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Annex to SWEDEN´S SECOND NATIONAL REPORT UNDER THE CONVENTION ON NUCLEAR SAFETY, Ds 2001:41

Answers to questions received by Sweden in the second review process under the Convention on Nuclear Safety

The sections below, and the section numbers mentioned in the text, refer to corresponding sections in the Swedish National Report. The questions are assigned to the different sections as indicated by the questioning country.

Executive summary

1. *Regardless the dialogue between SKI and the licensees, the regulator should have a clear picture of what safety level is required in existing installations and present this to the licensee as a prerequisite for obtaining/keeping a licence. Now it appears that the responsibilities of the Reg. Body and the licensee are diffused (see also question above). Also from art. 18.1 (p. 100/101) it seems that it is still unclear what safety level is required.*
   Please explain what is discussed in this dialogue and how art. 8, sub 2, is met.

As the central authority for nuclear safety, SKI has a clear mandate and obligation to define requirements on safety. This is formally done by proposing amendments to the Act on Nuclear Activities, and normally by issuing regulations in the SKI Code of Regulations (SKIFS). According to Swedish law, all governmental authorities have a legal obligation to enter into a dialogue with the stakeholders before issuing regulations. The purpose with the dialogue is not to negotiate, but to make sure that the intention of the authority is understood and that the proposed requirements are reasonable. There is also a legal requirement on the authority to make a cost-benefit analysis showing that the overall benefits of the proposed regulations are greater than the costs. This analysis can not be done without input from the stakeholders regarding the costs for specific implementations. According to the SKI procedure, this dialogue is conducted in two steps, one informal and one formal. The informal step is taken early in the process by soliciting comments and suggestions, in order to avoid any misunderstanding at a later stage. In the formal step the mature proposal is sent for comments to a large number of organisations, not only to the direct stakeholders, but also to other authorities and interest groups, which could have something to add to the proposal. Both steps are carefully documented.

The mentioned dialogue with the industry to define reasonable requirements for back-fitting during the remaining operating time, is now in the informal phase. A series of meetings are held to discuss a proposal of SKI to amend the general recommendations to the safety regulations SKIFS 1998:1, regarding design and construction of nuclear reactors. The discussion focuses on two aspects: 1) is the wording of the proposal sufficiently clear and 2) what are the technical and economical consequences for the industry of the proposed guidelines. No commitments are made by any of the parties in this dialogue. The result will be evaluated by SKI before issuing the proposal for formal comments.

2. *Is there any more to tell about the common view on the use of risk-informed justifications? Are there formal approaches towards more risk-informed regulations under development?*

The mentioned proposal on back-fitting guidelines opens for a careful introduction of risk-informed arguments. See answer under Article 18. SKI has also changed the general regulations and guidance for in-service inspections. The new regulations opens for the use of both qualitative and quantitative risk informed in-service inspection programmes.

Introduction

1. *What kind of modernisation programmes were postponed or reduced as a result of the deregulation of the electricity market?*

The more strict economic control in a competitive market means that modernisation projects are more carefully scrutinised with respect to their objectives and profitability. This may lead to a choice of condition-based maintenance instead of replacement governed by time schedule or to postponing measures, which cannot be justified by present economic estimates. Modernisation projects, which have been modified or postponed, are such that could not be justified by safety or environmental objectives. Investments for improved safety are governed by other factors and have not been significantly affected by deregulation. A more careful check than before that the safety objectives are reached by planned measures is, however, made.

2. *It is stated that personnel in safety related positions will remain outside the reorganisations (outsourcements/ slimming down organisations, etc.). Has there be any dispute between SKI and the operating organisations whether certain positions were safety relevant or not within the context of such a reorganisation.*

There has been a general discussion between SKI and the licensees on how to interpret the expression used in SKI regulations, "personnel with tasks of importance for safety". One of the licensees proposed a more narrow definition than SKI could accept. An agreement has now been reached on this issue.

3. *Is the amount of participation in international projects and organisations influenced by staff reductions at the utilities in the last few years?*

Several factors determine the participation in international work and there is no evidence that staff reductions have caused a reduction on the utility side. The fact that some international groups have ceased their work or been merged with others and that Sweden has left INPO has reduced some activities but others have developed. In general it can be noted that participation in WANO activities (like peer reviews) is found to give valuable experience feedback and are favoured. Requests for IAEA missions, which often require participation over a week or more, are found more difficult to satisfy for highly qualified plant staff with heavy workload.

Article 6: Existing Nuclear Installations

1. *Has the problem of intergranular stress corrosion cracking detected at some plants been resolved completely, and what are the operating limits that were imposed by SKI with respect to this problem? Furthermore, how have the "revealed weaknesses in the material inspection scheme" been addressed?*

Many different measures have been taken over the years to avoid degradation of safety related components by stress corrosion cracking. When this type of degradation is observed by in-service inspection, the most obvious action is to replace the affected component by a new one, manufactured of less susceptible material. Other options are to change the water chemistry by reducing the oxygen content, and thereby make it less aggressive. In cases when new components are not available, or changes of water chemistry are not possible, temporary repairs are performed.

This is the situation for the supports in the core spray system were stress corrosion cracking was observed during 1999 and 2000. Some supports in the core sprays have been replaced and other supports have been repaired. However, complete new core sprays will be installed in the near future.

The reason for the weakness in the inspection programmes has been identified: the utilities used old procedures, which were not updated and in agreement with the new inspection requirements. Corrective actions have been taken. SKI has reviewed performed investigations by the utilities, as well as the corrective actions taken.

The observed cracks in Ringhals 3 and 4 safe-end welds have been removed as a temporary measure to stop further crack growth. Subsequent safety assessments have shown that sufficient safety margins remain for a limited time period. Measures are planned for removing the susceptible weld material and replace it with another material less sensitive to stress corrosion cracking.

2. *How do the utilities ensure that the deregulation of the electricity market along with increased taxes imposed on nuclear power supplies does not have a negative impact on plant safety?*

Safety, environment, competence and economy have been identified as four key areas, where excellence is required to guarantee continued successful operation of the Swedish nuclear plants. Excellence in safety is required by society and vital for the continued confidence of the public, the media and the governing and licensing bodies. The importance in these areas and safety in particular is continually communicated within the organisation to maintain high awareness.
The safety requirements of each plant are defined in its Safety Report, its Technical Specifications and its Management and Quality Handbook. The safety performance of the plant is closely followed and reviewed by the safety department on site, which is reporting direct to the plant manager. All modifications of importance for safety are reviewed in two steps (primary and independent review) in accordance with SKIFS 1998:1. Safety indicators and operational reports are reviewed and discussed at regular meetings at different levels in the operations organisation. A program for safety improvement has been established at each plant and is regularly updated.

3. *What actions and programmes are implemented by the operator to extend the planned lifetime, and how are those programs discussed with the regulatory body?*

As described in the national report, there are programs at all sites and for all units – the extension may vary somewhat – in order to maintain safety and operational capability for the planned lifetime of the reactors. These programs run over a long period of time.

One example is the Forsmark site, where one investment program (P2000) has recently been terminated. The purpose of that program was to implement renewing measures to assure the appropriate safety and production capability for the operation until year 2010. A new program (P40+) has now been launched in order to assure the safe operation of the units for a lifetime of (at least) 40 years, to maintain present safety margins and to adapt the plants to safety and environmental requirements of the new century. Essential parts of this program will be various measures to increase the safety in the plant. These measures are identified through the reactor safety programs, which are established and authorized by the plant management. The safety programs are updated annually according to the general safety regulations SKIFS 1998:1.

The reactor safety programs are regularly discussed with the regulatory body, although there is no formal requirement of submission to or approval by SKI. There is no discussion in Sweden to extend the planned lifetime of reactors beyond the design lifetime of 40 years.

4. *Was the requirement on design basis reconstitution specified by the regulatory body-SKI? /6.2/*

As mentioned in section 6.2, the initiative, to perform design basis reconstitution projects, was taken by the utilities as a consequence of the five-reactor-stop in 1992. The pilot projects started in 1993. No legally binding orders were given by SKI at the time, and will not be issued as long as the utility work plans are acceptable. I some cases SKI has not agreed with priorities, presented by the licensees, on elimination of identified specific weaknesses. In such cases, SKI has ordered measures to be taken within a certain time.

5. *What are the main basis for establishment of modernization programmes for your nuclear power plants? /6.3./*

The basis for the modernization programs completed or under way is to secure generation capability with maintained or improved safety for a specified period of time. The older plants are subjected to problems, e.g. aging equipment and difficulty to find appropriate spare parts. Modern safety criteria and new knowledge in the reactor safety area are other challenges to the older reactors. As an example the objective for the ongoing program in Forsmark has been set:

- To maintain generation capability up to at least 40 years' operation time
- To maintain present safety margins
- To adapt the plant to the safety and environmental requirements of the 21st century

6. *Based on the information provided on the safety-oriented modernisation of Swedish NPPs; describe the expected evaluation process and the outcome when complying with the new regulatory guideline on back-fitting from year 2002 on.*

This assessment is not yet completed. A consequence and cost/benefit analysis of the new back fitting guidelines will be completed later this year, when the final proposal is issued for general comments. It is expected that especially the older plants will need to improve physical and functional separation. This will have implications for fire protection and protection against pipe breaks. It is further expected that all the Swedish NPPs will need to improve the protection against Common Cause Failures by diversification measures. Certain measures to further improve the management of severe accidents also need to be addressed. Furthermore, it is expected that the safety cases of the reactors will be more transparently documented.

A specific assessment will be made for each of the 11 reactors. The necessary measures to be taken for each reactor, and the time schedule for implementation, will be issued by SKI as licensing conditions.

7. *Some events are reported including intergranular stress corrosion cracking and BWR core instability. Does SKI review and approve the adequacy of remedial measures for these events before their implementation?*

Remedial measures taken by the utilities when cracking incidents occur will normally be reviewed and assessed by SKI. However, in situations were observed cracking results in replacements of components, a third party inspection body will do the detailed review to assess conformity with SKI regulations.

According to the general safety regulations (SKIFS 1998:1), SKI must be notified about plant modifications, such as preventing core instability by installation of new equipment or limitations in the operating range, before they are implemented. SKI then decides whether to review the case or not and whether further or additional conditions shall be established for the modification.

8. *It is reported that the collective dose to workers shows large reduction in these three years. What are the major contributors to the reduction? Reduction of dose received during operation, maintenance work, inspection work or surveillance work?*

The total radiation dose to personnel at the Swedish nuclear power plants was 6.7 manSv in 2001. This is the lowest value since 1976. This is the fourth year with decreasing radiation doses to personnel in the nuclear industry. The reason for this is of course not to be found in a single cause.

Many of the Swedish NPPs are now in a phase where they profit from earlier campaigns to reduce dose rates in reactor systems. Examples here are stellite reduction and reactor water chemistry optimisation. The on-site ALARA work has also included soft issues like improvement of working procedures and choices between different solutions. In some cases large modernisation work has been scheduled to take place over several years. This gives a lower dose impact per year.

A third explanation is that most of the reactors during this period have had less extensive maintenance- and repair-work, as a result of reconstruction of reactor systems, which in turn results in dose reduction. For example the frequency of material testing and maintenance of systems have been lowered in many cases, due to campaigns with exchange of pipes to less IGSCC sensitive material.

9. *It is reported that utilities reduce the number of personnel and outsource support functions. Does SKI impose any restrictions on outsourcing support functions?*

According to SKI regulations, the licensee must always have sufficient and competent personnel available for all task of importance for safety. SKI shall be notified of outsourcing of support functions, which have direct or indirect importance for safety, and SKI can establish conditions for this outsourcing. Outsourcing of importance for safety has to be justified by the licensee from the safety point of view and safety reviewed in two steps, before notifying SKI. It would be very difficult for SKI to accept an outsourcing of support functions, which have direct importance for safety, such as core management and chemistry. In cases of more indirect importance for safety, such as computer support and archiving, SKI will review the proposed provisions and the safety review made by the licensee. The licensee must present evidence that there remains enough competent in-house staff for ordering, managing and evaluating the results of the proposed contractor.

In cases of permanent outsourcing to another company of major activities included in the original licence, an amendment to the original licence is needed. This does not include normal procurement of equipment and services.

10. *Will the operating limits imposed by SKI on the reactors affected by stress corrosion cracking influence the remaining operational lifetime of these reactors?*

The time limits imposed by SKI in the referred, or similar, cases will not influence the remaining lifetime of the reactors, as long as the utility takes corrective actions. Such actions can be to replace susceptible material in the components with another material less sensitive to cracking or other degradation.

11. *Is there any control mechanism for the assurance the utilities keep their promise that safety will be prioritised as prior to deregulation? How is "paying attention to the utilities effort to manage the changes" filled in by SKI? Is there a relation between this regulatory task and the safety management provisions as defined by the utilities (see page 58 and 59)?*

There is no specific control mechanism in place. As mentioned in section 6.4, SKI considers that the development of regulatory requirements and practices over the last years has provided the necessary instruments to supervise the effects of market deregulation on safety. Especially important, for assessing the safety priorities of the licensees, are the new annual integrated safety assessment procedure SKI-Forum, described in section 7.4, and the resulting top management meetings between SKI and the respective facility. The structured process of SKI-Forum enables an assessment of performance trends. It will be investigated whether performance indicators are suitable to support these assessments. Major agenda points at the top management meetings, also held with the corporate utility level, are current safety challenges, safety priorities and associated action and investment plans.

The minutes of the licensee safety committee meetings, mentioned on page 58, are available for SKI as well as the safety investment programmes. These documents also provide important input to the mentioned management meetings.

12. *It is stated that part of the collective dose reduction came from less extensive maintenance. Was this reduction in maintenance due to radiation protection considerations or was it the by-product of a measure to shorten the refuelling outage? Are further dose reduction investments planned for the future?*

Reduction of collective dose to personnel is generally not taken as a reason to reduce maintenance. The dose reduction obtained by shorter outage times can be considered a by-product (lower waiting dose etc). Several planned investments will include the opportunity to reduce personnel doses, although this is generally not the only motive for the investment. The replacement of tubing material in the primary circuit, which were carried out recently, are for example expected to reduce doses by decreasing the need for testing and inspection.
In Ringhals some of the early dose reductions related to maintenance, were initiated by the radiation protection engineers, who questioned the standard maintenance programs proposed by the manufacturer. By different measures the system reliability could be improved and the need to dismount and reinstall for maintenance was reduced. This resulted in improved quality and safety by reduced risk for remounting errors and in lower personnel doses.

13. *In the paragraph on design basis reconstitution it is stated that deficiencies in safety were identified and that regarding the corrective measures relevant recent international safety requirements and practices were taken into account. Was there a formal approach to adapt the old licensing basis to these international state-of-the-art safety requirements and practices in order to get a reference framework? Was there a role for the PSAs in this process and was there a role for safety goals (Note: SKIFS 1998:1; see Art. 10.1, p. 57)?*

There was no formal approach specified by the regulator for this process. The work was outlined in meetings between SKI and the licensees. Focus was set on "hidden" safety deficiencies and the work included both an extensive review and updating of the safety analyses report as well as an evaluation of weakness found in the PSA.

PSA played an important role to identify plant weaknesses and to evaluate the safety significance of deviations from the deterministic requirements. The utilities used and use safety goals both on total core damage frequency and on individual contributing sequences.

14. *In various places in the report it is indicated that reactor modernisation programmes have been cut due to increase cost awareness following the deregulation of the electricity market. But these cuts did not affect safety, as it is said (although p. 34 states that safety investments are affected). However, modernisations are done either for safety or for economic reasons. It is difficult to understand that modernisations that improve economics have been cut due to economic reasons! Were there any regulatory criteria which were used for allowing these changes in the modernisation plans? Please explain what precisely is done and give examples of such cuts in modernisations that have been made (e.g. as addressed in 11.2, last line – p. 64). TWICE and other projects (p.104) clearly aim at non-safety improvements!*

In a competitive market there are several factors, which have to be taken into account in decisions on investments. For non-safety investments an overall estimation has to be done and it is important to consider:

- The effect on the economic result, both increase in profit and pay-back time
- Restrictions on investment money, due to competing high-priority investments (for example restructuring and purchase of assets).
- Uncertainties regarding future safety requirements, which may require costly plant modifications.
- Other uncertainties, e.g. future price development

In general this has caused the investment programs to be divided in several phases with stepwise decisions and options to stop or modify in the process.

Safety investments are controlled by other factors and have not been affected in any significant degree by a tighter economic situation. They are, however, subjected to a more careful review regarding their effectiveness, i.e. a better control is executed that the safety goals are really achieved by the proposed measure. See also answer to question no 1 by the Netherlands on the Introduction.

15. *Effects of deregulation. Deregulation of the electricity market affects also the regulatory body, as it is described in this chapter. Sweden appears to develop new regulation, to meet this situation. Are the effects of the "large cost cutting programmes implemented in operation and maintenance" assessed and monitored by the licensee and/or SKI; e.g., by the use of LPSA? If yes, in how far are the safety management provisions as described on pages 58 and 59 used? Internationally, in this context often the term reversed ALARA/ALARP is used. In other words, allowing for small risk increases where large cost reductions are at stake. Are this kind of ideas also used in the associated dialogues between licensee and regulatory body? Is there also an effort to decrease unnecessary regulatory burden, e.g. by risk-informing the regulation (as it is done e.g. in the USA)? I.e., beyond the existing inspection guideline in SKIFS 2002:1? (some probability is mentioned in 14.1, p. 80 – mid, and 18.2, p. 102 - mid)*

SKI is not developing any regulations in response to the effects of deregulation. As mentioned in the answer to the question under Article 18, there were other motives for developing the new back-fitting guidelines. As mentioned in section 6.4 the existing regulatory instruments are considered sufficient to deal with this situation. As further mentioned in section 6.4 of the Swedish report, the effects of cost cutting programmes are monitored by both the licensees and SKI. LPSA is not used in this context. Trading of risk increases against cost reductions is not part of the dialogue between SKI and the licensees. There has been no pressure so far on SKI to reduce "unnecessary regulatory burden", although SKI has felt that a larger effort is needed, as compared to before deregulation, to justify the regulatory position in some cases.

16. *Have the new demands on the regulatory work and oversight process also implications for the size of the regulatory staff? It is assumed that the preparatory work will need a lot of manpower, while the every day regulatory work continues. Or is a large part of this work contracted to Technical Support Organisations?*

The mentioned new demands on the regulatory work and oversight process have implications for the efficiency the regulatory body, rather than for the size of staff. The present size of staff is felt to be sufficient, but it has been necessary to develop activity planning and the work processes in order to use the staffing resources in a more efficient way. This development work is now almost completed and positive results are visible.

17. *It appears that SKI (nor SSI) uses the services of a Technical Support Organisation (TSO); this is one of the reasons why the workload is so high. In addition, the use of such a TSO brings about a better separation between the people developing requirements/guidelines and the ones assessing whether they have been met, and would make it possible to concentrate better on long term aspects. Has SKI considered the use of such a TSO (like e.g. GRS, AVN, Studsvik centers) and, if yes, what were the conclusions?*

SKI has considered the use of an external TSO but has concluded that it is better to integrate the services of a typical TSO in the ordinary organisation. This was also reported to the Government in the response to the report of the 1996 International Review Commission, which raised this issue. As a result of this review, the resources of SKI were increased in 1997, making it possible to recruit nine qualified persons for safety assessment, research administration and in-depth investigation of safety issues. SKI considers it to be a major advantage for development of in-house competence and motivation of the staff to integrate these tasks. Provisions are made to protect these resources, intended for long term work, from event triggered resource mobilisation. It should be added that of course SKI uses external organisations when needed, such as universities and qualified consultants, to investigate technical issues and for research and development work. A specific budget is provided for this.

Article 7: Legislative and Regulatory Framework

1. *Do you submit any additional EIA reports for your NPPs based on requirements of the law adopted in 1999?*

Retroactive application of a law is not allowed according to the Swedish Constitution, if not explicitly stated in the law. In this case, earlier permits have validity in relation to later legislation. Therefore, SKI can not insist upon additional Environmental Impact Assessment (EIA) reports for facilities with existing licences. However, it is possible for SKI to require an EIA if a licensee wants to apply for an additional nuclear activity, or a change of the nuclear activity that the licence is valid for.

According to existing law, it is mandatory to submit an EIA together with an application for a licence to construct, possess or operate a nuclear power plant. In the case of applications for a licence for other matters than those mentioned, the Government or the appointed authority may issue regulations calling for an EIA to be included in the application for a permit.

2. *Describe some of the main goals and common work processes for obtaining a well-integrated safety assessment and review by the two separate safety authorities (SKI and SSI).*

As described in detail in the first report to the Convention, there are separate laws in Sweden dealing with nuclear safety and radiation protection respectively. There are also two separate and independent regulatory authorities (SKI and SSI). The adequacy of this system has been investigated on several occasions, as described in section 8.3 of the first report to the Convention. The necessity, to co-ordinate the regulatory activities, has been emphasized, but so far there has been no official proposal to merge the two authorities. This issue will be reviewed again in a recently commissioned governmental investigation of safety and radiation protection at the Swedish NPPs. This investigation report is due for submittal to Government on 1 October 2003.

With regard to transportation of nuclear material and handling of nuclear waste, there are legal requirements on co-ordination between the two authorities. In other matters, co-operation has developed over the years, on a voluntary basis, and on the insight that integrated safety assessments and reviews are functional for both authorities as well as for the industry. The most important co-ordination mechanisms are the following:

- the director general of SKI is a member of the SSI board and vice versa
- regular joint management meetings are held
- both authorities are represented in each others research committee and SSI is represented in the SKI reactor safety advisory committee
- the authorities consult each other in regulatory reviews of major safety issues
- co-ordinating inspection meetings are held before the annual outages
- a formal co-operation exists between the emergency preparedness organisations of the two authorities and the information service is co-ordinated for nuclear emergencies
- both authorities co-operate in the production of an annual report to the Government on the status of safety and radiation protection at the Swedish NPPs

3. *It is reported that earlier routine inspections have been transferred to another manual and renamed "covering of current plant issues".*
   1) What does "covering of current plant issues" mean?
   2) Is it a system, or a document?
   3) What are the contents?

"Covering of current plant issues" is a kind of simplified inspection procedure. The background is that SKI has made the normal inspection procedure more strict with regard to planning, conduct, assessment of compliance and non-compliance with regulations, and regarding documentation. This created a need for a more simplified procedure to be applied in cases where SKI wants to inform itself on-site about activities of the licensees, collect information about plans, status of ongoing projects etc, without explicitly making an assessment about compliance with regulations. Also in these cases preparation and documentation of the findings are required, but much simplified in comparison with inspections. The result from "covering of current plant issues" is normally used for preparation and planning of other regulatory activities.

4. *Which nuclear power safety related activities are subject to authorization (issue of license, permit or agreement) by the regulatory body?*

According to the Act on Nuclear Activities (1984:3), a license in required for construction, possession and operation of a nuclear facility, as well as for acquisition, possession, transfer, processing, transport or other dealings with nuclear material and nuclear waste (very small quantities are excepted). A license is also needed for import into and export from Sweden of nuclear material and nuclear waste. Furthermore, a license amendment is needed for permanent delegation to another company of activities included in the original license. This does not include normal procurement of equipment and services.

The Government normally decides on licenses. However, the Government has delegated to SKI to license acquisition, possession, transfer, handling, processing or other dealings with low enriched uranium, depleted and natural uranium, small quantities of plutonium and of nuclear wastes. If a small facility is required for any of these activities, SKI is authorized to license such facilities. Furthermore, SKI is authorized to license transports and, with some restrictions, import and export of nuclear material.

The Government has delegated to the Radiation Protection Institute (SSI) to decide on licensing of transport, import and export of nuclear wastes, as well as construction, possessing and operation of ground storage of low - radioactivity nuclear waste.

According to the general safety regulations (SKIFS 1998:1), the SAR of a facility, the Technical Specifications, the Physical Protection plan, the Emergency Response plan and the Decommissioning plan shall be submitted to SKI for approval. SKI must be notified of changes in these documents and can decide on additional or different conditions to be applied for these changes. SKI shall also be notified of significant technical and organisational modifications to a licensed facility. Also according to SKIFS 2000:2, dealing with mechanical components and in-service inspection, there are a number of specified cases where SKI shall be notified and where SKI can decide on further measures to be taken. The term "agreement" is not used in Swedish regulations.

5. *To what extent do you use performance indicators to assess the safety performance of a licensed reactor? What indicators are used?*

A pilot project has been done at SKI to study the feasibility of performance indicators in support of the integrated safety assessments (SKI-Forum) mentioned in section 7.4. The indicators studied were deduced from SKI safety regulations and data were taken from already required utility reports to SKI. Comparisons were made with WANO indicators and NRC indicators. It was concluded that indicators are helpful for the focussing of the regulatory oversight, and it has been decided to continue the development work. It was also concluded that proper indicators related to organisational performance are difficult to develop, but necessary for a balanced picture of reactor safety performance.

Indicators are used by the utilities at both plant and corporate level to identify trends and to compare performance with international standard. Both the WANO performance indicators and some internally defined indicators described in chapter 10 of the Swedish report are used.

6. *How does the regulator use the risk assessment data; for example in planning inspections, developing inspection procedures, developing technical specifications, and evaluating incidents? How does the operator of the facility use the risk data?*

Risk assessment data is currently used by SKI only to a very limited extent for the mentioned purposes. In assessment of modifications of technical specifications and in evaluation of incidents, the relative risk contributions and risk increase factors are considered if applicable. The use of risk assessment data will be considered in further development of the SKI assessment procedures.

The results from PSA (level 1 and 2) are mainly used by the operators for achieving a balanced design, identifying weaknesses and need for safety improvements. In general the core damage frequency is not used for comparison with other plants but a target value is set as a guide for evaluating the need for safety improvement. In addition PSA methodology is used to assess risk impact of occurred incidents and of planned actions. Risk increase factors based on PSA are also included in the Safety Index used in Ringhals and Forsmark (see chapter 10 in the Swedish report).

Article 8: Regulatory Body

1. *Do you plan to join nuclear and radiation regulatory body SKI and SSI similarly to other countries?*

There is no such plan at present. See further the answer under Article 7.

2. *Which are the SKI work criteria for a decision whether to review a notification of a principal NPP modification?*

As mentioned in section 8.5 there are three main criteria: safety significance of the notification, other relevant circumstances and the degree of confidence SKI has in the self-inspection of the licensee. Under each main criterion there are sub-criteria: eight sub-criteria under safety significance, five under other circumstances and five sub-criteria under self-inspection. The sub-criteria under safety significance deal with the possible impact of the modification on the barriers and defence in-depth system of the facility. Sub-criteria under other circumstances are 1) use of new or complicated technology, 2) use of data or assumptions with significant uncertainty, 3) risk for introduction of CCF, 4) use of solutions which have earlier led to problems, and 5) possible introduction of a precedent. Under self-inspection are sub-criteria on lack of knowledge or uncertainty about: 1) a good QM system is in place with documented procedures for internal safety review, 2) there are sufficient resources and competence for internal safety review, 3) there is clear division of responsibilities and authorities, 4) there is a proven capability to make good safety analyses, and 5) there is a proven capability to follow up results from self-inspection.

A proposed modification is reviewed by SKI if all three main criteria are fulfilled, i.e. high safety significance, other circumstances of importance and there is a deficiency in the self-inspection of the licensee. If one or two of these criteria is fulfilled, random reviews are made. If none of the main criteria is fulfilled, the modification is not reviewed by SKI. The complete criteria sheet is available in Swedish only.

3. *It is reported that 53 of the notifications out of 230 technical and organizational notifications resulted in a review by SKI. Are there any objective criteria, based on which an organizational notification results in a review by SKI?*

In the SKI general safety regulations, organisational modifications are treated in the same way as technical modifications. The same criteria are used in the decision by SKI to review the modification or not. See answer above. Organisational modifications, where SKI must be notified, are those, which modify what is reported in the SAR, i.e. principles for management and control of: operations, maintenance, nuclear materials and waste, safety and quality and emergency preparedness. Examples of such modifications are: change of ownership relations, merging or split of production units or technical support functions, centralisation or decentralisation of on-site maintenance, significant downsizing and outsourcing of functions important to safety.

4. *How the new notification practice has influenced the licensing system? Does the license must be changed in case of significant notification?*

In cases where a proposed modification is challenging very basic assumptions or very basic design prerequisites of the plant according to the SAR, which is the basis for the license, SKI may decide that the whole updated SAR must be submitted for new approval. In practice that would be a re-licensing, within the basic license given by the Government.

5. *The organizational diagram for SKI does not include a separate unit for rulemaking nor licensing. International safety requirements for duties and responsibilities of Regulatory Bodies explicitly mention these tasks. Question: Is the SKI organization appropriate to cover aforementioned tasks? Also, describe how effective separation is achieved between on the one hand rulemaking and on the other hand inspection and assessment.*

SKI does not recognize the significance of the question. Separate units for rule making and inspection and assessment are no guarantee for regulatory independence. The SKI Office of Reactor Safety has a typical competence oriented organisation, with expert units for the major competence areas required for inspection and safety assessment of nuclear power plants. In the SKI annual activity planning, the Office is assigned missions and sub-missions. These are based on the tasks given by the Government and on the short-term and long-term regulatory challenges, identified in the activity planning process. The current list of missions for the Office include: development of regulations, integrated safety assessments of the nuclear facilities, inspection, licensing reviews, long-term investigation and development work, emergency preparedness, international exchange and research administration. These missions are specified in sub-missions with assigned sub-mission leaders. These leaders are given a budget and staff resources from the expert units. The results of the sub-missions, and accumulated on the mission level, are regularly followed up by the SKI management during the year.

The development of reactor safety regulations at SKI is presently co-ordinated, under the Office director, by the Office co-ordinator. He is responsible for the formal processing of the regulations according to the specific quality management procedure for rulemaking. The technical input is given by a sub-mission, defined for this task and composed of relevant experts.

At the SKI level, all development of regulations is monitored by a standing group of senior regulators and the senior legal advisor. They assess each project at different stages in the process and report to the Director General. The final decision on the new regulations is taken by the SKI board, which is composed of members of parliament and independent safety experts. SKI has found this way of working to be functional, providing practical experience with NPPs, as well as independence, to the rulemaking process.

6. *Please make a reference to the mentioned 'earlier audits' of the SKI. Some of these mention the neglect of e.g. developing proper regulation as the consequence of full attention to all type of regulatory ad-hoc work (assessments, inspections). The report states that 6 individuals have been attracted, but this cannot change such an unfavourable situation. What has been changed in SKI's policy and long term planning to alleviate the concerns expressed in 1999?*

The mentioned earlier audits, discussed in the first report to the Convention, were the 1994 Energy Commission and the 1996 International Review Commission. The recommendations of the Review Commission led to an increase of SKI staff with nine qualified persons for long-term tasks. This added resource together with a more efficient activity planning process, the new safety regulations and the new quality management system, has structured the work of SKI in such a way that earlier expressed concerns about the workload have been alleviated. The regulatory supervision is more clearly focussed. The activity planning is based on a more realistic analysis of the regulatory tasks and challenges, a more realistic analysis of resources needed for different tasks, has more clear priorities and is followed up in a more structured way. Mechanisms have been developed to change priorities in cases of conflicting demands on the staff. Staff surveys are made regularly to monitor the workload and to solicit suggestions on how to further improve the work situation. These suggestions are discussed in the line organisation and action plans are developed. However, as mentioned in section 8.2, there is still room for improvements.

7. *Table 5 shows the SKI budgets. Explain the relative amount of administration and research in the total budget. What is included in administration. Given the relative high share for research please give an explanation for this. Is this all regulatory specific research or research together with the utilities?*

As can be concluded from table 5, administration is about 56% of the total SKI budget 2000. Administration includes salaries, office rental, travelling and all operational expenses. The budget for research includes all research and development activities contracted externally for direct support of short-term and long-term regulatory activities in the area of reactor safety as well as nuclear non-proliferation and nuclear waste management. Some of these projects are made in co-operation with the utilities, however most often with shared financing. The SKI research budget also includes financing of some basic resources for education and research at university departments, in order to maintain the national nuclear competence, as reported in chapters 4 and 11.

One reason for the relatively large research budget of SKI was considerations after the TMI-accident to increase national knowledge, especially in the fields of human factors and severe accident phenomenology and management. Another reason was to compensate for not having access to a national TSO for the support of the regulatory body.

8. *How managed SKI the development of SKIQ without the consequence of paying less attention to the every day regulatory work?*

In 1997 SKI employed a full-time QA-manager in order to push and co-ordinate the development work. A reference group was established to support the QA-manager. A project manager was assigned, together with a small group, for the development and documentation of each process to be included in the quality management system. The work was prioritised in the activity planning. However, the difficulties were somewhat underestimated at the beginning and the complete development work took four years. The answer can be summarised as: a clear organisation of the work and a long working period.

9. *One of the most difficult challenges in assessing the safety performance at a nuclear power plant is to recognize the early signs of declining safety performance, before conditions become so serious that regulatory sanctions must be imposed or, worse, a serious incident or accident occurs. In this connection, it is widely known that a good approach is to have senior resident inspectors who can observe the day-to-day operations of the plant.*
   (1) What is the role of resident inspectors in the regulatory framework?
   (2) What is the size (number) of resident inspectors per reactor or site?
   (3) What are the major activities of resident inspectors?
   (4) What are the requirements for the qualification of resident inspectors?

SKI does not use resident inspectors. The 14 inspectors at the Inspection Department of the Office of Reactor Safety are stationed at the SKI office in Stockholm and travel to the sites when needed. Inspections are normally done with participation also of other SKI staff, which are experts on the specific matter to be inspected. There is one site responsible inspector assigned to co-ordinate the regulatory activities directed at each site. This inspector is rotated after about four years. 1-3 inspectors are assigned to work more specifically with each site. The role of the site responsible inspector is to maintain contacts with the site and to follow activities at the site. He/she also co-ordinates all SKI activities directed at the site, including to prepare and participate in inspections, prepare the integrated safety assessments (SKI-Forum, see section 7.4), prepare and participate in the top management meetings. A site responsible inspector should have a long nuclear experience and normally at least five years experience as a regulator.

Article 9: Responsibility of the Licence Holder

The sentence starting on the 5th line sounds as a contradiction. It is hardly imaginable that a utility reduces its budgets that aim at a more economic operation. These investments normally give sufficient return to be profitable. Can this situation be explained more in detail.

See answer under Article 6.

Article 10: Priority to Safety

1. *Figure 5 shows the safety index used in Forsmark and Ringhals. How are performance indicators, safety index or environmentally oriented index, communicated to the public, and used for enhancement of public confidence in safety of nuclear installations?*

The safety and environmental indexes at Forsmark and Ringhals are primarily intended for internal communication with employees, management and board. They are not explicitly communicated to the public, but some of the elements of the index together with several other indicators are used and referred to in annual reports and other publications directed to the public.

2. *Is the safety policy of the licensee formally approved by the SKI? If not, what happens if the safety goals apparently are not met? Requirements, recommendations, sanctions, nothing? Is the plant safety committee formally required by SKI?*

A licensee safety policy is required in the SKI general safety regulations. The policies are reviewed by SKI in connection with inspections and reviews of the safety management provisions of the licensees, however they are not formally approved. The safety policy is regarded as the licensee own management tool and SKI takes a general interest in how the safety policy is formulated, used and followed up. If SKI has established that the safety goals of the licensee are not met, for instance actions are not taken despite PSA results or performance indicators out of targets, this will be brought up in the top management meetings with the licensee. In such cases SKI will probably also make an inspection, or a regulatory review, to establish whether there are any specific deviations from safety regulations. Depending on the nature of such deviations, different sanctions are issued, from a remark to a direct order to correct the issue within a certain time.

The legally binding requirement is to make an adequate investigation and to collect sufficient advice before decisions are taken on safety issues. The general recommendation to this provision says that a safety committee should be established, in order to advice management on safety issues. The committee should have a high integrity and a broad competence in nuclear safety. In addition to this, there are legally binding requirements on independent safety review of certain issues.

3. *Is there in Sweden a systematic program agreed with the Regulatory Body for the management of ageing and plant life extension ?*

The Swedish utilities have no systematic programs agreed with SKI for management of ageing and life extension. SKI regulations include both general and more specific requirements related to management of ageing. These requirements have to be followed by the utilities. Life extension has not yet been an issue in Sweden.

See further answer under Article 6.

Article 11: Financial and Human Resources

1. *What specific measures are foreseen to ensure that a sufficient number of adequately qualified staff will be available for the remaining operating plant lifetimes?*

Future availability of competent staff has been identified as an issue of high strategic importance for the years to come and several actions have been initiated:

- The competence planning at the plants has been focussed and improved. The need for high-level competence in specific areas has been identified and competence profiles have been defined for all positions. By comparing these profiles with available expertise the need for development and training of employees and for recruiting has been assessed. Discussions are held within the industry on how resources in the nuclear area should be organised to make efficient use of available expertise and secure highly needed competence.
- As mentioned in chapter 4 and in section 11.5, the Swedish Nuclear Technology Centre has expanded its scope to support both research and basic education at several technical universities in Sweden (previously only the Royal Institute in Stockholm). It is sponsored by the Swedish utilities, SKI and Westinghouse Atom. The mentioned agreement under discussion has now been concluded, to financially secure professorships in nuclear subjects, and funding has been granted for higher education and research projects.
- The nuclear power plants are co-operating with regional high schools and colleges by offering summer jobs, support for thesis work and trainee programs.
- In the modernisation projects, recently graduated engineers have been employed to create an opportunity for them to build up a knowledge and experience comparable to that obtained by those generations, who participated in the construction of the plants.
- As a response to a request by the Government, SKI has started work to plan its future research, where one aim is to enhance and increase competence and available expertise in areas of importance for nuclear safety in the future. In this context a study has recently been carried out of the demand and supply of qualified nuclear specialists in Sweden, presently and in 10 years, within 11 essential competence areas for nuclear power operations and nuclear waste management. This study gives a positive picture of the future situation, with regard to replacements and covering of new needs, despite loss of the most experienced staff at the Swedish nuclear facilities through retirements during the next 10 years.

2. *What are the practical provisions for insurance of your nuclear power plants?*

The national legislation, which implements the obligations under the Paris Convention and the Brussels Supplementary Convention, is the Act on Nuclear Liability. This Act provides that the operator of a nuclear installation, which is the source of a nuclear incident, is liable to provide compensation to those who have suffered personal injury or damage to property as a result. The liability of the operator is strict and exclusive. The liability amount has been raised progressively since the Act was first passed in 1968. The current limit, which came into effect on 1 April 2001, is 300 million Special Drawing Rights (SDR) which correspond to approximately SEK 3 300 million. Except in the case where a nuclear installation is operated by the state, every Swedish nuclear operator must have insurance, approved by the Government, to cover his liability, as set out in the legislation.

The Act provides for compensation over and above that available under the terms of the Paris Convention and the Brussels Supplementary Convention. If there is a nuclear incident for which the operator of a nuclear installation located in Sweden is liable, and the amounts available under the two Conventions are insufficient to allow compensation in full, the state will compensate the victims from a maximum sum of SEK 6 000 million per incident. This extra tier of compensation is available only in relation to nuclear damage suffered in Sweden, Denmark, Finland, Norway, or in the territory of any other Party to the Brussels Supplementary Convention (and only to the extent that this Party provides similar additional compensation for damage suffered in Sweden).

A person wishing to claim compensation under the Nuclear Liability Act must do so within three years of becoming aware of his or her entitlement to compensation, or, in any case, within 10 years of the nuclear incident which caused the damage complained of. The Act also contains provisions establishing which Swedish courts have jurisdiction over a particular claim for compensation.

Each plant is insured for nuclear responsibility in accordance with Swedish law and the Paris and Brussels conventions. In addition property loss and damage is insured through insurance companies on the market or, in the case of Vattenfall, through its own captive company, Vattenfall Insurance, which reinsures its risks on the open market.

3. *Which specific requirements does SKI apply to assess the adequacy of the utility financial resources other than those connected to the nuclear waste fund. E.g. specific requirements to achieve a financially stable enterprise able to carry the costs for unforeseen safety related measures?*

There are no specific requirements related to the financial stability of a licensee. However, both the Act on Nuclear Activities and SKI safety regulations contain a number of legally binding requirements on safety, which require commitment of large economical resources. The Swedish licensees are subsidiary companies to the major utilities with known financial records. There are no regulatory concerns regarding the financial stability of those companies. The Swedish state is still the major owner of the Swedish NPPs. In the case a licensee cannot fulfil the safety requirements, the licence will be revoked. In the case of an application for transfer of a licence to a company with a new or unknown owner, SKI will require an extensive financial report supported by independent audits. This report will most probably be reviewed by a competent third party organisation, since SKI lacks experts on corporate financing. If there are any indications of financial problems, SKI will not recommend the transfer of the licence in its report to the Government.

3. *What is the expectation regarding the availability of nuclear specialists for regulatory staff functions in the coming 10 years? Is there also a high retirement rate at SKI in the coming years?*

Taking into account the current venture to support nuclear academic education and research, reported in section 11.5, SKI does not foresee any specific problem to recruit the needed qualified staff in the next 10 years. The average age is currently 47 years and 11 persons (less than 10% of the total), are expected to retire from SKI in the next five years. A new rule in Sweden, effective from 2003, makes it possible on a voluntary basis to continue work until 67 years of age. This could mean a slower retirement frequency.

Article 12: Human Factors

1. *What are the requirements for content of the documentation for organizational changes on the operator's side needed to obtain the necessary approval by SKI?*

The licensee is required to have a documented procedure for managing organisational changes and for reviewing organisational modifications.

It is expected that the documentation on an organisational modification contains

- A presentation of how the project is controlled and managed including a timetable of the project, its phases and decision points.
- A statement of why the change is needed, the goals and objectives
- An analysis of the involved safety issues and a description of how they are addressed
- How the staff is involved in the change process
- An implementation plan
- A plan for monitoring and evaluation of the change
- Documentation of the primary and the independent safety review of the change, and of measures taken in order to deal with the comments made in the safety review

2. *It is reported that an associate professorship on human factors has been created at Malardalens Hogskola university.*
   Does the lecture on human factors attract many students?
   Do students take jobs in nuclear industry after graduation?
   Do students come from industry and regulatory bodies?

The teaching of Human Factors is an integrated part of existing education programs at the Mälardalen Högskola and so far no specific Human Factors program has been established. Later this year a specific, non-integrated course of human factors is expected to start, aiming at both industry employed people and students attendance. The professorship is fairly recently established and the activities have so far been focussed on recruiting doctorate students and start of research projects.

3. *The description at paragraph 2 of page 70 introduces that the large plant modifications, such as the upgrading Oskarshamn 1, will be reviewed and inspected. What are the scope and contents of I&C modification in Oskarshamn unit 1, and criteria/methods to evaluate the safety of human factors design for the large plant modifications from the MTO (man-technology-organization) viewpoints?*

Regarding scope and contents of the I&C modification, see answer under Article 18.

Regarding regulatory review, the purpose of the MTO review is to verify that accepted human factors practices and guidelines have been incorporated into the design. For that purpose, the design process is assessed, by taking samples of the actual practice. Most of the following elements are reviewed

- MTO program management
- Operating experience review
- Functional requirements analysis and allocation
- Task analysis
- Staffing, qualification and training
- Human reliability analysis
- Human system interface design
- Procedure development
- Training program development
- Human Factors verification and validation
- Design implementation

SKI will also review the primary and the independent safety review required by the licensee and which also must include an MTO-review. The review consists of reviews of licensee and vendor documents, including their plans, methods and results from tests in part-system simulators and integrated validation in a full scope simulator before design implementation.

Article 13: Quality Assurance

1. *Does the Swedish regulatory body SKI monitor QA of nuclear contractors? Which criteria for evaluation are used?*

SKI does not normally monitor QA of nuclear contractors, since this is a responsibility of the licensees. However, in reviewing modification projects, SKI has reviewed the audits made by the licensee of contractors and vendors and also how the licensee has ensured that deviation reports have been dealt with timely. The criteria used by SKI follows the IAEA Safety Series No 50-C/SG-Q.

Article 14: Assessment and Verification of Safety

1. *Did you implement any changes on the units in operation based on the nuclear safety analysis results and the present state-of-the-art (e.g. providing for physical separation of high-pressure admission steam pipelines and those of feedwater) ?*

In the case of the oldest of the Swedish reactors, Oskarshamn 1, the consequences of the latest safety analysis results are that the main process concept and plant lay-out has remained unchanged, but as for the safety systems like core cooling and residual heat removal they have been physically separated. The same goes for the emergency power supply system and the I&C systems. Contributing to these changes and resulting in the introduction of the new safety concept have also been a modern thinking in the design of nuclear power plants.

Different types of safety analyses form the basis for safety improvement measures in reactors in operation. These can be based on the inventorying of modern requirements, i. e. European Utility Requirements, or other guidelines, or from events in own plants or externally. In Forsmark as well as for the other plants the results of the analyses are used when identifying measures for improving the safety according to the annual reactor safety programme. The following safety improvement measures taken at Forsmark can be mentioned

- Implementation of two-phase safety relief valves
- Separation of power supply by using different busbars for safety related objects than for other objects
- Improved cooling of rooms where emergency core cooling pumps are located
- Improved fire separation of cables / cable trays
- Increased isolation valve function safety

In Ringhals one important example is the fully redundant and diversified (separate diesel powered) feed-water line in Ringhals 1, which had a significant impact on the core melt frequency in the PSA study

3. *It is reported that risk-informed regulations are introduced in the field of non-destructive testing, or in test object selection for in-service inspection. Would you provide us with any interesting experiences in this field?*

The presently used qualitative risk approach was first introduced in 1987. It is based on the division of components and parts thereof into the control groups A–C. After a transition period of five years it become mandatory in 1992 for all components and parts thereof, except reactor pressure vessels and some steam generator parts. For the reactor pressure vessel and for steam generator tubes special rules still apply.

The division shall be such that it takes into account the risks for nuclear fuel damage, discharge of radioactive materials, unintentional chain reactions, and the degradation of the other safety levels as a result of cracking or other degradation process. In this respect, both the probabilities that such cracking or other degradation will occur in the specific component or component part must be taken into account, as well as the possible resultant consequences. Structural parts for which the resulting risks are assessed to be highest are assigned to control group A. Structural parts for which the risks are assessed to be lower than for group A are assigned to control group B. Structural parts for which the risks are assessed to be low are assigned to control group C.

For the practical application of this approach, a qualitative system was developed, where the division into the control groups is performed according to a risk matrix and assignment of a damage index and a consequence index to each component and parts thereof.
The consequence index gives a qualitative measure of the likelihood that a crack or other degradation process will result in nuclear fuel damage, damage to the reactor containment tightness, discharge of large amounts of radioactivity or other damage which could lead to ill health or an accident. In reactor plants the consequence index is determined mainly by the margin to such consequences as the result of a break or malfunction of the specific component or system part. Two aspects of importance when determining consequence index are:

- system technical margins, i.e. how many systems or system circuits that are essential in relation to how many are available, and
- thermal technical margins, i.e. how much the fuel can be heated up, in relation to the values which are considered to be acceptable.

The damage index gives a qualitative measure of the likelihood for crack formation or other degradation process occurring in the specific component, and it is determined by the probable loads and environment in relation to dimensions and material properties of the component. Components or parts which may be exposed to loads or other conditions which experience has shown, can result in the occurrence of damage should be assigned damage index I. Components or parts which may be exposed to loads or other conditions which experience has shown are not expected to result in the occurrence of damage should be assigned damage index II. Components or parts which are considered to be exposed to minimal loads or other benign operational conditions should be assigned damage index III.

Experience of the used qualitative approach is, from an overall point of view, positive so far. The system is transparent, as well as easy to understand and manage. It works relatively well and the degradation of components appears to be detected before the required safety level is affected. However, opportunities for improvement exist. The use of more quantitative risk oriented strategies is one way for such improvements. Several pilot studies have been conducted during the last years. At least one of the Swedish utilities will in a near future apply for changes of their in-service inspection program and base them on full quantitative risk informed approaches. The practical experience in Sweden so far of these quantitative approaches is however limited.

3. *It is reported that the preventive maintenance serves to maintain the equipment within its design and operating conditions and to extend its life. Are there any specific measures addressing ageing in the strategies of preventive maintenance?*

Through the inventorying of systems and the ordinary preventive maintenance, problems have been identified regarding the support of spare parts. This is due to the fact that utilised technology has been obsolete and that suppliers of spare parts are vanishing from a shrinking market. The consequence has been campaigns to change components and projects leading to new technical platforms. Work is going on to develop methods and tools for availability-centred maintenance, where ageing is one essential parameter.

There is a development towards a more condition-based maintenance. Focus is more towards components and parts of the systems that are degrading and where ageing may be a reason. For components that cannot be easily checked, a maximum time of operation is set and when that is achieved, the components in question are replaced.

4. *It is reported that insights from probabilistic safety analysis is important for the optimization of the balance between maintenance and equipment modification or replacement. Are there any qualitative or quantitative criteria to optimize the balance?*

It is correct that PSA-techniques can – and will probably in the future – be used as a support when deciding on modifying or replacing components, but this is not practised today. If there is a noticeable impact on the core damage frequency, the technique could be applied, but there are no criteria established. One could say that the PSA-result is used indirectly as component failures are reported to the database that serves as the basis for PSAs.

In Ringhals a pilot project on RCM (Reliability Centered Maintenance) has been completed at Ringhals 1 and it has been decided that this method should be used at all 4 units at the Ringhals site.

5. *See also question regarding 6.2; page 26. What was agreed between SKI and the licensees regarding the "new knowledge, requirements and practices"? How widespread and thorough should the consultation of relevant references be;? What were the boundary conditions /necessary efforts for the development of the new SARs/ periodic safety reviews?*

SKI has not issued any specific guidance regarding what new knowledge, requirements and practices should be followed. SKI expects that the further development of the original licensing basis is followed and used to reassess the plants. This means as a minimum all the NRC Regulatory Guides, the IAEA Safety Series and the norms of ISO, IEC, ANSI, ANS, IEEE and ASME. Regarding periodic safety review, comparisons have been made also with a reference plant General Electric ABWR and the design rules included in EUR Requirement Volume 1

6. *It is described that current development on the use of PSA includes optimization of maintenance and in-service inspection. What is the regulatory position on the licensee use of PSA in optimization of maintenance and in-service inspection?*

The strength of PSA is recognised as lying in its ability to address the relative importance of various components, systems, safety functions and structures. PSA has turned out to be effective in ranking the importance of components, independent of the complexity of the accident sequences they are included in. However, a living plant specific PSA is an important prerequisite for any application of risk oriented inspection. Full-scope Level 1 PSA is certainly required, and Level 2 PSA provides insights in the risk to the environment. Highly detailed PSA model construction is also emphasised, in order to maintain the PSA in a living fashion. The PSA models and data have to be updated with a certain frequency and every time there are substantial changes to plant configuration or in-data. Other important aspects are e.g. the use of plant specific data in PSA, and a related continuous plant specific data collection and processing system needs to be set up and maintained. Sensitivity studies and uncertainty analyses are also necessary to identify the impact of the lack of knowledge about data, assumptions and phenomena on the quantitative analysis results

Article 15: Radiation Protection

1. *It is reported that when deciding on dose-reduction measures an alfa-value (cost/benefit value) of 4000 kSEC/manSv is considered. Are there any relevant references to this number?*

When an alfa-value was first introduced in the safety policy of Vattenfall in 1992, it was based on an investigation of internationally used or suggested alfa-values and on comparable information from other fields. A value of 4 MSEK/manSv (firm money value) was established by a management decision in Vattenfall in 1994. The same value is now used by all Swedish plants and it has recently been raised to 4.5 MSEK. In the Vattenfall policy, it is emphasised that the alfa-value should be complemented by other relevant facts (such as individual doses and dose rates) when making decisions on dose reducing measures. In recent years compilations of internationally used alfa-values have been made within ISOE, which is an OECD/IAEA organisation for exchange of experience in radiation protection.

2. *What are the reasons of comparatively high effective doses to individuals in the critical group during 1992 to 1997 in the Ringhals NPP vicinity?*

The main reason for this is that the Ringhals-1 (BWR) had a fuel leakage at this time with secondary damages on some fuel pins. This, in combination with a reduced efficiency in the delay systems from the turbine (no recombiner), resulted in the peak releases shown in figure 9 of the Swedish report. The uranium contaminated spent fuel in Ringhals-1 was successively exchanged and technical measures, regarding the withholding and delaying systems, have been taken by the operator. These measures and a policy to exchange damaged fuel at an early stage, have significantly reduced releases in the late nineties as can be seen in the figure.

From figure 8 in the Swedish report, it can be seen that as well the C-14 value is higher in Ringhals than in the other NPPs. The doses value for C-14 is calculated from the actual release points and are based on installed reactor capacity and reactor type. The value for the release in Bq is fairly constant under power conditions, however the calculated dose to the critical group differs between reactors due to different highs for the release points. The release points at Ringhals PWR (3 reactors) are at a relatively low altitude, with about a factor of 10 in lower dispersion of releases. This is the main reason for higher values at Ringhals. It should be mentioned that SSI recently has issued a new regulation, into force from January 2002, requiring also the C-14 releases to be sampled and measured.

3. What is the cost/ benefit value for the decontamination of the 2-year old fuel elements?

A cost/benefit analysis has not yet been made. The decontamination method is still in a qualification phase and it is uncertain if it will be used in Ringhals 1, where the qualification takes place. The reason for this is the foreseen cost together with the fact that collective dose and dose rates have been effectively reduced by other measures like decontamination, stellite replacement and equipment modifications. After a decontamination campaign in 1997 dose rates have been stabilised at a low level compared to previous values.

Article 16: Emergency Preparedness

1. It is reported that an international exercise has been held to test existing mobile systems for identification and measurement of radioactive ground contamination, and comparisons were made between the measurement systems of Baltic states. Would you provide us with any interesting results?

It is difficult in this context to describe shortly the results from the Baltic exercise, where different mobile systems for measurement of radioactive ground contamination where compared. The exercise report[1] can be ordered from the NKS secretariat, PO Box 30, DK-4000 Roskilde, Denmark (e-mail: Annette.lemmens@catscience.dk, home page: www.nks.org).

2. It is reported that a new information system, a web-based PC-system, has been introduced by SSI. What kind of information is communicated on the system? Radiation monitoring and others?

In essence, all kinds of information that is of interest for the actors involved in the emergency response, are communicated with the new system. That is, for instance, weather and dispersion prognoses, results from radiation measurements, information on decisions taken on protective measures, and technical information about the situation at the accident site. The web-site serves as a powerful complement to more traditional emergency communication means, such as fax and telephone.

Article 18: Design and Construction

1. With respect to core instability, what measures have been taken to avoid core power oscillations?

[1] Karlsson, S; Mellander, H; Lindgren, J; Finck, R; Lauritzen, B. RESUMEE 99, Rapid Environmental Surveying Using Mobile Equipment. NKS-15. ISBN 87-7893-065-0

The experienced core instability events at Swedish BWRs have led to an extensive work in order to learn more about this phenomenon and to try to find appropriate counter measures. Models for stability calculations have been developed as well as other development work, e.g. participation in EU sponsored programs.

One conclusion is that instability cannot be eliminated completely by changing the fuel or core operation regime. Instability can occur in almost all situations if the right circumstances are at hand. In spite of the fact that modern fuels are designed for improved stability, design improvements in other areas to optimise the operation may lead to a deteriorated core stability. As more of the old fuel in the core is replaced, the modern fuel will gradually have a greater and positive impact on the stability.

The major countermeasures to avoid power oscillations include improved monitoring of stability, improved analytical techniques, restrictions in the allowed flow-power operating window, and improved fuel management strategy. One major activity, which still is in progress, has the objective to develop algorithms for detection and suppression of core instability so that automatic measures can be taken in the case of core oscillations.
All the operating Swedish BWRs are equipped with stability monitors. These serve as operator aid to determine the reactor stability, and they in general give warnings to the operators when the stability becomes poorer. These monitors normally use the APRM-signals (Average Power Range Monitors) to detect global, in-phase instability. Since regional instability in which regions of the reactor oscillate with opposite phase, can be more safety significant, the monitors have been developed to detect such instability also. Regional instabilities may also be avoided by improved fuel reload and control rod strategies.

Improved analytical capability has led to more accurate predictions of instability. At least one Swedish utility uses such tools to determine the stability for the whole fuel cycle. Comparisons with data obtained during the operating season contribute to improvement of the accuracy.

Restrictions in the flow-power operating range allowed have been used for Swedish BWRs to enhance stability. The restrictions are imposed in the operating range near the low-flow and medium power area. Analyses as well as tests in the plants check the adequacy of the restrictions.

Strategies for fuel reload and control rod patterns may also contribute to stability. Poor choice of control rod pattern has, for example, once caused a regional instability in a Swedish reactor. Reduction of the bottom peaked power profiles using shallow control rods insertion is also an example of possible measures that has led to improved stability. Our experience is that measures taken to obtain a stable core after reload, in the long run have quite small consequences on the fuel economy.

Algorithms are being developed to obtain improved automatic diagnosis of instability from the signals of the plant. The objective is to define automatic measures that can be adjusted to actual plant conditions to quickly detect and suppress oscillations. One difficulty is to determine plant conditions in such a reliable way that the instability mitigation measures are not unjustifiably activated. The development work is near completion and such systems will be installed in at least some of the plants.

2. *It is stated that SKI has decided to extend the general recommendations to SKIFS 1998:1, regarding design and construction of NPPs; the final result should be an essential compliance of all Swedish reactors with modern safety requirements and practices. How is „modern safety requirements and practices" defined ? Are*

recent IAEA requirements documents and guides taken into account, e.g. IAEA NS-R1, NS-R2, NS-G1 ?

See answer under Article 14.

3. *There is a statement that PSA methodology is being used to an increasing extent as a complementary basis in the modernisation work. Has SKI established specific probabilistic criteria for the decision to modernise or replace specific equipment?*

SKI has not established any specific probabilistic criteria. The licensees have such criteria, which are acceptable for SKI. The new back-fitting guidelines will include rules for application of PSA, such as

- Deterministic requirements are the basis for the license. They should be verified and amended with the use of PSA.
- PSA should be used in order to achieve a balanced safety level (no dominating weaknesses)
- Extra strength in one barrier should not be credited in order to accept a weakness in another barrier.
- A change of a deterministic requirement should be assessed with sensitivity analysis in order to show that the design remains sufficiently robust.
- At the change of one requirement, all other requirements on systems belonging to the same safety function or barrier, should be considered.

4. *I&C has been changed and new control room concepts have been used. Which requirements and procedures are used for licensing of digital I&C in general and specifically for certification of digital I&C for safety functions (e.g. RPS)? Is it required to have a hard-wired back-up system if the RPS is a digital system?*

SKI applies a process oriented review principle. The case is reviewed with regard to quality of the design process and whether the new system fulfils the specifications. This is combined with some in-depth technical reviews taken as samples of the design process. The reference document currently used by SKI in review of digital I&C is: ”Common position of European nuclear regulators for the licensing of safety critical software for nuclear reactors”. Report no. EUR 19265 EN, May 2000.

There is no requirement for a hard-wired back-up system, if the RPS is a digital system.

4. *Core instabilities were experienced at Swedish BWRs after use of modern fuel designs. Which countermeasures are taken or under consideration to cope with this problem?*

See answer above.

5. *It is reported that the total radioactive fallout over Sweden after the Chernobyl accident corresponds to more than 1% of the core content of cesium in the Chernobyl reactor. Are there any relevant references to the number of 1 percent?*

The total deposition of Cs-137 over Sweden was estimated at 4.25 PBq. This figure is based mainly on country wide airborne measurements by the Swedish Geological Company (SGAB). According to Gudiksen et al., Health Physics 57 (1989) 697, the Cs-137 inventory in the reactor was 210 PBq, of which 40 percent were released into the atmosphere. This indicates that roughly 2 % of the core inventory was deposited in Sweden.

More information is given in the SSI report from 1991 named "The Chernobyl fallout in Sweden, Results from a research programme on environmental radiology, Ed. L Moberg, The Swedish Radiation Protection Institute". Address for further information: Swedish Radiation Protection Institute, SE-171 16 Stockholm, Sweden.

6. *It is reported that the perspective of operating the present plants for several decades more has initiated development programmes for defining adequate levels to be required for extended operation, and that the objective is to issue back-fitting guidelines valid for the rest of the operating time of the Swedish reactors. Do the guidelines strike a balance between the length of lifetime extension of each plant and the extent to which back-fitting should be applied?*

The proposed back-fitting guidelines are the same for all plants irrespective of age and remaining operating time. In the application of the guidelines, specific individual upgrading plans for each of the 11 reactors will have to be developed. These plans will extend over several years. If a decision is taken to permanently shut down a reactor, within the time schedule of the upgrading plan, this will certainly affect the scope of measures that must be taken. It should be observed that the expression, "perspective of operating the present plants for several decades more", does not refer to a general plan for lifetime extension of the Swedish reactors, but refers to the recent political decision, to revoke an earlier decision to phase out all plants by 2010 at the latest. There is no discussion in Sweden to extend the operating life, of any reactor, beyond the design life- time of 40 years.

7. *It is reported that in Oskarshamn new digital I&C-equipment has been introduced including in the reactor protection system. What were the measures taken to verify reliability of digital I&C-equipment?*

A major part of the process of qualifying the implementation of digital I&C equipment is to verify that the equipment has an acceptable standard and a reliability corresponding to criteria according to IEC 1226, which is 10E-4. The qualification process is very comprehensive with analyses, tests, verifications, review of operational experiences etc., being the bases for the estimation of the equipment. The strategy for qualification is based amongst others on the requirements in IEC 880 supplement 1 (1996) draft. The Oskarshamn experience is that this is not sufficient to achieve the reliability demands that were put on reactor protection systems by the operator. For that reason a diversified non-programmable system has been introduced as a complement in certain functional areas. When accomplishing the PSA the reactor protection system has to be modelled in order to achieve and verify an acceptable value for the entirety.

8. *It is reported that a few instability incidents have occurred during the last few years, and that development work is going on to improve the in-depth understanding of the core instability problem. Did the development work result in any interesting conclusions?*

See answer above

9. *Given the nature of the general safety requirements SKIFS 1998 : 1, is the direction of the extensions that make up the new safety guidelines a recognition of the fact that the general safety requirements are too global? What has been the experience since 1 July 1999 with SKIFS in this respect. Specify e.g. with regard to usefulness to the utilities – reg. body discussions in specific safety issues. Also, with regard to appropriateness to give guidance to SKI staff. What does the SKI staff use in addition to SKIFS 1998 :1. Is there an accepted policy.*

The level of detail in the general safety regulations SKIFS 1998:1 is about the same as in the IAEA Safety Requirements (NS-R-1 and 2). The experience so far is that these regulations support the regulatory supervision in a good way, and the level of detail is right in order to provide for necessary flexibility in the implementation. However, regarding design and construction of nuclear power reactors, SKI has concluded that the general recommendations on the implementation of the regulations need to be extended and developed in more detail in order to serve as general back-fitting guidelines for the remaining operating time of the Swedish reactors. This means that the recommended interpretation of the present regulations is documented more extensively and formally in a regulatory document, and is made more precise and more strict on some points, compared to the earlier accepted interpretation. One motive for this work was a request from the utilities to be able to foresee the requirements for the next decade, as one input to major investment decisions. In parallel SKI found it suitable, at this age of the Swedish nuclear programme, to summarise in back-fitting guidelines the consequences of operational experience gained so far and insights gained from safety analyses, research and development. A specific application of these guidelines on each reactor, then has to be investigated and decided as licensing conditions.

As reported in section 8.4, SKI has developed five assessment guides (now completed) to be used in inspections and safety assessments, in order to promote a consistent approach among the staff. These guides elaborate what needs to be observed in order to assess whether requirements in SKIFS are fulfilled, and what factors need to be taken into account, when making assessments on compliance with the regulations.

10. *Reference is made to the European Utility Requirements. These reqs. are meant for future reactors. Please explain how these reqs. will be incorporated in the new guidelines (backfitting guidelines) for existing reactors.*

The EURs are not used as a reference in the work with the back-fitting guidelines. The EURs provide a general framework consulted in the discussion on specific issues, for instance regarding diversification and hardware provisions to deal with severe accidents.

Article 19: Operation

1. *It is written that the TechSpecs of the plants have been adjusted to the terminology of the new safety regulations. Could you please give some examples for this adjustment process?*

Examples are new categories of operational events, which require specified actions and reporting to SKI, new reporting deadlines and new principles for safety review. The operational limits and the requirements on functional testing and operability control, have not been changed as a result of the new safety regulations.

2. *It is stated in the report that staff of the Swedish NPPs is reduced as well as the use of consultants. Are there critical limits for reduction of staff? Have criteria been developed to which extent a reduction of personnel is acceptable? If staff and consultants are reduced in parallel, which measures exist to compensate for this reduction of personnel? How is adequate in-house competence maintained?*

No specific criteria have been adopted with respect to reduction of staff. When a reorganisation is initiated, a systematic analysis is carried out to define what resources and competence are needed for specific functions and tasks and that the new organisation will be able to provide it. In the new organisation the aim is to organise work in the most efficient form and eliminate unnecessary tasks. Those areas where own expertise is considered essential are defined. Staffing plans are established as the basis for deciding present and future needs for human resources. For service functions, which are not directly safety related, solutions are sought where market competition can be used to optimise costs. This is often done by outsourcing, i.e. transferring functions or tasks to contractors, and often including transferring of personnel as well. On the other hand experts may be recruited from contractors, so personnel is transferred both ways and in general a reduction of own staff is not combined with a reduction of the use of consultants.

An example of the process is given by Ringhals, where those areas were identified where own competent staff was considered essential. Those areas were reinforced and in 2001 27 engineers, previously acting as consultants, were employed by the Ringhals group. In other areas, which are not unique for operation of nuclear plants, it was noted that several competent contractors were available on the market. In those cases outsourcing to other companies was chosen as a suitable option. For the last question see the answer to the question by Austria under Article 11.

3. *SKI safety regulations require that the licensee shall ensure that experience from the own facility and other relevant facilities is continuously analysed, used and communicated. Which organisation is responsible for the evaluation of the incident reports of the IAEA Incident reporting system?*

The company for nuclear training and safety, KSU, which is jointly owned by the Swedish nuclear power plants, evaluates incident reports from, amongst others, the IAEA and distributes its results to the plants. The organisation units for experience feed back at the plants are in charge of further evaluation and distribution of the information within the plant organisation. Also SKI reviews among others the IRS reports, in order to assess the need for regulatory interventions.

4. *It is reported that the Technical Specifications shall be submitted to SKI for approval. Does SKI have any criteria or guidelines to review and approve the Technical Specifications?*

The basic Technical Specifications shall be submitted for approval by SKI. After this approval, SKI shall be notified of any principal changes. This notification shall be subject of safety review by the licensee. The general safety regulations SKIFS 1998:1 contain the basic requirements on contents and quality of Technical Specifications. In addition to these requirements, US rules are used in the SKI review.

5. *In relation to programs to collect and analyze operating experience, the licensee shall ensure that experiences from the facility and similar activities in other relevant facilities are continuously analyzed, used and communicated to the personnel involved. What is the regulatory body's role in these programs to collect and analyze operating experience?*

SKI has no role in the licensee programmes to collect and analyse operational experience. SKI inspects and reviews the experience feedback system applied by the licensees. However, SKI has an own programme for analysing events, as an input to the regulatory supervision, and is responsible for INES reporting and reporting of significant Swedish events to IRS.

6. *In relation to OEFB(operational experience feedback) system,*
   (1) There are in general some technical and economic aspects are involved when operational experience is feedback to other NPPs. Does your country have any good method to implement the OEFD system effectively?
   (2) If a quantitative analysis is needed, how is it analyzed?

The Operational analysis and feedback system of Sweden was described in the first national report (section 19.2.7) and this description is still valid. In addition to each site having its own organisation for analysing and implementing experience from its own and other plants' operation, the utilities co-operate within the Nordic Owners Group where incidents and trends are analysed and the results reported to the members. Incidents and occurrences of higher safety importance are reported to the WANO experience system.

One economic aspect on experience feedback in a deregulated market concerns the importance for competition of sharing new knowledge with competitors. The general policy in this respect in Sweden is full openness in sharing information of importance for safety, but to make available solutions to specific technical problems on a commercial basis.
