

# Safety review experience of 3-stage Indian nuclear program: Lessons for the future

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## Indian Regulatory system – key characteristics

- Regulatory framework for NPP – developed concurrently with the nuclear power program and the technology.
  - Addressing the needs of the program
- Essential elements
  - Regulatory Requirements
  - Regulatory Processes
  - Human resources – competence management



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## Regulatory / Safety Requirements

- The safety requirements / criteria for most part of NPP lifecycle for currently established NPP designs are available
- Requirements and guidance take account of scientific principles of issues and current international benchmarks, including the relevant IAEA safety standards.
- Due consideration of **views of relevant stakeholders** in the development process for requirements and guidance
- The **views of the general public** are also considered in finalising the regulatory requirement documents.

*The approach of concurrent development facilitate suitably addressing the insights from experience and emerging issues in requirements and guidance, enhancing their relevance and rigor.*

*In the areas where AERB has not specified its own requirements, established international standards, including IAEA standards are taken into account to support regulatory decision making.*



## Requirements and Processes

- Covers almost entire life cycle
  - Siting
  - Design, construction and commissioning
  - Operation
    - Periodic safety review – safety enhancements
  - Safe Management of radioactive Waste

*Tuned for the indigenous technology – influenced by the technology and entity that is being regulated*



## Human resources – Competence Management

- AERB places significant emphasis of enhancing technical and regulatory competence of personnel.
- HR approach aims that most of the competence requirements for implementing the regulatory processes for the currently established technologies should be available in-house.
- The regulatory framework facilitates AERB to tap technical support for regulatory activities from other relevant organisations, including the academia.

*Exposure to indigenous programme immensely benefited in the competence management (Knowledge, Skills and Attitudes) for regulatory personnel*

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## Safety review during the operational phase (1/3)

- Operation of NPPs governed by **AERB Safety Code on 'Nuclear Power Plant Operation'** (AERB/NPP/SC/O, Rev.1, 2008) and related Safety Guides.
- During regular operation, safety reviews cover
  - Compliance to Technical Specifications for Operation, AERB Safety Codes & Guides and the licensing conditions.
  - Reports as per the reporting criteria, including events, radiological safety status, radioactive waste management & radioactivity discharges to environment,
  - Adherence to QA and safety management aspects,
  - Review of proposals for modification in hardware, control logics, plant configuration management,
  - Results of surveillance and in-service inspection programmes and
  - Inputs from regulatory inspections.
- In case of any deviations / non-compliances, AERB intervenes including appropriate enforcement actions, depending on the safety significance.
  - Can range from issuance of written directives for ensuring compliance to requirement to restrictive measures including curtailment of the activity, suspension of the operating license, etc.



## Safety review during the operational phase (2/3)

- Periodic Safety Review - AERB Safety Guide 'Periodic Safety Review for Nuclear Power Plants (AERB/SG/O-12 Rev. 1)' - Typically once in 10 years
- Safety assessments under PSR cover cumulative effects of ageing, plant modifications, improvements in safety standards and practices, and feedback of operating experience, revisit of hazard assessments with the latest available information, etc.
- Comparison with the current safety standards / practices – opportunity for identification and implementation of safety enhancements.
- PSR forms the basis for renewal of Authorisation for operation.
- Experience gained from PSR of one NPP is utilised in reviewing PSR of subsequent NPPs. Facilitate efficient and effective review of PSR.
- All operating NPPs have undergone PSR, since the initiation of the PSR process in the early 2000s.



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## Safety review during the operational phase (3/3)

- Operating experience feedback (OEF) - lessons from experience elsewhere utilized to effect safety enhancements.
- Feedback from Indian as well as overseas experience is utilized. Extensive use of inputs from IAEA International Reporting System (IRS).
- Numerous examples of safety improvements based on OEF.
  - Initiating systematic life management programme for PHWR pressure tubes in 1983, improvements in fire protection measures following the turbine fire at NAPS in 1993, improvements in flood protection measures following the flooding incident at KAPP in 1994, inspection and health assessment of reactor core shrouds in the BWRs at TAPS, inspection and health assessment of PHT feeder pipes in PHWRs, Leakages from PTs of KAPS 1&2 in 2015-16, etc.
- In addition, Special reviews are also initiated following events / developments of major safety significance, to assess their impact on safety of Indian NPPs and need for corrective actions.
  - In the past, such special safety reviews were done following the TMI accident of 1979, Chernobyl accident of 1986, tsunami at the MAPS in 2004 and the accident at the Fukushima Daiichi NPP in 2011.
  - Resulted in enhancements in the design of plant systems, safety management as well as regulatory requirements.

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## Safety review experience of 3-stage program

Stage-1	Stage-2	Stage-3
PHWRs	Fast Breeder Reactors (FBTR, PFBR)	AHWR / MSR / CHTR (under development)
<b>Status of Requirements:</b>		
Codes on Site Evaluation and Operation – have undergone review subsequent to the accident at Fukushima Daiichi – applies to all stages. Currently undergoing review		
Code on Design		
Code on Design of LWR based NPPs – 2015	(PFBR Safety Criteria – 1989 FBR safety Criteria – 2015)	
Code on Design of PHWR based NPPs (under final stage of Revision)	Code on Design of SFR based NPPs (under final stage of Revision)	

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## Future Scenario

- Poised for significant expansion in nuclear power capacity – different designs, PHWRs, LWRs, FBRs...
- One area of capacity building is in development of regulatory requirements and guidance documents to facilitate review and assessment of new designs – care is given to keep the technology specific aspects to minimum.
- FOAK systems pose a special challenge for qualification.
  - An adequate approach involving qualification by prototype or scaled experimentation and analysis to establish their 'basis of acceptance' is currently practiced. During safety review and assessments, such systems can be accepted after thorough justification based on review of experimental results and R&D reports. During commissioning, FOAK systems should be tested as far as practicable, to demonstrate their design intent. This approach would help early detection of potential issues and implementation of corrective actions.



## Future Scenario (Contd.)

- Safety assessments and regulatory reviews for new reactor technologies, where AERB has not yet stipulated its own regulatory requirements or guidance, could be following the relevant IAEA and other international safety standards. This approach would be useful, as developing comprehensive regulatory safety documents indigenously would require adequate time and experience in the relevant technology. Further, first-hand experience gained from the reviews based on international safety standards would provide crucial inputs for developing the regulatory safety documents.
- This approach for the construction and commissioning phases of PFBR. With the experience of regulation of NPPs so far, there is confidence that the approach of (a) concurrent development of regulations with the technology and (b) development and maintenance of adequate competence, regulatory system will have the resilience to handle challenges from the subsequent phases of the nuclear programme, including adoption of advanced technologies.

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## Future Scenario (Contd.)

### Issue of new entities....

- Current requirements and practices are significantly influenced by entity (NPCIL..). The approach may have limitations with new entities.
- Need to find solutions...Ongoing activity!
- Impact definitely on requirement and guidance documents for Regulation, Leadership and Management for safety (QA), and the processes.
- A subject of the 'Manthan' exercise...
- The suggestions discussed during this Conference will be given active consideration.

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## Future Scenario (Contd.)

- The current Licensees (NPCIL and BHAVINI) can set examples..

*“Radioactive material and sources of radiation should be handled in Atomic Energy Establishment, in a manner, which not only ensures that no harm can come to workers in the Establishment or anyone else, but also in an exemplary manner so as to set a standard which other organization in the country may be asked to emulate”.*

*- H.J. Bhabha; Directive issued on 27 Feb, 1960*

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*Thank you!*

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