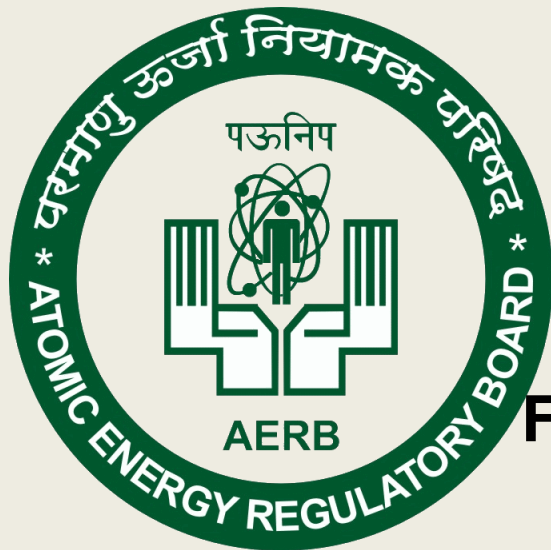


Way for efficient and effective review of upcoming LWRs



S.K. Mehta
Chairman, ACPSR-LWR
&

Former Director, Reactor Group, BARC



Outline

- **KKNPP-1&2: Challenges & Review Approach**
- **Upcoming LWRs**
 - **Nuclear Safety Regulation**
 - **Design Review**
 - **Manufacturing & Construction Review**
 - **Commissioning Review**
 - **Severe Accident & Management**
 - **Feedback from Review of imported designs**
- **Challenges in Safety Review of NPPs: Post-Fukushima**
- **Safety Criteria for Upcoming LWRs: AERB's Focus**
- **Conclusions**



KKNPP-1&2: Challenges & Review Approach

Challenges:

- First of its kind systems (examples PHRS, QBIS, II stage hydro accumulators , H2 Combiners, Core Catcher)
- VVER design licensed in country of origin
- Limited Resources
- Reliable Performance of Passive systems

Review Approach:

- Consideration of Russian Normative Technical Documents (NTDs). Need to understand equivalent known standards in India such as ASME,ASTM etc. IAEA Safety Standards, as applicable
- Independent in-house review & assessment in view of different standards/requirements; based on the input data from Design Documents Such Inter-comparison enhances confidence and system knowledge.



Upcoming LWRs - Nuclear Safety Regulation

- Regulatory Safety Review Challenges for mix of different NPPs BWRs, PHWRs, PWRs & FBRs.
- Need to adapt to **the plant-specific design features** and tune the regulatory approach accordingly in terms of:
 - Safety review as part of Consenting Process
 - Regulatory Inspections
- Steps towards overcoming these challenges:-
 - For LWRs, Design code (AERB/NPP-LWR/SC/D) & Commissioning Guide (AERB/SG/O-4C) were developed.
 - Further Challenges would be Siting Criteria and Design Safety Review of GENIII+, GENIV & SMRs having Inherent Safety Features & Passive Safety Systems.



Upcoming LWRs - Design Review (1/2)

- ✓ **Design** - Licensable in Country of Origin (Imported NPPs)
- ✓ **Availability of detailed information regarding design of SSCs** - Functional Requirements & Design Conditions with Basis under NO; AOO; DBA; DEC and Extreme Conditions; Design Methodology including Design Codes Used; Basic Assumptions; and Material used & their Properties
- ✓ **Proprietary Information:** Ensuring availability of information adequate for safety review, plant safe operation; yet respecting proprietary interest
- ✓ **Compliance with AERB Codes & Guide, other stipulations and that of Current International safety requirements**
- ✓ **Improvements in the I&C system**
 - Systematic **verification and validation** of I/C systems and In-house Development of **Control & Safety algorithms**
 - Early Action to cater to the obsolescence in I&C



Upcoming LWRs - Design Review (2/2)

- ✓ **Radiation Protection & Radioactive Waste Management**
 - Planning for Radio-active waste, particularly High Level waste should be planned to cater to the requirements
- ✓ **R&D Reports for system performance (especially FOAK) and efforts to understand the accident phenomenon**
- ✓ **R&D Development of Analysis tools & computer codes to verify the plant safety under different plant states (NO, AOO, DBA, DEC & External Events)**
- ✓ **Industrial safety & Nuclear Security**
- ✓ **Ageing & Life Extension**
 - Identification of parameters to be considered to estimate ageing and provisions available for appropriate monitoring
 - For life Extension consideration should be given to the current safety requirements
- ✓ **Decommissioning:** To be taken into account at the design stage and appropriate infrastructure provisions should be planned.



Upcoming LWRs – Manufacturing & Construction Review

- Concurrent regulation
 - ✓ Progressive submissions.
 - ✓ Special attention needed for FOAKs as they may involve:
 - New construction techniques/mock-ups
 - Construction sequences vis-à-vis their interfacing SSCs
- Ensuring functionality of SSCs throughout their design life
- QA of the Components to meet Design Requirements
(Preferably by QA Team of Utility)
 - ✓ To check and assure that relevant Quality Requirements (including shop-testing) are met at the Vendor Shop. Also ensuring Material Certification, Witnessing QC tests and Shop/Test Set-up Performance before Shipping Release



Upcoming LWRs - Commissioning Review

- ✓ Extensive tests to demonstrate functionality (Design & Procedures) and First Plant Only Test (FPOT)
- ✓ FOAK - Extent of in-situ tests, designer participation (specifically imported NPPs), etc.
- ✓ Ensuring well planned procedure for Pre-commissioning & Commissioning of NPP should be planned ahead with Acceptance criteria and adequacy of monitoring Instruments should be checked
- ✓ Commissioning data from NPPs of the same design, if possible to be obtained
- ✓ Every modification should be well documented supported with technical justification/analysis



Upcoming LWRs - Severe Accident & Management

- Overcome of Core Damaging Events: TMI, Chernobyl, Fukushima - human performance with enhancement of design
- Practically eliminate Large Early Release by design provisions – Provisions for Mitigation of its consequences
- Provisions to handle extreme external events
- Emphasis on passive safety features
- Training manpower with special emphasis on handling of Design Extended Conditions (DECs) - Maintain the preparedness against the DEC-A & B



Upcoming LWRs – Feedback from Review of imported designs

- ✓ **KK-1&2 experience w.r.t. New Imported Technologies** - To ensure that feedback from Design Safety Review/ construction / commissioning / operation of earlier NPPs is adequately taken care in design.
- ✓ **Development of Regulatory Documents covering New LWRs** – like AERB/NPP-LWR/SC/D & AERB/SG/O-4C
- ✓ **Need to evolve conceptual technology-independent safety criteria and technology-specific detailed criteria** - Need for interaction of RBs of different countries with common issues for exchanging experiences
- ✓ **Need for enhancement in regulatory process and requirements** - In view of regulating different technologies, all at the same time.



Challenges in Safety Review of NPPs: Post-Fukushima

- Fukushima has shown that multi-units co-located at a Site can at the same time get severely affected due to an extreme external event
- Evaluation of safety margins beyond design basis. Re-examining the robustness of NPPs against extreme external hazards
- Need of Periodic assessment for external hazard.
- Combinations of external hazards with consequential internal events to establish a bounding case.
- Revision of the AERB Codes/ Guides taking lessons from Fukushima is initiated.



Safety Criteria for Upcoming LWRs: AERB's Focus

Based on the experience gained through review of VVER reactors and external events, AERB safety criteria for Upcoming LWRs should be focused on:

- Strengthening of Defense In Depth;
- Consideration of Multiple failures under internal and external events;
- Provisions for additional and complementary safety features for mitigating Design Extension Conditions;
- Design requirements for Additional and Complementary safety feature system; and
- Ensuring that there will be no permanent resettlement - Post Severe accident.



Conclusion (1/2)

- **Review of Advanced Reactors with more passive features** will take more resources.
- Ensuring compliance with AERB Codes & Guides, other stipulations and that of Current International safety requirements.
- Gap in Technical Information Needed for Review, need for
 - In-house analysis capability enhancement in NPCIL and AERB
 - In-house R&D to address technical issues in NPCIL and AERB
- Generation 3+ requirement Confirmation
 - FOAK system qualification and understanding



Conclusion (2/2)

- Utility Human Resource Development
 - In-house capability to resolve operational issues
 - Capability for design modifications
- Technical Capability development (NPCIL & AERB)
 - Computer code development / procurement for analyzing different plant states
 - Code verification and validation- certification?
 - Generation of data for safety analysis
 - Critical facility
- Action Plans for Mid-course corrections that may arise due to new input / accident scenarios such as Fukushima
- Need for more prompt and comprehensive responses from Designers of imported reactors



TO REMEMBER

**FOR IN-DEPTH DESIGN & SAFETY REVIEW
IT IS IMPORTANT TO UNDERSTAND**

HOW

OF NPP

BUT IT IS ESSENTIAL TO UNDERSTAND

WHY

OF NPP



Thank You