CURRENT STATUS OF CIEMAT FACILITIES FOR RADIOACTIVE MATERIALS

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Effects of Irradiation in the Structural Materials

Corrosion of Materials in Nuclear Power Plants

Behaviour of Metallic Materials in Energetic Plants

Severe Accidents

Diagnostic Technology

Characterization of Radioactive Material and Waste

R & D on Low and Medium Level Radioactive Waste

R & D on High Level Radioactive Waste

Management of Radioactive Waste

Follow-up of CIEMAT-ENRESA agreement on Radioactive Facilities
EFFECTS OF IRRADIATION ON STRUCTURAL MATERIALS

- Vessel Steel Embrittlement
- Testing of Surveillance Capsules
- Low Activation Materials for Fusion

MATERIAL COOLANT INTERACTION

- Stress Corrosion Cracking in BWR
- Steam Generator Tubes: PWSCC, IGA/SCC...
- Vessel Head Penetrations
- Irradiation Assisted Stress Corrosion Cracking
MATERIALS PROGRAMME

LIFE EXTENSION ACTIVITIES

IMPROVED SURVEILLANCE PROGRAM

- Participation in CRP (IAEA) on “Assuring structural integrity of reactor pressure vessels”

- Subsized sample studies in cooperation with Polytechnic University of Madrid

- Welding reconstitution techniques
  - Stud Welding
  - Electron Beam

- Evaluation of Fracture Toughness ($K_{IC}$) using dynamic test
### Spanish Nuclear Units

<table>
<thead>
<tr>
<th>Plant</th>
<th>Capacity (MWe)</th>
<th>Supplier</th>
<th>Type</th>
<th>First Operation</th>
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<tbody>
<tr>
<td>Cabrera</td>
<td>160</td>
<td>Westinghouse</td>
<td>PWR</td>
<td>1968</td>
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<td>La MATERA Garoña</td>
<td>460</td>
<td>General Electric</td>
<td>BWR</td>
<td>1971</td>
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<td>Westinghouse</td>
<td>PWR</td>
<td>1981</td>
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</table>
MATERIALS PROGRAMME

RADIOACTIVE FACILITIES

- Microscopy
- Surface Analysis
- Semi Hot Cells
  - Mechanical Testing
  - IASCC Testing Loop
- Hot Cells
  - Mechanical Testing
  - Optical Microscopy
  - Mechanization
Microscopy

- SEM/EDS
  - HITACHI 30 kV
  - 35 Å resolution
  - KEVEX EDS System

- TEM/EDS
  - JEOL/JEM 2010
  - 200 kV
  - LINK EDS detector with ultrathink window for microanalysis
Surface analysis

- AUGER
  - PHI 660
  - Fracture by impact
  - Fracture by tension (Minimum extension rate 1 \( \mu \text{m/s} \))
- ESCA
  - PHI 5400
  - Lens system to analyze an area as small as 200 \( \mu \text{m}^2 \)
Semi Hot Cells

- Charpy 300 J;
  - T Range: -70°C – 200°C
- Hardness
  - Vickers (Hv 10, Hv 30)
Semi Hot Cells
Servohydraulic Testing System (MTS 810, 100 kN)

- Tension
  - T range:
    -100°C  700°C

- Fracture Toughness
  - CT (1 & 1/2 “)
  - Three Point Bend
    - T range:
      -100°C  150°C
MATERIALS PROGRAMME

LIFE EXTENSION ACTIVITIES

IASCC ACTIVITIES

Participation on International Groups

OCDE Halden Reactor Project

International Cooperative Group on IASCC

Cooperative IASCC Research (CIR) Programme

As Technical Representative of Spanish Utilities
**MATERIALS PROGRAMME**

**LIFE EXTENSION ACTIVITIES**

- **IASCC ACTIVITIES**
  - **Experimental Programme:**
    - Proton irradiation as alternative to neutron irradiation in cooperation with University of Michigan
    - Microstructure and Microchemical studies
    - Corrosion tests
    - Testing of neutron irradiated materials from Spanish Plants
- BWR or PWR Conditions
- 2 autoclaves
- Constant Load 1
- CERT 2

(Disp. rate > 1μm/h)
Hot Cell Facilities

- Milling, Cutting and Drilling
- Visual Inspection and Dimensional Control
- Sample reconstitution by Stud Welding
- Mechanical testing
  - Tension, Fracture Toughness
  - Instrumented impact test (300 and 25J)
  - Hardness