Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

SHIELDED FACILITIES
FACT SHEET

SUMMARY

CNL has provided post-irradiation examination and testing of irradiated materials, including nuclear fuels and reactor components, for over forty years. Its shielded facilities provide a comprehensive set of capabilities, from material handling and sample preparation, non-destructive examination, to microscopic examination/analysis, bulk chemical and surface analysis, plus a range of mechanical testing capabilities.

KEY FACILITIES

Universal Cells

The Universal Cells include four multi-purpose cells that can accommodate a wide variety of testing and analytical equipment, from non-destructive visual and dimensional examination to burst testing, compression testing, profilometry, axial and linear gamma scanning, helium leak testing, and fission gas analysis (in conjunction with CNL's on-site analytical chemistry laboratory). A fifth cell is dedicated to Cobalt-60 processing. The Universal Cells can receive, size-reduce, and prepare samples for analysis from materials up to 20 tons in weight and 5.4 meters in length.

NRU Reactor Rod Bays

The spent fuel cooling bays at the National Research Universal (NRU) Reactor allow CNL to receive large and highly active samples, such as a full-size spent fuel rod from a commercial pressurized water reactor, cool them until they can be safely handled in the Universal Cells.

Fuel & Materials Cells

The Fuel & Materials Cells are primarily for the destructive examination of irradiated fuels and fuel channel materials. The Fuel & Materials Cells contain microscopic and spectroscopic analytical equipment for X-ray diffraction (XRD), scanning electron microscope (SEM), secondary ion mass spectrometer (SIMS), differential scanning calorimeter (DSC), and optical light examination, as well as precision mechanical testing of material strength to ASTM standards. There are three specialized cells dedicated to basic mechanical testing and examination of non-fissile materials. Computer-numerical controlled machining equipment can machine samples as small as 1mm x 1mm x 2mm.

ANALYTICAL CAPABILITIES

Capability	Equipment	Application
Visual and Dimensional Examination	Fiber-optic cameras and optical macro- and microscopes	Visual examination of irradiated material
	Profilometer, bundle length measurement apparatus	Dimensional measurement of length, diameter, and bow of irradiated samples such as fuel pellets or pressure tubes
Microscopic Examination	Optical light microscope	Ceramographic and metallographic examination of microstructural characteristics (e.g., ceramic fuel, zircaloy sheathing)
	Scanning electron microscope with energy-dispersive and wavelength-dispersive x-ray spectrometers	Topographical and compositional analysis, including electron microprobe analysis, to study fission product distribution, migration, and surface deposition
	Transmission electron microscope Focused Ion Beam	Study radiation damage and deformation at the atomic level, particularly the effect of hydride formation and fission gas / fission product formation
Physical and Mechanical Testing	Helium leak tester	Identifies defects (e.g., in fuel pellets)
	Fuel element puncture and gas collection apparatus	Captures fission gases for volume measurement and analysis
	Gamma scanner (linear and axial)	Measure gross gamma activity and distribution of individual isotopes
	Hardness and tensile testing	For basic material props
	Fatigue and fracture	For defect tolerance and fitness for service

Capability	Equipment	Application
Physical and Mechanical Testing	Delayed hydride cracking test frames with acoustic emission detectors	Measuring threshold stresses for the initiation of cracks by hydrogen cracking mechanisms in irradiated material, and the speed of propagation
	Burst test rigs	Burst testing at a range of temperatures and pressures
	Hardness and tensile testing	For basic medical props
Elemental Composition	Secondary ion mass spectrometer	Analyze composition of material as it changes over its depth profile; used for Fourier Transform Infrared Reflection (FTIR) to measure corrosion film thickness on zirconium alloy and Impedance spectroscopy (IS) to examine barrier layer oxide
	Hot vacuum electron mass spectrometer	Measures hydrogen and deuterium concentrations in zirconium alloys
	Magnetic sector mass spectrometer	Analyzes the composition of fission product gases (as distinct from fill gases)
	High-performance liquid chromatograph	Burn-up analysis and subsequent simulation of fission yield
	Differential scanning calorimeter	Heat capacity of irradiated sample, and estimating hydrogen and deuterium concentrations in zirconium alloy reactor components
	Coulometric titration apparatus	Measures oxygen-to-metal ratio

SPECIFICATIONS

Facility	Inside Dimensions (m)(wxdxh)	Shielding (m)	Work Stations	Specimen Dimensions (cm) (1 x d)	Function
Universal Cells 1 & 2	2.7 x 2.4 x 4.6	1.1 concrete	3	15 x 15	Co6O isotope extraction (1) Receiving & mechanical testing (2)
Universal Cells 3	4.9 x 1.8 x 4.0	1.1 concrete	2	360 x 15	Receiving & general purpose
Fuel & Materials Cells (FMC) 1	3.0 x 1.5 x 3.7	0.7 concrete	1	50 x 15	General purpose- fuel channels
FMC 2	3.7 x 1.8 x 3.9	0.9 concrete	1	50 x 15	General purpose - fuel bundles
FMC 3	5.0 x 1.7 x 3.5	0.25 lead	1	8 x 8	Fourier Transform Infrared Reflection Spectroscopy Metallography
FMC 4, 5, 6 & 7	1.0 x 1.0 x 1.0	0.13 lead	2	5 x5	Optical microscopes
FMC 10	2.4 x 1.2 x 2.2	0.5 concrete	0.5	50 x 8	Clean - DSC & precision weighing
FMC 11	3.0 x 1.2 x 3.3	0.6 concrete	0.5	50 x 8	Clean - CNC milling machine
MTC 1 & 2	2.7 x 1.5 x 3.2	0.4 concrete	2	12 x 12	Mechanical property testing
MTC 3	2.6 x 1.2 x 3.2	0.4 concrete	1	12 x 12	Delayed hydride cracking tests

Canadian Nuclear Laboratories (CNL) is Canada's premier nuclear science and technology laboratory, dedicated to developing peaceful and innovative applications from nuclear technology through its expertise in physics, metallurgy, chemistry, biology, and engineering. We address global issues across the nuclear lifecycle – reactors and fuels, waste management, nuclear safeguards – and develop novel medical isotopes and devices.

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