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Filling the Neutron Gap at CNL after Shutdown of the NRU Reactor

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Canadian Nuclear Laboratoires Nucléaires Canadiens

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Chalk River Laboratories is the single largest science and technology laboratory in Canada.

9,100 acres with 200 acres of lab complex17 nuclear facilities, 70 major buildings3,100 employees (500 PhDs & Masters)1,600 engineering, scientific & technical staff

Advanced nuclear fuels and materials research Radiobiology, radioecology and dosimetry Hydrogen and hydrogen isotopes management Nuclear safety, security and risk management Nuclear and systems engineering Nuclear chemistry applications

The NRU reactor enabled 60 years of scientific innovation.

500M+ patient treatments CANDU reactor Neutron spectroscopy

so now what?

Context shaping our strategy

- Canada is committed to achieving its climate goals
- Nuclear power is 18% of Canada's energy mix
- Nuclear science and technology (S&T) drives a \$6B domestic industry and 60,000 jobs
- **\$25B** is being invested to refurbish CANDU reactors
- Canada has established federal nuclear S&T priorities for CNL for 10 years
- Canada is investing \$1.2B over 10 years in CNL to sustain the capabilities needed in its national nuclear laboratory
- CNL's long-term strategy* features small modular reactors, supporting existing reactor fleets and much more
 *http://www.cnl.ca/site/media/Parent/Long_Term_Strategy_2017April18.pdf

Canada's Nuclear S&T Priorities



Science & Technology Federal

Supporting the development of **biological applications** and understanding the **implications of radiation on living things**

Enhancing **national and global security** by supporting **non-proliferation and counter-terrorism**

Nuclear preparedness and emergency response

Supporting safe, secure and responsible use and development of nuclear technologies

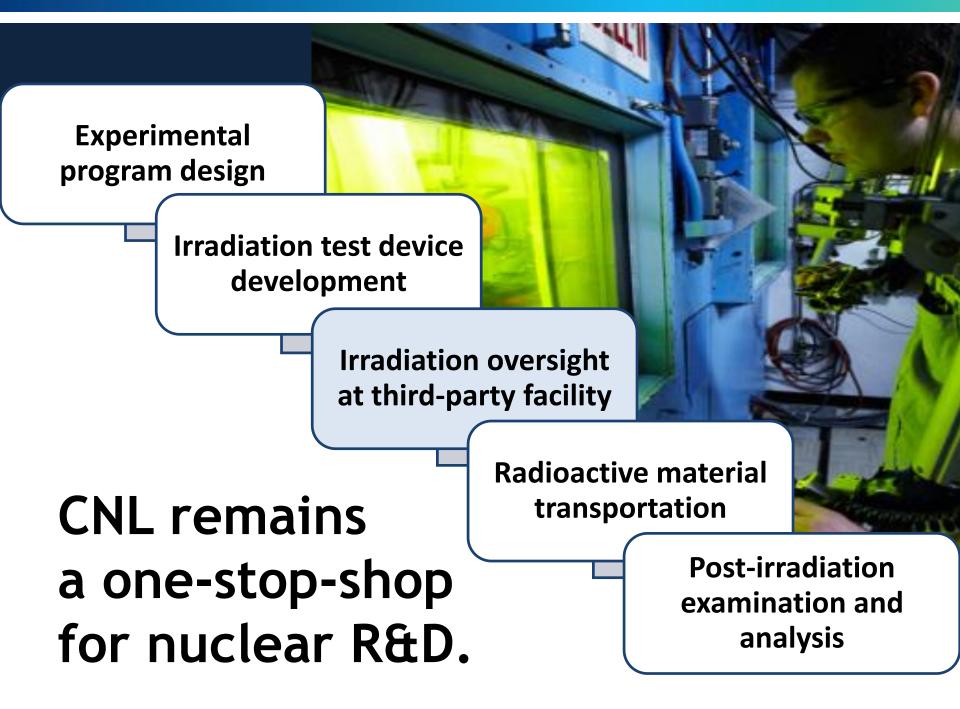
Supporting **environmental stewardship** and radioactive **waste management**

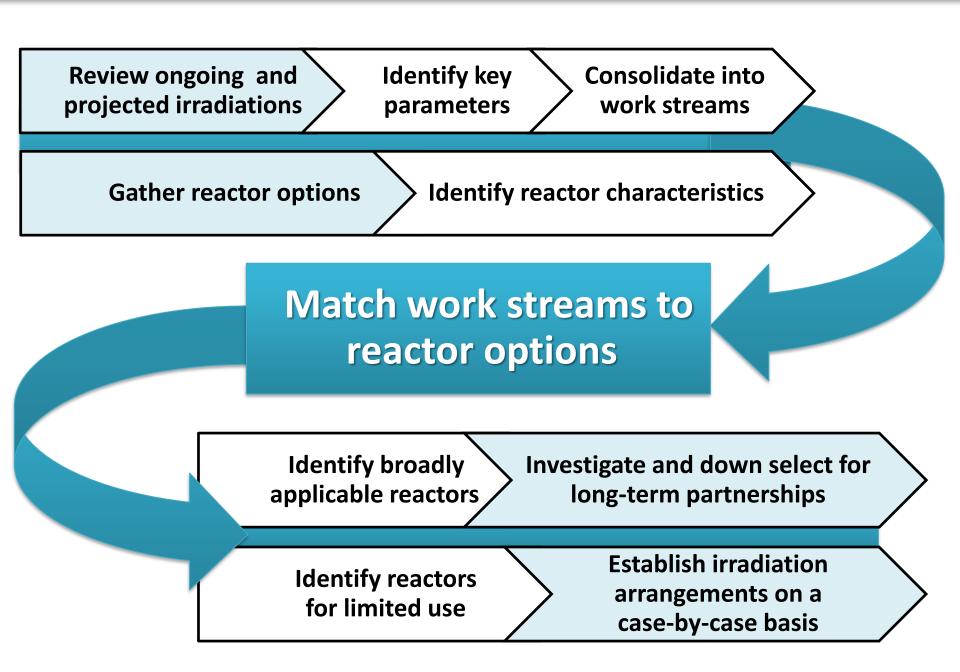








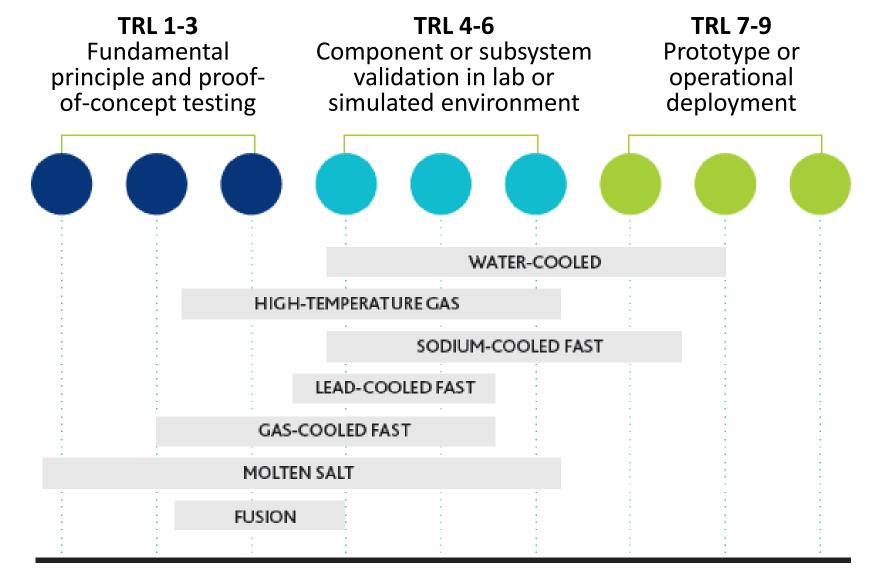




Projecting irradiation demand

- Support the development of various reactor designs through fuels and materials irradiations, including specific small modular reactor fuels for qualification, and next generation fuel development
- Underpin studies and experiments related to the aging, safety and life-extension of CANDU and light-water reactors
- Support the training and skills development of Canada's future nuclear workforce
- Preserve and advance strategically important CNL facilities and expertise
- Leverage existing irradiated material inventory and nuclear data while addressing knowledge gaps related to the development of fuels of interest to Canada and commercial fuel vendors

Advancing SMR Technology Readiness



http://www.cnl.ca/site/media/Parent/CNL_SmModularReactor_Report.pdf

Defining key parameters for ongoing and future experimental programs

- Suggested/actual reactor used
- **Required Power**
- Required Max Thermal Flux
- Required Max Fast Flux
- Irradiation arrangement and test conditions
 - loop, in-core position/channel, reflector position, rabbit, beam port gas-cooled, flows, pressure/temp, instrumented,...
- Required largest thermal flux test volume and thermal flux
- Required largest fast flux test volume and fast flux
- Time frame (dates), duration and number of tests
- Irradiation demand trend, drivers, etc.

Irradiation needs are varied.

| Work Stream | Thermal Neutron Flux Required (n/cm ² /s) | Fast Neutron Flux Required (n/cm ² /s) | Irradiation Environment Conditions Required | | |
|---------------------------------------|--|---|--|--|--|
| FUEL | | | | | |
| CANDU Reactor | 1.5 to 3.0E+14 | >1.0E+14 | Pressurized Heavy Water Reactor preferred (CANDU or Advanced CANDU Reactor) | | |
| Light Water Reactor | >1.0E+14 | >1.0E+14 | Light Water Reactor preferred | | |
| Research Reactor | >1.0E+14 | >1.0E+14 | Pool Reactor | | |
| Advanced Reactor (fast or thermal) | >2.0E+14 | >2.0E+14 (up to 7E+15) | Design-specific advanced reactor conditions | | |
| Advanced Reactor (SCWR) | To be determined | >2.6E+13 | Reactor-specific design conditions | | |
| MATERIAL | | | | | |
| High Neutron Damage | >1.5E+14 | >1.0E+14 | Reactor-specific design conditions | | |
| Corrosion Loops | 0.4 to 1.5E+14 | ~5.0E+13 | Reactor-specific design conditions | | |

Identifying preliminary list of technical characteristics of existing research reactors

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Evaluation Criteria

- / Technical requirements
- ✓ Strategic partners and cooperation
- Cost, transportation, logistics
- ✓ Reactor accessibility and long-term availability
- CNL's ability to perform key activities to sustain technical competencies

Exploring several options to address technical requirements

- Utilizing multiple research reactors
- Setting up long-term agreements for reserved space with one or more reactors
- Leveraging the IAEA International Centre based on Research Reactors (ICERR) scheme
- Securing space in an operating power reactor
- Acquiring time on a new test reactor
- Participating in the development of a new test reactor

There is no one-size-fits-all solution.

Providing solutions to challenges in energy, health, safety, security and the environment



What amazing things is the world turning to Chalk River for?

Clean energy. Health care. Industrial solutions. Advanced fuels. Innovative technology.

For starters.



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