NUCLEAR TECHNOLOGY EDUCATION CONSORTIUM

N06 REACTOR MATERIALS AND LIFETIME BEHAVIOUR

Summary

This module describes the science and engineering of reactor materials, and the factors that influence the lifetime of these materials, including corrosion, environmentally-assisted fracture, and irradiation embrittlement. Other topics covered in this module include fracture mechanics and structural integrity, non-destructive evaluation techniques, as well as plant monitoring and lifetime issues. Also considered are materials specifications and fabrication processes for materials used in nuclear power systems.

On completion, students should have obtained:

• An understanding of the materials science structure/property relationships of key reactor materials, and how these are affected by corrosion and the environment (Light Water Reactors, AGRs).

• An understanding of the methods of structural integrity assessment of reactor pressure vessels.

• The ability to perform basic structural integrity assessment using the R6 code.

• An appreciation of the methods of non-destructive testing and plant monitoring.

• An appreciation of the factors which limit the lifetime of reactor components, such as radiation damage.

• An appreciation of the specifications and methods of material fabrication for reliable performance in nuclear power system environments.

Syllabus

This module consists of lectures, and a tutorial. The course content comprises

• Materials Science and Engineering

  o Structure and Properties of Metals and Alloys used in Reactor Systems

  o Corrosion

  o Graphite

• Mechanics and Lifetime

  o Fracture Mechanics

  o Non-Destructive Testing and Plant Monitoring

  o Lifetime Issues including Radiation Damage

  o Materials Specification and Fabrication for high reliability in nuclear power systems

The lectures will be supplemented by a Structural Integrity Assessment Tutorial and a Materials Evaluation and Analysis Session. The Structural Integrity Tutorial will include worked examples and problems. The Materials Evaluation and Analysis Session will include demonstrations of fractographic characterisation and microstructural analysis using scanning electron microscopy and energy dispersive x-ray spectroscopy, as well as a tour of the advanced analytical microscopy facilities and environmental testing facilities for nuclear materials research.

Assignments/Grades

Students will have a brief pre-course assignment and a post-lecture project dealing with an aspect of Material Degradation in a nuclear power system. There will be a multiple choice test at the end of the week's lectures, and a final examination at a later date.