Beyond code safety requirements for nuclear pressure systems

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Content

- Work of the UK Forum for Engineering Structural Integrity
- The present workshop

- Hinkley Point C power station

FESI role

- Membership organisation for Engineering Structural Integrity (ESI) in the UK
- UK representative for the European Structural Integrity Society (ESIS)
- Disseminates the latest advances in ESI, promotes the exchange of technologies and knowledge between industrial, regulatory, academic and professional communities, and encourages best practice and guidance
- FESI's role as the UK's authority on ESI is supported and endorsed by a number of eminent and progressive organisations drawn from several industry and business sectors and academia
- FESI is steered by a Council of ESI experts and specialists
  - Chair: Dr Brian Tomkins FREng

Links to other organisations

- UK representative body of the European Structural Integrity Society (ESIS)
- Chinese Structural Integrity Consortium (CSIC)
- Research Centre for NDE (RCNDE)
- UK Technical Advisory Group on the Structural Integrity of High Integrity Nuclear Plant (TAGSI)
- Lloyd Register Foundation (LRF)
- Structural Integrity Monitoring Network (SIMoNET)
- Engineering Integrity Society (EIS)
- Institute of Mechanical Engineers (IMechE)
- Institute of Materials, Minerals and Mining (IOM3)

Structural integrity requirements

- Many industries seek to achieve safe and economic production/operation
- An essential input is demonstrating the integrity of the structures and components
- Design engineers achieve this using appropriate codes, standards, analytical tools and databases
  - UK (including R6, R5 and R3)
  - ASME
  - ISO
  - other
- The operator has to ensure the plant is secure against the design intent across the service life
- It is essential to have a knowledge of mechanical and physical properties of the materials and the environment both for design and operating life

Structural integrity requirements

- There are challenges from variability in input parameters, material properties, service loads, environment, etc
- Failure to respond as designed is often because of changes over service life: thermal ageing of the material, corrosion, etc (prediction based on accelerated laboratory tests; less secure for longer term service)
- Unforeseen factors when moving to ≥60-year life
  - Unknown unknowns

Structural integrity requirements

Time dependent processes

- Thermal ageing: Degrades material properties
- Irradiation: Degrades material properties
- Corrosion (aqueous): Reduces section of the component or structure
- Environmentally-assisted cracking
- Oxidation (at temperature): Reduces section of the component
- Creep: Time-dependent failure
- Fatigue: Cyclic loading
- Combinations of these

Structural integrity requirements

- A regulatory requirement for safe operation of nuclear power plants is to demonstrate no risk of failure for safety critical components over the operating life
- Pressure boundary conditions require highest reliability, so there is a need to impose additional requirements compared with design codes
- Requirements include consideration of
  - Inspection qualification
  - Repeat inspection
  - Plant monitoring
  - Knowledge of material composition
  - Mechanical properties
  - Fracture mechanics assessments
- Overall increased design margins

Workshop objectives

- To develop a consistent understanding of the beyond code requirements
- To identify
  - Areas of good practice
  - Where advice/interpretation of beyond code safety requirements could be improved

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Forum for Engineering Structural Integrity

FESI Publishing

Thank you

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