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Multinational Cooperation on the EPR Design Review

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General design goals for new plants

1. Increased public expectations:
   - no event should lead to large releases that would require protective measures for the public – a need to reduce the probability of severe accidents and to provide adequate mitigation of core meltdown accidents
   - provision of improved protection against terrorist acts and other external hazards, including large air plane crash
2. Increased regulators' expectations:
   - improved designs of "3rd Generation" plants that are more safe than the currently operating plants

Are these expectations similar in all countries?

Challenges for regulators

- What are the new safety criteria that should be met by the 3rd Generation plants?
- Are the regulators able to agree on common safety criteria / safety requirements that are more stringent than those generally applied in the last century?
  - are there constraints that come from national legislations / rules and could hinder regulators finding common approach?
  - if there are such constraints, are the regulators able and willing to change the national legislations / rules?
- Are the regulators able to handle a situation where the operating plants are not required to meet same safety criteria as the new plants?
  - are public expectations different in different countries in this respect?

What do we mean today by “design basis”?

- Design Basis Accidents (DBA) were used in 1970´s
  - DBA’s connected with deterministic safety analysis provided both the design limits for safety systems and the conditions for operation (Technical Specifications)
  - can we still identify DBA’s that have the same role?
- In connection with the 3rd Generation plants we speak about Design Extension Conditions (DEC) and Severe Accident Management (SAM)
  - DEC refers to postulation of multiple / common cause failures and leads to requirements on increased diversity in safety functions and safety systems
  - are DEC and SAM part of the design basis? do they influence the design limits and the conditions for operation?

What is required in the systems design?

- When systems are designed to cope with the DEC or to provide means for SAM, should we
  - require dedicated systems that are safety classified and manufactured to meet the respective quality standards?
  - require dedicated systems that are failure resistant (redundancy, diversity, physical separation,...)? could the failure resistance requirements be less stringent for “DEC systems” and “SAM systems” than for “DBA systems”?
  - accept systems designed for normal operation or for some other “non-nuclear safety” purpose to be used as “DEC system” or “SAM system”?
  - accept systems designed for DBA (or to support DBA systems) to be used also as “SAM system”?

What is required in the safety analysis?

- For analysis of DBA and for analysis based on DEC,
  - do we accept use of best estimate assumptions and models?
  - do we apply similar acceptance criteria?
- For analysis of SAM, do we accept use of best estimate assumptions and models?
- What are the acceptance criteria for SAM analysis?
- Do we use probabilistic acceptance criteria for DEC, SAM?

Where could we discuss and agree on common design criteria? (1/3)

- **IAEA, Safety Standard NS-R-1: Design of Nuclear Power Plants**
  - the ultimate goal should be worldwide use of this standard for design
  - a draft for revised NS-R-1 was recently out for comments by Member States and is now being processed by the IAEA before it goes further to the next round in the respective standards committees
  - it seems evident that the draft still needs much improvement to be applicable for the “3rd Generation” plants
  - work being done by WENRA in Europe and multinational cooperation done in MDEP groups such as safety goals and design specific groups (e.g. EPR review group) could provide useful insights and input for completing the preparation of NS-R-1

Where could we discuss and agree on common design criteria? (2/3)

- WENRA is an association of the heads of Nuclear Regulatory Authorities of the EU countries with NPPs and Switzerland
- WENRA has established a Reactor Harmonisation Working Group (RHWG) to harmonise safety approaches with the aim to continuously improve nuclear safety
- A draft report written by the RHWG, “Safety Objectives for New Power Reactors” is currently on the website www.wenra.org and WENRA welcomes any comments on it until the end of June 2010.

Where could we discuss and agree on common design criteria? (3/3)

- After receiving comments on its draft report “Safety Objectives for New Power Reactors”, WENRA is planning to discuss the comments in a meeting with the European industry group ENISS and also with the Safety Goal group of MDEP.
- WENRA is aiming to endorse the report in consensus, possibly in its meeting to be held in November 2010.
- Current draft of WENRA report provides safety objectives that are very close to those used in the design of EPR.

EPR is a good worldwide test case for cooperation of regulators

Can the regulators of different countries set concrete goals and requirements in consensus, and meet public expectations in their own countries?

Current status of EPR projects

- Designed as French-German cooperation in 1990's
- Conceptual design accomplished in 1999 was approved by the respective French and German experts bodies (IRSN, GRS) and regulatory bodies
- Three EPR plants are in construction:
  - Finland, Olkiluoto 3, construction permit 2/2005
  - France, Flamanville 3, construction permit 4/2007
  - China, Taishan 1, construction permit 8/2009
- Design review is ongoing in three countries:
  - USA, submittal for design certificate 11/2007, referenced in four COL's
  - UK, Generic Design Assessment, start in 5/2007
  - Canada in early stage of review

Bilateral co-operation ASN - STUK for design review of EPR, 2003-2006

- meetings at expert level twice a year on topics agreed in advance
- topical areas in discussions
  - 2003: I&C systems design and qualification, validation of severe accident management concept, assumptions and acceptance criteria for design basis LOCA
  - 2004: safety analysis (steam line break acceptance criteria, SGTR mitigation strategy, design basis LOCA, sump design), air plane crash protection, diversification of electrical power systems, severe accidents management, loss of heat sink
  - 2005: qualification of equipment to accident conditions, civil construction standards, construction inspection programmes (technical, organizational)
  - 2006: I&C for severe accidents, PRA

USNRC joint the EPR cooperation in September 2006, start of MDEP group

- meeting topics in September 2006
  - accident and transient analysis
  - fuel handling accidents
  - radiation protection and releases
- meeting topics in October 2006
  - licensing practice in general
  - LOCA design basis
  - plane crash
  - failure criteria, diversification requirements
- meeting topics in March 2007
  - I&C, electrical power systems
  - regulatory oversight of pressure equipment manufacturing
  - regulatory oversight of construction

Enlargement of MDEP group in January 2008 - UK, China, Canada

- five members are active but China has not participated meetings
- work has been divided in four subgroups since November 2008
  - Accidents and Transients
  - PSA
  - Digital I&C
  - Severe Accidents
- each subgroup has had 1-2 meetings / year
- practical exchange of information between experts, time not spent on administrative issues
- teleconferences on mixed topics as needed: fire protection, human factors engineering

Cooperation has facilitated review and approval of many 1999 EPR design features

Examples:

- Containment pressure control and decay heat removal without spray system
  - respective Appendix K requirements were recognized not relevant for EPR design
- Verification and validation of safety analysis
  - comparison of results from analysis made independently by different organizations in support of regulatory bodies
  - information on experiments in facilities simulating EPR design features
- Use of TXS as protection system platform

Some improvements in 1999 EPR concept have been approved or required in a consistent manner

Examples:

- Adding steel liner to inner reactor containment
- Severe accident features: modified primary system depressurisation, tuning of systems designed for molten core handling and cooling
- Two compartment containment (causes challenge to hydrogen management in severe accidents but is suggested by licensees for operating flexibility)
- Aircraft crash protection
- Sump design (but all EPR sump versions may not have back flush system for cleaning the glogged sump sceen)

Different modifications required in some of the EPRs by the national regulators

Examples:

- pipe whip restraints of reactor coolant system, to reduce dynamic loads to core internals in case of 2ALOCA
- hard wired systems for starting main protective functions, to back up digital I&C
- diversity added to fuel pool cooling systems
- SAM systems' failure resistance and full independence from other safety systems
- upgrades in fire protection
  - fire compartments
  - divisional separation in annulus space
  - use of FRNC cables with or without fire suppression systems
  - fire suppression system for Main Coolant Pumps
  - fire suppression systems in cable spreading room below Main Control Room

Conclusions

- Multilateral cooperation has strengthened the EPR safety assessment made by the regulators in participating countries
  - discussions among experts reviewing similar topics have brought more insight and understanding
- Cooperation has helped to reduce the amount of total work needed for regulatory review
- Some safety improvements have resulted from the review, and cooperation has given an opportunity to implement these in a consistent manner; respective improvements have been brought to the “standard EPR”
- There is still a need to strive for improved harmonization of the regulatory requirements; making a standardized EPR design is not possible without further actions on the regulators’ side.