
National Nuclear Laboratory

Electrochemical Corrosion Testing in a Hot Cell Environment

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Windscale Laboratory Facilities

- Originally constructed in 1960's for PIE of uranium metal (Magnox) fuel
- Extended to provide capability for water reactor and gas reactor fuel
- Facilities range from large hot cells to specialised analytical laboratories

P.I.E at Windscale Laboratory

- PIE capability at B13 Windscale results from over 40 years experience of nuclear operations

- Flexibility - capable of handling a full range of fuel and irradiated material of differing scales and types

- Range of non-destructive and destructive testing techniques

Overview of Hot Cells Area

- 13 large, heavily shielded concrete cells
- Shield walls 1.4m thick
- Typically 10.5m long, 2.6m wide, 3.5m high
- Interconnected by shielded service corridor

Hot Cell layout

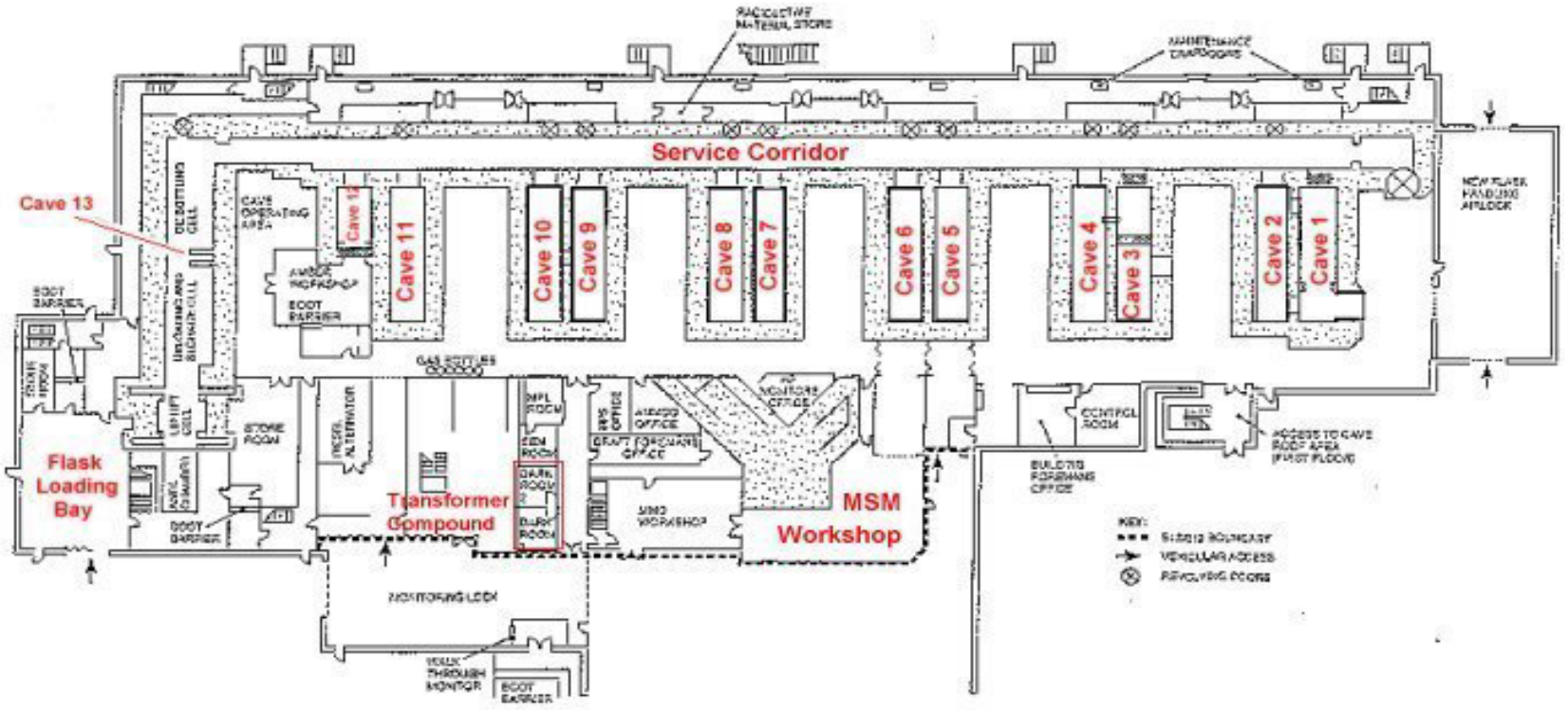


Fig. 4 Ground Floor Plan - B13

Electrochemical Corrosion Testing

- Work for Sellafield Ltd
- In support of safety case development work-
  - Long term storage of fuel before reprocessing

Electrochemical Corrosion Testing

Purpose:

Test pre-fabricated, inactive IGA (inter-granular attack) sensors alongside irradiated stainless steel

- Observe the effect of electrolytes on the steel
  - Corrosion initiation and inhibition
- Observe the effect of range of temperatures (40-60°C)

Test Programme

Requirements:

- Samples of a uniform size and surface area
- Electrode and subsequent assembly
- Water tanks
- Test to run at elevated temperatures of 40°C, 50°C and 60°C for 60 day periods
- Transmission/measurement to out-of-cell location of open circuit corrosion currents
- Minimise chemical contamination

Design Requirements

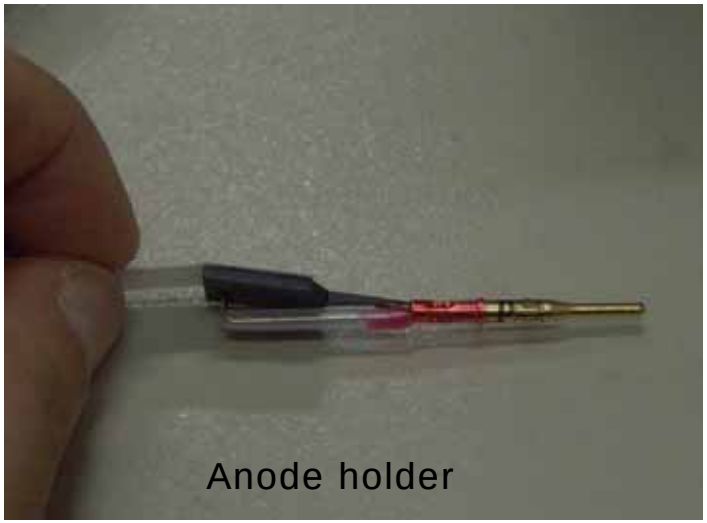
- “Friendly” to remote operations and handling
- Radiation tolerant materials
- Minimal repair/maintenance
- Size and weight restrictions
- Handling of small components
- Minimise chemical contamination
- Testing and commissioning

Design Requirements

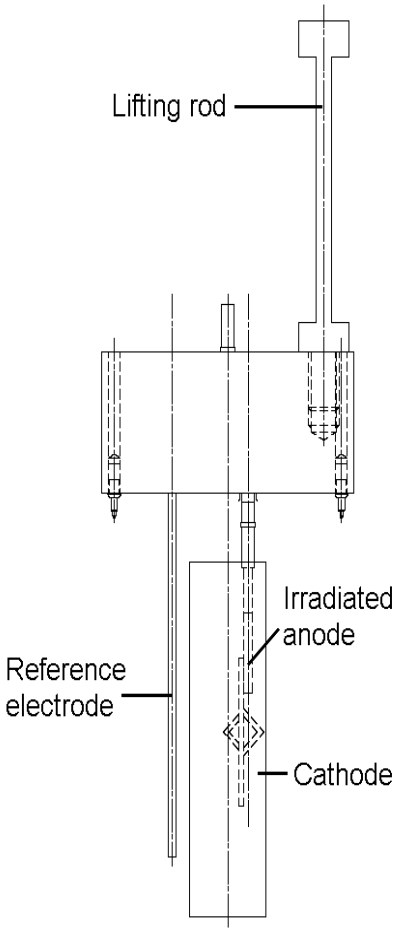
- Equipment required:
  - corrosion tanks
  - spot welding equipment
  - Cutters
  - specially designed tools (e.g narrow MSM “fingers”)
- Feeding solution into hot cell
- Constant monitoring of corrosion currents
- Pre-assembly of components

Pre-assembly

- Electrode holders- PEEK
  - electrical connectors and reference electrodes
- Unirradiated cathode sections
- Anode holders



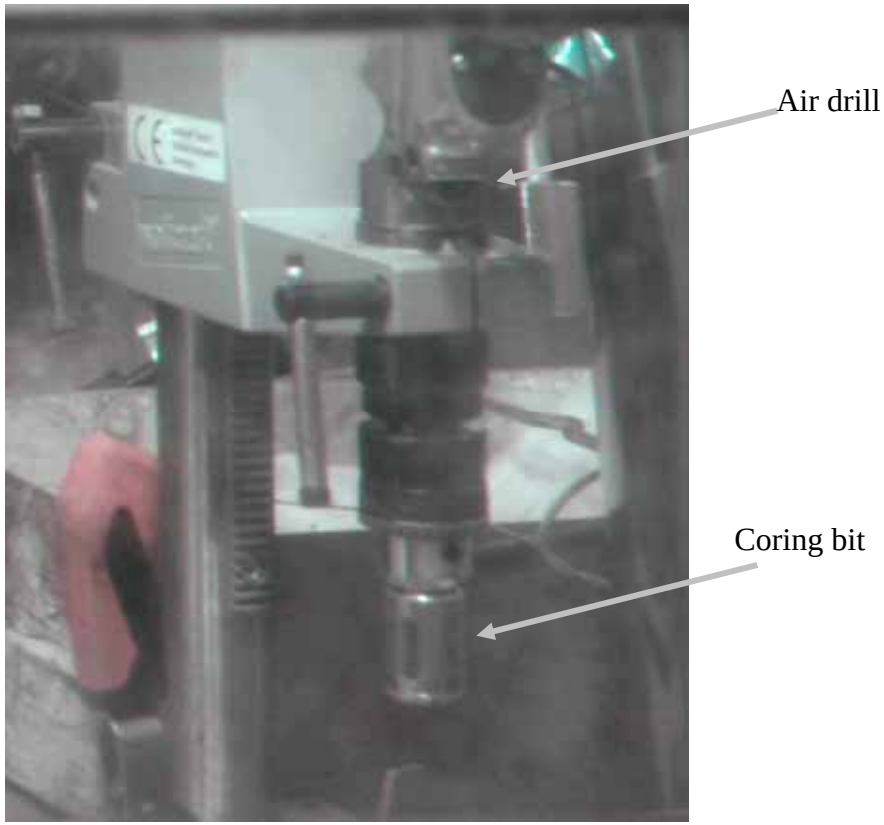
Anode holder



Cutting

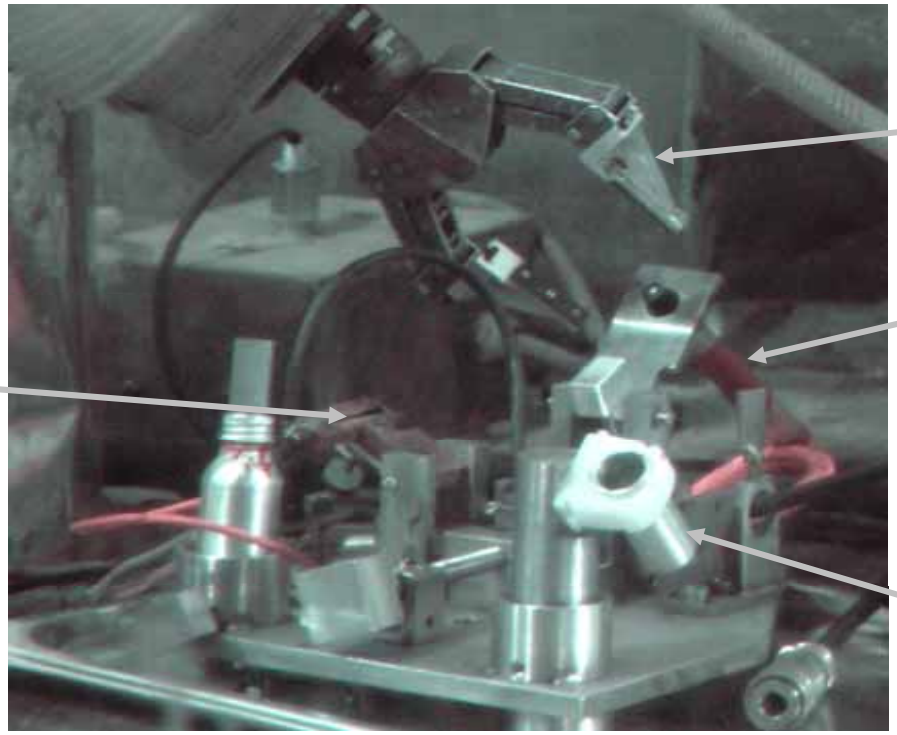
- Diamond-tipped coring bit
- Air-driven tool
- Camera
- Self- centering vice

Sample size 25 x 15 x 2mm



Anode Assembly

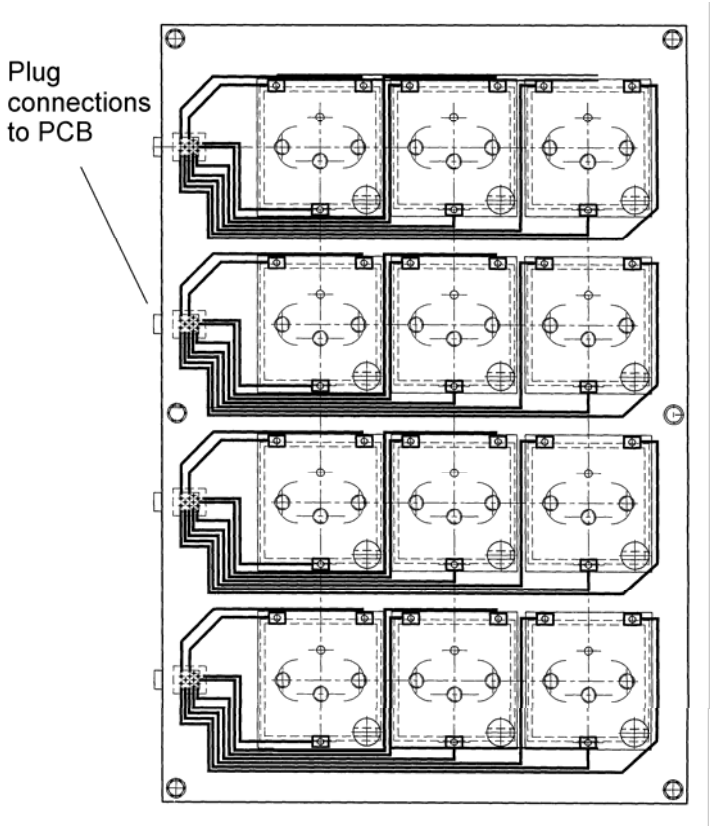
- Grinder for clean weld area
- Spot welding for attaching anode holder to cored sample
- Camera
- External controls

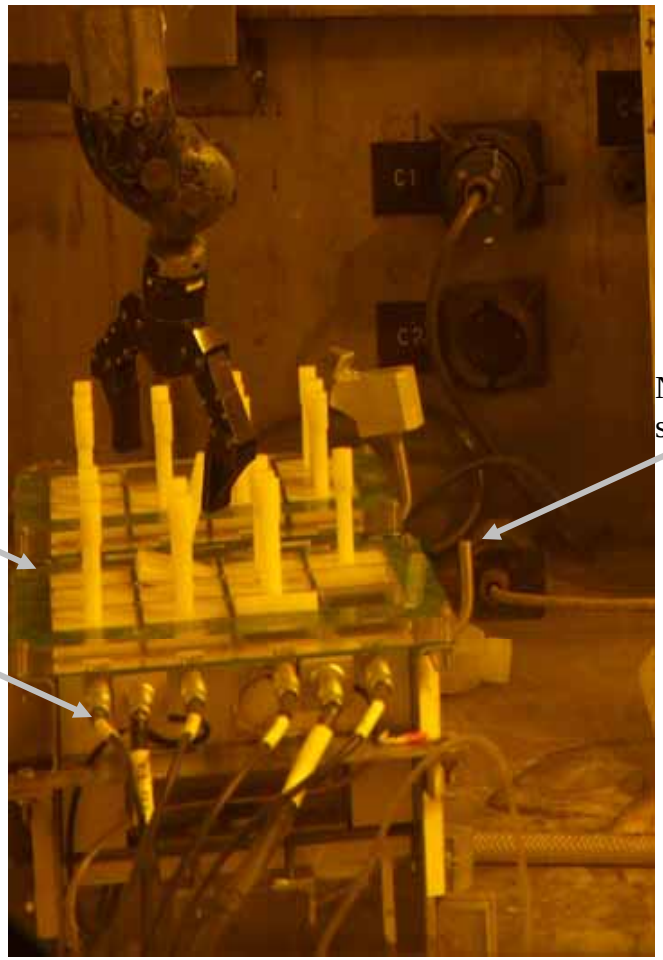


Corrosion Tanks

- External solution feed tanks
- Stainless steel frame
- Adjustable legs (for levelling)
- Mica heating pad
- Insulation- ceramic calcium silicate plate
- Perspex covered PCB lids (minimise degredation and damage)
- Gold contacts
- Electrical connections on each tank
- Overflow system

Corrosion Tanks





Experimental Progress

- First stage successfully completed

How do we know this?

- Overall solution chemistry regularly changed or maintained
- Corrosion currents occurred- stable welds
- Initiation and inhibition of corrosion observed

Summary

- In-house equipment design and inactive testing
  - Maximisation of in-cell lifetime
- Successful design, set up and operation in a hot cell environment

The status for future planned tests is positive, and the implications for reliable production, assembly and testing of small irradiated components on a large scale are excellent.

Any Questions?