Session 3. 10

Evaluation of the Design Code for EPR-Transport- and Handling Devices

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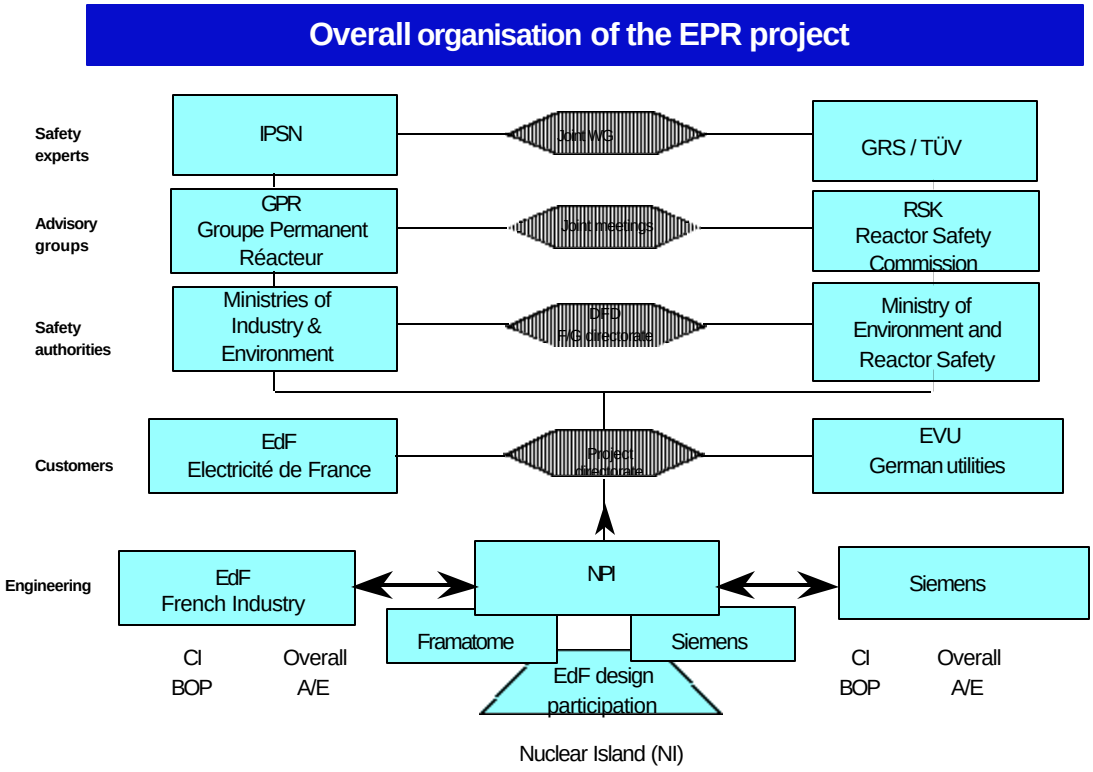
Introduction

In the 1990ties, after Harrisburg and Tchernobyl severe accidents, the Nuclear safety boards and industry develloped concepts of improvements, practical accident management and measures against severe core melting and fire hazards for future NPP. In France and Germany this lead to new design concepts of NPP. The European Pressurized Reactor is the most important of these. For the EPR-project the French and German bodies founded international governmental and industry working groups to find common solutions with. This international cooperation was necessary because of the acceptance procedures in both countries.
Based on the major design concept/conditions defined in the basic design report BDR) [2] and fundamental safety requirements from ETC-S [3] there were given component and equipment Specifications within 7 Technical Codes (ETC).
Coordinated by GPR and GRS we worked together with IPSN and TÜV-Northgermany on this project to evaluate the technical code for EPR Transport- and Handling devices.



Volume

The designation of the design code for handling and transport equipment is ETC-Handling Devices (HD) [1].
The volume covers all load chains of the EPR reactor building (RB) and fuel building (FB). It is generally defined in the BRD-Register of auxiliary systems.
The following scope of application is regarded:

- Cranes (e. g. Polar crane in RB, heavy crane in FB, gantry crane, cranes in auxilary-, safeguard- and diesel building)
- Fuel handling equipment (e. g. refuelling machine, fuel transfer facility, spent fuel mast bridge, fuel elevator, auxilary bridge, spent fuel cask transfer machine, spent fuel examination facility)
- Standard-hoists (handling-beams), handling-tools (grippers) and
- Load Attaching Points (LAP of flasks, casks, all other components and heavy loads to be handled).

Classification

General classification requirements are descriped in ETC-S. The EPR-overall „Functional"-classification of safety systems (e.g.F1A, F1B, F2) differs from that used for handling devices. Within ETC-HD there are two major classes (Saftety and non saftety-classified handling devices). The saftey classified ones are devided in 3 subclasses (Increased, Additional Specific, and Addditional Requirements). This distinguishment was mainly derived from different levels of consequences (hazard potentials) occouring after an assumed load drop and leads to design measures to be taken for protection against this consequences.
Increased requirements must be fullfilled if a postulated load drop could lead to:

- a criticality accident or
- a loss of residual heat removal function or
- a release of radioactivity with inadmissable (PCC4 limit) radiation exposure in the plant vicinity

Design provisions must be made that for handling devices classified according to increased requirements a load drop has not to be postulated.
Handling devices classified in this class are main hoist of polar crane in the RB and main hoist of heavy crane in FB.

Additional requirements are chosen if a postulated load drop could lead to:

- a release of radioactivity with radiation exposure inside the plant that affects the zoning or
- a non isolating release of primary coolant fluid inside containment or
- a redundancy overlapping failure of F1 systems (Systems necessary for shutdown, maintaining subcriticality and residual heat removal)

The secondary and auxiliary hoist of polar crane in RB and the hoisting installations of the refuelling machine, fuel transfer facility, spent fuel mast bridge, auxiliary bridge, and fuel elevator are classified in this class.

Additonal specific requirement class involves the definitions of additional requirement class plus several more details which are mainly derived from specific functions of handling devices (e. g. steering installations as mechanical, electrical or software based end stops of fuel transfer facility, fuel elevator or refuelling machine)

General Design

General design provisions are taken following the French FEM [4] requirements. The FEM standard is partially used and also well known in German hoisting design. For additional and increased requirements the special definitions for load-, calculation-, construction- and test conditions are listed in ETC-HD. Load- and calculation conditions are fixed within several tables for operation and erection phase.

Design Examples

The dynamic load factor for lifting mechanism and normal operation loads within increased requirements and additional requirements is taken from FEM.
Saftety factor for general stress analysis and operation loads is 3.2 (to rupture stress of material);for eathquake loads 1.0 (to yield stress) or 0.7 (to rupture stress)
Construction of loop drive trains within increased requirements:

- double open loop drive train or
- single loop drive train with additional drum saftety break a service break and a emergence break

Construction of loop drive trains within additional specific requirements:

- single loop drive train with service break and drum safety break

Construction of loop drive trains within additional requirements:

- single loop drive train with an emergence break and a service break

Test load factor for static test 1.4 x lifting load, for dynamic test 1.2 x lifting load

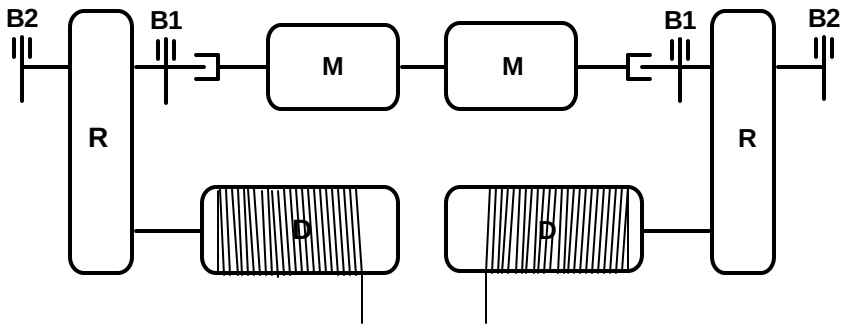


Fig.: Principle of double open loop drive train

Evaluation

First step of evaluation was to check the compliance of ETC-HD to ETC-S [3] and BDR [2] definitions. As a second evaluation step we have to verify the Key topics and then it was to compare the ETC-HD [1] detail design specifications with the requirements in French standard (FEM) [4] and German standard (KTA) [5]

The difficult target was to find a balanced common solution. It was clear that because of the high system safety features of the EPR design there was no need to fullfill the existing national standards completely. Therefore socalled Key topics (or major design points) were derived and have to be evaluated too.
The drafts of the evaluation results were discussed at serveral working meetings. A bundle of questions were given to NPI.

The results are written within an evaluation report. The paper is named "IPSN/GRS/TÜV –Comments to ETC – Handling devices". It was presented at the preparation meeting at Paris and GPR meeting at Bonn.
The essential results/questions/findings are as follows:

1. The Volume of ETC-HD does not include standard hoist and Load attaching points.
2. We could confirm the classification principles as they comply with ETC-S and even with national requirements in France and Germany.
3. The classification of some HD has to be verified in detail on basis of the criteria ("consequence analysis") (e.g. secondary hoist of RB-crane)
4. Load factors for dynamic loads do not comply with french and german experiences or rules.
5. Seismic loads not combining with operational lifting loads has to be assessed on basis of suitable probabilistic criteria.
6. Assumed friction factor 0.2 of sliding crab must be verified
7. The constructional principle of an double closed loop drive train is not acceptable within increased requirements. Within this class also an emergence break has to be added too
8. Several design definitions for Electrical and Control equipment of HD are missing.
9. Quality asurance definitions for design documents, materials, manufactureing tests and verification are necessary.
10. Test load factors are not in sufficient accordance with german and french stanards. (1.5 –static test load, 1.25 – dynamic test load)

The "open points" from evaluation are written in the socalled "Questionaire" (Question list) NPI answers are mainly that the comments we made are completely clear and discussion or definition will be made within the next step of Design the "Detail Design

Conclusion

French and German bodies on the EPR – HD project recognized the wide range of common definitions for the classification and design of HD and also the national different methods.
The German government decided in the year 1999 to stop the sharing in the EPR project. The common teamwork we have done with the german and french collegues brought useful experience and views to french design concepts. The ETC-HD was brought on the way to an practial nuclear european specification. Within the "Detail Design Phase" this work could be finalized taking into account the new releases (Iss. 6/99) of KTA- Rules 3902, 3903 and 3905.

References

[1] EPR-Requirements for Handling Devices (ETC-HD) (Iss. 2/97)

[2] EPR-Basic Design Report (BDR) (Iss. Febr. 1999)

[3] ETC-S: EPR-Technical Code for Basic Safety Requirements (Issue 9/1997)

[4] F.E.M. 3rd Edition Oct. 87 Sec. I (Federation Europeenne de la Manutention): French Rules for Handling Equipment

[5] KTA 2201: Rule for seismic design in German NPP (Iss. 6/90) KTA 3602 (Iss. 4/85), KTA 3902 (Iss. 6/92), KTA 3903 (Iss. 6/93), KTA 3905 (Iss. 6/94): Rules for Storing, Handling and Transport in German NPP