Renewal of Hot Cell infrastructure

• Irina Aho-Mantila • Ulla Ehrnstén • Tarja Jäppinen • Wade Karlsen • Petteri Lappalainen • Jari Lydman • Tuomo Lyytikäinen • Marketta Mattila • Marko Paasila • Aki Toivonen • Seppo Tähtinen • Matti Valo

1.1 Background

Many critical issues concerning plant life management for operating nuclear power plants are related to materials. Present plans for concurrent lifetime extension, power upgrading, and construction of new plants that may employ new materials in new conditions will require investigating and solving problems related to components and structural integrity. A national research capability is a basic requirement of the safe use of nuclear power in Finland, and significantly contributes to making the exploitation of nuclear energy economical and efficient. A key component of this is hot-cell facilities for the handling, testing and examination of activated nuclear power plant structural materials. However, the current domestic research infrastructure requires renewal.

VTT has been hosting the national hot laboratory infrastructure since it was first constructed and equipped in the 1970's. However, the current hot labs are neither technically up to date nor adequate to all present research requirements, in addition to being housed in a building that is being renovated by its new owners. In November 2011 VTT made the decision to go forward with the effort to have a new facility built. The facility will be called the VTT Centre for Nuclear Safety (CNS).

1.2 Profile of the new Centre for Nuclear Safety

In its current rendition the CNS is comprised of a 3,300 m^2 office wing and a 2,360 m^2 laboratory wing. The office wing is intended to serve nuclear sector researchers in areas such as computerized fluid dynamics, process modelling (APROS), fusion plasma computations, severe accidents, core-computations, nuclear waste-management and safety assessments. The laboratory wing includes a basement level and two floors of laboratory space. The laboratory space is arranged around the main high-bay, which houses the hot-cells proper, while the basement is primarily intended for storage and handling of radioactive materials and waste. The laboratory activities include radiochemistry, nuclear waste, dosimetry, failure analysis as well as mechanical and microstructural characterisation of structural materials.

1.3 Hot-laboratory facilities

The hot-laboratory facilities of the laboratory wing are arranged in three main zones, according to the level and nature of radioactivity intended to be handled, which dictates the safety features required in the facility. The C-laboratory has the least requirements, and is dedicated primarily to radiochemistry and nuclear waste experiments. The B-laboratory has a moderate level of requirements, and in addition to radiochemistry and nuclear waste, it includes an iodine laboratory and microscopy of structural materials of low activity.

The main focus of the REHOT project is the A-laboratory and the hot-cell facilities. This primarily dedicated to the testing and examination of irradiated reactor structural materials, including reactor pressure vessel steel, stainless steel and nickel base internals materials, and fuel cladding. Irradiated nuclear fuel itself is NOT researched in the facilities. Besides the laboratories, the transport, handling and storage of radioactive materials is a key function of the hot-laboratory facilities.

Activities in the A-class hot cells

- Active material receiving and shipping
- Nondestructive examination (NDE)
- Test specimen preparation
  - Sawing methods
  - Machining methods
  - Electric discharge machining (EDM)
  - Reconstitution method: EDM & electron beam welding
- Mechanical testing
  - Impact testing
  - Fracture mechanics testing
  - Tensile testing
  - Cyclic loading
  - Hardness testing
- Bellows devices for fuel cladding tests
- Environmental testing
- Metallographic characterization of materials
  - Dimension measurement
  - Preparation of metallographic specimens
  - Optical microscopy and microhardness testing
  - Scanning Electron Microscopy (SEM)
  - Transmission Electron Microscopy (TEM)
  - TEM and SEM microanalysis
- Waste management, sorting and packaging
  - Solid waste
  - Liquid wastes containing active species