year) updated "living" operational safety analysis reports and detailed reports concerning ageing of main safety related pieces of equipment (selected construction elements).

Furthermore overall inspection and some specialised ones of preparedness of equipment and personnel for nuclear fuel reloading is performed. The inspection includes machinery systems and components, electrical systems, I& C, compliance with QA program, in-service inspections and tests etc.

**5. How do you develop and update your rules and regulations (i.e., standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

Czech documents needed for the utilisation of nuclear energy can be placed into three main categories (levels) :

- Laws issued by parliament
- Regulations, licenses, permits/approvals and other documents issued by the regulatory body
- Guides and other advisory documents.

Development and updating of rules and regulations is based on our and international experience with respect to Czech cultural background and on comparison with those ones published mainly in the IAEA documents and those ones used in advanced countries. The main principles of above mentioned documents are implemented into Czech rules and regulations. For evaluating and justifying of the current level of safety the IAEA Safety Standards and similar documents are used in preference. (Please, see also item 7).

Czech legislation does not specify in detail technical requirements e.g. for the construction and in-service inspections. For implementing the requirements laid down in laws and regulations, the licensee can refer to non-mandatory technical standards, guides etc. thus making them mandatory for the authorised activities. Applicable codes and standards shall be identified and their use justified. If different codes or standards are used for the same item or area, the consistency between them shall be demonstrated.

For systems, structures and components for which appropriate established codes and or standards do not exist, criteria justified by experience, tests, analysis or a combination thereof must be applied.

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception)**

Mandate and competence of the State Office for Nuclear Safety is provided by the Atomic Act. Above mentioned additional criteria are not in SÚJB competence .

**7. Describe what are the key technical issues related to upgrading and long term operation you are addressing or plan to address.**

The IAEA initiated in 1990 programmes in order to identify major design and operational safety issues in WWER plants. Safety issues are deviations from current recognised safety practices in design and operation judged to be safety significant by their impact on plants' defence in depth. Issues both related to design and operation are ranked according to their safety significance in four categories of increasing severity. The identification of safety issues is based on safety studies conducted by the operators of WWER units and by organisations dealing with these reactors, on safety missions to WWER plants and on information obtained from specialist from various countries during the IAEA meetings. Generally about one half of safety issues of WWER 440/213 plants (from 87 safety issues) and one third of WWER 1000/320 plants (from 84 safety issues) have been identified by operational experience. The remaining safety issues have been identified as deviations from current standards and practices, which have evolved since the WWER NPPs were designed. The reviews of the safety features of WWER plants show that the main safety concept of these reactors is similar to PWR units designed at the same time in other countries. Therefore, the backfitting process is not much different from that which is/was going on in other plants built to earlier safety standards all over the world. This safety issues, their ranking and impact on defence in depth, measures proposed and recommendations are described in documents IAEA-EBP-WWER-03, 1996 and IAEA-EBP-WWER-05, 1996.

The SUJB requires solving all those "generic" safety issues that were not addressed in the original lay out. A significant number of safety improvements are being or have been incorporated into the NPPs' designs already.

**8. Describe what key management issues you are addressing (i.e., organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long term operation.**

Practically all key management roles, duties, etc. (excepting economy) have to be implemented into NPPs' QA programmes which are approved by the SÚJB. The requirements laid down on QA programmes are set in Regulation No. 214/1997 Coll., on Quality Assurance in Activities Related to the Utilisation of Nuclear Energy and in Radiation Practices, and Laying Down Criteria for the Assignment and Categorisation of Classified Equipment into Safety Classes. Observance of QA programmes is subject of numerous SÚJB inspections.

**9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

Up to now deterministic methods are used as a main tool in evaluation of safety. Probabilistic methods are used as a subsidiary tools.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

## FINLAND

### **1. Describe the key elements of your legislation (i.e.; rules and regulations) relevant to upgrading and continued long-term operation.**

The fundamental safety requirements to be continuously fulfilled in use of nuclear energy as well as the licensee-holder's responsibility for safety are manifested in Nuclear Energy Act (990/1987). The Act also describes the licensing procedure for all kind of use of nuclear energy. The Nuclear Energy Decree (161/1988) supports the Act by providing the necessary details for licensing procedure, licensing documentation and e.g. financial provision for nuclear waste management. The Radiation Act (592/1991) and Radiation Decree (1512/1991) were revised in 1991 taking into account the latest ICRP recommendations (1990). The general radiation protection principles and rules of the Radiation Act concerning radiation work are applied to the use of nuclear energy.

The Council of State has issued general regulations on safety of NPPs (395/1991), physical protection (396/1991), emergency preparedness (397/1991), safety of disposal of reactor waste (398/1991) and safety of disposal of spent fuel (478/1999). For continuous upgrading of the safety of NPPs the key element is the Section 27 of the Council of State Decision 395/1991 requiring that "Operating experience from nuclear power plants as well as results of safety research shall be systematically followed and assessed. For further safety enhancement, actions shall be taken which can be regarded as justified considering operating experience and the results of safety research as well as the advancement of science and technology".

STUK issues YVL Guides, which provide detailed safety requirements and advise how to fulfil the mandatory general regulations. These guides are systematically revised in order to address the most recent safety concerns and to reflect the latest knowledge in safety issues. In case of existing plants the new requirements are applied as found necessary on the basis of a separate safety assessment and as provided in STUK's formal decision (for implementation, see also point 5).

### **2. Do you have a term license (licenses for a fixed period)? If yes, how long and what is the legal basis?**

According to the Nuclear Energy Act (990/1987) the operation license shall be granted for a fixed term. When considering the length of the license particular attention shall be paid for ensuring the safety and to the estimated duration of operations. In practice, the duration of operation licenses has varied from 5 years to 10 years. The first OLs were granted for 5 years, after that for 10 years. At the moment Loviisa NPP has an OL for 10 years and Olkiluoto NPP has an OL for 20 years, however, with a special license condition to carry out a Periodic Safety Review after 10 years operation.

The Finnish policy is that there is no fixed predetermined lifetime for a plant. If the technical components are maintained/replaced as necessary to cope with e.g. wearing and ageing, and the plant systems, structures and components are being continuously modernised according to the principle of Section 27 of State Council Decision 395/1991 (see above), the limiting factor for continuation of operation would probably stem from other factors such as political climate or financial profitability considerations of the owners, if e.g. the fulfilment of some new safety requirements or replacement of ageing components would be considered too costly.

**3. If you have a limited term licenses, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?**

The OL can be extended as described in response to question 2. The criteria are presented in nuclear legislation and decisions issued by the Council of State. These basic safety criteria are the same for OL extension as well as for licensing a new plant. When preparing the general regulations for safety of NPPs (395/1991) some provisions were included in these regulations to take into account the older design features of existing plants. These provisions concern the containment and safety system design as well as release limits in case of severe accidents. In practical case, if an existing plant can not meet the latest design requirements given e.g. by an YVL Guide, the safety significance of the deviation will be assessed both deterministically and probabilistically, and to the extent necessary, compensatory measures and systems will be provided to ensure the continuation of safe operation.

**4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

The periodic license renewals, typically every 10 years, are being considered as hold points, at which the inspection and assessment work done during the previous license period is compiled and the overall safety level checked. License renewal is to some extent similar to a PSR, considering the periodicity and contents, however, in our approach the PSRs (or license renewals) are complementary to the ongoing inspection and assessment activities.

The documents submitted to STUK, when relicensing is applied for, include: the final safety analysis report, a PSA report, a QA programme for operation, the technical specifications, a summary programme for in-service inspections, plans for physical protection and emergency preparedness, a programme for the control of nuclear materials, administrative rules for the nuclear facility and a programme for environmental radiation monitoring. When applying for an OL for a nuclear facility that has already been in operation, these documents have to be submitted only to the extent that they have not been submitted before. Because nuclear legislation requires that these are the documents, which have to be updated continuously, in practice only very recent changes have to be reported.

Also, a full coverage comparison with the existing safety requirements (regulations, YVL guides) has to be carried out. When comparing the plant status with the existing regulations, the main emphasis is on accident and transient analyses, which have to be performed again, using updated (state of the art) computer codes and other analysis tools and methods. In case of non-compliance with the existing regulations, justification for continuing the operation has to be presented and/or plans to improve the safety by plant modifications.

**5. How do you develop and update your rules and regulations (i.e., standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

The Section 27 of the State Council Decision 395/1991, as cited above, calls for continuous awareness of the developments of safety research, science and technology as well as consideration of operational experience. The implementation of this rule together with active participation in international co-operation and benchmarking provide a good opportunity to stay informed about the latest knowledge of nuclear safety issues world-wide. This is the basis for continuous updating of STUK's YVL Guides, which usually takes place every 5 - 7 years. According to the internal quality system requirement the first systematic evaluation of needs to update a guide is carried out 5 years after the issuance of the guide. All guides

reaching the age of 10 years are systematically re-evaluated and updated. If determined necessary, any guide can be revised even before the 5-year age.

The nature of legislative documents (acts, decrees, and general regulations) is more stable and the need for updating more rare. The Nuclear Energy Act has been amended 9 times since the original issuance 1987.

When preparing a new regulatory guide the licensees are given the opportunity to present their views on the planned new requirements. Discussions are arranged with the licensees to give them the floor to complement the written opinions submitted. Already during the preparation also a preliminary Impact Assessment is prepared by STUK to evaluate the actions needed for the implementation of the new rule. After issuing a new guide there will be a hearing process first in which the licensees are asked to evaluate the compliance of their existing plants and activities with the new requirements. If deviations are recognised, the licensee shall assess the safety significance of those deviations, and based on that analysis, shall justify the existence of a deviation, make a proposal for plant modifications in order to comply with the new requirement or, propose some other actions necessary to provide an equal safety level as meant in the guide.

STUK carries out its own final regulatory analysis, based on the preliminary Impact Assessment and the analysis presented by the licensee, and issues a separate Implementation Decision on the actions needed at the plant. This decision making is based on deterministic engineering judgement supported by relevant PSA-analysis. A formal cost-benefit analysis is not required nor in use in Finland. No exact risk values are presented in Finnish regulations to justify the continued operation of existing plants. Numeric safety goals exist only for the design of new plants.

For the use of deterministic and PSA methods in safety analysis see the response to question 9.

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception)**

In general, the operation would be stopped if the conditions of the OL (e.g. LCOs) are not met anymore or the assumptions and prerequisites used as a basis for the safety assessment to grant the OL are not any more valid. If not made by the licensee, the decision would be made by STUK on deterministic bases based on a regulatory analysis. PSA -studies would complement the analysis to support the decision making, however, no definite limit values exist in Finnish regulations leading automatically to shutting down a plant. However, some internal guidance exists. The authority to shut down a plant, if the safety would be compromised, is given to STUK through the nuclear legislation.

Basically, the continued operation of a NPP has two prerequisites: it must be profitable and safe. If it is not profitable to the owners, they shut down the plant. On the other hand, if the people would not believe in the safety of a NPP, their representatives in the Parliament could launch an action to cancel the license. If the justification for cancellation would be purely political, and not based on technical safety argumentation the licensee is entitled to a reasonable amount of compensation from the State. The Nuclear Act stipulates that one prerequisite, additional to the safety requirements, for the use of nuclear energy is that "taking into account its various effects, it shall be in line with the overall good of society". A re-assessment of the compliance with this requirement could be used as justification to cancel the OL.

According to the Nuclear Energy Act stopping the operation, cancellation of a license or expiration of its validity shall not release the license-holder, or one who has had a license, from compliance with what has been prescribed in the Act or in the license conditions (e. g. waste management obligation). See also the response to Question 9.

**7. Describe what are the key technical issues related to upgrading and long term operation you are addressing or plan to address.**

The plant life management systems in both Finnish utilities have been developed to support the long-term operation of the plants. In Loviisa the systematic collection of data from inspection, testing, maintenance and repair activities was started in 1995 together with the use of specially designed data systems. For this purpose the plant systems have been classified based on their safety significance in the Technical Specifications, influence on plant production and maintainability. Individuals responsible of prescribed systems follow the ageing of important components in these systems and update the data systems, which are then exploited in planning the future maintenance activities. All major activities are planned in annual meetings attended by organisation units from operation, maintenance and technical support including experts in ageing.

Correspondingly in Olkiluoto responsible persons have been appointed to almost all components. These persons analyse the operational experience of the components, evaluate the need for maintenance and suggest changes and/or improvements. They are supported by specialists of different technical disciplines and also by cross-organisational working groups which can make recommendations for changes and improvements. A development programme to enhance the present maintenance activities is currently in progress. In this programme all equipment locations will be classified based on their risk influence, importance for production, Technical Specifications, maintenance and repair costs and regulatory requirements. The work aiming to a renewed maintenance programme using this classification will be carried out in 2001-02. The existing data systems will be further developed to support this programme.

The maintenance programmes in both utilities are an important source of information for planning the substantial investments for component repairs and renewals carried out annually.

The use of plant specific probabilistic safety analysis (PSA) for directing and optimising pre- and in-service inspections as well as periodical testing is currently being studied through pilot cases. The results of these studies are expected to increase the use of the risk-informed approach in future inspection, testing and maintenance activities.

The work to create the Finnish practices to qualify non-destructive testing systems is going on in a working group formed by the utilities and inspection companies. This work is based on a consensus report by the national nuclear regulators of EU, "Common position of European regulators on qualification of NDT systems for pre- and in-service inspections of light water reactor components", EUR 16802 EN. STUK has set the requirements of this document as the minimum level for qualification in Finland. The process to requalify all inspections according to this "standard" will take years and require considerable effort.

The Loviisa 1 reactor pressure vessel core zone weld was annealed in 1996 due to faster than expected embrittlement. The re-embrittlement after annealing is currently being studied by a specially made surveillance sample material to evaluate whether a second annealing is needed and at what timepoint it would be optimally carried out for long term operation.

One key safety issue that has been addressed in Finnish plants is severe accident management (SAM). Plant-specific SAM strategies have been developed and implementation of dedicated hardware, procedures, as well as backfitting of existing systems to complete SAM implementation, is an ongoing effort at both plants. Advances in research have in a few cases inspired modification of some SAM measures implemented earlier. While the modifications presently underway are believed adequate, the situation will be reassessed periodically according to the national practice of continuous improvement.

During the next 10 years the I&C systems of Finnish NPPs will be refurbished. In the coming modernisation projects new computer based technology will be taken into use in large extent. The introduction of the new technology sets new challenges both for the personnel training, internal procedures and the modification design of the systems. Also accommodation to the new licensing procedures is needed.

During the last 10 years the ageing of the electrical and I&C systems has been systematically followed. However the methods for this follow-up need to be developed continuously. As an example the ageing of the cables inside the containment have been controlled by separate cable samples in certain containment locations. This has turned out to be insufficient because very local hot areas due to defects in the insulation of components have located near the cables. The local hot spot ageing has caused extensive cable changes during the last years inside the containments of Loviisa NPP. Though design changes are in this case necessary to achieve acceptable environmental conditions also new monitoring and ageing follow-up methods are needed to predict the future component replacements in a timely manner.

**8. Describe what key management issues you are addressing (i.e., organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long term operation.**

Justification for the long-term operation is to maintain the adequate safety level at nuclear power plants regardless to the social and economic situation in the country. In this respect the key issue for the regulator is that safety requirements are up to date based on the results of safety research and operating experience, and that adequate national infrastructure (research and education) is in place.

To keep the safety level and safety requirements up to date the key management issue is that regulators, utilities and research organisations have competent personnel. To have and maintain competent personnel requires education in the nuclear field, exchange and documentation of operational experience to the next generation. This means that established infrastructure in the nuclear field is maintained and enhanced.

In order to control the justifications for the long term operation the key issue is that regulator has to be able to adjust its review and inspection practices to the present day situation related to the economic situations in the society and utilities. To perform its actions on stable basis the economic environment of the regulator should also be stable and not related to the economic situation in the society.

It is of utmost importance for the nuclear community to maintain the high level of safety culture in all organisations concerned - including the utilities, regulators and research organisations. The influence of organisational factors on safety has been recognised, and the concept of safety culture must be made concrete and conscious in the every day life of the organisations.

Quality of the work among all relevant organisations/organisational levels is one of the key issues. In past the concept of Quality Assurance was often understood as an external supervision tool of the management. Result of the external control was degradation of the motivation. Quality systems have been improved during the last few years. It seems that the tendency is to give more expectations directly for individual organisational units to perform duties and tasks, and to produce all necessary information regarding work and performance. Development of regulatory requirements including above mentioned performance criteria and indicators are some examples of the development needs.

Privatisation of the electricity production and integration of electricity market gives pressure for reducing the costs of the operation of NPPs. In future it is highly important to maintain the existing level of economical resources (funding) for R&D, operation and maintenance and for regulatory supervision.

## **9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

Plant safety status in terms of both equipment conditions (ageing), as well as the required performance characteristics of safety-related systems, structures and components, are assessed on the basis of deterministic criteria laid out in the YVL Guides. The assessments are based on the current safety standards, which have evolved considerably since the initial licensing done in the context of plant commissioning. On the other hand, the assessment makes use of lessons learned from safety-related research and operational experience (national and international) as well as advances in technology, both in terms of improved safety analysis capabilities and modern equipment. When and where appropriate, plant backfitting or upgrading efforts have been initiated by both the utilities and the regulator.

Plant modifications are licensed on the basis of a pre-inspection package, which is required to contain a safety analysis of the proposed modification. This safety analysis involves both deterministic and probabilistic aspects.

Deterministic analyses consist of calculations of plant behaviour, supported by experiments on key physical phenomena. The calculations may range from simple hand calculation to application of state-of-the-art computational tools. The main result of all deterministic analysis is understanding of the plant and system behaviour, and this understanding is the foundation on which all subsequent applications can be built (e.g. decisions about whether a physical criterion is met, or analyses from a different vantage point, such as probabilistic safety analysis).

Deterministic assessment is complemented by probabilistic safety assessments.

In Finland, plant-specific level-1 and level-2 PSA studies are required by STUK. Plant specific living PSAs have been completed for all operating Finnish plants, including internal initiators, fires, flooding, harsh weather conditions, seismic events for operation mode and internal events for low power mode. These PSA studies are used in support of regulatory decision making and safety management at utilities and at regulatory authority, respectively. The guidelines for applying the Living PSA are set forth in the Guide YVL 2.8 issued by STUK. The Living PSA is formally integrated in the licensing procedure already in the early design and it is to run through the construction and operation phases all through the plant service time.

PSA has been applied much in evaluation of plant modifications. Probabilistic assessment of modification has to be submitted to STUK independent of the Safety Class, which the modified systems belong to. Up to now a number of plant modifications have been performed based on the insights from level 1 PSAs, assigning highest priority to modifications with most risk impact.

In the area of operational events PSA is a standard tool to assess the safety significance of component failures and incidents. Accordingly systematic risk follow-up studies are being made at STUK.

PSA is used to give arguments for relaxing Technical Specifications. In such a case however it is required that the short exceedance of the allowed outage time (AOT) contributes only a tiny increment to the core damage probability compared with normal operation. Furthermore, the meaningfulness of some AOTs given in Technical Specifications has been re-evaluated by PSA techniques. Additional items have been included in the Technical Specifications for Shutdown States, based on results from shutdown and low power mode PSA. For example, STUK set forth a new requirement to keep the lower air lock of the containment closed during the maintenance of main circulation pumps of BWR plants because this task increases the probability of large bottom LOCA of the reactor vessel.

Usually majority of maintenance works is performed during annual overhaul. However STUK allows Preventive Maintenance also during power operation if deterministic criteria are fulfilled (e.g. single

failure criteria). PSA is used to minimise the risk deriving from on-line PM. At the BWR plant it is allowed to take one redundancy out of service at a time for a limited time period. In 1989, the risk contribution of on-line PM was approx. 5 %. Later on the schedule was optimised further and currently the risk contribution of on-line PM to the mean CDF is approximately 1 %.

A project dealing with PSA support to In-Service Inspection (ISI) and In-Service Testing (IST) is in progress. The aim of the project is to explore on how the plant specific PSAs can best be used effecting ISI and IST. The study is aimed to consolidate the use of PSA in the respective regulatory process. The study is also to make the ISI and IST more safety-effective and aside to lessen the unnecessary burden of the licensee.

Guide YVL 2.8 on Risk Assessment sets forth some numerical design objectives for controlling and regulating the designs of possible new nuclear power plants in Finland. The safety objectives are set for the reliability of most important safety functions, core damage frequency and large radioactive release. These criteria are not used as such for operating plants. It is however believed that if operating plants' safety figures will not meet the numerical criteria set for new designs, they will come up with a reasonably high safety level in comparison with the aforementioned criteria thanks to the Finnish practice of continuous re-assessment and safety improvement that has resulted in extensive backfitting and plant modification.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

The international nuclear safety community faces a big challenge in the identification and resolution of safety issues that arise from research or operational experience. This has become a challenge because of the currently prevailing stagnation in nuclear energy; lack of “drive”, together with public acceptance issues and recently coupled with market pressures due to deregulation of the industry, has resulted in an atmosphere where open discussion of actual safety issues has become difficult. A recent example of a novel problem, the ECCS sump performance issue, is discussed below.

*ECCS sump/strainer performance*

The issue is whether post-LOCA coolant recirculation from suppression pool (BWRs) or containment sumps (PWRs) can be guaranteed to a degree comparable to the rest of ECCS systems. Technically, the issue arose when operational experience demonstrated that actual behaviour of insulation materials in LOCA conditions differs from early expectations and widely held beliefs, challenging the coolant recirculation function much more severely than perceived at the time the plants were commissioned.

In regulatory terms the international sump/strainer challenge is now to establish technically sound new sump/strainer design criteria and efficient regulatory guidance, and to review licensee resolution proposals. The regulatory criteria and guidance impact also future reactor designs: current low level of attention on part of some regulators has already resulted in industry unawareness of the issue, and use of outdated design guidance results in equipment and system designs that, in the light of modern data and (still developing) understanding, are substandard or even non-functional. This is detrimental to the future of nuclear technology, all the more so because the sump/strainer issue is technically tractable with reasonable cost.

*Development of the use of Living PSA*

STUK and the utilities (Fortum and TVO) have agreed on how to introduce the Living PSA and to implement the regulatory and plant safety management applications under common procedure. The

guidelines for applying the Living PSA are set forth in the Guide YVL 2.8. In compliance with those guidelines the Living PSA is formally integrated in the licensing procedure already in the early design and it is to run through the construction and operation phases all through the plant service time. Living PSA applications being introduced in Finland include risk informed ISI, IST and Tech Specs.

For further details see the point 9 above.

## FRANCE

**1. Describe the key elements of your legislation (i.e., rules and regulations) relevant to upgrading and continued long-term operation.**

*France's basic nuclear regulation, the 1963 decree related to nuclear facilities, provides a balance between two principles :*

- authorisations delivered to facilities are not time limited, but
- the ministries responsible for industry and environmental risks can at any time ask for an in-depth safety reassessment of any facility

**2. Do you have a term license (licenses for a fixed period)? If yes, how long and what is the legal basis?**

As indicated above, France regulatory practice for nuclear facilities is not based upon limited term licences.

**3. If you have a limited term licenses, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?**

Whenever deemed necessary by the Safety Authority, the nuclear operators are requested to perform an in-depth safety reassessment of their facilities.

Over the past years, this principle has worked on a ten-year periodic basis, but, on a case by case basis, this period could be modified.

**4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

The French notion of "safety reassessment" can be assimilated to a periodic evaluation of overall plant design.

A safety reassessment in France has two main goals :

- check facility compliance with its current safety requirements (e.g. list of equipment deemed to be qualified to design basis accidents);
- assess the need for improvement of safety requirements (e.g. by comparison with more recent facilities of the same kind, by implementation of the results of safety studies especially those regarding external hazards, or by implementation of the results of operating experience) and implement corresponding upgrades.

As regards these two goals, a list of specific design topics is selected (eg., seismic design of anchoring or buildings, robustness of equipment to extreme cold temperatures).

Furthermore, safety reassessments on French 900 MWe PWR plants (at 20 years of age) and safety reassessments of 1300 MWe PWR plants (at 20 years of age) comprise a complementary investigation program of passive components not monitored by existing periodic surveillance programs in order to check the adequacy of these programs.

**5. How do you develop and update your rules and regulations (i.e., standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

- Ministerial orders (eg. for design and operation of the NSSS, for implementation of specific quality assurance requirements in nuclear facilities)
- Basic safety rules (eg. rules for the classification of safety systems, rules for external hazards)
- Plant safety analysis reports (prepared by operator but approved by Safety Authority)
- Letters from Safety Authority on specific safety issues

Furthermore, the operators have developed design and construction codes (eg. on mechanical components, civil engineering, electrical equipment) which are requested to comply with safety regulations.

Ministerial orders are reviewed at a governmental level.

Basic safety rules are updated according to upgrades in technology (eg. development of a new rule on safety software) or improvements in safety studies (eg. revision of a previous rule for the calculation of seismic profile or development of a new rule on the implementation of PSAs).

Basic safety rules are, in principle, enforced without retroactivity to existing plants; nonetheless, enforcement on existing plants of new or revised rules can be decided on a case by case basis. Furthermore, in-depth safety reassessments on existing reactors provide a regulatory framework to perform safety upgrades in comparison with more recent facilities or more recent safety standards.

Basic safety rules modifications, plant safety analysis reports modifications, implementation of results from a safety reassessment process all require the formal consultation of the expert groups which support the French Safety Authority. Therefore, criteria to justify or upgrade the current level of safety of nuclear facilities are defined on a pragmatic way.

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception).**

Nuclear facilities have to comply with the technical criteria set in their “decree of authorisation of creation” (eg. containment leaktightness criterion for PWRs, to be maintained during all plant life). Non compliance would prevent plant operation as long as it is not corrected.

At a lower regulatory level, nuclear facilities have to comply with the criteria set in the safety analysis reports.

Nuclear facilities, of course, also need to comply with waste management and effluent regulations, environmental nuisance regulations and work regulations.

**7. Describe what are the key technical issues related to upgrading and long term operation you are addressing or plan to address.**

Apart from safety reassessment issues dealt with in the previous paragraphs, the French Safety Authority currently focuses on specific topics linked to life management in PWRs :

- a) Close monitoring of ageing of non replaceable components :
  - Core vessel : ageing studies are made by utility (irradiation effects...) to justify long term in-service behaviour. Related to these studies, for 900 MWe PWR reactors, the French Safety Authority accepted in 1999 the validity of the demonstration until the third ten-yearly outage (after 30 years) insofar as some controls are realised and their results are convenient.
  - Containment building : leaktightness and evolution of mechanical properties of prestressed concrete are subject to specific investigations and corrective measures (implementation of a partial liner on some reactors inner containment wall in the case of the 1300 MWe PWR double containment wall design).
- b) Development by operator of replaceability studies as a preventive measure.
- c) Monitoring of I&C upgrades (more linked to obsolete systems than ageing aspects)

Furthermore, with a view to the forthcoming 30 years of operation of oldest operating PWRs (from 2007 on), the French Safety Authority has engaged an assessment of the investigation needs for an overall technical ageing diagnosis of each plant at 30 years.

**8. Describe what key management issues you are addressing (i.e., organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long term operation.**

The French Safety Authority is especially interested in organisational and technical measures taken by PWR operator EDF to address global ageing issues (lessons learned from feedback of experience, specific studies, R&D programs, management of obsolescence issues of components or repair parts and long term management of subcontractors know how).

The French Safety Authority is also monitoring the implementation of EDF action plan to ensure long term sustainability of accident qualification of components.

Finally, the French Safety Authority monitors EDF actions with a view to anticipating possible replacement of sensible heavy components in the framework of ageing management.

**9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

Deterministic methods are used as the counting of thermo-hydraulic transients on passive pressurised mechanical components to be compared to the original design hypothesis.

Probabilistic methods have been punctually used as a tool for ageing management. For example, the content of the complementary investigation program on passive components in the current PWR safety reassessments has been selected through a probabilistic methodology.

Complementary demands as regards the implementation of probabilistic assessments on specific issues are also made in the frame of the safety re-evaluation to derive design or operation safety upgrades.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

The French Safety Authority expects that EDF, during the next years, will assess the lifetime of the most sensible heavy components of its PWRs (apart from NSSS, core vessel and containment building). The results of this assessment will have to be available in due time over the third ten yearly outage, after 30 years of operation.

The content of this assessment (investigation..) will have to be adjusted on the characteristics of each reactor (age, design...).

## GERMANY

### Introductory Remark

The coalition parties of the German Government, the Social Democratic Party and Alliance 90/the Greens, have stated under „modern energy policy” in their coalition agreement that the use of nuclear power is to be phased out in Germany and that the corresponding regulation shall be established during this legislative period. Consensus talks have been conducted with the utilities to achieve this goal without producing calls for compensation.

On June 15, 2000, the Government and the leading producers of electricity achieved a major breakthrough in their negotiations by agreeing on the cornerstones of the phase-out program.

Under the chairmanship of Chancellor Schröder, the Minister for Environment, the Minister of Economics, the head of the chancellery and the COEs of VEBA, VIAG, RWE and EnBW agreed on the following:

#### I. NPP

- a) Basically, the operation time of NPPs is limited to 32 years. However, not the time of operation time per se will be limited, but the remaining amount of electricity to be produced. The total amount permitted is 2623 Tera Watt hours. In case of early closure of elder NPPs, their share can be credited to more modern ones. This results in more economic flexibility for the utilities.
- b) The Government assures during the remaining lifetime of the NPPs that operation and waste management will be free of governmental interference under the provisions that a high level of safety is maintained and the regulatory requirements are fulfilled.
- c) The operation of the disputed NPP Mühlheim-Kärlich will not be resumed.

#### II. Transport of Spent Fuel

In order to avoid transports of spent fuel, the utilities build as soon as possible interim storage facilities at the NPP sites .

#### III. Reprocessing/Direct Disposal

Starting from 01. July, 2005, the removal of spent fuel from the NPPs will be restricted to direct disposal . Until then, transports to reprocessing facilities are permitted

#### IV. Disposal Sites

The investigation of the Gorleben salt dome (all types of nuclear waste) will be interrupted for at least 3 and up to 10 years at the most. During that time the German waste management policy will be reconsidered and new criteria for the selection of appropriate disposal sites will be established. The licensing procedure of the former Konrad ore mine (radioactive waste with negligible heat generation) will be finished according to the legal provisions.

#### V. Costs

Government and utilities understand that there will be no compensation claims.

## VI. Atomic Act

The Government will amend the Atomic Act corresponding to the agreement. In this amendment, PSRs will be introduced as a legal obligation of the licensees.

The new German energy policy will not affect Germany's responsibility regarding its international obligations and does not reduce the efforts towards nuclear safety, at least as long as nuclear power plants will be operating in Germany".

### **1. Describe the key elements of your legislation (i.e.; rules and regulations) relevant to upgrading and continued long-term operation.**

The Legislative and Regulatory Framework is described comprehensively in the German National Report under the Convention on Nuclear Safety [1].

The following key features shall be mentioned here:

- The Federal States (Länder) are responsible for licensing and supervision of nuclear installations. The Federal Government supervises the Länder to achieve nationally uniform practices.
- The German nuclear safety regulations are hierarchically structured with the Atomic Energy Act at the top followed by ordinances, general administrative provisions, regulatory guidelines, nuclear safety standards and recommendations from advisory bodies .

The basic requirements regarding the licensing of nuclear installations are laid down in the Atomic Energy Act. According to Section 7 of this Act, a licence is required for the construction, operation or any other holding of a stationary installation for the production, treatment, processing or fission of nuclear fuel, or for essentially modifying such installation or its operation. A licence may only be granted if the applicant meets the individual requirements that are spelled out in Section 7 Atomic Energy Act as licence prerequisites:

- trustworthiness and qualification of the responsible personnel,
- necessary knowledge of the otherwise engaged personnel regarding safe operation of the installation,
- necessary precautions against damage in the light of the state of the art in science and technology,
- necessary financial security with respect to legal liability for paying damage compensation,
- protection against disruptive actions or other interference by third parties,
- consideration of public interests with respect to environmental impacts.

Even if the prerequisites are fulfilled the regulatory authority is not obliged to grant the license.

A special aspect of the prerequisites for obtaining a license in Germany is that the measures regarding precaution against damage must correspond to the state of the art in science AND technology.

According to the existing Atomic Energy Act licenses for nuclear power plants have to be issued without time limitation. The government plans to amend the law by introducing a maximum operating period of 30 years.

Over their entire lifetime, from the start of construction to the end of decommissioning, nuclear installations are subject to continuous regulatory supervision in accordance with the Atomic Energy Act and accessory nuclear ordinances.

The supervisory authority pays particular attention [1] to

- the compliance with the provisions, obligations and ancillary provisions imposed by the licensing notices,
- the compliance with the requirements of the Atomic Energy Act, the nuclear ordinances and the other nuclear safety standards and regulatory guidelines, and
- the compliance with any supervisory order.

These aspects are key criteria for operation and have to be complied with at any time. Justification of long term operation is provided in this way.

The supervisory authority - if necessary assisted by authorised experts or other authorities - monitors in particular:

- the compliance with the operating instructions,
- the performance of in-service inspections of components and systems important to safety,
- the evaluation of reportable events,
- the implementation of modifications in the nuclear installation or its operation,
- the radiation protection monitoring of the nuclear power plant personnel,
- radiation protection monitoring in the vicinity of the nuclear installation, including the operation of the independent authority-owned remote surveillance system for nuclear reactors,
- compliance with the prescribed limits for radioactive discharge,
- the measures taken against disruptive actions or other interference by third parties,
- the trustworthiness and qualification and the maintenance of the qualification of the responsible persons as well as of the knowledge of the otherwise engaged personnel in the nuclear installation,
- the quality assurance measures.

According to the Atomic Energy Act, the authority officials as well as the authorised experts working on behalf of the supervisory authority have access to the nuclear installation at all times and are authorised to perform necessary examinations and to demand pertinent information.

Decisions for upgrading have on the one hand been driven by the need to meet the mandatory safety criteria, for example after a safety related shutdown as a prerequisite for restart or in anticipation of problems. On the other hand, upgrading has been conducted to enhance plant safety in order to bring the safety level closer to modern standards without immediate obligation of the licensee but rather as an expression of his commitment to safety. Both motivations, problems and commitment to safety, have been present in safety related decision making.

The following table gives an overview of the main technical modifications important to safety, broken down with regard to the four design generations of PWRs and the two construction lines of BWRs [1].



**2. Do you have a term license (licenses for a fixed period)? If yes, how long and what is the legal basis?**

No, according to the existing Atomic Law licenses for nuclear power plants have to be issued without time limitation. However, the Federal Government plans to introduce license terms for the existing NPPs by an amendment of the Atomic Energy Act. The length of the term will be arranged in the legislative process.

**3. If you have a limited term licenses, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?**

As pointed out in the answer to question 1, in the frame of continuous supervision it is checked from the regulatory side that the conditions of the license are fulfilled during operation. The associated yearly effort per unit on the regulatory side is typically around 30 man-years including assistance by technical experts.

Measures for maintaining quality over a long time period (ageing management) have been an integral part of the quality requirements specified in German nuclear safety regulations from the very beginning [1].

Comprehensive measures are employed in German nuclear power plants to counter unacceptable effects from ageing. These measures are, in particular:

- the consideration of current knowledge on ageing during design, manufacturing and inspection of technical equipment,
- the monitoring of equipment and operating conditions with respect to detecting any deterioration important to safety,
- the regular replacement of parts known to be susceptible to failure by preventive maintenance,
- an upgrading or replacement of technical equipment in case weaknesses important to safety are found
- the optimisation of technical equipment and of operating conditions,
- continuous evaluation of operating experience, implementing findings of the feedback of experience,
- acquisition and maintenance of personnel qualification at a sufficient level.

This practice is being supplemented by appropriate research and development work.

The results achieved with respect to reliable and sound operation confirm the effectiveness of the measures taken.

In 1988, the German Reactor Safety Commission recommended, as a complement to the continuous regulatory supervision process, to make every operating nuclear power plant subject to comprehensive safety reviews at time intervals of about 10 years. The purpose of these Periodic Safety Reviews (PSRs) is to check that sufficient precaution has been taken against damage on the basis of the state of science and technology. If necessary, remedial measures have to be determined to enhance safety. PSRs are being conducted under the utilities' responsibility and reviewed by the competent supervising Federal State authorities. Up to now, PSRs have been carried out on a voluntary basis. They were scheduled to begin with the older plants and are presently being completed with the most modern (Konvoi) plants. The Government plans to amend the Atomic Energy Act by introducing the obligation of the licensees' of nuclear power plants to carry out PSRs.

It is emphasised that PSR is seen as a complementary measure to continuous supervision. It is supposed to provide a more integral view of plant safety at periods of 10 years. PSR certainly contributes to the evaluation of long-term operation but it has not been introduced for this purpose.

**4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

Essential elements of the PSR - introduced in the answer to question 3 - are a deterministic analysis including an evaluation of the overall safety status and the operational experience of the plant, and a probabilistic safety assessment. This means that the PSR is not only directed to the evaluation of the design, it assesses the full safety status of the plant including operational experiences.

For the different elements of PSR regulatory guides have been filed by BMU after discussion in the Federal States Committee for Atomic Nuclear Energy:

- The guide on basic principles of PSR provides fundamental guidance and addresses the overall evaluation of the different types of analyses.
- The guide on safety status analysis provides the fundamental requirements for the protective goal oriented analysis required in the frame of the safety status analysis.
- The regulatory guide on PSA sets out the fundamental requirements concerning the performance of PSAs. The guide is supplemented by two technical documents treating the details on the methods and data to be used in PSAs. At present, probabilistic safety analyses of PSRs are of Level 1+ (i.e. Level 1 plus active containment systems but without consideration of core degradation). Thereby the active engineered design safety features are covered exhibiting the well balancedness of the design or possible vulnerabilities.

**5. How do you develop and update your rules and regulations (i.e., standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

At the different levels of the hierarchy of legal prescriptions and regulatory guidelines, guides and standards addressed under the answer to question 1 the system of rules and regulations is developed to reflect the state of science and technology. For example, the nuclear safety standards (KTA) are reviewed every five years for the need of updating.

The safety assessment as conducted in the frame of PSR is based on the following criteria:

- Does the evaluation of operational experience exhibit a sufficient reliability of the respective system?
- Have vulnerabilities and/or non-balancedness been identified in the safety concept?
- Are the proofs that the design basis accidents are controlled by the engineered safety features still valid, reflecting the present state of science and technology. Do the safety features exhibit the required effectiveness and reliability for all plant states to be considered?
- Do technical equipment and measures exist to manage beyond design basis accidents, i.e. preventing core melt and/or mitigating their consequences?

In the assessment of the plants' safety status the role of PSA is supplementary to the deterministic evaluation. By comparing the frequencies of event sequences or groups thereof leading to plant states that are not controlled it is possible to detect vulnerabilities and to assess the balance of the safety concept. PSA results can underpin decisions on the necessity and urgency of safety improvements.

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception)**

In the case of non-compliance with respect to legal provisions or to requirements of the licence permit and also if health or property of third parties is endangered, the competent supervisory authority of the Federal State (Land) is authorised by Section 19 Atomic Energy Act to issue orders

- to apply specified protective measures,
- to store radioactive materials at a place prescribed by the authority, or
- to interrupt the handling of radioactive materials, the construction and operation of nuclear installations temporarily or - in case of a revocation of the licence - to suspend it permanently.

As already pointed out in the introduction public perception with respect to nuclear power has contributed to the political decision to phase out nuclear power. However, public perception is not considered to be a regulatory criterion when deciding about the shut down of a plant.

**7. Describe what are the key technical issues related to upgrading and long-term operation you are addressing or plan to address.**

It was already pointed out in the answer to question 3 that upgrading occurs to correct weak points or to adapt the plants to the state of science and technology and that measures are in place which successfully deal with ageing. The key elements of the German approach to identify technical issues of relevance for long-term operation are:

- Continuous evaluation of operating to identify changes in the reliability of systems, components and structures.
- Extended plant monitoring to enhance the understanding of system behaviour and load conditions of the components.
- Evaluations of safety margins for lower bound conditions by experimental and/or analytical research and development programs.
- Generic studies to identify areas of weak knowledge respectively potential future problems.
- Early replacement of components potentially sensitive to degradation in order to enlarge safety margins.
- Updating technical requirements in codes and standards to avoid repetition of non-optimised technical solutions.

Technical aspects that have been considered recently with view of long term operation include pre-stress effects, thermal ageing of martensitic Cr-steel, radiation induced material changes, requalification of I&C under accidental conditions, ageing of electrical components - especially cables - , influence of thermal stratification on pipes, austenitic steel (remaining plant life test, weld simulation, low temperature sensitisation) and crack initiation and growth in ferritic and austenitic steels. In some cases, extended monitoring was introduced for early detection and timely response.

Furthermore, many plants have decided to carry out safety improvement measures to reflect the insights gained in periodic safety review or are in the process of doing so.

**8. Describe what key management issues you are addressing (i.e., organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long-term operation.**

Organisational matters and questions of personnel qualification and training are seen as very important to plant safety. There are KTA safety standards (KTA: Kerntechnischer Ausschuss, Nuclear Standards Committee) pertaining to administrative provisions. Section 7 of the Atomic Energy Act specifies the prerequisite that a license for the construction and operation of a nuclear power plant shall only be granted if the persons responsible for construction and operation have the necessary qualification. Likewise, the personnel otherwise engaged during operation must have the necessary knowledge with respect to safe operation, possible risks, and relevant protection measures. Furthermore, there shall be no doubts as to the trustworthiness of the personnel. Accordingly, proof of the qualification of the responsible personnel as well as of the necessary knowledge of the personnel otherwise engaged during operation must already be included in the license application for construction, operation or essential modifications. Detailed regulations are in force on qualification, especially of the responsible shift personnel including training requirements to maintain qualification.

In the frame of the project KTA 2000 a set of basic KTA rules is presently being developed. Among these is a rule on „Personnel and Organisation” which is related to questions of safety culture, human factors, qualification and organisation.

Economic deregulation, maintaining competence and extended use of subcontractors are seen as challenges to the regulator, which might become more serious in the future. It will be the task of supervision to make sure that even under such circumstances rules and regulations are complied with. The instruments described in the answer to question 6 are available for the case of non-compliance. This implies that the justification for long-term operation is provided by the continuous control in the frame of supervision.

**9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

In the answer to question 5 it was described how the insights from deterministic analyses and PSA are integrated in an overall decision making process.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

Beyond the measures described in the answers to questions 1 to 9 no additional regulatory issues are seen.

*References*

[1] The Federal Minister for the Environment, Nature Conservation and Nuclear Safety: Nuclear Safety in Germany Report under the Convention on Nuclear Safety for the First review Meeting in April 1999 September 1998, <http://www.bmu.de>

**HUNGARY****1. Describe the key elements of your legislation (i.e., rules and regulations) relevant to upgrading and continued long-term operation.**

The key elements of Hungarian legislation concerning the long term operation of NPP-s are included in §11. of Government Decree 108/1997 (VI. 25) Korm.on the Procedures of the Hungarian Atomic Energy Authority in Nuclear Safety Regulatory Matters

## § 11.

- (1) HAEA NSD shall conduct nuclear safety inspections in nuclear facilities within ten years from the first day of validity of the first operation permit granted for initiating operations, and every tenth year after that.
- (2) In respect to nuclear power plants with more than one individual operation permit, the inspection may be carried out jointly, in observation of regulations set forth in Subsection (1), for the units (blocks) containing independent nuclear reactors.
- (3) Licensees shall conduct internal inspections at least one year prior to the date determined for the inspection and shall submit periodical safety reports to HAEA NSD on the results of such inspections.
- (4) In the periodical safety reports licensees shall demonstrate all factors that determine the facility's operational risk compared to the provisions of the final safety report serving as basis for the operation permit.
- (5) When needed, licensees shall take measures to increase safety and to eliminate or reduce risk factors. Licensees shall also prepare a program, including performance deadlines, as part of the periodical nuclear safety report defined in Subsection (3) and submit such to HAEA NSD.
- (6) HAEA NSD shall pass a resolution, on the basis of the licensee's periodical nuclear safety report and on the basis of the findings of its own periodical nuclear safety inspection, to specify the conditions of further operations. Reviewing the periodical safety report shall be accomplished during the operation licensing procedure.
- (7) The content and formal requirements of periodical safety reports are set forth in the Regulations.

**2. Do you have a term license (licenses for a fixed period)? If yes, how long and what is the legal basis?**

Formally legal basis for a fix period of licences was excluded of the new Atomic Law and its executive rules, but most of safety related equipment have a limited operation term (mainly 30 years and 40 years for the RPV), established by manufacturer and included in the Final Safety Analyses Report, which serves as a basis for the operational licence. The renewal of terminated licences is possible on request of the Licensee according to §14. of Atomic Law.

**3. If you have a limited term licenses, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?**

The criteria of the long-term operation licence are written in paragraph 1. The detailed requirements for the Periodic Safety Review can be found in attachment of the Safety Code Nr. 1, which is an appendix of aforementioned Governmental Decree.

**4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

The overall plant design is periodically evaluated besides PSR during the assessment of FSAR, which should be upgraded according to §5. of Governmental Decree. The requirements of FSAR can be found in the attachment of the Safety Code Nr. 1 (they comply with the requirements of US. NRC's Reg. Guide 1.70.)

**5. How do you develop and update your rules and regulations (i.e., standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

Regulations (Safety Codes) were issued as attachments to Governmental Decree. Their use and revision is regulated by the Decree as follows:

§ 3.

(1) The types of regulatory permits of HAEA NSD, the detailed licensing procedure, nuclear safety requirements and the Nuclear Safety Regulations (hereinafter referred to as "Regulations") governing the order of inspections are contained in Attachments 1 - 5 to this Decree.

(2) Satisfaction of the safety requirements prescribed in the Regulations is a prerequisite for the issuance of a regulatory license. If the licensee ensures nuclear safety in ways other than described in the Regulations, during the regulatory procedure, it shall prove conformity, or an equal or greater degree of safety for the selected method - supported by an expert opinion.

(3) HAEA NSD may prescribe conditions in order to enforce the requirements specified in the Regulations.

(4) The Regulations shall be reviewed, and updated as needed, once in every five years, with regard to scientific achievements and international experience.

The application of new regulations to existing plants are regulated by Decree:

(5) With regard to nuclear facilities already in operation, if the provisions of this Decree differ from previous ones or if this Decree sets forth new requirements, complete or partial enforcement of the new requirements or provisions shall be accomplished during the next periodic nuclear safety inspection or if so initiated by HAEA NSD. For enforcement, the risks caused by the deviation shall be examined and evaluated. The extent and schedule of the measures necessary for the enforcement of newly enacted requirements shall be determined and executed on basis of the significance of discrepancies for safety reasons. In the process of full or partial enforcement of the requirements and provisions, to have uniform nuclear safety requirements applied within the nuclear facility must be taken into consideration

Besides regulations (Codes) there are regulatory guides for definition of the methods of fulfilling the requirements, prescribed by Codes. The guides are issued by the Director General of Hungarian Atomic Energy Authority, they can be changed or reissued as necessary.

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception).**

There are no specific criteria that would not allow continued operation. There are only requirements for operation. If these requirements are not met and no opportunities for necessary upgrading in due time, the operation will be stopped by Regulatory Body.

**7. Describe what are the key technical issues related to upgrading and long term operation you are addressing or plan to address.**

There is a huge program of safety upgrading measures for complying with new regulatory requirements, which is approved (or prescribed) by the Regulatory Body in the licence of operation after the PSR.

**8. Describe what key management issues you are addressing (i.e., organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long term operation.**

The Licensee's organisation and its changes are submitted to regulatory approval. The requirements to the organisation of the Licensee can be found in Safety Code Nr. 4. (Operation). The competence of personal is inspected through approval of qualification requirements and participation in the exams. The qualification of possible subcontractors of the Licensee used to be performed by the Regulatory Body at the earlier stage. Now it is the right of the Licensee under control of the Regulatory Body (including documentation control and participating in some audit processes). With regard to economic deregulation there are important prescriptions in the new Atomic Law e.g.

Section 63

(1) The licensees are obliged to cover the costs of the final disposal of radioactive waste, as well as of the interim storage and final disposal of spent fuel, and of the decommissioning (demolishing) of nuclear facilities by contributing to the Fund.

(2) In the case of nuclear facilities, the amount of payment shall be determined in a way that it fully covers all the costs arising as a result of the final disposal of radioactive waste and of the interim storage and final disposal of spent fuel generated during the total operating period of the facility and at the time of decommissioning, as well as all the costs related to the decommissioning of the nuclear facility.

Section 10

(1) Users of atomic energy are responsible for the safe application of atomic energy and compliance with safety requirements.

(2) The licensee - in its scope of activity - is obliged to provide the technical, technological, financial and personnel conditions required for the safe use of atomic energy and for maintaining and developing safety, and furthermore to monitor continuously the radiation conditions in accordance with the most recent certified results of science, international expectations, as well as experience. The general public shall be informed regularly - at least on a monthly basis - about results of monitoring the environmental radiation conditions.

(3) The licensee is obliged to undertake continuous activities to upgrade safety, taking into consideration its operational experience and new knowledge regarding safety.

**9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

The Regulatory Body relies on deterministic methods in its evaluation as a basic approach. However the probabilistic methods are also used for supplementary information to analyses. The Licensees are encouraged by the Regulatory Body in use of probabilistic methods first of all for rating different risk contributors and prioritising of upgrading measures.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

There is a need in elaboration of detailed guidelines of ageing management, qualification of equipment, evaluation of physical conditions of aged equipment and in general of the life extension and licence renewal process.

## JAPAN

**1. Describe the key elements of your legislation (i.e.; rules and regulations) relevant to upgrading and continued long-term operation.**

In Japan, electric utility companies take initiative in exercising their own judgement and taking responsibility to realise continuation of operation for a long period as well as enhancement of operating performance. Law or regulation does not particularly provide such an initiative.

**2. Do you have a term license (licenses for a fixed period? If yes, how long and what is the legal basis?)**

There is no legal or regulatory provision on the term of operating license for nuclear power plants in Japan. They are, however, subjected to periodical inspections once in every 13-month of operation, in which MITI inspections are enforced.

**3. If you have a limited term licenses, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?**

A term of operating license is not particularly provided in Japan. The reason for absence of term provision is that periodical inspection in 13 months of operation is mandatory, and integrity of plant equipment, etc. is always confirmed by this inspection.

**4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

Evaluation and verification are performed by periodical safety review and periodical inspection.

**5. How do you develop and update your rules and regulations (i.e., standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

In the review and discussion of the nuclear power plant ageing issues that had been conducted in relation to compilation of a report named 'Basic Concept of Dealing with Nuclear Power Plant Ageing', published in April, 1996, it has been understood to prepare a set of technical standards dealing with plant ageing (which will provide maintenance criteria to determine whether an existing fault need not be evaluated, or, if it need to be evaluated, whether the subject component should be repaired or it can be placed in service without repair, and so forth).

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception)**

There is no regulatory criterion for licensing of continued operation. The continued operation, however, may not be permitted if any outcome in periodical inspections, which are performed in every 13 months, is *not satisfactory*.

**7. Describe what should be the key technical issues you are addressing or plan to address.**

In evaluation studies conducted up to the present time, in which evaluations were performed for a postulated operating term of 60 years, a loss of function or seismic safety of components and/or structures due to emergence of ageing phenomena can be prevented by implementing current maintenance activities, (such as operation monitoring, routine patrolling inspections, periodical tests and inspections, repair and replacement works as preventive maintenance measures, prevention of event recurrence, replication by similarly designed plants, etc.)

If a problem to be dealt with is found by evaluations and/or analyses in relation to future periodical safety review or periodical inspection, or new interpretation is introduced by technology development and other progress, such problems will be taken into account.

**8. Describe what key management issues you are addressing (i.e., organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long term operation.**

Although this is not directly related to the validity of long-term continued operation, it is being planned to improve the management by enhancing the periodical inspection practices, conducted in every 13 months, to incorporate plant-ageing points of view.

The electric utility companies formulate long-term maintenance plans. MITI requests their maintenance practices in relation to these long-term maintenance plans, as well as the performance of routine maintenance, during periodical, in order to confirm, as appropriate, whether such utility plans are properly implemented.

**9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

Current evaluation practices are fundamentally based on deterministic methodology. That is, the evaluation is conducted on the information obtained in reference to past examples and the most advanced knowledge. If it were deemed based on future new knowledge that certain issues should be treated by probabilistic methodology, such methodology would be adopted in a flexible manner.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

At present, it is deemed that the issues related to plant ageing are within the scope of our current projections, and there are no particular problems that have to be urgently dealt with. If new problems are recognised in future in reference to newly acquired knowledge, appropriate measures will be promptly incorporated.

*Note: 1999 Report on Assessment of Ageing Countermeasures of Electric Utility Companies for Nuclear Power Plants and Future Approaches to Management of Plant Ageing was distributed at Meeting.*

## MEXICO

### **1. Describe de key elements of your legislation (i.e. rules and regulations) relevant to upgrading and continued long-term operation.**

The most important document in the legislation as regards to the operation of power nuclear reactors is the Ruling Law on Nuclear Energy of the Constitution of Mexico in its Article 27 which states: the use of nuclear energy for power generation purposes is given only to the state through the state owned utility Comisión Federal de Electricidad.

Specifically, in reference to applying measures to enhance the safety level of the plant (upgrading), the most important legal document is the set of requisites attached to the Operation License which for the case of Laguna Verde NPP in its paragraphs No. 3 and No. 5 indicates :

- The utility has to follow all approved regulations in nuclear, radiological and physical safety of the International Atomic Energy Agency (IAEA) and the regulation of the country of the nuclear reactor vendor. For the case of Mexico, both nuclear power reactors were designed in the United States of America, therefore the 10 Code of Federal Regulations part 50 (10CFR50) was adopted.
- There has to be a continuous feedback of international and national operational experience related to the implementation of modifications to the regulation which the regulatory body considers appropriate for a better protection of the environment, and the safety of the public. Furthermore, every 10 years the utility has to submit a global evaluation of the safety status of the nuclear power plant including that of the radioactive waste.

Regulation relevant to the continued long-term operation has not been directly addressed because both nuclear reactors at Laguna Verde NPP has only few years of operation, but it is very likely that the approach taken in the future in this matter will be consistent with the used in 10CFR Part 54 Requirements for Renewal of Operating Licenses for Nuclear Power Plants.

### **2. Do you have a term license (licenses for a fixed period)? If yes, how long and what is the legal basis?**

Yes, both nuclear reactors at Laguna Verde NPP have a license to operate for 30 years.

The legal basis is the Operating License given by the Ministry of Energy with the technical advise of the regulatory body.

### **3. If you have a limited term licenses, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?**

We have not addressed this issue yet, because of the short time of operation, but as it was described in the answer to question No. 1, it is very likely that the approach taken in the future will be consistent with 10CFR Part 54.

**4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

Yes, currently both the utility and the regulatory body are in the process of the first periodic evaluation of overall plant design. This evaluation covers most of the topics addressed in the Final Safety Assessment Report. This periodic safety evaluation is not related to the long-term operation but to an Operation License requisite.

**5. How do you develop and update your rules and regulations (i.e. standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

*In order to develop and update our rules and regulations, we use international and national operating experience and follow closely documents issued by the United States Nuclear Regulatory Commission (USNRC), other regulatory bodies and the IAEA. Examples to be used as regulatory documents are Generic Letters, Bulletins, Regulatory Guides from the USNRC, and Safety Guides from the IAEA. Typical safety issues taken from the international operating experience are: Power oscillations in Boiling Water Reactors (BWRs), Strainers of ECCS, Reactor Water Level Instrumentation in BWRs. We use the same type of regulation enforcement as the USNRC.*

Currently we are in the process of conducting the ten year Safety Periodic Review of Laguna Verde NPP Unit 1; where one main activity is precisely re-assess and update the rules and regulations.

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception)**

No there are not any specific regulatory criteria as regards for not allowing continued operation. However, public perception, financial motives or national energetic policy could have an impact in any decision as to continue operation beyond that already licensed.

**7. Describe what are the key technical issues related to upgrading and long term operation you are addressing or plan to address.**

Technical issues being addressed related to upgrading are: Computer Software and Hardware maintenance, and implementation of the Maintenance Rule. We expect to address more key technical issues as a consequence of the ten year Periodic Safety Review of Laguna Verde NPP Unit 1.

**8. Describe what key management issues you are addressing (i.e., organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long term operation.**

We expect to address these points after reviewing the results of the ten year Periodic Safety Review of Laguna Verde NPP Unit 1.

**9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

We have licensed the operation of both units at Laguna Verde NPP using deterministic methods. Currently probabilistic methods are being developed for safety assessments. We use probabilistic methods only as complementary information; we still regard deterministic methods as the basis for our safety evaluations. We expect to use the same approach for the case of long term operation.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

Regulatory issues we believe should be addressed include for example: environmental equipment qualification, materials surveillance programs, new technologies (software and hardware equipment). We expect to gain more insight in these matters once we conclude the evaluation of the ten year Periodic Safety Review of Laguna Verde NPP Unit 1.

## THE NETHERLANDS

### *General Remark*

Since March 1997 there is in the Netherlands only one operating nuclear power reactor. The operation of this reactor will stop in the year 2003 after an operating lifetime of 30 years. The final shut down is based on a license condition that was introduced some years ago. The formal appeal procedures have not yet come to an end, but given the political situation there is not much hope for a continuation after 2003.

As a result of this situation there is no discussion at all about Life Extension of nuclear power plants in the Netherlands.

### **1. Describe the key elements of your legislation (i.e., rules and regulations) relevant to upgrading and continued long-term operation.**

In general the law does not give a basis for in time restricted licenses. Originally the license was without a time limit. However the license does contain now a condition that requires the licensee to evaluate after 10 years time interval the installation taking the current safety regulations and state of the art technology as a reference.

### **2. Do you have a term license (licenses for a fixed period)? If yes, how long and what is the legal basis?**

See previous question

### **3. If you have a limited term licenses, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?**

Periodic reviews after 10 years time intervals.

### **4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

The evaluation is a true integral safety evaluation comprising not only the design aspects but also the personnel, the organisational and administrative aspects. Ageing evaluation is also included.

### **5. How do you develop and update your rules and regulations (i.e., standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

On the occasion of these 10-yearly evaluations the non-compliances with current regulations are judged with regard to their importance to safety. On the other side of the balance is the cost of improvement measures. In a sort of matrix with various classes of safety importance and various levels of expenditures decisions can be taken on the necessity or justification of improvement measures. More of an absolute is the consideration that non-compliances that lead to a core damage frequency higher than  $10^{-4}$  /year are not permissible.

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception).**

Probabilistic Radiological acceptance criteria exist which shall be satisfied. Maximum allowable individual risk due to accidents must be smaller than  $10^{-6}$ /year, the max. allowable group risk is 10 casualties within few weeks with max. probability of  $10^{-5}$ /year (100 casualties,  $10^{-7}$ /year)

**7. Describe what are the key technical issues related to upgrading and long term operation you are addressing or plan to address.**

At present no project for upgrading. Depending on the future of the only remaining NPP.

**8. Describe what key management issues you are addressing (i.e., organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long term operation.**

At present no project for upgrading. Depending on the future of the only remaining NPP.

**9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

At present no project for upgrading. Depending on the future of the only remaining NPP.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

Organisational structure and means provided by that to **continue** to improve the level of safety where reasonably possible in stead of routinely fulfilling the requirements (safety culture).

**SPAIN**

**1. Describe the key elements of your legislation (i.e.: rules and regulations) relevant to upgrading and continued long-term operation.**

The recently updated Royal Decree 1936/1999 Governing Nuclear and Radioactive Installations, approved 3<sup>rd</sup> December, 1999, establishes the system for the licensing of nuclear installations, in development of the Nuclear Energy Act and the Nuclear Safety Council Charter Law.

Specifically the afore mentioned regulation establishes that the operating permits are granted for the periods defined in the license itself, and the Ministry of Industry and Energy is provided with the Faculty of imposing new license conditions or modifying the existing ones.

The approach which has been defined it is to grant the operating permits for a ten years period, after the successful realisation and assessment by the regulatory body of a Periodic Safety Review (PSR), which is required in the license conditions to be presented one year before the expiration of the operating permit.

Spanish nuclear power plants (NPPs ) have in their license a requirement to analyse the applicability of changes in the regulations of the countries from which their basic technology has been imported. The on-going process in the United States to extend the operating permit of NPPs beyond the forty years period, according to the 10CFR54, is being followed by the utilities and the CSN and will provide guidance on the *potential life extension of the Spanish NPPs*.

**2. Do you have a term license (licenses for a fixed period)?. If yes, how long and what is the legal basis?**

Spanish NPPs have at the present time operating permits ranging from five years (plants which have been requested to prepare their first PSR) to ten years (plants whose PSR has been completed successfully).

There is no fixed term license in our regulations, as explained in the answer to question 1.

**3. If you have a limited term licenses, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?.**

The operating permits will have in a near future an standard term of ten years. Their renewal for a new term will be based mainly in the results of the evaluation by the regulatory body of a Periodic Safety Review. Increased requirements in the Periodic Safety Review scope are foreseen when the new license enables the plant to operate beyond its design life.

**4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?.**

No. An special review and updating of the design bases was initiated in 1997 for all the Spanish nuclear plants, with the intent of leaving in place reliable mechanisms to keep up to date design base information and the Final Safety Analysis Report. This review is expected to be completed in year 2000 for all the plants.

**5. How do you develop and update your rules and regulations (i.e., standards, requirements, etc.)?. How do you apply these on existing plants?. What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards).**

Spanish rules and regulations are updated to take into account the emerging safety issues and the need to clarify or improve the regulatory oversight process. By a license condition all the licensees are required to analyse the applicability to their plant of new regulatory requirements to similar plant in the country from where the basic technology was imported.

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception).**

Licensed plants can operate from safety standpoint while complying the license conditions, the Technical Specifications and the connected surveillance program. The need for equipment refurbishment, design improvements or additional surveillance which a new license term can involve, specifically when going beyond the design life, can force based on financial considerations the cease of operation.

From the utility standpoint financial criteria are considered of main importance when a decision for continued operation should be taken. From January 1998 an economically deregulated market for electricity prohibition is in force in Spain. In this situation only competitive sources of energy will remain in operation in the long-term. NPP continued operation will depend on whether they are competitive in comparison with continued cycle gas and fuel plants

From the political (public perception) standpoint recently one out of the two main political parties in Spain has included in its election program, decommissioning of all a Spanish NPP as a goal in a 15 years time frame.

**7. Describe what are the key technical issues related to upgrading and long term operation you are addressing or plant to address.**

The areas of review of Periodic Safety Reviews are:

- a. operating experience analysis and trends (including the radiological impact).
- b. equipment behaviour (in-service testing, in service inspection, plant life management program).
- c. new regulations and regulatory requirements (both national and in the country of origin of the technology).
- d. on-going and foreseen safety improvement programs.

When plants are applying for license renewals where the plant will go over design time, area b) above is foreseen to be the most critical one. Programs which all the plants have in place to manage the useful life of their components and structures according to a nationally developed methodology, will play a central role to that purpose.

**8. Describe what key management issues you are addressing (i.e., organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long term operation.**

Management issues and specifically the one on maintaining competence will be key factors to consider in the regulatory oversight of all the operating plants and when evaluation license renewals.

**9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

Spanish NPPs have completed detailed plant specific PSAs level 1 and 2 which are being used for different applications under preparation or completed:

- In-service testing.
- In-service inspection.
- Graded QA approach.
- Modifications of Technical Specifications.
- Deviations from modern standards.

Probabilistic methods are used to complement deterministic methods in the assessment of Spanish NPPs safety.

Probabilistic methods have been introduced in Spain as early as in 1986 when a systematic program for Spanish NPP to perform and apply PSA was established by CSN. Up to now probabilistic methods are being used as a complementary approach to deterministic methods traditionally applied for plant design, construction and operation.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

Main regulatory issues to address concerning upgrading and long term operation are:

- Ageing of components (degradation mechanisms and surveillance).
- Maintaining technical competence.

**SWEDEN***General Remarks*

Many answers to the Swedish situation are found in the new regulation “The Swedish Nuclear Power Inspectorate’s Regulations Concerning Safety in Certain Nuclear Facilities”, SKIFS 1998:1, effective by July 1 1999. The code has a regulative part and a part with general recommendations. (The whole regulation is found at [www.ski.se](http://www.ski.se) )

**1. Describe the key elements of your legislation (i.e.; rules and regulations) relevant to upgrading and continued long-term operation.**

The key elements are:

- Maintenance, Surveillance and Testing (SKIFS 1998:1 Chapter 5, 3 §)
- Experience feedback (SKIFS 1998:1 Chapter 2, 3 § and Chapter 5, 4 §)
- Safety Program (SKIFS 1998:1 Chapter 4, 4 §)
- Periodic Safety Review (SKIFS 1998:1 2 Chapter 4, 5 §)

References are stated below

*Chapter 2:*

3 § The licensee of a nuclear facility shall:

1. establish documented guidelines for how safety shall be maintained at the facility as well as ensure that the personnel performing duties, which are important to safety, are well acquainted with the guidelines,
2. ensure that the activity carried out at the facility is controlled and developed with the support of a quality system which covers those activities which are of importance for safety,
3. ensure that decisions on safety-related issues are preceded by adequate investigation and consultation so that the issues are comprehensively examined,
4. ensure that adequate personnel is available with the necessary competence and of the suitability otherwise needed for those tasks which are of importance for safety as well as ensure that this is documented,
5. ensure that responsibilities and authority are defined and documented with respect to personnel carrying out work, which is important to safety,
6. ensure that the personnel is provided with the necessary conditions to carry out work in a safe manner,
7. ensure that experience from the facility’s own and from similar activities is continuously utilised and communicated to the personnel concerned, 8. ensure that safety, through these and other measures, is maintained and continuously developed.

*Chapter 4**Safety Programme*

4 § After it is taken into operation, the safety of a facility shall be continuously analysed and assessed in a systematic manner. Any need for safety improvement measures, engineering as well as organisational, which arises as a result of such analyses and assessments, shall be documented in a safety programme. The safety programme shall be updated on an annual basis.

*Periodic Safety Review of Facilities*

5 § At least once in every ten years, a new, integrated analysis and assessment of the safety of a facility shall be made. The analyses, assessments as well as the measures proposed on the basis of these shall be documented and submitted to the Swedish Nuclear Power Inspectorate.

*Chapter 5*

*Maintenance, Surveillance and Testing*

3 § Building components as well as other components, systems and other devices of importance for safety at a facility shall be inspected and tested on a continuous basis in order to control that they function in a safe manner and that there is no sign of damage. In order to prevent abnormal events, incidents and deficiencies of importance for the safety of the facility, such parts and devices shall be maintained in accordance with special maintenance programmes which shall be documented.

The maintenance programmes shall be updated on a continuous basis, in the light of experience gained, at the facility in question as well as at other similar facilities.

*Investigation of Events and Conditions*

6 § Events which have occurred and conditions which are detected and are important to safety, shall be investigated in a systematic manner in order to determine sequences and causes as well as in order to establish the measures required to restore the safety margins and to prevent recurrence. The results of the investigations shall be disseminated within the organisation as well as shall contribute to the development of safety at the facility. The results shall be reported to the Swedish Nuclear Power Inspectorate in accordance with the provisions of Chapter 7. 1 §.

**2. Do you have a term license (licenses for a fixed period)? If yes, how long and what is the legal basis?**

No

**3. If you have a limited term licenses, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?**

The relevant regulatory measures are to review the measures taken by the utility including the specified reporting to the Inspectorate. That is:

- Plant inspection.
- Review of operating experience including maintenance, surveillance and testing.
- Review of the Safety Program.
- Periodic Safety Review.

**4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

Yes.

*Periodic Safety Review of Facilities*

SKIFS Chapter 4. 5 §

At least once in every ten years, a new, integrated analysis and assessment of the safety of a facility shall be made. The analyses, assessments as well as the measures proposed on the basis of these shall be documented and submitted to the Swedish Nuclear Power Inspectorate.

General recommendations on chapter 4. 5 §

The periodic safety review should be carried out in a systematic manner and using a described methodology. The licensee should take the initiative and, in good time, inform the Swedish Nuclear Power Inspectorate that a periodic safety review is being initiated so that the necessary dialogue can be conducted concerning the scope, direction and methodology of the review.

The periodic safety review should be based on the current safety report, additional analyses of the technical and organisational experiences of the past ten years as well as evaluations of the safety improvement measures which have been implemented during the period covered in the review. Assessments should be made of the safety status of the facility, in relation to developments which have occurred within the applicable part of the nuclear industry, with respect to knowledge, technology and methods as well as in relation to the development of norms, standards and safety requirements. The knowledge base for the safety work should also be evaluated so that any research and development needs can be identified within different areas which are of importance in order to maintain and develop safety. The evaluations made in a periodic review should at least include the following areas:

- the design and state of the facility, e.g. the ageing of systems and components,
- current safety analyses and how they are being applied in the safety related work,
- the facility's guidelines for maintaining safety, management, activity planning, safety programmes and organisation, – evaluation of the effectiveness of the activities (processes) which are of importance for safety, e.g. operation, preventive maintenance, periodic inspections and tests, plant modifications, quality assurance, safety review, training and competence follow-up, experience feed-back, research and development and emergency preparedness.

The reporting of a periodic assessment should contain descriptions of the purpose of the assessment, premises, methodology and scope, the reporting of the analyses and investigations which have been carried out in the assessment, including results and conclusions. It should also contain a summary with conclusions concerning the safety of the facility and the measures to be implemented on the basis of the assessment. References to underlying data shall be clearly specified in the report.

**5. How do you develop and update your rules and regulations (i.e., standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

The new regulation as is today does not imply any immediate design or organisational changes. There is however an additional general recommendation on the way which defines a modern design that the power

plants shall meet within 4-8 years. The new recommendation is planned to be effective by the end of year 2000.

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception)**

Yes. There are some events defined where continuous operation is not allowed until necessary measures have been taken and approved by the inspector. These events are defined in SKIFS 1998:1, 2 Chap. 2 §:

Any deficiency in a barrier or in the defence-in-depth system shall be evaluated and classified, as described in Appendix 1, taking into account its importance to safety and be investigated without delay. Any safety-related measures considered necessary shall subsequently be implemented without delay. Before the facility may be returned to normal operation, a safety review in accordance with Chapter 4. §3 shall be conducted of investigations carried out and measures implemented and such investigations and measures shall be evaluated and approved by the Swedish Nuclear Power Inspectorate in accordance with Appendix 1.

When a severe deficiency in a barrier or a severe deficiency in the defence-in-depth system has been observed, or when there is reason to suspect that safety is severely threatened, the facility shall be brought to a safe state without delay. The facility shall also be brought to a safe state, without delay, when it is found that the facility is functioning in an unexpected manner, or when it is difficult to determine the importance of a deficiency for safety.

*Appendix 1*

Deficiencies in a barrier or in the defence-in-depth system or well-founded suspicions that safety is threatened shall, in accordance with Chapter 2. 2 §, be classified as follows:

Category 1 Observed severe deficiency in one or several barriers or in the defence-in-depth system as well as a well-founded suspicion that safety is severely threatened.

Before the facility may be returned from a safe state to normal operation following an event or condition which has led to such a deficiency or suspicion, a safety review of investigations conducted and measures adopted shall be carried out in accordance with Chapter 4. 3 § and the investigations and measures shall be evaluated and approved by the Swedish Nuclear Power Inspectorate. The following events or conditions are of such a nature that they shall be assigned to Category 1.

1.1 exceeding the highest permissible limit, in accordance with the definition in the Technical Specifications,

1.2 a deterioration in the integrity of any of the barriers for the containment of radioactive materials, such as – a nuclear fuel failure which results in a release of nuclear substances to the reactor coolant to such an extent that the activity level is significantly raised,

- damage to the primary system pressure boundary which results in the activation of the facility's safety functions,
- damage to the reactor containment which means that the containment does not fulfil the postulated leaktightness and materials strength requirements in the safety report, 1.3 an unplanned reactivity increase in a reactor or unintentional criticality in a reactor or in areas where nuclear substances are handled, stored or kept,

1.4 a deficiency in the activity, management or control which is of such an extent that it severely threatens safety,

1.5 a deficiency or deviation, which gives cause to question the safety report in such a way that it is of essential importance to safety.

No other criteria for regulatory reasons are known but there are political decision made on phasing out nuclear power

**7. Describe what are the key technical issues related to upgrading and long term operation you are addressing or plan to address.**

See answer to question no 4 and the new regulation mentioned in answer to question no 5. Some of the areas discussed in the new regulations are as follows:

- safety classification of system upgraded to modern standard,
- increased redundancy, diversity and physical separation,
- increased protection against local pipe break impacts,
- increased protection against external events,
- increased demand on control room (information, lay-out etc.),
- increased demand on emergency control room,
- increased demand on systems related to severe accidents,
- increased demand on verification and control of safety system operability,
- increased demand on use of PSA,
- etc.

**8. Describe what key management issues you are addressing (i.e., organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long term operation.**

See answer to question no 4.

**9. Describe how you apply deterministic and probabilistic methods in your evaluation**

Risk informed evaluation will play an important part in upgrading the plant as mentioned in answer to question no 5. The reason is mainly that the demands will be formulated in a general way but the plants have different design and therefore will choose different ways to fulfil the demands. Certain roles and procedures have to be developed on how to combine deterministic and probabilistic analyses. This is an attempt that will be developed further more.

Some preliminary statements have been set up:

- The deterministic roles are the bases for licensing and operation. They should be verified and supported with probabilistic methods to ensure a more complete coverage of the safety case.
- PSA should be used to support a uniform safety level without dominating weaknesses or unnecessary conservatism.
- PSA should not be used to justify exempt from design that incorporates multiple barriers and a defence-in-depth system. PSA should allow for different solutions to protect barriers and maintain a defence-in-depth system.
- etc.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

How can inspectors reveal that a utility is not taken necessary measures to ensure safe continuous long-term operation? What would be the necessary attribute to convince the inspector that the utility has an effective process to identify all necessary activities to ensure safe continuous long-term operation? What would be early warning sign?

**SWITZERLAND***General Remarks*

In its letter dated November 15, 1999, the CNRA wrote:

Following the recommendations made in the report on Future Nuclear Challenges, CNRA agreed to set “Life Extension and Upgrading” as the topic for the 2000 Special Issues meeting. Many of the factors and issues discussed in the report draw attention to the need for regulators to address requests by licensees for plant life extension. As noted in the publication, “For plant life extensions, analysis must show that the plant will continue to operate within its design basis”. Corresponding regulatory challenges listed in the report included:

- To have an adequate knowledge of the current design basis of the plant,
- To have a correct picture of the actual state of the plant, and
- To define the analysis needed to support life extensions and demonstrate that the plant will still operate within its design basis.

CNRA has set up a special committee to investigate the approaches used in the different member states on these topics. The committee has sent out a questionnaire with 10 relatively general questions on how each member state addresses “Life extension and Upgrading”, and what regulatory requirements are needed.

This note contains the response to the 10 questions from Switzerland. Please note that additional information (including HSK regulatory guidelines) is available via the HSK Internet homepage <http://www.hsk.psi.ch/> ; also the details on the Convention on Nuclear Safety and of the International Regulatory Review Team (IRRT) are available here.

*Introduction*

Nuclear power plants in Switzerland (from the NSC report)

There are nowadays four different utilities producing electricity from nuclear energy in five units. The Swiss NPPs have four different reactor designs, four different containment designs and were delivered by three different reactor suppliers. Although there is no Swiss reactor supplier, there are local suppliers for civil engineering and buildings, and for mechanical and electrical equipment.

The four NPPs in operation in Switzerland together with their respective utilities are as follows:

- Beznau I+II (Nordostschweizerische Kraftwerke AG)
- Mühleberg (Bernische Kraftwerke Energie AG)
- Gösgen (Aare - Tessin AG für Elektrizität)
- Leibstadt (Elektrizitäts – Gesellschaft Laufenburg AG).

The main technical characteristics of the Swiss NPPs are compiled in Table 1

Table 1: Main technical characteristics of the Swiss NPPs (January 1998)

	First generation NPPs			Second generation NPPs	
	Beznau - I	Beznau - II	Mühleberg	Gösgen	Leibstadt
Licensed thermal power $P_{th}$ [MW <sub>th</sub> ]	1130	1130	1097	3002	3138
Nominal electrical power $P_{el}$ [MW <sub>el</sub> ]	365	357	355	970	1030
Reactor type	PWR	PWR	BWR	PWR	BWR
Containment type	Large dry, free standing steel inside concrete building	Large dry, free standing steel inside concrete building	Pressure suppression, Mk I inside concrete building	Large dry, free standing steel inside concrete building	Pressure suppression, Mk III inside concrete building
Normal heat sink	river (Aare)	river (Aare)	river (Aare)	wet cooling tower (Aare)	wet cooling tower (Rhine)
Number of reactor coolant pumps	2	2	2	3	2
Number of turbine sets	2	2	2	1	1
Number of fuel assemblies	121	121	240	177	648
Fuel	UO <sub>2</sub> +MOX	UO <sub>2</sub> +MOX	UO <sub>2</sub>	UO <sub>2</sub> +MOX	UO <sub>2</sub>
Number of control assemblies	25	25	57	48	149
Reactor supplier	W	W	GE	KWU	GE
Turbine supplier	BBC	BBC	BBC	KWU	BBC
Site License	1964	1967	1965	1972	1969
Construction license	1964	1967	1967	1973	1975
First operation license	1969	1971	1971	1978	1984
Commercial operation	1969	1971	1972	1979	1984
Backfitted bunkered automatic shutdown and residual heat removal system since	1993	1992	1989	included	included
Filtered containment venting system since	1993	1992	1992	1993	1993

This document addresses the 10 questions submitted by the CNRA special committee on 'Life extension and Upgrading'.

In the text below, several Swiss institutions / organisations are referred to:

- FC: Federal Council, i.e. Swiss federal government top level  
 HSK: Swiss Federal Nuclear Safety Inspectorate, i.e. regulatory authority  
 KSA: Swiss Federal Nuclear Safety Commission, advisory to the Federal Council

**1. Describe the key elements of your legislation (i.e.; rules and regulations) relevant to upgrading and continued long-term operation.**

Article 8 of the Atomic Energy Act specifies:

The Federal Council and the authorities designated by it shall have the right in executing their supervisory function to order instructions at any time that become necessary for the protection of man, third-party properties and of important rights, for the preservation of the external security of Switzerland and the compliance with the obligations she has entered into under international commitments; they are also entitled to supervise the compliance with these instructions.'

Furthermore, Article 9 of the Radiological Protection Act stipulates that

“in order to limit the radiation exposure of each individual person as well as the totality of all those concerned, it shall be required to adopt all measures dictated by experience and the state of the scientific and technological art “.

Based on these Articles, the utilities and operators of NPPs are obligated to undertake all necessary actions to guarantee public health and safety, in accordance with the state-of-the-art in science and technology. This implies that changes in state-of-the-art technology will provoke regulatory assessment, based on which nuclear power plants may be required to upgrade their equipment through appropriate design backfits, procedural changes, or other hardware modifications.

The requirements of the safety authority are documented in a set of regulatory guidelines and recommendations for Swiss NPPs, which supplement the existing international safety standards. These guidelines and recommendations are periodically updated to reflect the advancing knowledge in nuclear safety technology. These requirements are mandatory for new NPPs; the existing operating power plants shall be upgraded to the extent reasonably practicable, and have to apply plant specific accompanying measures, including hardware and procedural modifications (e.g. accident management strategies). It is important to note that such upgrades are not necessarily based on formal cost/benefit criteria.

Examples of such upgrades include the specially protected and independent decay heat removal system for the two older NPPs (SUSAN for Mühleberg, and NANO for Beznau I and II), in order to compensate for safety deficiencies against external events and the lack of redundancy of safety systems. The systems went into operation in 1991 for Mühleberg, 1992 for Beznau II, and 1993 for Beznau I.

In 1987, HSK published a list of about 30 issues, called “measures against severe accidents,” to improve plant safety within the design basis envelope, to reduce the frequency of severe accidents, and to mitigate their ensuing consequences. Some of the aspects addressed by these issues include improvement in systems reliability, extension of plant performance beyond the original design basis accident envelope by backfitting special systems for mitigating severe accidents, and review and improvement of emergency operating procedures and site emergency planning and organisation.

**2. Do you have a term license (licenses for a fixed period?) If yes, how long and what is the legal basis?**

The NPPs Beznau Unit 1, Gösgen and Leibstadt do have a timely unlimited licenses, whereas the licenses for the Beznau Unit 2 and Mühleberg are limited to the year 2004 and 2012, respectively. Licenses are granted by the FC.

The difference made between the NPPs is rather artificial and based on historical reasons. During the early 70's, based on the discussions on the possible inadequacy of emergency core cooling systems (ECCS), the FC decided to issue temporary permits only (the timely unlimited license for Beznau Unit 1 was released already before this ECCS issue became known). Since then, and especially after the TMI incident, the ECCS capabilities were largely improved; the time limited permits for Beznau Unit 2 and Mühleberg were, however, never made permanent as it was considered that even with ECCS improvements the 'state of the

art' level of ECC - as included in the designs of the newer NPPs - could not be attained (e.g. physical separation of the different trains). Even though this is also true for Beznau Unit 1, the timely unlimited license for this unit was not changed.

**3. If you have limited term licenses, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?**

Limited term licenses can be extended; such extensions have already been granted several times in the past. The license extension is issued by the FC, based on a positive recommendation from the HSK's technical assessment as documented in a detailed Safety Evaluation Report (SER) and on concurrence from the KSA in the form of a written statement. No formal criteria are in place for passing judgement on the license renewal application; however, the following areas are reviewed in detail as part of HSK's technical assessment:

- condition of structures, systems and components relevant to safety and operational radiation protection,
- plant and fuel performance,
- design basis accidents (DBA) and beyond design basis accidents (including PSA),
- organisation and personnel,
- emergency preparedness,
- waste management and decommissioning,
- backfits / modifications,
- ageing and ageing surveillance.

To control long term operation for those NPPs with a permanent license, periodic safety reviews (PSR) are performed by HSK at least every 10 years (ref. our answer to question 4). These reviews basically include the same items as listed above for the SER.

**4. Do you perform a periodic safety evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

In accordance with international practice HSK has, from the beginning of the 90's, started to perform a Periodic Safety Review (PSR). The plant safety is compared against the standard that would apply to new installations; further, a review of past plant performance is made, and also backfits, modifications and ageing are addressed.

For all Swiss plants except Gösgen, PSRs have been combined with safety reviews for major backfitting programmes or power upgrades. The PSR report for Gösgen has been published end of November 1999. Thus, PSRs have now been performed for all Swiss NPPs. The next PSRs to be performed are for the NPPs Mühleberg and Beznau in 2002 and 2004, respectively. The topics covered by the PSR are basically the same as those mentioned in the response to question 3.

For a PSR, four different reports have to be submitted to the HSK:

- An updated Safety Analysis Report (SAR);
- An updated plant-specific level-1 and level-2 PSA report (including external initiating events);
- A detailed review of the plant-specific operational experience (overall plant performance, systems performance, component performance, review of all incidents happened) since the last PSR;
- A summary report showing that the safety requirements are met, or deviations are within acceptable limits.

A draft of a guideline for regulating PSRs will be released for comments to the utilities and the KSA beginning of February 2000. The guideline will be finally issued before the end of the year.

**5. How do you develop and update rules and regulations (i.e. standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

The Swiss policy for regulation and supervision of nuclear installations, as expressed in the legislation, is to keep regulations short (without going into technical aspects), providing only the essence for ensuring nuclear safety and radiological protection.

The legislation and regulations are thus limited to the prescription of safety objectives. This puts the applicants/licensees under the obligation to propose and seek technical solutions reflecting the internationally recognised state of science and technology, as well as corresponding safety criteria. The necessary governmental review and assessment of these proposals (being an essential part of the application) is done by the safety authorities.

Although the applicants/licensees have the obligation to propose acceptable technical solutions, experience has shown that it is useful to make it known to them how the safety authorities will review and assess the application for a license. This is done by means of guidelines prepared and established by the safety authorities.

These guidelines indicate ways of implementing some of the safety requirements. They address particular aspects in which the HSK must be involved; these are based on experience gained in Switzerland and abroad, and on the state-of-the-art in science and technology. In particular, the guidelines state in detail, how the HSK proposes to carry out its legal obligations.

Most of the guidelines are so-called “design guidelines”. They are not mandatory, and applicants may choose other solutions: however in such a case they have to demonstrate that the same level of safety is attained. A few guidelines, called “procedure guidelines”, prescribe (administrative) procedures that have to be followed; they are thus mandatory.

There is no goal to cover all safety related areas or functions with these guidelines, and the decision to prepare a new guideline is made on a case-by-case basis. HSK guidelines are used to complement the regulations of the country of origin of the Swiss nuclear power plants. In preparing the guidelines the IAEA NUSS Codes and other international standards are used as reference material.

The guidelines are updated whenever new insights from research activities or occurrences show that part of the guidelines may no longer be up-to-date. As part of the Quality Management System, which is being introduced at HSK, the guidelines will be reviewed for completeness and correctness regularly.

For existing NPPs detailed assessments are made to find out if a new requirement can be implemented without unreasonably high costs, or if complementary measures can be put in place or are already in place. In most cases, the impact of a new requirement to the plant's safety and risk is evaluated. In this case, a plant-specific PSA is an important tool to quantify the risk-impact of a plant change or of a new requirement. Especially for requirements to prevent and/or mitigate the consequences of severe accidents, a

risk-informed decision making process is taken into account. HSK has proposed a more formal decision process, which is outlined in the attached paper.<sup>1</sup>

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception).**

There are no formal regulatory criteria for discontinuing plant operation. However, a plant license may be revoked based on the conditions as spelled out by Swiss law.

Article 8 of the Atomic Energy Act stipulates:

“<sup>1</sup>The nuclear installations and every form of ownership of radioactive nuclear fuels and residues shall be placed under federal supervision”.

“<sup>2</sup>The Federal Council and the authorities designated by it shall have the right in executing their supervisory function to order instructions at any time that become necessary for the protection of man, third-party properties and of important rights, for the preservation of the external security of Switzerland and the compliance with the obligations she has entered into under international commitments; they are also entitled to supervise the compliance with these instructions”.

“<sup>3</sup>Each planned modification of a nuclear installation has to be notified to the competent authorities even if the planned modification is not subject to licensing”.

Especially based on paragraph 2 of this Article, the HSK has the authority to impose all measures needed for the safe operation of an NPP. In addition, Article 9 of the Radiological Protection Act stipulates that “it shall be required to adopt all measures dictated by experience and the state of the scientific and technological art”.

Based on this Article, plant operation must not only be safe (e.g. show a low Core Damage Frequency), but has also to be in accordance with the state-of-the-art in science and technology.

The HSK is under the obligation to constantly review if the above two basic requirements are fulfilled and, if not, whether deviations are acceptable. In practice, after every longer outage, especially after every refuelling outage, the HSK checks if the NPP is in safe condition and in accordance with regulations. Only if this is the case, the NPP receives the approval for start-up.

Article 9, paragraph 2, of the Atomic Energy Act specifies that:

“a license may be revoked by the competent licensing authority if it was obtained on the basis of false or incomplete information or if the prerequisites for it are not or no longer fulfilled”.

By this article, based on HSK's recommendation, the FC may revoke a license at any time, should the basis or the prerequisites for the license not be fulfilled. Examples of such prerequisites are: the licensee must provide evidence of proper insurance coverage (civil and nuclear liability), and must demonstrate that the operating staff holds the necessary skills for safely operating the plant.

---

<sup>1</sup> (“Risk Analysis and Regulatory Safety Decisions” by U. Schmocker et. al., presented at the International Conference on Advances in the Operational Safety of Nuclear Power Plants, held in Vienna, September 4-8, 1995).

A non-regulatory reason for invalidating an existing plant license would be if the outcome of a public vote (which is a common Swiss institution) is against the continued use of nuclear power generally, or in favour of shutting down a particular NPP. Until today, several public votes on the subject of nuclear power have taken place, resulting in a moratorium for constructing new NPPs but in favour of continuing operation for existing nuclear power stations. More public votes are expected in the next 1-2 years.

**7. Describe what are the key technical issues related to upgrading and long term operation you are addressing or plan to address.**

No premeditated action for addressing plant upgrade or long term operation exists at the regulatory level. As mentioned earlier, the HSK reviews the safety level of NPPs on a regular basis, comparing to the state-of-the-art safety requirements, which may result in the NPP being obliged to implement upgrades.

As an example, the NPPs Beznau (Units 1 and 2) and Mühleberg went through a extensive backfitting program. The reason was that the original design of these “first generation” plants was based on safety rules of the mid-60, at which time some principles of nuclear safety that were not yet commonly acknowledged were not taken into account, such as:

- separation criteria for electrical and mechanical equipment to protect the NPP from common cause failures by e.g. fire or internal flooding;
- rigorous application of the single failure criterion, also to supporting systems, considering the case of loss of the off-site power;
- protection of residual heat removal (RHR) systems against external events (aircraft crashes, earthquakes, floods, lightning strikes and sabotage);
- an auxiliary shutdown capability from a remote location in case of a loss of control from the main control room.

To remedy these deficiencies, two major backfitting projects were imposed by HSK during the early 1980's for improving the RHR systems in these first generation plants. These projects were known under the name “NANO” at the Beznau PWR and “SUSAN” for the Mühleberg BWR, which extended over several years. Further backfits took place in the late 1980's, when a seismic re-qualification was carried out. The backfitting was mainly performed by adding one or two completely separate systems for shutdown and RHR, including support systems. These backfits resolved the above mentioned four issues on safety principles.

For long-term operation, the ageing of components and systems are key issues. Therefore, the implementation of an ageing surveillance programme (ASP) was required from all NPPs by the HSK in 1991. The aim of this programme is to ensure that safety goals would be maintained throughout the life of the NPPs. In 1992, a utility working group was formed to set up a joint approach for ageing surveillance and management. The main target of this group is to fulfil the HSK's requirements, and in addition to provide a technical basis for optimising maintenance and improving the reliability of components. The ASP is part of the overall maintenance strategy for the Swiss NPPs. The ASP addresses the areas of civil, electrical and mechanical engineering and is concentrated on classified components, systems and structures.

In particular, the ASP gives information on the relevant ageing and degradation mechanisms, materials, environmental effects and operation history etc. As the main result, for every safety-relevant component, it will be possible to make an assessment of the existing maintenance programme and the possible deficiencies therein. In the latter case, a list of improvements related to operation and maintenance has to be presented to the HSK. Until now, no new ageing mechanism has been identified which could seriously reduce component's safety margins in the foreseeable future.

Another important indicator for the safety of long-term operation are the results from the PSRs, which give a complete and in-depth review of all safety aspects of a Nuclear Power Station over a 10-year period. Details on PSRs are given in the response to previous questions.

**8. Describe what key management issues you are addressing (i.e. organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long term operation.**

The importance of organisational and human factor aspects for safety in NPPs is referred to in the HSK Guideline R-17 and R-27. These cover the recruitment, the qualification, the training, the re-qualification as well as the licensing of persons whose duties have an immediate bearing on safety. All licensed members of the operating staff have to be examined at the time of recruitment and if necessary at appropriate times thereafter to ensure that their psychological and physical condition is suited for the duties and responsibilities assigned to them.

Besides these rather traditional staffing aspects, organisational and individual attitudes to safety are focused on, which issues have become important over the last years and relate to what is called “safety culture”. Safety culture is a relatively new concept, which is drawing increased attention in Switzerland.

Due to the opposition of the general public against nuclear power the availability of qualified consulting companies and qualified contractors is decreasing. Also, economic deregulation forces the operators of NPPs to revise their resource strategies resulting in outsourcing of non safety relevant activities and company reorganisation. These challenges are recognised by the plant operators; some of them already initiated collaboration programmes in the area of maintenance and radiological protection.

In order to have a sound basis for the evaluation of organisational changes, the HSK will need to analyse the existing organisation of the NPPs prior to a major change. This analysis should comprise the definition of functions important to safety (short and long term) and the influence of the planned organisational changes on the effectiveness of these functions.

The HSK addresses these issues in the periodic top level management meetings with the plant operators.

**9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

In Switzerland, regulation has traditionally been based primarily on deterministic evaluations and performance. In many cases, however, regulatory reviews at HSK also include probabilistic risk analyses (PRAs). With such PRAs, the HSK aims at developing a more systematic understanding of plant features, of vulnerability to potential severe accidents, and of plant specific operating characteristics.

*Safety Assessment of safety systems, safety related systems, and their components:*

The safety review process for a modification, replacement or repair of safety relevant equipment is described in various HSK Guidelines (R-18, R-23, R-35). The applicant must submit an appropriate application to HSK which encompasses all safety relevant issues and describes the measures taken to ensure safety. The HSK review covers, in particular, the following aspects:

- quality assurance for manufacturing, assembling and commissioning;
- personnel qualification (e.g. for welders);
- specifications of systems and components, system and instrumentation and control (I&C) equipment drawings, construction drawings;
- impact on safety concepts and on results from safety analyses, stress analysis;
- plant operating experience, experience from other plants;
- test programme.

The depth of review is dependent on the safety significance of the systems or components concerned.

*Review of design basis accident analysis*

The review is aimed at confirming the expected behaviour of the plant under postulated abnormal conditions. Based on a set of accident scenarios, the licensee has to demonstrate that the relevant plant and core specific parameters stay within their safety limits. In addition, the licensee must show that the individual dose limits for the general public as defined in the HSK Guideline R-11 are not violated. This has to be proven for any postulated single failure under the most conservative assumptions.

The HSK review covers at least the following aspects:

- qualification, validation and state-of-the-art of the methods and models used;
- compatibility of assumptions with systems and components design;
- conservatism of simplifications and assumptions;
- adequacy of postulated single failures;
- compliance with relevant operational and safety limits.

*Review of probabilistic safety assessment*

These reviews are focused on:

- understanding the general validity of the PSA models, assumptions, analytical methods, data and numerical results;
- understanding the range of uncertainties in core damage frequencies, containment performance, and releases of radioactive effluents;
- assessment of applicability of PSA models as tools to assist plant operation and effective control.

A two step evaluation process has been developed for this review:

**Preliminary review:** This review is aimed at performing a quick qualitative evaluation of PSA findings and major conclusions, PSA approach and analytic methods, documentation and plant design features for preventing as well as for mitigating potential severe accidents. This preliminary review should also identify areas for more focused assessment and analysis in the next review stage.

**Detailed quantitative review:** This review aims at a detailed quantitative evaluation of the PSA models, assumptions, data, and analysis techniques and the adequacy of PSA logic model in representing the actual plant design and operational characteristics.

As part of this review phase, a detailed reanalysis is performed, often using alternative methods. For the Level 1 part of the analysis, a fault tree linking technique is used; the Level 2 portion of the PSA is evaluated based on state-of-the-art computer codes, assessing severe accident behaviour, containment loads, containment performance, containment failure modes, and accident source terms.

A PSA review guidance document has been prepared to support the assessment process. This document contains specific instructions for PSA review, applications, and review documentation.

In practice, the costs for the implementation of the requirements and the level of probability for an actual need for the specific installation are weighed against each other. In order to make the decision process

transparent, the HSK uses the following ranking approach to decide on the implementation of the safety measures:

- those required by the legislation ( including terms of license);
- those required by the state-of-the-art in science and technology;
- those appearing desirable from experience and/or from the state-of-the-art in science and technology, while simultaneously being reasonable from a cost/benefit point of view.

As mentioned in the response to question 5, HSK has proposed a risk-informed regulation process especially for (but not limited to) measures against severe accidents.

It is important to mention that the neither the deterministic not the probabilistic approach by itself can give a complete and consistent picture. They complement each other, and only together one can get a correct picture as long as the defence-in-depth concept is fulfilled. This is the key safety principle which cannot be overruled by any argument, especially not by a very low Core Damage Frequency.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

Safety management: define the critical organisational aspects of safety issues. This could be a help for the operators (self assessment) and for the regulators (regulatory assessment).

Change Management: identify critical issues to be addressed in the case of for organisational changes (e.g. due to economic pressure from deregulation).

*Note: 1995 Paper on Risk Analysis and Regulatory Safety decisions was distributed at Meeting.*

## UNITED KINGDOM

### **1. Describe the key elements of your legislation (i.e. rules and regulations) relevant to upgrading and continued long-term operation.**

1.1 The primary legislative provision is the Health and Safety at Work Act (HSWA) 1974, under which safety related sections of the Nuclear Installations Act (NIA) 1965 are a relevant statutory provision. It is the NIA which empowers Ministers to grant NII (as part of HSE) power for issuing licenses and attaching conditions to them.

1.2 A key requirement of the HSWA 1974 is the duty on every employer to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable (SFAIRP) that his employees and others who may be affected thereby, are not thereby exposed to risks to their health or safety. This principal requirement is the basis for all regulatory decisions pertaining to Life Extension and Upgrading. The regulatory control itself is exercised through the Licence Conditions and the arrangements which the licensee is required to make under them.

1.3 The principal Licence Conditions of relevance are:

- LC15: which requires the licensee to make and implement adequate arrangements for the periodic and systematic review and reassessment of safety cases; (and is relevant to both life extension and upgrading).
- LC22: which requires the licensee to make and implement adequate arrangements for the control of any modification which may affect safety; (and is relevant to Upgrading).
- LC23: which requires the licensee to produce an adequate safety case to demonstrate the safety of any operation that may affect safety; and,
- LC31: which gives HSE the power to Direct a licensee to shutdown any plant, operation or process (which HSE could use if it believes the licensee has failed to make its case for continued operation).

1.4 In addition to the licence conditions, the HSE also has direct powers from the HSWA enabling it to issue Improvement Notices, if it believes that continued operation is unacceptable without some upgrading, and Prohibition Notices, which can prohibit a stated activity if HSE believes the activity will involve a risk of serious personal injury.

1.5 In assessing a licensee's safety case, NII applies its Safety Assessment Principles for Nuclear Plants (1992) (SAPs) which sets out a large number of engineering principles and some numerical risk criteria. Although written primarily for new designs, it is used as a basis for assessing operating plant for continued operation.

1.6 NII expects the periodic safety reviews required by licence condition 15 to be undertaken at least every 10 years, and to have as one of its objectives a comparison with modern standards and a search for worthwhile improvements. The arrangements under LC15 are also expected to include more frequent interim reviews to account for modifications and operating experience.

1.7 The requirement to avert risk, SFAIRP, is applied by means of the principle of reducing risk to As Low as Reasonably Practicable (ALARP) which has been set out in the Health and Safety Executive's (HSE) publication "The Tolerability of Risk for Nuclear Power Stations" (referred to as ToR) published in 1992. The test of reasonable practicability should not just be based on cost benefit analysis (CBA), but is expected to take a holistic view, and the term "risk" is interpreted in British law as the potential for harm. NII will not accept an argument of a short remaining life as an excuse for not upgrading a plant which falls

short of the required standards. Where the expected life of a facility is less than 10 years at the time of a review, NII expects the licensee to assume at least 10 years further life when deciding what upgrades are reasonably practicable, unless a firm written commitment of the shutdown date has been given (against which a licensee expects to be held to by regulatory action).

1.8 An ageing plant may be found to have degraded so far from modern standards that the cost of refurbishment will never be justified on ALARP grounds. In such cases, NII will not allow continued operation, but would use the powers under LC 31 to ensure cessation of an unacceptable operation.

**2. Do you have a term licence (licenses for fixed periods)? If yes, how long and what is the legal basis?**

No.

**3. If you have a limited term licence, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long term operation (i.e. periodic reviews, limitations on long-term operation)?**

The control of long-term operation is via the periodic reviews of safety cases under LC15 and the other regulatory powers as described above for Question 1.

**4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

The periodic review process (see Question 1) requires a systematic evaluation against modern standards of the plant and all its safety related systems, structures and components and for their design justification to be revalidated, or updated, with the implementation of the required improvements in accordance with the ALARP principle. This review is carried out by the licensee. NII establishes with the licensee a Decision Date, which, in addition to being the date by which NII requires the periodic review and any safety significant improvements to be completed, is also the date by which it intends to make a decision over the acceptability of continued operation. It may choose to do this via a press release or public report.

**5. How do you develop and update your rules and regulations (i.e. standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

5.1 The Licence Conditions are kept under review and have been added to when a significant additional requirement has been identified. They are currently undergoing a more systematic review.

5.2 Documents setting out standards and guidance such as SAPs and TOR are also kept under review on about a 10-year periodicity. TOR is being reviewed, with a discussion document called “Reducing Risk, Protecting People” (R2P2) published in May 1999.

5.3 The application of these to existing plant has been described above.

5.4 The criteria used by NII in assessing a licensee’s safety case are set out in SAPs. Two levels of risk have been established. A Basic Safety Limit is set, above which risk is intolerable and a complementary Basic Safety Objective is set as the point below which regulatory resources will not be used to seek further safety improvements in the quest for ALARP. However, where it is reasonably practicable for the licensee to further reduce risk below the BSO, he is obliged to do so. In the ALARP region, increasing stringency is applied as risk moves from the BSO to the BSL.

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e. considered financial, public perception).**

6.1 The BSLs set out in SAPs (see 5.4 above) provide specific criteria where continued operation would not be allowed. Reasonable practicability and CBA do not apply in such a situation. Cases where the comparison of an old facility against modern standards leads to the conclusion that continued operation is unacceptable, will also be based on judgement and may apply even if on pure probabilistic terms the BSLs are not exceeded.

6.2 HSE does not apply financial criteria, other than in assessing CBA; but CBA is never used alone in making judgements.

6.3 Public perception is taken into account in so far as the levels of acceptability set out in TOR were based on a view of public perception.

**7. Describe what are the key technical issues related to upgrading and long term operation you are addressing or plan to address.**

7.1 The periodic safety reviews (PSRs) carried out to date have given rise to a list of generic issues. These provide the key technical issues which are being addressed in the UK. (See Annex 1).

7.2 A key issue associated with PSRs is the evolution of that part dealing with decommissioning and radioactive waste management as the life of the facility progresses. Initially it should address design and broad technical requirements. At the end of life it should address decommissioning management issues, the retention of corporate knowledge and expertise and the retraining of staff.

7.3 Another key issue is the implication for ILW storage in the UK of the absence of a defined programme for a repository. This requires the development of systematic planning of structural inspection and refurbishment for stores which will now have a much longer strategic life. It also implies the need to address the requirements for all identified sources of ILW (a survey has been published by NII in 1999 entitled Intermediate Level Waste Storage in the UK: A Review) and minimising the hazards by application of the principles of inherent safety, and where possible, passive safety features. This long term storage requirement will require a more stringent control of the store environment so that waste package identification is preserved over the long term.

7.4 An associated issue is the question of early decommissioning versus concepts such as 'Safestore' as proposed by BNFL Magnox for the Trawsfynydd site.

**8. Describe what key management issues you are addressing (i.e. organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long term operation.**

8.1 There are 3 key issues:

- (i) The "intelligent customer" - i.e. the definition of the minimum organisational requirement in terms of knowledge and competence needed by a licensee in order to remain in control of safety and to thereby be the "intelligent customer" for the advice and information bought in from contractors.
- (ii) The use and control of contractors by licensees in carrying out its operations (and the related issue of defining the "user" of a site for the purposes of the NIA (1965).
- (iii) The requirement to have in place by April 2000 adequate arrangements under LC36, which is a new licence condition related to the control of organisational change. (See Annex 2).

8.2 Issues (i) and (ii) above are germane to the current need to re-licence the UK Magnox reactor sites following the acquisition of Magnox Electric to become BNFL Magnox within BNFL. They are also relevant to the issues raised with British Energy in a recent audit.

## **9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

9.1 NII's role in evaluation is, among other things, to judge the adequacy of the underlying safety assessment carried out by the licensee in fulfilment of his duty under the law and to provide confidence as to the fitness for purpose of any proposed construction, installation, operation, modification, experiment or decommissioning of any plant or process for the purposes of any regulatory decision.

9.2 In doing this, NII assesses the use of deterministic and probabilistic methods used by the licensee, rather than applying them itself. NII's expectations as to how the licensee should apply deterministic and probabilistic methods is set out in its Assessment Guidance used by its own specialist inspectors.

9.3 NII expects the licensee to make a robust deterministic case based on a realistic evaluation of the existing conditions and mode of use of all safety systems structures and components. The state of the plant and the demands on these systems during foreseeable transients (such as start-up and shutdown) and during design basis accidents should be deterministically assessed against all of the engineering principles in SAPs.

9.4 For such analysis, conservative assumptions should be used to provide a robust demonstration of fault tolerance, so that for the design basis faults

- a) none of the barriers to radioactivity escape is breached, or if any are, then at least one remains intact;
- b) there is no release of radioactivity except in the most severe cases, and even then, no-one outside the site will receive a dose of >100mSv, and;
- c) no person on the site will receive an excessive dose from radioactivity release or direct radiation, including that from criticality incidents.

9.5 Deterministic analysis should also be used for beyond design basis faults in order to identify the failures of barriers or shielding to determine the characteristics of the consequences and form a basis for suitable accident management strategies. This should be done on a best estimate basis, in order to give realistic guidance.

9.6 Probabilistic analysis using best estimate data should be used to ensure that the overall risks are ALARP and that there is no undue sensitivity to faults in a particular area of the plant or operation. It thus seeks out weaknesses where improvements might be required, checks the adequacy of the provisions for defence in depth, and provides an estimate for the overall risks to workers and the public.

## **10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

A key long term issue in the UK is the recruitment training and retention of key technical resources and competences in an industry which has no new major development programme.

## LIST OF MAGNOX LTSR GENERIC ISSUES

### 1. Reactor pressure circuit safety case

- (a) Consider the reasonable practicability of extending in-service volumetric examination to the pressure vessel welds and ductwork features within the biological shield.
- (b) Confirm that defects which could have survived the original proof-pressure test could not propagate to failure within the projected lifetime of the station.
- (c) Confirm the adequacy of the leak-before-break case for the pressure circuit and show that procedures and equipment are available to detect sub-critical defects before they could propagate to failure.
- (d) Confirm that the material properties during the projected lifetime are adequate for all operating conditions, particularly for start-up and shut-down and for conditions arising when circuits are taken into and out of service while the plant is on-load.
- (e) Confirm adequate operating rules are in place to meet the conditions described in (d).
- (f) Confirm the extent to which the pressure circuit can withstand boiler tube failures.

### 2. Biological shield

The capability of the biological shield to withstand the pressure loading arising from duct failure should be demonstrated. In particular the demonstration should show that the function of circuits next the affected duct is not impaired.

### 3. Shut-down systems

- (a) Confirm the extent to which the overall performance of the shut-down systems complies with modern standards and introduce any reasonably practicable improvements.
- (b) A diverse means of shutting down the reactor separate from the control rod system should be installed and must be capable of initiation from the central control room.

### 4. Post-trip cooling

- (a) A diverse means of supplying post-trip cooling water to the boilers should be installed and should, as far as reasonably practicable, meet modern standards.
- (b) The capability of natural circulation to cool the reactor following a trip from the most adverse operating conditions for post-trip cooling requirements should be demonstrated.

### 5. Fire hazard

Consider whether any improvements to fire zoning and equipment are available and confirm the extent to which the installed system complies with modern standards.

### 6. Resistance to earthquakes

Demonstrate what level of earthquake the plant can withstand without sustaining unacceptable damage.

### 7. Operator action following faults

- (a) The role of the operator under major fault conditions should be considered.
- (b) Any actions required by the operator within particular time periods to limit the effects of faults should be shown to be practicable.

## 8. Reactor control room

Consider the reasonable practicability of providing an alternative emergency indication centre.

## 9. Ageing

- (a) Produce a systematic programme for the examination and monitoring of plant and components for the effects of ageing.
- (b) Confirm that no component important to safety will limit the safe operational life to less than the projected life of the station.

## 10. Reactor refuelling machines

Undertake volumetric non-destructive testing of those parts of the refuelling machine pressure vessel components where access is reasonably practicable.

## 11. Cranes

Confirm that cranes do not pose an unacceptable risk to plant safety.

## 12. Radiological protection

- (a) Provide a comparison of radiation doses to operators with NII's safety assessment reference levels and make any reasonably practicable improvements if they are not met.
- (b) Confirm that direct radiation doses to members of the public comply with the most recent recommendations of the ICRP.
- (c) If occupancy factors are claimed in (b), demonstrate by habit surveys that these are soundly based.
- (d) Where doses from direct radiation to members of the public are in excess of NII's safety assessment reference levels, consider and introduce any reasonably practicable improvements.

## ANNEX 1

### LICENCE CONDITION 36: CONTROL OF ORGANISATIONAL CHANGE

- (1) The licensee shall make and implement adequate arrangements to control any change to its organisational structure or resources which may affect safety.
- (2) The licensee shall submit to the Executive for approval such part or parts of the aforesaid arrangements as the Executive may specify.
- (3) The licensee shall ensure that once approved no alteration or amendment is made to the approved arrangements unless the Executive has approved such alteration or amendment.
- (4) The aforesaid arrangements shall provide for the classification of changes to the organisational structure or resources according to their safety significance. The arrangements shall include a requirement for the provision of adequate documentation to justify the safety of any proposed change and shall where appropriate provide for the submission of such documentation to the Executive.
- (5) The licensee shall if so directed by the Executive halt the change to its organisational structure or resources and the licensee shall not recommence such change without the consent of the Executive.

**UNITED STATES**

**1. Describe the key elements of your legislation (i.e., rules and regulations) relevant to upgrading and continued long-term operation.**

Section 103 of the U.S. Atomic Energy Act of 1954 permits the issuance of renewed operating licenses for commercial nuclear power plants. To implement this legislation, the U.S. Nuclear Regulatory Commission (USNRC) has promulgated a license renewal rule, Title 10 of the Code of Federal Regulations, Part 54 (10 CFR Part 54), which addresses the technical requirements for license renewal of nuclear power plants. This rule focuses the license renewal review primarily on the ageing management of long-lived, passive structures and components, as well as those structures and components that involve calculations or analyses based on time-limited assumptions defined by the current term of 40 years. The USNRC has also amended its environmental regulations, 10 CFR Part 51, to facilitate the environmental review for license renewal in December 1966. In addition, the USNRC regulatory process also includes public participation through hearings (10 CFR Part 2) and regular meetings to ensure stakeholders' involvement in the decision-making process.

**2. Do you have a term license (licenses for a fixed period)? If yes, how long and what is the legal basis?**

Yes, U.S. nuclear power plant operating licenses are limited to a fixed term of 40 years. The Atomic Energy Act of 1954, Section 103c, states that "each such license shall be issued for a specified period, as determined by the Commission, depending on the type of activity to be licensed, but not exceeding forty years, and may be renewed upon the expiration of such period". Section 54.31(b) of 10 CFR Part 54 further provides that "[a] renewed license will be issued for a fixed period of time, which is the sum of the additional amount of time beyond the expiration of the operating license (not to exceed 20 years) that is requested in a renewal application plus the remaining number of years on the operating license currently in effect. The term of any renewed license may not exceed 40 years".

**3. If you have a limited term licenses, can it be extended and what are the criteria? If you do not have limited term licenses, what are the relevant regulatory measures in place to control long-term operation (i.e., periodic reviews, limitations on long term operation)?**

As stated in Responses 1 and 2, the Atomic Energy Act permits license renewal beyond the current license term of 40 years, and 10 CFR Part 54 outlines technical requirements for extending a license for a maximum period up to 20 years. Aside from the environmental requirements that are set forth in 10 CFR Part 51, the controlling technical requirements for license renewal are set forth in the 10 CFR Part 54 rule, which consists primarily of four major elements, among other process and administrative requirements. The four major elements are: scoping, integrated plant assessment, time-limited ageing analyses, and standards for issuance of a renewed license.

**4. Do you perform a periodic evaluation of overall plant design? If yes, describe what is included, if no, how do you justify long-term operation?**

The USNRC license renewal process does not require a periodic evaluation of the overall plant design. Instead, the justification for long-term operation is based on the following two key principles:

- (1) The regulatory process, continued into the extended period of operation, is adequate to ensure that the current licensing basis of all currently operating plants provides and maintains an acceptable level of safety, with the possible exception of the detrimental effects of ageing on certain plant systems,

structures, and components and possibly a few other issues related to safety only during the period of extended operation.

- (2) The plant-specific licensing basis must be maintained during the renewal term in the same manner and to the same extent as during the original licensing term.

For those detrimental effects of ageing issues expected during the period of extended operation, the license renewal process requires each applicant to evaluate and manage the ageing effects in sufficient detail to conclude that the plant can be operated safely during the period of extended operation as required by 10 CFR Part 54. This information must be sufficiently detailed to permit the USNRC staff to determine whether ageing will be managed such that the plant can be operated during the period of extended operation without undue risk to the health and safety of the public.

**5. How do you develop and update your rules and regulations (i.e., standards, requirements, etc.)? How do you apply these on existing plants? What criteria are used to evaluate and/or justify the current level of safety in comparison to modern safety standards?**

The USNRC is authorised by the Atomic Energy Act of 1954 to promulgate rules or regulations, as necessary, to effectuate the purposes and provisions of the act. As part of the USNRC's rulemaking process, comments have always been sought from the industry and the public.

The 10 CFR Part 54 rule was first issued in December 1991. The rule was approved by the Commission after it considered extensive comments from both the industry and the public. However, significant difficulties were experienced when the rule was implemented. The most significant obstacle was the introduction of the concept of "age-related degradation unique to license renewal". This measure was found to be impractical and hard to implement. As a result, the rule was amended and reissued in May, 1995 on the basis of comments received and numerous deliberations between the industry, the public, and the USNRC staff. This amended rule has been effectively implemented in the review of two license renewal applications.

A feedback process was formally established and documented as part of the license renewal process. This feedback process will enable the NRC staff to document the lessons learned from the reviews of license renewal applications and owners group topical reports and feedback on any issues that may have a potential effect on operating reactors. Once an issue is identified, the NRC regulatory process will initiate appropriate actions.

10 CFR Part 54 does not require backfitting of newer safety standards. Newer safety standards could be required at any time in the life of the plant in accordance with 10 CFR 50.109 if the Commission determines that there is a substantial increase in the overall protection of the public health and safety or the common defence and security to be derived from the backfit and that the direct and indirect costs of implementation for that facility are justified in view of this increased protection.

As discussed in Response 4 above, the USNRC relies on its regulatory process to maintain plant safety and does not require periodic evaluation of the plant licensing basis.

**6. Are there any specific regulatory criteria where continued operation would not be allowed? Identify any other additional criteria (i.e., considered financial, public perception).**

All licensees for U.S. operating nuclear plants are required to maintain their licensing bases throughout the life of the plant. If the USNRC determines that a licensee had violated its licensing bases, the licensee would be required to take necessary corrective actions to bring the plant back into compliance with its

licensing bases, or the plant would be required to shut down. For instance, Yankee Rowe Nuclear Power Station had voluntarily chosen to shut down prematurely. One of the primary reasons for the shutdown was that it was not cost-effective to bring the plant back into compliance with the NRC regulation pertaining to reactor vessel fracture toughness requirements, 10 CFR 50.60 and 50.61. Another example was Rancho Seco Nuclear Generating Station. It was prematurely shut down after a public referendum.

**7. Describe what are the key technical issues related to upgrading and long term operation you are addressing or plan to address?**

Each applicant must provide USNRC an evaluation that addresses the technical aspects of plant ageing and describes the ways those effects will be managed over the life of the plant in accordance with the 10 CFR Part 54 requirements. On the basis of the experience gained from the review of two license renewal applications, several issues are highlighted below for the reason that these issues were extensively discussed between the applicants and the USNRC staff.

Credit for existing programs - The concern was whether or not an existing program can be credited for ageing management without a demonstration of its effectiveness, which is required by the license renewal rule, 10 CFR Part 54. To address the demonstration issue, the USNRC is currently undertaking a task to develop a generic ageing lessons learned (GALL) report which will catalogue existing programs commonly used at nuclear plants and evaluate them for their applicability for ageing management, such as in-service inspection program contained in Section XI of the American Society of Mechanical Engineers (ASME) Code.

Time-limited ageing analyses - Analyses that involve effects of ageing and time-limited assumptions defined by the current operating term, for example, 40 years. Analyses for fatigue, thermal and neutron embrittlement, prestressed tendons, and environmental qualification of electrical equipment, among others, fall into this category. An applicant for license renewal will be required to address these issues using one of the following three options:

1. Justify that these analyses are valid for the period of extended operation;
  2. Extend the period of evaluation of the analyses such that they are valid for the period of extended operation, for example, 60 years; or
  3. Justify that the effects of ageing will be adequately managed for the period of extended operation if an applicant cannot or chooses not to justify or extend an existing time-limited ageing analysis.
- Scoping - The concern was what systems, structures and components should be included within the scope of license renewal. The license renewal rule defines the scope of license renewal in 10 CFR Part 54. Because of the vintage of a plant, however, questions may arise as to what design-basis events should be considered for the purpose of scoping.

**8. Describe what key management issues you are addressing (i.e., organisation, economic deregulation, maintaining competence, use of subcontractors, etc.) to justify long term operation.**

The U.S. utility companies that operate the nuclear power plants are publicly owned and ultimately are responsible for safe operation of their plants. The USNRC does not regulate the organisational or operational structures of these companies, but our performance based oversight process is intended to identify problems in these or other areas should they begin to affect plant performance.

**9. Describe how you apply deterministic and probabilistic methods in your evaluation.**

The licensing basis for currently operating plants is largely based on deterministic engineering criteria. Consequently, there is considerable logic in establishing license renewal scoping criteria that recognise the deterministic nature of a plant's licensing basis. Without the necessary regulatory requirements and appropriate control for plant-specific probabilistic risk analyses (PRAs), the USNRC concludes that it is inappropriate to establish a license renewal scoping criterion that relies on plant-specific probabilistic analyses. Therefore, within the construct of the license renewal rule, PRA techniques are of very limited use for license renewal scoping.

In license renewal, probabilistic methods may be most useful, on a plant-specific basis, in helping to assess the relative importance of structures and components that are subject to ageing management review by helping to draw attention to specific vulnerabilities. Probabilistic arguments may assist in developing an approach for ageing management adequacy. However, probabilistic arguments alone will not be an acceptable basis for concluding that, for those structures and components subject to an ageing management review, the effects of ageing will be adequately managed in the period of extended operation.

**10. Identify additional regulatory issues or concerns that you believe need to be performed (either within your country or internationally) but are not yet actively planned for upgrading and long term operation.**

Depending on the experience gained from the review of license renewal applications and owners groups topical reports, the USNRC may amend the license renewal rule in the future, if warranted.