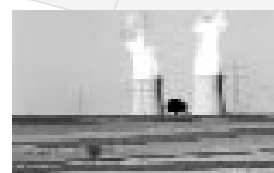




**INTERNATIONALE
LÄNDERKOMMISSION
KERntechnik**

Baden-Württemberg · Bayern · Hessen



ILK Statement

on the General Conclusions Drawn
from the KKP 2 Incidents associated
with the Refueling Outage of 2001

Für deutsche Fassung bitte umdrehen!

May 2002

No.: ILK-09 E

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 currently consists of twelve scientists and experts from Germany, France, USA, Sweden and Switzerland. The ILK acts as an independent and objective advisory body to these German states on issues related to the safety of nuclear facilities and radioactive waste management and the risk assessment of the use of nuclear power. In this capacity, the Committee's goal is to contribute to the maintenance and further development of the high, internationally recognised safety standards of nuclear power plants in the southern part of Germany.

The approach taken by the ILK in the field of Man-Technology-Organization is a systemic and holistic one. It is clear to the ILK members that the incidents associated with the refueling outage in 2001 in the nuclear power plant Philippsburg must be approached from this systemic angle and that insights touching upon essential aspects of nuclear safety could and should be deduced from these events. These aspects have a general significance extending beyond the concrete incidents and provide an opportunity to learn and further improve the safety oriented operation of other plants as well.

The following statement, which was adopted at the 17th ILK meeting on May 17, 2002 in Stuttgart intends to bring into focus again some topics that are essential to nuclear safety. This statement therefore addresses all licensees and regulatory authorities.

The Chairman



Dr. Serge Prêtre

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1 Introduction

The International Committee on Nuclear Technology (ILK) has addressed the events in the Philippsburg Nuclear Power Plant (KKP 2) associated with the refueling outage 2001 and the ensuing consequences. Errors made in the filling of the water storage tanks led to the restart of the plant while three of four storage tank pairs had lower concentration levels of boron than the 2200 ppm prescribed by the operating manual (Betriebshandbuch, BHB). The concentration levels went unnoticed until about two weeks after the restart. A further one-and-a-half weeks passed while the situation was remedied during commercial operation. About seven weeks after restart, the licensee shut down the plant in order to investigate the events in more detail and to undertake safety-related improvements. The reason for this was given by the assessment at this point in time of all involved parties that the insufficient level of boron concentration had to be regarded as the non-availability of the train in question. Consequently, the safety-related significance of the event was regarded as corresponding to Level 2 of the international INES-rating scale. During the investigation of the incident, a further finding was made: during restart, the storage tanks were not completely filled when the reactor coolant system pressure had reached 10 bar as laid out in the operating manual, but only at a later point in time. This had been the case for all start-up procedures since commencement of operations of the power plant unit. A detailed exposition of the events is given in [1], [6] and [7].

The events were investigated and evaluated by the regulatory proceedings. A report by the licensee has been prepared [1], who has commissioned expert opinions by a Swiss third-party expert [2] as well as an external Human-Factors investigation [3]. Moreover, the regulatory authority (Umwelt- und Verkehrsministerium Baden-Württemberg, UVM) commissioned an expert opinion by the TÜV Rheinland/Berlin-Brandenburg e.V. on the restart [4] as well as an additional Human-Factors expert opinion [5]. The GRS (Gesellschaft für Anlagen- und Reaktorsicherheit) prepared an Information Notice (Weiterleitungsnachricht, WLN) [6]. UVM prepared a report on the event and its consequences [7].

The present ILK statement draws on these documents. ILK has not conducted its own inquiries into the facts beyond these existing reports. In its statement, the ILK does not address all of the details that played a role in the context of the incidents. The objective pursued here is to point out in the following chapters the general aspects beyond these current incidents that the ILK believes to be significant also for other power plants.

In the following, the ILK takes a detailed stance on the superordinate topics of actual impact on safety, safety culture and adherence to specifications. The ILK also notes the following additional points, not addressed in depth in this statement:

- The licensee has conclusively examined the course of events and contributing factors and presented them in a clearly comprehensible way.
- The ILK regards the corrective measures derived from the course of events to be appropriate, in particular, the technical measures in [1], for example, the measurement of boron concentration and valve locking.
- Without knowing the exact background details of the present case, the ILK points out that the suspension of employees that have committed errors represents a double-edged measure. On the one hand, it demonstrates a willingness to take all necessary consequences – including unpleasant ones. On the other hand, it can hinder, rather than promote an organization's ability to learn by personalizing organizational problems and creating the impression that by simply suspending a person, the problem itself is eliminated.

2 General issues

2.1 Actual impact on safety

The borated water reserves in the storage tanks are required for controlling loss of coolant accidents. Such incidents have a frequency of occurrence of approx. 3×10^{-3} /year or less, depending on the size of leak. In the current case, the coolant reserves in the storage tanks sufficed at all times to cool the core should a loss of coolant accident have occurred. The amount of boron also sufficed to keep the reactor shut down. Both statements also apply when taking into account the hypothetical system failures assumed within the context of the licensing procedure. However, the investigations performed after the events showed that during the course of certain incidents, it was questionable whether recriticality could have occurred due to layers of different boron concentrations forming in the storage tanks or due to boron segregation during reflux-condenser operation. In part this could subsequently be ruled out; calculations are partly still in progress. While the errors that occurred did not lead to a hazard thanks to the error tolerance of the defense in depth safety concept, safety margins provided for by the design basis were, however, partly no longer available.

Thus at the time when he made a decision, the licensee could not be completely sure that the actual safety was guaranteed. Under no circumstances should the rules prescribed for safety purposes be deviated from for operating reasons. On the one hand, the whole point of conservative margins lies in providing reserves for unexpectedly adverse situations. This purpose is forsaken once the reserves are utilized during plant operation. On the other, the specifications made in the operating manual were based on careful analyses. When a decision is made in a situation that suddenly arises in the operating context, it cannot be guaranteed that all aspects of the situation are weighted with the same degree of carefulness. This is true of the current case where the statement that accident mitigation systems were not impaired for specific instances were only confirmed by extensive later investigations. The decision that the reduced boron concentration was sufficient was thus not conservative. Safety-oriented behavior demands that the prescribed rules of the operating manual are adhered to, thus ensuring that the safety margins taken into account by the underlying analyses remain untouched.

2.2 Safety Culture

The ILK observes that in the course of events leading to the underboration as well as in subsequent reactions to this event, a number of actions and omissions occurred that should not have taken place given consistently practiced safety-oriented behavior. Examples include:

- no lessons were derived from the precursor event in 2000,
- no feedback was given on valves that were in an unexpected position,
- non-observance of the fill-level in the boric acid container,
- tardy filling of the storage tanks,
- tardy measurement of the boric acid concentration,
- delayed start of investigations into the causes of boron dilution and thus delayed recognition of the common-mode potential.

Several of these points each had the potential, during the preliminary phase and the beginning of the event, of completely avoiding the further course of events if they had been properly carried out.

Single maloperations cannot be fully ruled out, even if high safety standards are applied. However, in this case, undesirable effects are counterbalanced by the plant design and plant operation as laid out by the defense in depth safety concept. In the view of the ILK, the sheer number of maloperations, however, indicates that the measures taken by the licensee for resolutely implementing safety-oriented staff behavior were insufficiently effective. The licensee also states deficiencies in safety culture in its own analysis (part 1, KKP report [1]) and intends to take corrective measures (part 3, KKP report [1]). The ILK strongly supports this response and outlines the following points it considers to be important, also for other plants:

- The staff should be sufficiently well informed of the actions that they are expected to perform. For this purpose, safety objectives should be formulated for each organizational unit and rules of conduct should be decided upon for relevant situations, to the extent that this has not already been undertaken. The analyses of organizational workflow that are planned by KKP (part 3, KKP report [1]) should determine which individual points demand a more concrete specification (of behavior). The ILK recommends the selection of an approach that gives due consideration to best practices performed in other plants. Staff should be informed of the objectives and procedures in an appropriate way.

- Achievement of set goals and maintenance of a high standard need to be continually controlled. Responsibility lies squarely with the relevant management. Important control steps should be defined as a part of workflow. The staff should be fully informed of the objectives and necessity of this quality assurance. Additionally, audits should be performed at appropriate intervals. A part of these audits should be undertaken by staff from other plants in order to avoid "organizational blindness".

2.3 Adherence to specifications

The ILK asserts that the evaluation of the underboration event has changed both in kind and consequence over the course of the discussion. KKP initially regarded as the essential assessment criterion whether the boron concentration was sufficient to assure the safety of the plant. The responsible TÜV ET-BW and the regulatory authority used the same criteria in their assessments. Only at a later stage did the question of adhering to operating manual specifications step into the forefront. The final analysis was decisively influenced by the fact that the three pairs of storage tanks did not conform to the concentration prescribed in the operating manual and thus were regarded as unavailable for a potentially necessary accident mitigation regardless of their actual effectiveness. The ILK surmises from this event sequence that there was insufficient clarity among participating parties as to which assessment criteria needed to be applied in such a case.

The ILK asserts that both perspectives – namely, the engineering point of view regarding adherence to the safety-related safety objectives and the formal legal correctness regarding adherence to binding requirements – are necessary.

Generally speaking, an indispensable basis for the cooperation between regulatory authority and licensee is that both pursue practical safety-related solutions and aim to adapt the measures taken to the actual safety significance of an issue. The licensee is responsible for the safety of the plant. He does not do justice to this responsibility solely by simply adhering to the sum total of all existing regulations. Conversely, a regulatory authority that only limits itself to the formal supervision of rule adherence cannot bring about an effective supervision. The ILK thus supports a fundamental agreement that the most important goalpost for the licensee and the authority is the safety that can effectively be achieved.

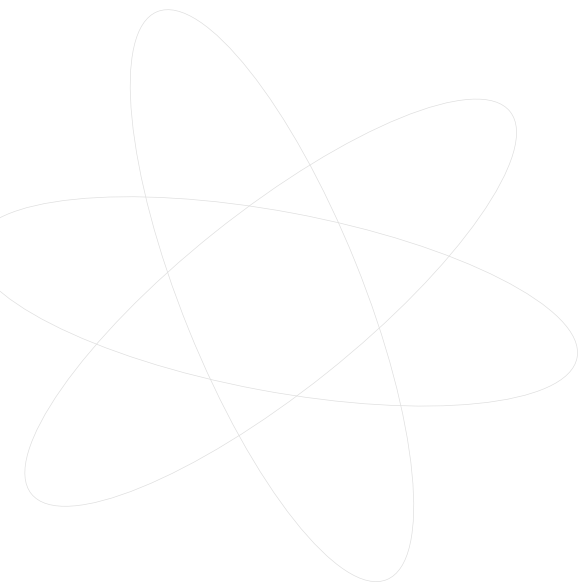
It is in any case necessary for a maximum degree of clarity and legal certainty to prevail in the core area of requirements. Here we are dealing with regulations that ensure that the nuclear power plant, as a plant that is subject to licensing, is operated within the framework of licensing regulations. These regulations include requirements on the availability of safety systems. The systems are necessary for controlling incidents. The requirement that all design basis incidents can be controlled is one of the most important preconditions for licensing. The aim of this core area of requirements must be that they are complete and clearly comprehensible – i.e. leave no scope for interpretation – and should be executed to the letter. The operating manual meets these graded requirements in that a part, namely, the safety specifications, are approved of by the regulatory authority and can only be modified with its approval. However, in the case of KKP 2, some of these requirements were too general (e.g. instruction, that boron concentration has to be measured after each refueling outage, but without indicating the permissible time frame), needed to be clarified by referring to other parts of the operating manual (e.g. for permissible maintenance times during shut-down < 14 days by reference to conditions for full-power operational state) and were not unequivocal enough (e.g. stipulation, that a redundant train has to be considered as not available if its functionality is not given in the event of a requirement, without additional definition of the term "functionality").

The aspect of strict adherence to licensing regulations plays a key role in the regulatory procedures of all countries. Often, this aspect is practiced in a substantially more legally formal way in other countries than was the case in the events of KKP 2.

To ensure the adherence of regulations in the core area of the operating manual, it is thus necessary to rework the safety specifications so that they fully and unequivocally reflect operating instructions that are vital for safety.

Although deviations from the safety specifications are not permissible even if they contain conservative margins, this, of course, does not mean that they cannot be modified. The modification should, however, be undertaken independently of a topical situation by following the customary revision procedure. This ensures that all necessary proofs are given and examined at the level of quality appropriate to this procedure. The ILK makes the recommendation to licensees that they should review the specifications for excessive conservative margins and to apply for modifications where appropriate. The ILK does not see this as a reduction of safety but instead takes the view that requirements whose sense and purpose is not evident to an expert do not contribute towards the maintenance of a high level of safety culture.

Proceeding from the logic that essential safety specifications need to be clearly pointed out, it also follows that the authorities should also pay special attention to regulation in this area and make sure that these specifications are being met. Pursuing the same logic, the ILK believes that it should be examined whether, beyond this core area, a greater scope of regulations should be left to the accountability of the licensees than is currently the case. The ILK's recommendation to the licensees is for them to make well-founded suggestions as to how this could be done.



3. Summary

The ILK is of the opinion that the Philippsburg incidents require specifying more precisely several fundamental aspects, apart from the specific consequences, or call these to mind using this example as an illustration. The ILK believes that the insights derived from these events are also useful for other facilities – also those that have a long track record of good availability and safety – and should be applied to these:

- Safety margins are an integral component of the defense in depth safety concept. They should be provided in the proper scope and must be available when they become necessary in the case of an incident. Excessive reserves can be removed using an orderly revision procedure but may not be called upon for operating reasons.
- Safety-oriented behavior of the licensee organization must be structured according to plan. Good results will be achieved if continuous improvement is the aim. Mere conservation of an apparently good condition leads to deterioration. If a resolute safety-oriented behavior is not practiced, then several measures that are suited to prevent incidents may simultaneously become ineffective.
- A joint striving for practical solutions must characterize the relationship of licensee and regulatory authority. Independently thereof, it must be entirely clear which set of requirements the licensee needs to adhere to in order to satisfy the licensing regulations. These must be unambiguously formulated and adhered to word by word. A corresponding revision of the safety specifications is thus recommended.

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Objectives of the International Committee on Nuclear Technology established by the States Baden-Württemberg, Hesse and Bavaria [Internationale Länderkommission Kerntechnik] - ILK -

Mission

Independently and objectively advising the states Baden-Württemberg, Hesse and Bavaria at the highest, internationally acknowledged scientific level on questions relating to the safety of nuclear installations, the regulated disposal of radioactive waste and the peaceful utilization of nuclear energy against the background of a sustainable energy supply.

Goals

1. Maintenance and improvement of the high safety standard of the German nuclear power plants and further development of the waste management concept for radioactive waste according to the internationally recognized state-of-the-art in science and technology.
2. Application of an holistic system approach to man-technology-organization.
3. Timely detection of safety defects against the background of competition in the liberalized European electricity market and development of countermeasures.
4. Inclusion of internationally acknowledged practice into the German safety philosophy and safety concept for improving state supervision and for increasing the safety standard of installations.
5. Treatment and evaluation of selected safety issues with regard to new scientific insights and development of recommendations on the harmonization of nuclear engineering standards on a European level.

ILK Publications:

- ILK-01** ILK Statement on the Transportation of Spent Fuel Elements and Vitrified High Level Waste (July 2000)
- ILK-02** ILK Statement on the Final Storage of Radioactive Waste (July 2000)
- ILK-03** ILK Statement on the Safety of Nuclear Energy Utilisation in Germany (July 2000)
- ILK-04** ILK Recommendations on the Use of Probabilistic Safety Assessments in Nuclear Licensing and Supervision Processes (May 2001)
- ILK-05** ILK Recommendation on the Promotion of International Technical and Scientific Contacts of the Nuclear Safety Authorities of the German States (October 2001)
- ILK-06** ILK Statement on the Draft Amendment dating from the July 5 2001 to the Atomic Energy Act (October 2001)
- ILK-07** ILK Statement on Reprocessing of Spent Fuel Elements (November 2001)
- ILK-08** ILK Statement on the Potential Suitability of the Gorleben Site as a Deep Repository for Radioactive Waste (January 2002)
- ILK-09** ILK Statement on the General Conclusions Drawn from the KKP 2 Incidents associated with the Refueling Outage of 2001 (May 2002)
- ILK-CD** CD with all presentations held at the ILK Symposium "Opportunities and Risks of Nuclear Power" in April 2001