



Approval Criteria Pertaining to the Revision of Safety-Related Relevant Testing and Maintenance Strategies

Torsten Röglin, Karl Götz and Rainer Großerichter

TÜV Süddeutschland Bau und Betrieb GmbH, Germany

ABSTRACT

The lecture points out, which request are to be placed against the evaluation of the safety of nuclear power stations under current conditions. In addition on the one hand the global competition and on the other hand the entitled demand count after high safety for risk technologies. Suitable evaluation instruments and possibilities of systematic application are presented. As crucial point the necessity is stressed to connect deterministic and probabilistic appraisal procedures. The positive operational experience of the nuclear power stations should be included more systematically than so far, in addition, in larger depth than so far into the evaluation. It is recommended to consider during the revision of sets of rules and regulations this realization progress.

The suggested methodology is illustrated by practical examples of Bavarian NPP.

1 INTRODUCTION

Production, distribution and consumption of industrial goods are essential parts of human life. Dealing with risks in industry, transport or pharmacy is a part of our daily life too.

First goal of any industrial enterprise is a continuous growing profit, on the other hand we can register in the last 20 years a growing sensitivity against all risk-technologies.

May be, that the influence of this sensitivity on decision making processes is not the same in every country and it has not same influence on every technologie at the same time. But we are sure, that this development will growing up at the next years.

Scepticism against different technologies up to political motivated retirement on special technologies in prosperous nations is one expression of this development.

This development can be right or wrong. Fact is that the society has a special claim to a high safety-level in technologies with high risk-potentials. an kann diese Entwicklung für rational begründet halten oder nicht. Safety or risk-prevention has primacy over growing profit rates in this technologies. This principles find their expression in detailed regulations and intensive research on new safety measures.

Global competition and liberalization make clear, that safety is not a static system of regulations. We have to find answers on safety related question in a dynamic context. Competition is at any time an advantage for the consumers and we have to accept, that the only way for the owners of industrial plants is to find out new strategies for cost reduction in operation. Re-

duction of costs seek out operators of nuclear power stations ever more frequently within the area of the maintenance and submit therefore of used strategies critical views. To be portable to all systems this methodology by the following structure of the current production costs in a German nuclear power station illustrates fig. 1 /1/.

Potentials for cost-reduction can be find in all parts of operation, especially in maintenance .ch erster Linie über den niedrigeren Preis einer nachgefragten Leistung realisiert. Der Erbringer dieser Leistung ist gezwungen, eigene Kostensenkungspotentiale aufzuspüren und energisch auszunutzen, um sich so Wettbewerbsvorteile zu verschaffen. Kostensenkungspotentiale spüren Betreiber von Kernkraftwerken immer häufiger im Bereich der Instandhaltung auf und unterziehen deshalb gewohnter Strategien kritischen Betrachtungen.

Fuel	20%
Electricity	25%
Administration	2%
Cap. recovery	5%
Spent fuel	10%
Power supply	15%
Maintenance	25%
Charges	12%

Fig. 1: Operation Costs in a German NPP /1/

In order for the social primat of safety under these conditions validity to provide is it necessarily that authorizing agencies, consultants and operators together to create creatively and realistic appropriate regulations for the evaluation of the pending modifications.

Nuclear power stations represent typical risk technologies in the eyes of the public at the latest since TMI and Tchernobyl. For hardly a technology are in such a way detailed sets of historically grown rules available. The identification of economical saving potentials and the attempt of the implementation place sections of these sets of rules to the planning.

We are looking for answers to the following questions:

- 1 When is a NPP safe?
- 2 How safety is to be determined?
- 3 How can modifications be evaluated?

These questions are to be answered in the following lecture from our view as consultants. We can fall back to a wealth of experience of more than 30 years application of the nuclear technology in Germany under changing internal and outside conditions.

2 WHEN IS A NPP SAFE?

This question provoking placed could lead to the response: " if it is switched off. " Orients oneself one at the realities and necessities has we world-wide approx. 500 nuclear power stations with rising tendency and a substantial proportion of the worldwide power supply. The input question about attainable and necessary safety to place, is thus evident. For the operators the question about the availability of a nuclear power station arises beyond that.

The German set of rules determines in addition that a system in operation was sufficient for the valid sets of rules at the point in time of the line-up, thus safety determined is. Around the continual examination of the safety status of a system to ensure it is monitored by the supervisory authorities quality assurance system installed, which ensure that the safety devices remain during the entire period of operation in operational status.

Modifications at this quality assurance system, among which the maintenance strategy ranks, require at least the proof of the safety neutrality. Rationalization efforts direct first at an expenditure minimization. They contain thereby in the interest of the perception of the operator responsibility a spectrum of be omitted, over changed emphasis up to the introduction of new maintenance measures. These intentions and also the changed possibilities, which arise as a result of progressive maintenance methods, lead to a changed interpretation of the term of safety and the safety record.

The following predicates indicate summarized the present situation:

1. The system operators/owner are anxious to minimize the expenditure for maintenance activities.
2. Considering the receipt of safety these efforts are to be supported.

To all modifications the principle of the safety neutrality is to apply in analogy e.g. to the equipment safety law. This means that the safety status of the system may not become worse as can be prove, than it was to be found before a modification. The balance of the system must be preserved concerning the spectrum of the design incidents /2/.

3 HOW SAFETY IS TO BE DETERMINED?

Because of the comparative character of a safety predicate concerning planned modifications, the demand for safety neutrality and the modification requirement lead consistently to the following request:

1. For the objective evaluation of the plant safety as far as possible quantitative procedures should be used (" risk based regularization ").

Sets of rules with a deterministic origin place the unique regulation of an accurately isolatable view article into the focal point. Thus are there detailed sets of rules for almost all areas of the mechanical engineering and the instrumentation. The analysis of disturbances and compulsorily notifiable events shows however that with altogether removing trend the cause connections become ever more complex. The unique technical individual defect be-

comes however more rarely. The causes for disturbances can be found in the interaction of humans, technique and organization.

2. Modifications, which entail a decrease of the safety level, require compensation measures, which set if possible close at the cause of the degradation.

This criterion results directly from the demand after safety neutrality. In connection with the preferential use of quantitative appraisal procedures the possibility of the document of identification of the range of the necessary compensation and the starting points for compensation possibilities results. The compensation can take place via technical and via organizational measures.

The comparison of both request with the current sets of rules shows that a such methodology is impossible during the evaluation from modifications from the principle and is given numerous organization possibilities. From our view explicitly the use of quantitative appraisal procedures should be included with the transformation by sets of rules.

The system-spreading view requires it to formulate the term of the plant safety to extent and depth in such a way that the interaction between humans, technique and organization is entered. This concretizing must be primarily guaranteed, that all operating phases (operation, shut-down procedure, shut down, start) be entered and may not limited to the safety system in the sense of the protection of the economic management.

Which consequences are derived from it for the permission of modifications of the maintenance strategy?

1. The complexity of modifications requires adequate evaluation models. These must illustrate the connection between technical and organizational operational sequence. The connection of " classical " deterministic evaluation methods with modern probabilistic tools is to be implemented. These must be developed further into the view depth necessary for it and to the necessary extent.
2. With these methods the proof of the safety neutrality is to be led qualitatively and quantitatively. Any negative deviations must be compensated demonstrably. In analyses of sensitivity one determines, at which points of attack optimization measures effectively to be set to be able. Appropriate measures will be increasing to find according to the technical level of development in the organization.

The implementation of both criteria in the optimization procedure is a suitable methodology to economic objectives while maintaining high safety-relevant standards

4 HOW CAN MODIFICATIONS BE EVALUATED?

On recommendation to Bavarian State Ministry for State Development and Environmental Affairs the owners of NPP were requested to a revision of their maintenance concepts. Background were the realizations from periodic safety examinations and also the owner's initiatives for optimization of maintenance concepts.

4.1 Test criteria for Maintenance Concepts

Experts of TÜV Süddeutschland AG have developed with consideration of the experiences at other operators, consultants and authorities a catalog for the evaluation of complex modifications. We assumed, that a lot of possible modifications contains deviations from valid regulations. For the proof of the safety neutrality the meaning of these deviations must be analyzed including a multiplicity of single realizations. The arranged catalog contains equally deterministic and probabilistic criteria:

- conformity with the relevant set of rules
- deterministic task,
- probabilistic priority
- effect of the check
- operational experiences, external experiences, recommendations
- completeness of the checks

The focus is situated to examine modifications in its effect on the total concept. In detail orients itself at the meaning and complexity of the measure. Negative results in the safety evaluation has to be compensated. The effectiveness of the compensation is evaluated according to the same criteria. Thus a closed safety-relevant evaluation and an open-endedness for newer realizations, advantages of deterministic and probabilistic procedures result are at the same time united.

4.2 Safety Culture

Safety culture can be understood as stand from principles, measures and declarations/agreements, which lends priority to the highest priority of safety in NPP.

It contains above all the safety-related organization of technical and organizational operational sequence as well as request to the personnel. Instruments and procedures for the implementation of the safety culture are usable thereby as indications for the description of the plant safety.

4.3 Data processing - Tools for the evaluation of safety of NPP

At operators, authorities and expert organizations a multiplicity of information is collected, entered and edited. The spectrum goes the management including maintenance over the description of the technical and organizational structures, up to measures according to irregularities in system operation.

These data are also today often still peripherally maintained and administered. The experts of TÜV Süddeutschland AG has in order to close the gap between volume of data and systematic use developed a modular structured and expandable system. For all periodic safety examinations an efficient information pool is available.

4.4 Probabilistic Safety Analyses (PSA)

PSA are an established instrument for the evaluation of the safety of NPP. Goals of the PSA are:

- Determination and quantification of events, which can lead to the endangerment of the fuel element cooling,
- Determination of quantitative values of the frequencies of these events,
- Evaluation of the balance of the safety concept and determination of weak points.

The execution of a PSA Level1+ is to facilitate the transition to the Living PSA and to make the safety level of different plants comparable.

The focus of the PSA compiled under this goal is unique on the determination of the safety status. The PSA orients itself at the full load operation, considered thus no on and driving off processes and no downtimes. Probabilistic analyses for these periods of operation are only gradually created.

The spectrum at events, which can be treated under the premise of full-power operation, as well as directly the systems necessary for the control of the initiating events (" front-line system ") are illustrated explicitly. The availability of further components and systems are involved to carry into the frequency of initiating events or in analysis boundary conditions in and in this way implicitly for the total result of the PSA. The in such a way created PSA is limited suitable to serve during operational optimization processes as decision making aid. On the other hand quantitative procedures offer basically large advantages in relation to qualitative appraisal procedures, because they can be enabled relatively simple version comparisons and applied therefore time near.

An analysis of operational disturbances showed that only a small number of operational irregularities is view article of a PSA Level 1+. At the same time there is a clearly larger number of events, which could be examined in a Precursoranalyse. Notes, that such events can have substantial safety-relevant meaning, show executed Precursor-Analyses /4/.

Even systems from this area are however the subject of operational optimization considerations. Probabilistic procedures (" Risk monitoring "!), which beyond the framework necessary for a PSA level 1+, could be used in this connection as meaningful tool for a version comparison and for a proof of the safety neutrality. A further application possibility represents the evaluation of compensation measures. It offers itself therefore from our view to use probabilistic procedures in a further application field than so far.

For the global evaluation of operational disturbances in this sense we suggest the following categorization:

- **Category 1 Initiating Events**

In this group all events are summarized, which can be possibly regarded as initiating events in the sense of the PSA-Manual /3/.

- **Category 2 Indicators for Initiating Events**

Under this group all events are classified, which caused a performance modification, but already on the basis the descriptions of the monthly reports not when initiating events to be possible. For the events of this group it cannot be excluded that they develop with unfavorable circumstances to initiating events.

- **Category 3 Non-relevant as Initiating Event**

Under this group all events are classified, which led too not planned performance modifications, but unique not when initiating events are to be regarded (no request of the safety system).

- **Category 4 Leakages**

Leakages with request of the safety system are initiating events (group 1). Further leakages, which did not lead to request to the safety system however to performance sinkings, are counted in this group.

The determined events should be submitted of a qualitative evaluation and be examined afterwards with probabilistic methods. Therefore it is necessary to create for these systems and components an appropriate reliability database.

Here logically the set closes, because with all evaluation instruments mentioned and - to be proceeded in the long run the necessary information for integrals an evaluation of the plant safety systematically entered and used. The effective and reliable evaluation of operational optimization solutions under priority of the safety neutrality becomes possible.

5 Literature

- /1/ E. Gauf, Neue Wege in der Instandhaltung von Kernkraftwerken
Vortrag auf KTG-Fachtagung 1998,
- /2/ Röglin/Steininger
Bedeutung der integralen Anlagensicherheit für die Anlagenbewertung
Vortrag Fachtagung Sicherheit und Zuverlässigkeit, 1998
- /3/ Leitfaden Probabilistische Sicherheitsanalyse
Facharbeitskreis "PSA für Kernkraftwerke", 1996
- /4/ Gesellschaft für Reaktorsicherheit
Precursoranalysen: Probabilistische Bewertung von meldepflichtigen Ereignissen des
Jahres 1993
GRS-A-2507, 1997