STATUS OF THE HARMONISATION PROCESS OF THE FRENCH AND GERMAN LICENSING REQUIREMENTS

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ABSTRACT

This paper describes the harmonisation process of French-German licensing requirements with special emphasis on the development of the common safety approach for future PWRs. The procedure is described as well as the technical content of the common safety approach. Difficulties due to different licensing practices are presented as well as solutions. The process is illustrated by some examples (external hazards, redundancy and diversity, secondary side overpressure protection).

1. FRENCH-GERMAN COOPERATION OF SAFETY AUTHORITIES

The development of national nuclear safety standards in France as well as in Germany was closely linked to the national nuclear programme and to the national technological environment. For this reason alone, it is not surprising that safety requirements are not identical in both countries. However, this does not mean that reactor safety issues had been treated in a completely isolated way by each country. Already in the early seventies a cooperation between the French and German safety authorities started by establishing the Deutsch-Französische Kommission (DFK). The work of this commission was focused on issues arising from nuclear power plants situated in France and Germany close to the common border and included a safety comparison between French and German plants.

A significant step in the extension of the cooperation was the establishment of the Deutsch-Französischer Direktionsausschuß (DFD) the Bundesministerium für Naturschutz, Umwelt und Reaktorsicherheit (BMU) and the Direction de la Sûreté des Installations Nucléaires (DSIN) in January 1990, which focuses on general national matters. One aim of DFD is the harmonisation of the regulatory approach in both countries with special emphasis on the development of common positions and safety principles for the design of future pressurised water reactors.

2. THE HARMONISATION PROCESS

This common safety approach is presently being developed applying the following procedure: the technical consultants Gesellschaft für Anlagen- und Reaktorsicherheit mbH (GRS) and Institut de Protection et de Sûreté Nucléaire (IPSN) elaborate the technical basis. Starting from essential background information (description of technical and physical conditions, present licensing practices, knowledge derived from research and development, etc.), common positions of GRS and IPSN are worked out in the form of comments and recommendations, and the need for further information is identified. This work is the basis for a detailed treatment of the subjects within the technical advisory bodies to the safety authorities Groupe Permanent chargé des Réacteurs Nucléaires (GPR) and Reaktor-Sicherheits-kommission (RSK) in joint meetings. These activities result in GPR/RSK recommendations, which are submitted to DFD for adoption.

The first set of common recommendations which represented the general safety approach was issued in May 1993 as the “GPR/RSK Proposal for a Common Safety Approach for Future Pressurised Water

Reactors". It was adopted by DFD in June 1993. This document is hereafter called the "Common Safety Approach of 1993". It is the basis for all further more detailed and refined recommendations and requirements, which have been developed following the same three-step procedure.

3. THE DEVELOPMENT OF THE COMMON SAFETY APPROACH

This chapter presents the development of the common safety approach from the viewpoint of the technical safety organisations, concentrating on the technical aspects and the safety strategy rather than on particular legal aspects, which are in the responsibility of the government.

Within IPSN and GRS, the active harmonisation work was preceded by a preparatory period of about two years. In seven working groups, this preparatory phase consisted of the two main tasks

- mutual understanding of the safety philosophy and the safety evaluation practice of the partners' country
- identification of similarities and differences related to proven safety principles and objectives in both countries.

Acquired knowledge on the situation in the partner country did not only include technical aspects, but also the procedures applied in the safety evaluation during a licensing process. These procedures partly differ from each other in both countries. In Germany detailed rules and guidelines specify many design details while the safety evaluation in France uses fundamental rules leaving some freedom to evaluate particular technical solutions case by case within the evaluation process itself.

After this introductory phase, IPSN and GRS were ready to develop a proposal for a common safety approach.

3.1 Content of the "Common Safety Approach of 1993"

The content of this basic approach, developed by IPSN/GRS, recommended by GPR/RSK and adopted by DFD is summarised briefly. It contains general safety objectives and technical principles for their realisation. They are considered to be an important basis for the future work.

The common opinion of the groups of experts is that the significant improvement aimed at for the next generation of PWRs (to be constructed at the very beginning of the next century) can be obtained in the "evolutionary" way if due consideration is given to the lessons learned from operating experience and from in-depth studies like Probabilistic Safety Assessment (PSA), as well as to the results of research, in particular on severe accidents.

Three important general safety objectives have been set up:

- A further reduction of the core melt frequency.
- The "practical elimination" of accident situations which could lead to large early releases of radioactive material. If those situations cannot be considered as physically impossible, provisions have to be taken to "design them out".
- For low pressure core melt situations the design has to be such that the associated maximum conceivable releases would necessitate only very limited protective measures in area and time (no permanent relocation, no need for emergency evacuation outside the immediate vicinity of the plant, limited sheltering, no long-term restrictions in the consumption of food).

A fourth objective can be added: A further reduction of occupational exposure to plant personnel.

The first and second objectives are in line with the present safety concept. The third objective characterises the development of a safety philosophy in the sense of an extension of "defence-in-depth" principles by adding an additional level of defence at the design stage. The technical principles derived from this safety objective ask for new technical solutions going beyond those which are presently implemented in operating plants for risk reduction (accident management measures).

In addition to the general safety objectives the “Common Safety Approach of 1993” also contains important safety principles which essentially support an „evolutionary“ development.

This “Common Safety Approach of 1993” has been used by the industry as one basis for the development of the EPR design concept. Details of this design concept have been given to GRS and IPSN (EPR Conceptual Safety Features Review File). This review file has been taken into consideration in the further development of common French-German recommendations, especially with respect to completeness and feasibility of the new recommendations.

3.2 Refinement of the Common Safety Approach

Since 1994, the common safety approach has been further developed, extended and refined. This procedure was carried out among the organisations as described in chapter 2. This process includes information exchange and discussions with industry that has developed in parallel their basic design. By this mutual exchange, industry has received important guidance from the recommendations and requirements spelled out by the authorities and their advisory groups and technical safety organisations. By receiving preliminary information on the design development, IPSN and GRS were able to analyse particular design aspects and to check their own recommendations and statements with respect to the appropriate applicability to the design.

The degree of detail within the refinement of the approach is the result of a balance between the two goals:

- Sufficiently concrete to give the designer a good guidance,
- Sufficiently general to allow for several design solutions.

The subjects which have been treated in this development and refinement process have been selected according to several criteria with an important time priority criterion being the relative date at which an important decision has to be made within the design process. The other selection criteria are typical harmonisation criteria, such as differences in French and German licensing, need for a re-evaluation of the existing practices due to progress in R&D or technical development, compliance of the designer proposal with the present practices and/or the “Common Safety Approach of 1993”. There are also some subjects which are new and which have not yet been addressed in previous licensing practice (e. g. core melt accidents).

The following subjects have been treated in detail since 1994, some subjects in more than one step.

- Severe Accidents (general approach, radiological consequences, impact on containment design, R&D needs)
- System Design and Use of PSA (general approach, use of PSA, primary system overpressure protection and depressurisation, reliability of shutdown function, consideration of shutdown states, secondary side heat removal, electrical power supplies, residual heat removal, secondary side overpressure protection, secondary side ruptures and containment bypass)
- Internal and External Hazards
- Primary Circuit Integrity (break preclusion concept)
- Radiological Consequences of Accidents
- Radiation Protection during Normal Operation.

Recommendations, requirements and comments developed for these subjects have been continuously issued as GPR/RSK recommendations adopted by DFD. A general overview has been given at the ARS ’97 conference [Frisch, Gros, 1997]. Some of the more recent examples selected for this presentation are chosen to characterise the harmonisation process between the two countries.

3.2.1 Design against Airplane Crashes

The development of a common approach with respect to external hazards (earthquakes, explosions, aircraft crashes) was not easy because of two facts: Firstly, the present practice is different in France and Germany. Secondly, loads from external events are site-dependent, and as the load functions recommended in the safety approach should apply to basically site-independent standard designs, they should be specified such that the majority of sites is covered. Excessively strong requirements derived from a few potential sites with extreme conditions should not be placed on a standard design in order to avoid unnecessary measures and cost. Within a licensing process site-dependent aspects have to be treated separately anyhow. Finally France and Germany have agreed on load functions for earthquakes, explosions and aircraft crashes.

With regard to the protection against aircraft crashes, several in-depth technical discussions showed that relevant parameters have changed in the past and will change in the future. One example is the significant reduction of the number of military aircraft movements in Germany after the political changes in Eastern Europe and the German reunification.

There was an early agreement that the design has to be made on the basis of reference load-time functions that also include crashes of military aircraft. The detailed discussions resulted in a common GPR/RSK recommendation of the load time functions to be applied. The safety functions to be ensured were fully defined (reactor shutdown and prevention of core melt, no dewatering of spent fuel in the pool), and the methods to be used to calculate the various aircraft crash effects (perforation, vibrations) were precisely specified.

3.2.2 Redundancy and Diversity

Another area of necessary harmonisation is safety system design. Not surprisingly, many differences exist in the safety practice of both countries. It is not the general safety philosophy (e. g. implementation of the defence-in-depth principle), but their technical realisation which shows differences, e. g. with respect to degree of redundancy, degree of automation, superposition of events and failures, etc.. On a first glance, the simplest way of harmonisation might have been the summing up of all requirements of both countries. However, this solution is not satisfactory because it would have been the most expensive and not necessarily safety-optimised. The summing up may even lead to contradicting requirements.

The required harmonisation process was strongly supported by the analysis of operating experience and by the knowledge gained from PSA studies performed for plants in operation in both countries. Important principles have been derived from this and turned into common recommendations of GPR/RSK, taking into account among others the statements of the “Common Safety Approach of 1993” on the usefulness of PSA:

“… Evaluation of PSA results against quantitative probabilistic targets can provide useful guidance. But, generally speaking, quantitative probabilistic targets are not to be seen as requirements; they are essentially meant to be orientation values for checking and evaluating the design“.

Some of the principles related to system design are:

- The reinforcement of the “defence-in-depth” of the plants will, generally speaking, imply a more extensive consideration of the possibilities of multiple failures and the implementation of diversified means to fulfil the three basic safety functions - reactivity control, cooling the fuel and confining radioactive substances - whatever the state of the plant.

- A reduction of the global probability of core melt will be achieved through an adequate combination of redundancy and diversity in safety systems; on this point, it is underlined that the unavailability of a redundant safety system consisting of identical trains probably cannot be demonstrated to be less than 10^{-4} per demand, and that due consideration has to be paid to the support systems when assessing the benefits from diversified systems or equipment.
- For determining the adequate combination of redundancy and diversity in safety systems, the designer can, as stated before, use probabilistic targets as orientation values; in that case, orientation values of 10^{-6} per year for the probabilities of core melt due to internal events respectively for power states and for shutdown states could be used, having in mind the necessity to consider associated uncertainties.
- For frequent initiating events, the reliability requirement on a safety function is such that two diverse systems or pieces of equipment might be necessary.
- For the safety systems required during all reactor states, including shutdown states, the designer has to combine the single failure criterion with the scheduled maintenance, taking into account the required capacity of the corresponding safety function during this maintenance.

The principles mentioned above are mainly aiming at a reduction of the core melt frequency. There are additional principles to be followed for systems that contribute to the “practical elimination” of such accident situations that would lead to large early releases.

These principles are the basis of recommendations on specific safety systems or safety system functions that have been specified in the course of the development of the common approach. Examples are the electrical emergency power supply and the primary system depressurisation. Some details are given on the latter one.

The recommendations of July 1994 state:

The GPR/RSK proposal indicates that “It must be a design objective to transfer high pressure core melt sequences to low pressure core melt sequences with a high reliability so that high pressure core melt situations can be “excluded”.” The above mentioned design objective can be dealt with by the means of pressure relief valves at the primary circuit, with such a discharge capacity to limit the pressure in the reactor coolant system in the range of 15 to 20 bar, at the moment of the reactor pressure vessel rupture. The designer has to propose such means with due consideration of the expected reliability of the valves; in particular these means must be clearly qualified under representative conditions. As an orientation, the equipment used to depressurise the primary circuit has to be as reliable as the relief valves used to prevent an overpressurisation. The use of specific valves—to be actuated only in case of core melt sequences—should be investigated.

Recently, the EPR project has proposed a design solution with a dedicated bleed valve for primary system depressurisation in case of a failure of the pressuriser valves. On this solution more detailed GPR/RSK comments have been given recently:

Their discharge function must be available in case of loss of off-site power and unavailability of all diesel generators. Once open, the bleed path should stay fully open with high reliability through the progression of the accident.

The discharge capacity of the dedicated valve has to be determined considering the following scenarios, with realistic assumptions:

- Loss of off-site power with unavailability of all diesel generators,
- Loss of off-site power with unavailability of all diesel generators, but with recovery of water supply during core melting,
- Total loss of feedwater and failure of primary feed and bleed.

Sensitivity studies regarding the discharge capacity, the hot gas temperature and the initiating criteria have to be done considering delayed bleeding and late reflooding as well as the uncertainties of the code models related to the late core degradation phase or reflooding.

The subject of safety system design is not yet completed. Detailed studies and analyses are necessary to support the development of a set of requirements that aim at a well balanced design.

3.2.3 Steam Generator Overpressure Protection

A thorough treatment of the secondary side overpressure protection function was necessary because the designer proposed a solution with a valve capacity which is significantly lower than in previous French and German plants. However, the previously higher capacity was not necessary for safety reasons but in fulfilment of conventional boiler rules. An overly conservative discharge capacity (overdesign in size and/or number of valves) even has a negative impact on safety by increasing the probability and/or the severity of secondary side depressurisation accidents. The new approach of the designer takes into account the reactor scram as a pressure reducing measure.

Some of the recommendations with respect to this subject are:

GPR/RSK agree that the reactor trip could be taken into account as a pressure reducing measure, which would permit reducing the overall discharge capacity. This approach could be used for the reference incidents and accidents. GPR/RSK emphasise that anticipated transients without scram (ATWS) have to be coped with. The designer has to study the most penalising transient in this field with respect to pressure increase on the primary side and on the secondary side, taking into account the durations of the transients, which depend on the effectiveness of the boration system. GPR/RSK also stress that the relief and safety valves have to be qualified for all fluid conditions which could occur during their use. The necessary discharge capacity has to be estimated in connection with the reactor trip availability; specific pressure limits have to be fulfilled depending on the frequencies of the postulated conditions. A global capacity of 100 % of the steam flow by an adequate combination of steam relief valves and steam safety valves could be judged necessary.

The designer had initially proposed a capacity of 75 % of nominal steam flow. Based on these new considerations it has been extended to 100 % (see table for a comparison of EPR with latest French (N4) and German (Konvoi) PWRs).

Comparison of Steam Generator Valve Capacities				
	N4	**Konvoi**	**EPR 1995**	**EPR 1997**
No. of safety valves per steam generator	7	1	1	2
No. of relief valvesper steam generator	2	1	1	1
Safety valve capacity	140 %	100 %	25 %	50 %
Relief valve capacity	50 %	100 %	50 %	50 %
Total valve capacity (in % of nominal steam flow at full power)	190 %	200 %	75 %	100 %

4. STATUS OF THE HARMONISATION AND FURTHER STEPS

It has been shown how the harmonisation process was carried out, and in some examples the achievement has been demonstrated. The harmonisation of requirements has been obtained in many other areas not explained in detail here. French-German harmonisation concerning the safety requirements for future pressurised water reactors is advancing well.

At the same time, conclusions on some essential issues are still pending. Further information is necessary before concluding on the general design of the safety systems. It should be borne in mind that this design must, indeed, be examined with respect to the two essential objectives: reduction of the core melt frequency and "practical elimination" of accident situations liable to lead to large early releases of radioactive substances. Furthermore, in view of the results of probabilistic safety assessments for existing plants, this examination should cover shutdown situations for which there is no doctrine equivalent to that developed in the past for situations with the reactor at power.

Another area not yet completed is severe accidents and containment design. Some conclusions can be drawn only after results of experimental programmes are available. R&D needs in this area have been and will be an important issue. Related to this subject is the question whether the containment tightness (1 vol.% per day) can be guaranteed under all expected severe accident conditions. GPR/RSK has recommended to investigation of an inner liner attached to the inner wall of the double wall containment.

The questions to be solved in the harmonisation process are not only those caused by differences in the present licensing practice in the two countries. Additional questions might occur if the industrial side would intend to eliminate "unnecessary" safety margins in a context of tough competition between different electricity generating technologies. There is, of course, no objection to the elimination of really "unnecessary" margins on the basis of a better understanding of some phenomena and improved simulation models. However, it must be stressed that compared to a conservative approach comprising somewhat arbitrary assumptions, a realistic approach requires study of a larger number of situations and to give precise justifications for the values adopted in the design studies.

Some subjects have not yet been treated within the harmonisation process, because they are not yet needed in the design process, such as core design and instrumentation and control. Work in this area has been started recently, taking into account the information in the "Basic Design Report" of the EPR which was submitted to the authorities in October 1997.

With the requirements developed so far and to be completed within the next year, the NPI project has a solid and detailed orientation for the continuation of the design of nuclear power plants potentially being licensable in both France and Germany.

So far, the harmonisation process on technical grounds has lead to a substantial number of common GPR/RSK recommendations, adopted by DFD. The aim was to arrive at common agreements without national deviations. The set of all agreements is supposed to be a strong guidance within a potential future licensing process in France and Germany. The legal implementation in the licensing process may be different in the different countries. However, their technical content is not meant to be subject to individual changes.

5. REFERENCES

1. Frisch, W., G. Gros, "Key Issues recently treated within the French-German Safety Approach". *2nd International Conference on Advanced Reactor Safety, ARS '97*, Orlando, USA, June 1-4, 1997.