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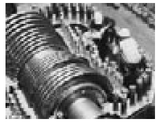

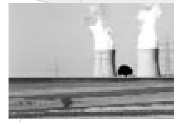

ILK Statement

on determining Operating Periods for Nuclear Power Plants in Germany

Für deutsche Fassung bitte umdrehen!

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Foreword

The International Committee on Nuclear Technology (Internationale Länderkommission Kerntechnik, ILK) was established by the three German states of Baden-Württemberg, Bavaria and Hesse in October 1999. It is currently composed of 13 scientists and experts from Finland, France, Germany, Sweden, Switzerland and USA. The ILK acts as an independent and objective advisory body to the German states on issues related to the safety of nuclear facilities, radioactive waste management and the risk assessment of the use of nuclear power. In this capacity, the Committee's main goal is to contribute to the maintenance and further development of the high, internationally recognised level of safety of nuclear power plants in the southern part of Germany.

The question of how long nuclear power plants can be safely operated while maintaining a high safety standard played an important role in the worldwide expert discussion in recent years. The ILK has dealt with the requirements involved in determining operating periods for nuclear power plants in a general way. In so doing, the ILK has taken into consideration the approaches practiced in France, Switzerland and the United States as well as generic requirements on nuclear safety. In the current publication, which was adopted after the 37th ILK meeting on September 26th/27th, 2005 in Stuttgart, the ILK takes the view that the current limitation of electricity generation quota for German nuclear power plants should be lifted and, at the same time, states the corresponding necessary conditions. These include in particular a special safety review which is to be performed before completion of 40 years of operation and which is to be evaluated by the corresponding authority.

This statement is addressed to the German state authorities in their function as the commissioning party of the ILK, but it is also addressed to the federal authorities, licensees and political actors.

The chairman

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Executive Summary

The question of how long nuclear power plants (NPPs) can be safely operated while maintaining a high safety standard played an important role in the worldwide expert discussion in recent years. Far-reaching agreement exists on which reviews and measures to undertake in order to safely operate such plants over longer time periods. In most countries operating licenses for NPPs are not limited in time; this is also the case for Germany. However, the authorization for power operation expires if the plant has used up its approved electricity generation quota. This quota corresponds to a value established in the Atomic Energy Act (AtG) for the individual unit that is based on an operating time of 32 years.

On the basis of operating experiences gathered with plants currently in operation and also due to available research findings, the ILK believes that there are no safety-related reasons for limiting the operating time of nuclear power plants a priori. The ILK notes that the German NPPs have a high safety standard that is constantly monitored by the regulatory authority. Periodic safety reviews (PSRs), which are performed every ten years, are part of this process. The ILK also takes the view, however, that in the case of very long operating periods, it makes sense to make the continued operation depend on a renewed evaluation (of the plant). This requires demonstrating that the plant displays a level of safety that corresponds to the requirements for the future operating period.

The ILK recommends the following approach:

- The limitation of production quotas currently laid down in the German Atomic Energy Act should be lifted;
- In addition to maintaining the current safety standard, licensees should examine improvement measures for the further reduction of the residual risk and, where appropriate, apply these. The effectiveness of the PSR in its current form should be assessed and the guidelines for their application should be updated, if necessary;
- After an operating period of 40 years at the latest, a special safety review should be supplied by the licensee and be evaluated by the authority. On this basis plant operation can continue for 10 more years at a time as insofar as the authority does not raise objections.

In addition to the analyses covered by the PSR, the special safety review contains the following requirements:

- The current status of the plant or its status at the start of the renewal period is to be compared to the requirements of the safety criteria and the RSK safety standards.
- Operating management is carried out according to the best current practices.
- An effective aging management exists.
- An up-to-date probabilistic safety analysis (PSA) that covers all operating conditions exists for Level 1 and Level 2.
- Backfits that are necessary for maintaining the existing safety level or lead to a further improvement of the safety level when taking the appropriateness of means into account have been or will be applied.

1 Introduction

In Germany, operating licenses for nuclear power plants (NPPs) are not limited in time. However, the authorization for power operation expires if the plant has used up its approved electricity generation quota. This quota corresponds either to a value established in the Atomic Energy Act (AtG) for the individual unit that is based on an operating time of 32 years, or another value arising from the transfer of quotas between different nuclear power plants [1]. In this way, the total amount of electrical energy that is generated in Germany from nuclear power is limited, but not the production quota nor the operating period of individual units. The ILK pointed out in its statement on the Atomic Energy Act Amendment [2] that these specifications, which were formulated in 2002, have no safety-related justification[1]. Instead, they represent a compromise that the German government was able to negotiate with the licensees of nuclear power plants in the pursuit of its goal of a so-called phase-out of nuclear energy.

The design of technical plants is usually based on a reference period. It serves to determine the total extent of those loads for which the sum of events, rather than individual events, over time is decisive for plant and component use. An example for nuclear power plants is the embrittlement of pressure vessel materials through the influence of fast neutrons or the number of transients that contribute to materials fatigue via pressure or temperature changes. During the operating time of a plant, the actually occurring loads can deviate from loads hypothesized by design considerations: also, the state of knowledge concerning the impact of loads on plant structures may change. The actual possible technical lifespan of components or the entire plant may thus deviate from the reference period chosen for giving proof of safety. Furthermore, the lifespan may be prolonged by exchanging limiting components or other measures. For most nuclear power plants in operation today, including all German ones, the reference period that was based on earlier conservative insights amounts to 40 years, and for some, 30 years. For the EPR currently under construction in Finland, a reference period of 60 years is assumed.

The question of how long nuclear power plants can be safely operated while maintaining a high safety standard played an important role in the worldwide expert discussion in recent years. Widespread international consensus exists on deciding which inspections to perform to determine whether the operating period of a plant can be extended and for establishing the measures required to ensure safety for a long period of operation.

[1] Response by the German Federal Government to questions at the 2nd/3rd review meeting of the Convention on Nuclear Safety: „The standard lifetime of 32 years has no technical basis. It is the result of a political agreement. This lifetime was defined on the base of a compromise between industry referring to the constitutionally based protection of investments and the government wanting to phase out of nuclear power as soon as possible."19], [20]

In most countries operating licenses for NPPs are not limited in time. In the USA, licenses are issued for durations of 40 years. An extension by 20 years is possible in the USA and has meanwhile been granted for numerous plants.

The ILK believes that safety should be given first priority when determining the operating periods of NPPs. Yet, the ILK also believes that a legally regulated decommissioning of power plants represents a waste of economic resources and thus should be avoided, as long as these power plants can be safely operated. In the following, the ILK takes a stand on how, in its view, safety related aspects can best be taken into account when determining operating periods.

2 Benefits and drawbacks of restricting operating times

The safety of a plant is not directly affected by limiting the duration or production quota of a plant's operation. However, the fact that the operation is limited may have indirect consequences:

- Limiting the operating period of a plant - which can be extended upon request - represents a planning uncertainty since until the decision on an extension has been made it remains unknown whether the plant will be permitted to operate beyond the set time limit. Larger investments including those improving safety may not be made under these circumstances or may be postponed to a later date. Similarly, the timely deployment of sufficient staff may be adversely affected because the company is waiting for the licensing outcome or because qualified prospective employees are deterred by an unclear career outlook. These drawbacks only come into play if the renewal does not occur in due time before expiry of the operating period. Comparable problems may also arise if the licensee terminates operation of his own accord. However, in the latter case, he has better opportunities to plan ahead since he is the one defining the cut-off date.

- Setting higher safety requirements on the extension period than normally applied in the event of continued operation without a renewed decision to carry on operation can be regarded as one safety-related advantage of restricting operating periods. This gives rise to an additional opportunity for taking into account advances in safety technology or a higher societal need for safety. Both can change considerably over time periods spanning 40 - 60 years. Nevertheless, in the case of an unlimited license, the licensee should - where it is meaningful - follow the state-of-the-art in science and technology and backfit his plant accordingly. However, the question of whether or not he may continue operating his plant in Germany does not depend on how closely he adheres to advances in science and technology but instead is based on whether a considerable hazard to staff, third parties or the general public is caused by the plant. The protection of a licensee's right to operate his plant is doubtlessly necessary in terms of legal security, yet it is open to debate whether this protection should be granted for indefinite periods of time.

3 Maintaining safety for longer operating periods

3.1 Technical measures

3.1.1 Control of aging effects

A majority of the plants currently in operation worldwide have already been operating for over 20, and some for over 30 years. Most German plants are more than 20 years old and one is over 30. The decommissioned plants Würgassen, Stade and Obrigheim were operated for 24, 30 and 36 years, respectively. The experience gained during this period of operation and from research does not indicate the existence of any effects entailing a worsening of plant safety features that would make a general limitation of operating lifetime necessary. This is also the conclusion arrived at by an extensive research program that has been running in the USA for over two decades that focused on aging effects of all relevant equipment [17]. However, modifications can arise in the individual case where a decommissioning is indicated. Since such evolutions can be detected in time, the question of whether to pursue extensive restoration work or decommissioning becomes a purely economic rather than a safety-related one. For example, the licensee of the NPP Würgassen abstained from repairing cracks in the core shroud given the framework conditions at the time and decommissioned the plant while operators of boiling water reactors in other countries opted for continued operation following repairs or increased monitoring in the face of similar findings.

Essentially, the following possibilities exist for avoiding detrimental consequences of aging effects on safety:

- Replacement

  Most of a power plant's components can be replaced. This also applies to large parts in the interior of the containment. For example, by now the steam generators of many, and especially of foreign, pressurized water reactors have been exchanged; these are vessels similar in size to the reactor pressure vessel. In Germany, NPP Obrigheim was the only plant to have its steam generators replaced. Mainly in other countries, I & C systems have been replaced on a grand scale. Also, long sections of pipes with large nominal diameters have been replaced in German plants. The replacement of smaller components, parts that are susceptible to aging or components of control systems belongs to routine maintenance.

- Reduction of aging influences and load reductions

  Older pressure vessels are more prone to embrittlement through neutron irradiation than more recently manufactured ones due to their construction and to the materials used. Among German NPPs, this applied for example to the vessels of the NPPs Obrigheim and Stade. Using a corresponding low-leakage core loading, the neutron flow and thus the neutron fluence increase was substantially reduced at critical points. Additionally, for the most critical cases, the load on the vessel was significantly lowered by pre-heating the emergency coolant. The highest loads would arise during feed-in of cold emergency coolant at high pressure in the event of a small leakage. For both plants, due to the implemented backfits, the embrittlement of the pressure vessel would not have resulted in a limitation of the operating period for several additional years. Further examples for the reduction of aging influences are given by avoiding operating modes where high and/or frequent temperature changes arise, by avoiding pressure transients and by controlling corrosive and erosive influences. By changing the control rod groups associated with the power and power distribution control, the number of steps of the drive mechanism can be evenly distributed thus reducing wear.

- Repairs

  Most aging impacts concern modifications of the materials or wear phenomena that usually cannot be repaired. For this reason, repair does not play a major role in controlling the effects of aging. In single cases, critical sections of reactor pressure vessels have been annealed in order to reverse structural modifications caused by neutron irradiation.

- Decommissioning of the plant

  As far as no technically or economically suitable measures are available for counteracting aging effects, the plant is to be put out of operation before parameter values fall below specified margins. In this way, safety-related drawbacks are avoided.

3.1.2 Safety improvements

The aspects discussed thus far concern the question of how a decline in plant safety can be avoided. Furthermore, over the past decades measures for increasing safety have been implemented. The INSAG assigns the safety measures for the construction and operation of NPPs to five safety levels (see annex, as well as [23] for a comparison with the classification typically performed in Germany).

The safety levels 1 (normal operation) and 2 (anticipated operational occurrences) aim to prevent accidents. Measures associated with safety level 3 (accidents) have the task to safely control those accidents assumed to occur despite the measures taken in levels 1 and 2. They are a precondition for licensing and are subject to an in-depth licensing procedure. Furthermore, safety levels 4 and 5 include measures that can control or reduce the impact of hypothetical event sequences that lie beyond the design basis.

The improvements undertaken over the last decades have touched on all levels:

- The reduction of radiation exposure of staff can be mentioned as being representative of the many advances achieved in the area of normal operation through a growing pool of operating experience. The radiation exposure was lowered over the years, for example, through the partial relinquishment of cobalt and other materials that form comparatively long-lived activated corrosion products, increasing the number of automated inspections, optimizing work processes and other measures.

- Considerable advances in reactor safety technology over the last decades have led to an increase of licensing requirements at the third safety level on new plants and a corresponding improvement of their safety provisions. Plants already in operation have been able to keep up with this development to a large degree.

  These safety improvements have come about through numerous individual measures that were implemented within the existing plant concept such as diversity in the actuation of safety valves or additional diversity in the reactor scram by interrupting the power supply to the bus bars feeding the control rod drive mechanisms. Also, requirements that have been met in the new plants through modified plant concepts were compensated for in older plants through other measures. Examples are the avoidance of failures affecting redundant trains and the thorough structural fire protection which have been implemented in the new plants by rigorous functional separation of redundant trains and the corresponding separate implementation of structures and fire protection measures. This could not be done in the older plants, in part because of the structural circumstances. In many cases, a similar result was achieved using additional systems, usually emergency systems. These systems are independent of the existing safety system and range from measurement readings to electricity supply, installation and fire protection and are suitable as a backup for a part of the safety system's functions.

- In the past one and a half decades, the focus of improvements lay on measures associated with safety levels 4 and 5. Research and development projects, also in connection with the design of EPRs, led to new insights on the frequency and course of severe accidents and thus to new results in the area of controlling scenarios such as those described for levels 4 and 5. The aims pursued with the measures of levels 4 and 5 are summarized in the design basis requirement on the EPR stating that the consequences of a core melt accident must be basically limited to the interior of the plant. This requirement cannot be met completely with existing buildings. The risk posed by such a postulated accident was, however, substantially reduced by internal accident management measures by, on the one hand, taking precautions for avoiding a core melt even in the event of a failure of the safety system and, on the other, taking measures to prevent containment failure modes with large early releases. Examples of measures for controlling beyond-design basis events are additional power supply feed-ins, the secondary loop pressure relief for PWRs and additional feed possibilities for steam generators as well as primary side pressure relief with subsequent feed-in into the primary loop. Examples of measures for avoiding large early releases include depressurization of the reactor pressure vessel (which even controls the event course given subsequent feed-in), catalytic elimination of hydrogen that arises during a core melt until a safe concentration has been reached and the filtered depressurization of the containment vessel. A series of these measures was suggested by the Reactor Safety Commission (Reaktorsicherheitskommission, RSK) and implemented by the licensees even in the absence of a requirement issued by the authority.

In sum, the backfits, some of which have been mentioned as examples above, have led to higher plant safety levels than was the case at the start of their operation. The question of backfitting plants that are currently in operation has also been discussed internationally. A group of experts from OECD-countries has submitted a report outlining how the regulatory authorities can judge necessary backfits [21].

The ILK recommends to carry on investigating measures and facilities regarding the extent to which beyond-design-basis events can be controlled even more reliably or how far their impact can be further mitigated. Since beyond-design-basis accidents are the focus here, measures should only be suggested if the safety-related benefit is in due proportion to the required expenditures. The suitable means for assessing the safety-related benefit are given by probabilistic safety analyses. The calculations for beyond-design-basis events should be performed on a best-estimate basis and the technical engineering requirements should be determined by applying the general technical rules. The analyses conducted thus far for older plants indicate that while they do not reach core melt frequencies that are as low

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as those for the newest plants, the values nevertheless lie in a range that is recommended by the IAEA for new plants.

3.2 Operating management measures

Next to technical equipment, organizational measures targeting safe operating management are very important for maintaining a high level of safety. These have also undergone a constant evolution over the past decades. In contrast to technical equipment, applying the up-to-date standards in this area does not depend on the age of the plant. Measures for a safe operating management are subsumed under the term safety management. The requirements that already have to be fulfilled today are described in the following.

In order to arrive at a common understanding of what is meant by a safety management system the definition proposed by INSAG-13 [3] offers a starting point.

> *The safety management system comprises those arrangements made by the organization for the management of safety in order to promote a strong safety culture and achieve good safety performance.*

The safety management system has two general aims:

- To improve the safety performance of the organization through the planning, control and supervision of safety related activities in normal operation, accidents and emergency situations.
- To foster and support a strong safety culture through the development and reinforcement of good safety attitudes and behavior in individuals and teams so as to allow them to carry out their tasks safely.

A set of universal features for an effective safety management system was developed in INSAG 13 [3]. Requirements to ensure a safe operation of nuclear power plants have been established by IAEA in the Safety Standards Series [4]. On this basis, reference levels have been established and used by WENRA ("Western European Nuclear Regulators' Association") in the pilot study on harmonization of reactor safety in WENRA countries [5]. Examples of the main components of an effective safety management system are as follows:

- Adequacy of the organizational structure

  A clear safety management framework exists within the organization with well defined requirements specifying the responsibilities and activities required to ensure safety and to satisfy legal and regulatory requirements as well as those of the operating organization. The adequacy of the organizational structure for safe and reliable operation is assessed on a regular basis.

  The management structures, responsibilities and accountabilities for safety are clearly defined throughout the organization and in supporting organizations. Changes to the organizational structure which might be significant for safety are justified in advance, carefully planned, evaluated after implementation and possibly improved.

- Issuing, communicating and implementing a safety policy

  Using a clear safety policy the organization, up to the corporate board, commits itself to achieving a high safety performance. It is supported by the provision of safety standards and targets and the resources necessary to achieve these. The safety policy is clear about giving operational safety the utmost priority at the plant overriding, if necessary, economic targets. The safety policy includes a commitment to excellent performance in all activities important to safety and encourages a questioning attitude. The safety policy is communicated to all staff and to subcontractors, with tasks important to safety, in a comprehensible and applicable manner. The staff is provided with the necessary resources and conditions to carry out work in a safe manner.

- Sufficiency and competency of staff

  Staff have the competence to carry out their tasks safely and effectively. The essential information on the plant design and its justification have to be available. A systematic approach is used to achieve, improve and maintain a high level of personnel knowledge, skill, and performance. A systematic assessment process is used to determine current training needs of all staff. The sufficiency of staff for safe operation and their competence and suitability for safety work is verified on a regular basis and documented. A long term staffing plan shall exist for activities which are important to safety.

- Learning by foresight and by feedback

  The safety performance of the organization is routinely monitored in order to ensure that safety standards are maintained and improved.

  Operating experience at the plant is evaluated in a systematic way. Abnormal events with significant safety implications are investigated to establish their direct and root causes, including organizational aspects and human performance. The results of investigations are used to identify and implement corrective actions without undue delay. Information resulting from such evaluations and

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investigations are fed back to the plant personnel. Relevant operating experience at other plants, international development of safety standards and new knowledge gained through R&D projects are systematically analyzed and continuously used to improve plant activities.

Audit and review systems provide feedback on safety performance, in order to provide the organization with assurance that its safety policy is being implemented effectively and for it to learn from its experience and that of others to improve safety. These audits and review systems include international peer reviews carried out by the IAEA (i.e. by Operational Safety Review Teams (OSARTs), and the World Association of Nuclear Operators (WANO) (i.e. peer reviews) as well as national reviews involving staff drawn from other sites within the operating utility and/or other utilities. These reviews provide the means to provide an independent judgment on the effectiveness of the safety management system and its implementation against external best practices. Appropriate corrective actions are identified and implemented in response to audit and review findings and objectives for improvements are identified as part of the process of striving for continuous improvement.

- Regular assessments of safety culture

  A self assessment system that addresses organizational and personnel aspects is used with the aim of ensuring: that an appropriate safety consciousness and a high safety culture prevail; that the provisions set forth for enhancing safety are observed; and that there are no indications of overconfidence or complacency. The self assessment tools meet acceptable quality criteria and are implemented correctly. The self assessment of safety culture includes the consideration of a rigorous root cause analysis (RCA) of events, including organizational aspects and human performance [6].

- Accident management for beyond-design-basis events

  The operating organization establishes the necessary organizational structure and assigns responsibilities for managing emergencies. The control room staff and on-site technical support are regularly trained and exercised, using simulators and diagnostic aids for the Emergency Operating Procedures, (as far as this is practicable for severe accidents). Planning and regular exercises exist for the emergency plan including repairs and other interventions needed to restore safety functions in case of emergencies.

In addition to the maintenance of staff competence, two instruments are of special significance with regard to the operating period of plants, namely aging management and the periodic safety review.

The periodic safety review (PSR) is carried out for all plants at intervals of 10 years and represents an up-to-date investigation of their safety status. The existing safety precautions are assessed using both deterministic means (with regard to the protection goals to be achieved) and also probabilistic means for determining the frequency of hazard conditions. The combination of both approaches not only enables an assessment of the existing safety status, but furthermore can point out in which areas improvements are reasonable. Next to safety issues, the PSR also looks at protection against the interference by third parties. This is done by performing a comparison with the existing deterministic requirements.

According to the IAEA [7], the objective of a PSR is to determine by means of a comprehensive assessment of an existing nuclear power plant: the extent to which the plant conforms to current international safety standards and practices; the extent to which the licensing basis remains valid; the adequacy of the arrangements that are in place to maintain plant safety until the next PSR or the end of plant life-time; and the safety improvements to be implemented to resolve the safety issues that have been identified.

All measures for controlling the influences of aging mechanisms share an effective monitoring as their essential ingredient. Together with systematic organizational provisions, they constitute aging management. For this purpose, a list of all aging mechanisms that are to be considered is prepared for the important safety-related systems and components. For each individual mechanism, the measurements and tests used for its control are described. These are to be defined and carried out and the results are to be compared with the specifications. The specifications are to be checked and, if necessary, updated at suitable intervals or when important new findings become known.

4 International situation

4.1 United States

The United States, which have officially limited operating periods to 40 years, have closely examined the issue of extended operating periods. The U.S. NRC (U.S. Nuclear Regulatory Commission) has published a guideline on the requirements placed upon license renewal [8]. The rule proceeds from the assumption that a plant that is in operation has an appropriate level of safety based on the applicable requirements. No extra requirements need to be laid down for a renewal. Instead, proof must be given that the applicable requirements can also be adhered to during the extended operating period. This concerns both safety and environmental compatibility. With regard to safety, the licensee is called upon to investigate the significant safety-related installations. He must show which aging effects may arise and which precautions he will take to control these effects to such a degree that the facilities under consideration can safely perform their intended function. The renewal application can be submitted at any point 20 years before expiry of the license. The renewal can be approved for a period of up to 20 years. The U.S. NRC checks the documents submitted by the licensee on safety and environmental compatibility, performs inspections, involves the public in hearings and finally decides upon the application. To date, license renewals for a total operating period of 60 years have been issued for 35 reactor units, 14 further renewals have been applied for (status: September 2005 [9]).

4.2 France

In France, operating licenses are not limited in time. However, at the request of the Nuclear Safety Authority, with reference to a ministerial decree, periodic safety reviews (PSR) are conducted every 10 years. PSRs play an important role for maintaining and advancing the safety standards of plants. Since the plants are standardized, the reviews are tailored to the individual construction lines. A representative plant is selected that serves as the basis for general investigations specific to the individual construction lines. The next step entails a demonstration that the results achieved in the general investigations also apply to the individual plants. Additionally, each plant must undergo individual testing. The PSR program is discussed between licensee and authority beforehand. Finally, the authority informs the licensee in writing which investigations and measures need to be carried out and what the associated requirements of the authority are. The program contains:

- Tests for determining the actual state and the integrity of components and systems, as well as measures for maintaining the required status
- Improvement measures resulting from operating experience, including experiences made with other construction lines and with international plants
- Improvements based on advances in reactor safety technology.

The authority examines the results of the safety review and, in the event of a positive assessment, approves ("no opposition to") continued operation for 10 more years till the next PSR[2].

[2] The overall process leads to issuing of new updated safety analysis report. The modifications decided are grouped in sets that are incorporated during the ten yearly inspections.

4.3 Switzerland

In Switzerland, operating licenses are generally issued without time restrictions. For historical reasons, unit 2 of NPP Beznau (KKB-2) that began operation in 1971 and the Mühleberg plant (KKM) that was commissioned in 1972 were subjected to a series of limited licenses that were repeatedly extended. The last renewals were issued on the basis of a PSR for a period of 10 years. These have expired on December 31st 2004 for KKB-2 and will expire on December 31st 2012 for KKM. The operator of KKB applied for a renewal in 2000 and also for the removal of the operating time limitation. The operator was requested to submit the following documents based on the PSR procedure by December 2002:

- An updated safety report as a description of the plant-specific safety concept including technical specifications, plant and accident management, incident and emergency rules, emergency protection concept, fire and lightning protection concepts, maintenance concept, and escape and rescue route concept;
- The report on operating management and operating experience including an evaluation of the fields organization and staff, safety culture and quality management;
- The status report dealing with the deterministic safety status analysis and especially with control of design basis accidents;
- An updated probabilistic safety analysis for full-load conditions (levels 1 and 2) and for low-load operation and shutdown (level 1).

The HSK (Hauptabteilung für die Sicherheit der Kernanlagen) prepared an extensive evaluation based on this information and on its own inspections and assessments. In it, the HSK arrives at the conclusion that KKB-2 meets the requirements for a safe continued operation. The HSK furthermore notes that no technical facts speak against lifting time restrictions on the operating license.

In turn, the KSA (Eidgenössische Kommission für die Sicherheit von Kernanlagen) itself prepared a statement on this procedure and underlined the following safety-related topics:

- Evaluation of the safety of operation
- Modifications in technology, operating management, organization
- Monitoring aging and technological aging of the plant
- Disposal of radioactive waste
- Radiation protection
- Emergency provisions

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This statement suggests several new requirements regarding individual issues but did not express any objections against continued operation. The KSA made no recommendations regarding limitation of the licensing period. It restricted itself to merely outlining the benefits and drawbacks associated with the limitation of licensing periods or its lifting.

A decision by the government (federal council) was reached in December 2004. The extension of the operating license was issued without time restrictions.

4.4 IAEA

The IAEA and its advisory body INSAG have given special attention to the safety of plants that have been in operation for longer periods of time and have made recommendations on all essential aspects. INSAG-8 [10] describes the general basis for evaluating older plants. The usefulness of safety reviews is emphasized and it is pointed out that both deterministic and probabilistic methods should be applied. INSAG-14 [11] deals with the operating lifetimes of nuclear power plants. The general safety goal that is articulated is to maintain the existing safety level on the one hand, e.g. by controlling the effects of aging, and on the other hand the supervision and increase of the reference safety level insofar as this is meaningful. Safety reviews are suitable for evaluation purposes. The report points out the importance of maintaining suitable technical competence for long-term safe operation. This aspect is dealt with in greater detail in INSAG-19 [12], which addresses the maintenance of the design basis integrity. In the report, organizational provisions are recommended to ensure that the know-how, plant design documents and their justification are available on-site or externally and that these are systematically applied during plant operation, particularly when modifications are made. IAEA safety standards have been published on the topics of periodic safety reviews [7], maintenance [13], plant modifications [14] as well as a guidance on aging management [15].

5 Evaluation and recommendations of the ILK

In the opinion of the ILK there are no safety-related reasons for limiting the operating period of nuclear power plants a priori. Rather, experience shows that given a responsible operating management, both the original level of safety can be maintained and furthermore an extensive adaptation to the advancing state of safety technology can be achieved. The ILK notes that the German NPPs have a high safety standard that is constantly monitored by the regulatory authorities. Periodic safety reviews (PSRs), which are performed every ten years, are part of this oversight process. The ILK also takes the view, however, that in the case of very long operating periods, it is

advisable to make the continued operation depend on a renewed evaluation (of the plant) that covers the requirements of the IAEA [7] and on the authority's consent to the evaluation outcome. This requires demonstrating that the plant displays a level of safety that corresponds to the requirements for the future operating period.

The ILK recommends the following approach:

- The limitation of production quotas currently laid down in the German Atomic Energy Act should be lifted;
- In addition to maintaining the current safety standard, licensees should examine improvement measures for the further reduction of the residual risk and, where appropriate, apply these. The effectiveness of the PSR in its current form should be assessed and the guidelines for their application should be updated, if necessary;
- After an operating period of 40 years at the latest, a special safety review should be supplied by the licensee and be evaluated by the authority. On this basis plant operation can continue for 10 more years at a time insofar as the authority does not raise objections.

In addition to the analyses covered by the PSR, the special safety review contains the following requirements. These are mostly already part of the continuous oversight process but are reassessed in summary on the occasion of the special safety review:

- The current status of the plant or its status at the start of the renewal period is to be compared to the requirements of the safety criteria and the RSK safety standards. Existing deviations may not bring about unacceptable risks. It must be ensured that the data and assumptions used for the design safety cases, the plant documentation and the current status of the plant are all in agreement with each other.
- Operating management including measures for promoting safety culture is carried out according to the best current practices. Measures for maintaining knowledge and technical competence with regard to the safety-related design and its justification have a special significance for older plants.
- An effective aging management exists that derives suitable monitoring measures from a systematic analysis of aging mechanisms and ensures their proper execution and evaluation as well as the implementation of the necessary measures. If a restriction on the permissible number of loads has been specified for the individual load types of mechanical components, it needs to be shown in particular that these loads can be safely handled also during extended operation.

- An up-to-date PSA that covers all operating conditions exists for Level 1 and Level 2. Level 1 is intended to show the balancedness of the safety systems and to indicate possibilities of improvement where appropriate. Level 2 should serve to evaluate those measures intended to prevent large early releases in the event of a postulated core melt. For probabilistic analyses, measures to ensure the necessary provisions against damages as well as additional measures taken by the licensee to reduce residual risk are considered. The sum of measures is intended to bring about that the core melt frequency lies in the order of magnitude of E-5/a or lower and that the frequency of large early releases is about one order of magnitude less probable. These are the values recommended in INSAG-3 [16] as target values for plants to be newly constructed. The requirements on performing the PSA should be updated (cf. also [18]).
- Backfits that are necessary for maintaining the existing safety level as well as those leading to a further improvement of the safety level when taking the appropriateness of means into account and thus to a suitable reduction in risk have been or will be applied. These backfits are based on, e. g., plant specific PSAs or on backfits in comparable plants. Decisions on backfits should be developed in a joint dialog between the licensee and the nuclear regulatory authority.

The review of measures concerning security should basically correspond to the review for safety measures. Insofar as more demanding requirements are to be placed in the future due to the hazard situation, this needs to be taken into account for the extension of operating periods.

Lifting restrictions on the duration of plant operation has consequences on the legal requirements on storage for spent fuel elements (see also [24]).

6 Concluding remarks

In the view of the ILK, nuclear power plants can be operated safely for long periods of time given a responsible operating management. For this reason, the currently established limitation of electricity production quotas should be lifted. However, for operating periods exceeding 40 operating years at the latest, the ILK considers it advisable to ensure sufficient safety in the future by undergoing a preceding renewed assessment in 10 year intervals. In so doing, the results of a special safety review should be used to prove that safety is maintained to the licensed extent for the renewal period and that it undergoes appropriate continued development. The steps to be carried out are listed in this ILK statement.

7 Additional comments by ILK member Prof. George E. Apostolakis

Although I agree with most of the contents of this ILK statement, I must dissent on a number of points. I am aware of the philosophy of continuous improvement that appears to be prevalent in Europe. I do feel, however, that documenting different perspectives is a healthy contribution to the continuing debate on how best to manage the risks from nuclear power plants. I offer the following comments in that spirit.

I am troubled by the following recommendation: *"In addition to maintaining the current safety standard, licensees should examine improvement measures for the further reduction of the residual risk and, where appropriate, apply these."* I find this recommendation vague, irrelevant to life extension and, therefore, inappropriate. In my view, if a plant is allowed to operate, i.e., if it is declared safe enough, one day before the expiration of its license, it should be safe enough the day after, if it continues to meet its requirements. The control of potential aging effects, as described in Section 3.1.1, is the means that allows us to reach a conclusion regarding the latter. If improvements are deemed necessary, they should be necessary for the plant regardless of whether it is being reviewed for life extension or not.

I disagree with the statement in Section 2 that *"Setting higher safety requirements on the extension period than normally applied in the event of continued operation without a renewed decision to carry on operation can be regarded as one safety-related advantage of restricting operating periods. This gives rise to an additional opportunity for taking into account advances in safety technology or a higher societal need for safety."* I don't believe that the regulatory system should be looking for "opportunities" to impose new requirements. The sole basis for such actions should be safety and, secondarily, cost-benefit tradeoffs.

In Section 3.1.2, the following statement appears: *"Since beyond-design-basis accidents are the focus here, measures should only be suggested if the safety-related benefit is in due proportion to the required expenditures. The suitable means for assessing the safety-related benefit are given by probabilistic safety analyses."* Although I agree with this statement in principle, I find that it contributes to the vagueness I mentioned above. As far as I know, there is no quantitative guidance in Germany as to how one would do tradeoffs between safety benefits and expenditures. Having a PSA is not sufficient; guidance on how its results and insights should be used in decision making is an essential part of the process.

Statement

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Annex

Levels of Defence in Depth according to INSAG-12 [22]

Levels	Objective	Essential means
Level 1	Prevention of abnormal operation and failures	Conservative design and high quality in construction and operation
Level 2	Control of abnormal operation and detection of failures	Control, limiting and protection systems and other surveillance features
Level 3	Control of accidents within the design basis	Engineered safety features and accident procedures
Level 4	Control of severe plant conditions, including prevention of accident progression and mitigation of the consequences of severe accidents	Complementary measures and accident management
Level 5	Mitigation of radiological consequences of significant releases of radioactive materials	Off-site emergency response

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