The Collection of Information, Data and Materials Samples from Decommissioned Nuclear Power Plant Concrete Structures for Ageing and Degradation Evaluation

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Investigations

- Visual Inspection
- Concrete characterisation programme
- Predictive models and safety evaluation analyses
- Detailed collection of information
  - *Structural Defects*
  - *Ageing Phenomena*
    - Materials ageing effects
    - Environmental effects
Visual Inspection

• Detailed plant survey is an essential preliminary step for the collection and recording of data

• Visual examination identifies ageing problems by detecting the visible effects of ageing stressors

• Focuses further investigation activities

• Cost-effective

• Limited Contribution (surface visible defects)
Concrete Characterisation Programme

- Access to areas inaccessible during operations
- Identify the most important chemical and physical degradation mechanisms and their effects
- Determine the mechanical and physical properties
- Opportunity to integrate non-destructive measurements with destructive tests
Concrete Characterisation Programme

• A better assessment of the state of preservation & ageing of concrete structures, prestressing systems and steel reinforcement

• The investigation of NDT capabilities in detecting material properties degradation, including development and validation of new innovative techniques

• An estimate of the durability of concrete and of the safety margins of the structures for periods equal or greater than the design life.
Predictive Models & Safety Evaluation Analyses

• Interpretation of experimental data
  – historical data
  – in-situ and laboratory test measurements
  – accelerated tests results

• Identification of the parameters that govern the predictive model’s response

• Validation of the predictive model on the basis of the effects of degradation processes measured on the structures
Detailed Collection of Information

• Structural defects may exist in the form of known or previously identified defects and unknown or undisclosed defects
  – Known defects may be in the form of defects identified previously on the particular plant or type defects identified on plants of a similar design through Operational Experience Feedback.
  – Unknown defects may be identified by comprehensive survey during decommissioning including the use of NDE or destructive sampling.
Detailed Collection of Information

• Materials ageing effects
  – Concrete / strength, fracture energy, modulus of elasticity, cracking, permeability, porosity & leaktightness
  – Steel liners/ steel-concrete interfaces, corrosion, weld cracking, coatings
  – Reinforcement steel /corrosion
  – Prestressing steel /unbonded tendons, bonded tendons, corrosion, loss of prestress, embrittlement
  – Extraction of failed instrumentation for investigation
  – Performance of previous repairs
  – Other plant-specific information
Detailed Collection of Information

- Environmental effects
  - Thermal exposure
  - Radiation exposure
  - High humidity exposure (with/without temperature)
  - Ground water exposure
  - Chemical exposure
  - Carbonation
  - Chloride content
  - Ingress of radioactive contamination
  - Other plant-specific information
Coordination of Activities

• In order that full benefit may be obtained from the collection of information, data and materials samples from concrete structures on nuclear facilities under decommissioning for ageing and degradation evaluation, these activities must be included in decommissioning plans.

• In cases where systems, structures and components have been selected for removal, sampling or testing for such purposes during decommissioning, these should be clearly identified and described. This allows specific hazards during these operations to be identified and prevents unintentional loss or destruction of the relevant systems, structures and components during decommissioning.
Information Transfer and Use

- It is important that information gathered during decommissioning is shared with designers of new plants and operators of existing plants.

- The collection, analysis and feedback of information from plants under decommissioning are likely to be problematic due to the division of responsibilities for the different phases in the lifecycle of a facility.

- There is an obvious requirement for mechanisms to be available to facilitate this process and a need for this information to be included in ageing management programmes.
Concrete - Particular Areas of Interest

- Nuclear Containments
  - Concrete/liner Interfaces
  - Prestressing systems
- Ponds
  - Liner Performance
  - Joints/waterbars
  - Contamination
- Marine Structures
- Cooling Towers
- Effects of in-service exposure conditions
Other Areas of Interest

- Nuclear reactor pressure vessels and reactor internals
- Nuclear power plant steam generators
- Piping and pressure vessels
- Cables, electrical and electronic components
- Instrumentation
- Chemical plant and processing facilities
Recommendations

• The opportunity to obtain samples and data from concrete structures on nuclear facilities should be taken whenever possible.
• Consideration should be given to the collection of samples and data from other types of decommissioned systems, structures and components on nuclear facilities.
• A comprehensive survey should be carried out during decommissioning including visual methods and the use of NDE or destructive sampling.
• The particular aim of any investigation during the decommissioning of a plant should be to identify in-service degradation and ageing effects.
• Systems, structures and components that have been selected for removal; sampling or testing during decommissioning should be clearly identified and described in decommissioning plans.
• Information gathered during decommissioning should be shared with designers of new plants and operators of existing plants.
• Mechanisms should be developed to facilitate the transfer of information gathered during decommissioning to designers and operators of nuclear facilities.