1. RFEOI Title	**Restructuring of AECL Nuclear Laboratories**
2. Lead Organization Responding (legal name)	Canadian Institute for Neutron Scattering (CINS)
3. Participating Organizations (name of each)	N/A
4. Location of interest:	Chalk River, ON
5. Identify one or more of the following areas of interest: c. Nuclear S&T e. Other (please specify): Ideas for governance and management	**5b. Indicate all facilities of interest:** a. Hot Cells b. NRU e. New Research Reactor h. Other: Machine shops, general laboratories

6. **How would you propose to participate at the Laboratories?**

CINS would seek to contribute to an oversight role so as to restore CRL to its proper position as a centre for research in Canada, and to ensure that its unique combination of capabilities is managed for the benefit of all clients, whether they be academic, government or industrial users.

7. **Expertise/Capabilities of the Respondent(s) (one paragraph)**

CINS is a not for profit, volunteer-run organisation of academic users of neutron beam techniques in research. We are actively involved in lobbying efforts to secure a replacement for the aging NRU research reactor as a major investment in national infrastructure for science and technology in Canada. We currently oversee ~$1.5M in annual operating funding for the NRC Canadian Neutron Beam Centre (CNBC) that we obtain from NSERC through their Major Resources Support (MRS) grant program. Oversight of the CNBC is exercised both informally through members who visit as users, and formally through biannual meetings with the director and staff.

8. **Summary of Interest (one paragraph)**

Our members are active users of the Canadian Neutron Beam Centre that is based around the NRU reactor at Chalk River. Our organisation seeks to promote the use of neutron beam research techniques and our members have been involved in research at Chalk River Laboratories almost since the facility was created. We believe that neither Chalk River Laboratories in general, nor Canadian neutron beam research in particular, have a meaningful future without a powerful research reactor on the Chalk River site, and that since NRU is coming to the end of its operational life, it is essential that a new research reactor be built as a matter of great urgency so that an orderly succession can be managed. Furthermore, in order to fully realise the scientific and technical potential of Chalk River Laboratories, a major shift in culture will be needed so that research is identified as a laboratory priority, and external users from academia, government and industry are both welcomed and supported in their research.

9. **Benefits expected by Government (one paragraph)**

The National Research Universal (NRU) reactor and the associated facilities at Chalk River Laboratories represent the largest national investment in research infrastructure in Canada. Despite decades of world-class contributions to research in all aspects of nuclear science and technology, the site was allowed to decay from the mid-90s and it has become a pale shadow of its former self. With investment in a new research reactor, and active promotion of a new research-centred mission for the laboratory, a revitalised Chalk River Laboratories could regain its position as a world leader in nuclear and neutron-based science and technology and serve a broad range of academic, government and industrial users. It would advance knowledge and contribute to the training of thousands of highly qualified people, both those who work on-site, and the far larger number of people who would visit the laboratories to use the facilities and interact with the teams of local specialists. By re-defining the site's mandate as "*research*", Chalk River Laboratories would be in a position to contribute to fields far from nuclear engineering and would support research in energy, environment, health, communications, materials science, fundamental physics and chemistry and manufacturing and process development for the automotive, aerospace and mineral processing sectors. The knowledge gained would both expand Canada's technological base, and also inform government as it seeks to develop science-based policies that support a technology-driven economy, and that both foster and regulate industry in Canada.

10. If available, would you be interested in a one-on-one session? YES

1 Respondent Profile

The Canadian Institute for Neutron Scattering (CINS) represents the Canadian scientific community of neutron beam users and promotes scientific research using neutron beams.

Neutron scattering is a versatile and powerful technique for research on materials of all kinds that was pioneered in Canada in the 1950s. Groundbreaking developments by Canadian researchers were enabled by access to two of the most powerful research reactors in the world: National Research Experimental (NRX) and later, National Research Universal (NRU), both located at Chalk River Laboratories. International recognition of these contributions came in 1994 when Prof. Bertram Brockhouse shared the Nobel Prize in Physics. Neutron scattering continues to play a valuable role in Canadian science, allowing scientists to explore the structure and dynamics of materials down to atomic length scales. We are proud to continue the tradition of neutron scattering in Canada.

CINS objectives are:

- To stimulate and facilitate research by Canadian scientists using neutron beams.
- To establish priorities for the development of facilities for neutron scattering in Canada.
- To make representations to the appropriate agencies and authorities for the provision of adequate facilities and funding for researchers using neutron beams.
- To co-ordinate the formulation of proposals for instrumentation and infrastructure for submission to granting agencies.
- To administer infrastructure grants that may be awarded for such research, subject to any conditions that may be imposed by the granting agency.
- To sponsor schools and workshops that provide theoretical and practical training, and to support travel for scientists located at large distances from the neutron facilities.
- To carry out any other activities that would further these objectives.

Our members include university faculty, professional scientists and engineers, research technicians, post-doctoral fellows and graduate students. As of 2011, our membership totaled over 500 individuals including more than 350 individuals from over 50 Canadian institutions from every province except PEI, representing 90 university departments from over 30 universities. The many university departments span disciplines from physics, chemistry, life sciences, earth sciences, materials science, and engineering. Our membership also includes more than 150 individuals from over 90 foreign institutions, including over 60 universities, reaching over 20 countries. There are currently 16 institutional members who pay fees that are applied to encourage scientific research using neutron beams, and to ensure access for the Canadian neutron scattering community to competitive research facilities.

1.1 Capability in oversight

As a not-for-profit, volunteer-run organization of professionals, CINS itself has no money to contribute but can participate in the restructuring of CRL in other ways.

CINS already participates in the oversight of the NSERC MRS grant which provides about $1.5M in annual support to ensure that the neutron scattering facility (The NRC Canadian Neutron Beam Centre – CNBC) is in a state of readiness to enable academic users to employ neutron beam techniques in their research. CINS members applied for the grant through the NSERC Major Resources Support program. We manage the use of the funding through an oversight committee, drawn from the user community, that meets with the director and his staff twice each year, once on-site at Chalk River, and once at the CINS annual general meeting. Reports of these meetings are submitted to NSERC and McGill University (the organisation that currently receives the funding from NSERC).

1.2 CINS CONTACT:

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2 Overview of Areas of Interest

The aging National Research Universal (NRU) reactor located on the Chalk River Laboratories (CRL) site, currently owned and operated by Atomic Energy Canada Limited (AECL), forms the centerpiece of a unique but underutilised Canadian research facility. The restructuring of AECL–CRL represents a golden opportunity to revitalise the site, to re-open it to a broader mission in support of Canadian science and technology, and make new investments in Canada's research infrastructure. It is the presence of NRU that makes CRL unique, and the research reactor provides a focus for almost all other activities. Without a research reactor at CRL, the facility will inevitably decline to being little more than a waste management site. Any long-term plan for CRL must therefore either include the construction of a new multipurpose research reactor to succeed NRU, or be a plan for a phased draw-down of activities and the decommissioning of NRU.

CINS is interested in a new research reactor with associated laboratories and infrastructure to succeed the aging NRU reactor.

CINS envisions a world-class research reactor to serve broad scientific, technological and health needs of Canadians for the coming decades. Such a facility would be multi-purpose in nature to achieve a balance of cost and benefits.

CINS is interested in joining a consortium of parties to develop a business case for a new multi-purpose research reactor, as a parallel process to other studies regarding the future of CRL.

CINS strongly believes that a new research reactor is essential to maintain and grow Canada's competency in the application of neutron beams for research on materials. Without a major domestic neutron source, Canada will quickly lose its expertise in this area.

Designing, building and commissioning a new research reactor will take more than ten years. If our existing research reactor (NRU) were to be shut down before the project were well underway, the resulting break in access to a domestic source of intense neutron beams would devastate the Canadian neutron beam user community. To avoid such a “neutron gap”, the NRU reactor will need to continue to operate well beyond 2016 so as to permit an orderly succession process as the new research reactor is built and commissioned (around 2021–2026).

CINS sees the restructuring of AECL as a golden opportunity to improve the mission and governance of the NRU reactor within the context of a revitalised Chalk River Laboratory site, using models that are better suited to their science and technology missions. CINS would like to participate in a greater role to provide oversight of CRL, and especially of the NRU reactor and associated facilities, to ensure that decisions are made to maximize the return on investment in the neutron beam mission in particular and the broader research mission of the site in general.

CINS believes that the realignment of the mission and governance should be reflected by corresponding cost-neutral changes to the funding model. An envelope of funds corresponding to the attributed cost of operating CRL for the neutron beam mission should not be given directly to AECL as is the case now (or to whatever party is responsible for the other missions of CRL in the future), but rather the funds should flow through an institution or another federal body that would be responsible to ensure that the funds are used to maximize the return on investment in the neutron beam mission. This model could allow a portion of savings in the costs of the large overhead at CRL and reactor operations to be re-invested in the neutron beam mission. CINS is interested in playing an oversight role in the use of these funds, similar to the role that it already plays in oversight of the NSERC MRS grant that is used to maintain the neutron beam laboratory in a state of readiness for access by the Canadian academic user community.

2.1 New Research Reactor

In 2008, CINS published our vision for the future as "*Planning to 2050 for Materials Research with Neutron Beams in Canada*" (http://www.cins.ca/reports.html#2050). In this long-range plan, we proposed the construction of the "Canadian Neutron Centre" (CNC), a new, multi-purpose research reactor facility that will serve broad scientific, technological and health needs of Canadians for the coming decades. It would succeed the aging National Research Universal (NRU) reactor at Chalk River, support all of the communities that currently use the NRU reactor, and represent a major national investment in research infrastructure for science and industry:

(1) The world-class neutron beam facility would exploit the intense flux of thermal and cold neutrons that could be drawn from the reactor core and would contribute to Canada's industrial and scientific competitiveness. Neutron beams support R&D by Canadian universities and industry. The unique knowledge obtained by neutron beams helps companies to develop more competitive products that are safer, more reliable and less expensive to manufacture. This new facility would continue the strong research tradition developed by the NRC Canadian Neutron Beam Centre (CNBC) located at NRU. The CNC would allow Canada to continue to be the world-wide leader in providing access to industry from key sectors: nuclear, aerospace, automotive and manufacturing. The CNC would also provide competitive facilities to support fundamental and applied research in many important areas: physics, chemistry, materials science, green energy technologies, communications and materials for the life sciences.

(2) The in-core facilities at the CNC would enable critical materials development that will be essential for Canada to continue in a leadership role in the international Generation-IV reactor program. They would also support orderly stewardship of and innovation in the CANDU power reactor fleet that operates around the world.

An alternative approach, based on a much smaller research reactor that is dedicated solely to providing neutron beams for materials research, is being promoted by the University of Saskatchewan. This option is briefly discussed under section 2.1.1. "Location of New Research Reactor".

This EOI focuses on a new reactor that would have to be justified on the basis of two missions (neutron beams for research and nuclear energy R&D). Our 2008 plan identified a third mission: Irradiation facilities and hot-cells to allow commercial producers of medical and industrial isotopes to supply these key commodities to Canadian and international markets, and also to permit Canadian researchers to continue to develop new isotope products.

This third, isotope-production mission is not considered within the current EOI because more recent government policy suggests that it is not the intention for the NRU reactor to produce medical isotopes (particularly Mo-99) beyond 2016. However, the future of medical isotope production beyond 2016 is still uncertain, and it should be noted that a new research reactor built to support neutron beam research and nuclear R&D could also provide a contingency option in the event that alternative methods of production of Mo-99 are demonstrated to be technically or economically unviable. Furthermore, accelerator-based production of Mo-99 (using linear accelerators or cyclotrons) is a solution to a single problem, and it cannot provide for the development or manufacture of next-generation, neutron-rich medical isotopes as radio-pharmaceutical technology searches for innovative replacements. If the isotope production mission were to be retained in the new design, a sustainable cost model would have to be developed to ensure proper revenue sharing with full-cost recovery for isotope production and eliminate government subsidies.

By establishing the CNC as a science and engineering facility that is open to all Canadian researchers, whether they be from government, industry or academia, we would be providing a platform for the generation and refinement of ideas. The facility would have a mandate to educate Canadian researchers, and to support and promote the uses of neutron-based techniques in research and development. The facility would provide active connections between academic and industrial users, facilitating the transfer of knowledge between fields of research and domains of application, with the development of new intellectual property, allowing Canadians to lead progress in both industrial and fundamental research. We view the CNC both as building on Canadian expertise and leadership that was established through the NRX and NRU reactors, and also as a natural continuation of the Canada Research Chair (CRC) and Canadian Foundation for Innovation (CFI) programs that attracted highly qualified people to Canadian universities. By providing a world-class multi-purpose user facility in support of science and industry, Canada would be making a clear commitment to the future. The CNC would enable the newly recruited talent to more fully express their creativity and would continue to attract new researchers to Canada.

Every industrialised nation has found it to be essential to have neutron beam research facilities and the need continues to grow. As some aging facilities are retired, others are refurbished and new facilities are being built. Britain is upgrading ISIS, the most successful pulsed neutron source to date. France has two research reactors, and has completed a major upgrade at its flagship facility, the Institute Laue-Langevin (ILL) in Grenoble, that will ensure that it remains the international gold-standard for research reactors for the foreseeable future. In the US, their main research reactor facility at NIST is undergoing major upgrades that will nearly double its capabilities, and a $1B upgrade for the new $1.4B Spallation Neutron Source in Oak Ridge is already planned, even as this new facility is still ramping up its beamlines. Australia, Korea, Switzerland, Japan and Germany all have thriving facilities. China recently opened its first neutron beam facility, and expects to complete its second in 2016.

A key feature of the CINS plan "*Planning to 2050 for Materials Research with Neutron Beams in Canada*" is a governance structure (discussed further below) that ensures that the facility is operated as a research facility that actively supports industry access, rather than as a production facility that tolerates some research access, so that the access needs of all users are properly balanced. The CNC is envisioned as a major component of Canada's national science infrastructure, put in place by the Government of Canada and operated by Canadians in support of Canadian science and industry for the benefit of Canadians.

In addition to neutron beam facilities, nations with prominent nuclear power programs have dedicated R&D laboratories to service the nuclear power industry and inform the regulatory bodies of those countries. To comment specifically on potential nuclear services role of a new CRL, CINS must defer to our colleagues at the Canadian Nuclear Society (CNS) and the Canadian Nuclear Association (CNA), nevertheless, we would like to emphasise that models for the successful collaborations between basic and applied researchers (industrial, government and university) at such nuclear R&D facilities do exist.

The Idaho National Laboratory (INL) is a "*science-based, applied engineering national laboratory dedicated to supporting the U.S. Department of Energy's missions in nuclear and energy research, science, and national defence*." Likewise, the UK's National Nuclear Laboratory (NNL) is a "*a leading nuclear technology services provider.*" For the NNL, the principal mandate of the laboratory is nuclear services, with applied research a secondary component. For the INL, the laboratory is positioned to fulfill the broader energy R&D mandates of the US Department of Energy, in addition to its role as a nuclear services company.

Both the INL and NNL are Government Owned, Contractor Operated (GOCO) organisations, with the not-for-profit Battelle Memorial Institute as the lead contractor. Both management structures are formed as limited liability companies, owned in whole or in part by Battelle, and managed in conjunction with other for-profit industrial, and university partners (Massachusetts Institute of Technology for INL, and University of Manchester for NNL).

The central INL facility is the Advanced Test Reactor Complex, "*vital for testing materials for the nation's next generation of nuclear power plants*", and a centre of radiochemistry research for medical isotopes. The NNL does not currently operate a research reactor, but the history of the main Sellafield research campus and Calder Hall power station bears a striking similarity to Chalk River and Canada's first power reactor: "Nuclear Power Demonstration" (NPD) originally located at Rolphton, Ontario.

Although NNL facilities do considerable materials testing, critical in-core radiation testing cannot be done by the NNL. Close access to other reactor-based nuclear testing facilities on the European continent allows the NNL to retain its expertise in reactor operations and licensing. Canada and the Ontario-centered CANDU Owners Group does not have that luxury, and must conduct its required testing for Canadian licensing requirements outside the country and more frequently, outside North America.

CINS would like to emphasise the synergy between basic-science materials testing using neutron beams and in-core materials testing for nuclear R&D. Such work is currently being carried out at NRU with strain scanning of nuclear components being used to evaluate and improve manufacturing techniques, and phase analysis of new fuel chemistries being used to evaluate their performance after realistic full-power irradiation in the core of NRU. Only the combination of the world-class materials science capabilities of the CNBC and the extensive experience within AECL handling extremely radioactive spent fuel components made this latter project possible. The combination of the two at a revitalised CRL would put Canada at the forefront of materials research, and may draw in business from other nuclear-power emerging countries that do not have such multi-faceted laboratories at their disposal.

2.1.1 Location of New Research Reactor

There are at least two very different options for the location of a new facility. The CNC, a large multi-purpose research reactor on which we focus here, would serve both nuclear energy R&D and neutron beam missions. CRL is the ideal location for such a facility: it is located close to the primary pool of users; the site possesses most of the required infrastructure; and the surrounding area has a largely receptive population who understand the benefits of nuclear technology. CRL is close to both the industrial partners that it will support, and the researchers who wish to use it. The site is already licensed, with established infrastructure for radioactive materials handling, waste disposal, security and access management. In addition, the CRL site currently has functional nuclear operation infrastructure. Exploiting existing infrastructure where possible, rather than reproducing all of these expensive facilities in another part of the country will bring significant cost savings. The surrounding population has over 50 years of direct personal experience with nuclear technology and would be very supportive of a major new reactor project on the Chalk River site, greatly simplifying many aspects of the licensing process and thereby shortening timelines. Chalk River is reasonably close to most of the major research universities and NRC institutes in Ontario and Quebec, and the proximity of the international airport in Ottawa means that researchers from across Canada and around the world have convenient access to the facility.

An alternative approach is to build a smaller reactor dedicated to neutron beam research only. Such a facility would not require the extensive infrastructure needed for the nuclear energy R&D mission and would make alternative locations more feasible. For example, the Government of Saskatchewan and the University of Saskatchewan have committed funds (about $200M) toward building a neutron beams only research reactor (called the “Canadian Neutron Source”) and propose to host it in Saskatoon, close to the Canadian Light Source (CLS) where the two facilities could share resources and encourage a synergistic relationship between the x-ray and neutron beam communities. This project is part of the province's bid to develop its nuclear science and technology capabilities, complementing the Canadian Light Source and uranium mining. Saskatchewan awaits a response from the Government of Canada concerning their proposed partnership to build such a facility. CINS actively welcomes the prospect of a neutron source dedicated to the neutron beam mission, but the government would need to consider the implications of this approach for the nuclear energy R&D mission. For example, would this imply an abandonment of key nuclear R&D capabilities or would a second research reactor be built at CRL (or elsewhere in Ontario) that is dedicated to meeting the needs of the nuclear industry? Ultimately, two research reactors will consume far more resources than one – the reason CINS has historically advocated for a multipurpose facility to achieve a balance of cost and benefits.

2.1.2 Business Case for a New Research Reactor

CINS is interested in participating in oversight of a project conducted by a consortium of parties to develop a business case for a new research reactor, as a parallel process to other studies regarding the future of CRL. CINS has a Memorandum of Understanding with the Canadian Nuclear Society (CNS) to seek private sector funds to meet any matching requirements for federal funding toward a business case.

CINS recommends a national dialogue to produce a business case for a new multipurpose research reactor. This approach responds to the need identified by the Government of Canada: *"A research reactor serves many missions. The need for a new reactor for these other purposes would need to be based on a thorough assessment of the missions, including neutron scattering and R&D for the nuclear industry, and consideration of the appropriate sharing of costs among the many users and beneficiaries of such a facility"* (Natural Resources Canada. Government of Canada Response to the Report of the Expert Review Panel on Medical Isotope Production. March 2010).

A thorough assessment requires participation of the many stakeholders to oversee the development of a rigorous business case to study the costs and benefits of such a facility. Although many parties including academia, industry and even provincial governments have a role, active federal involvement will be needed.

CINS estimates that developing the business case will cost about $5–10M and may take up to two years. The business case would be composed of key studies such as:

- A unified set of user requirements that will determine the design specifications for the conceptual designs;
- Comparative analyses of options for Canada's neutron-based science and technology (S&T): one multipurpose research reactor that can support two missions simultaneously (neutron beams for materials research, and in-core testing of nuclear materials and components); or a two-reactor scenario, with a single-purpose compact-core research reactor for materials research and education with neutron beams and a second large-core research reactor for nuclear R&D;
- An engineering conceptual design that determines the cost of Canada's future research reactor (or reactors) with significant confidence – this component represents the majority of the project costs;

- Reviews of the conceptual design by international technical experts at key stages of the project;
- Economic assessments of the historical impacts of the NRU reactor and of the projected return on investment in replacement capabilities;
- Business and governance models, with goal of cost-recovery revenues from industry;
- Risk analyses.

2.1.3 Associated Facilities for a New Research Reactor

Full utilization of a new research reactor for neutron beam work requires additional facilities such as attached laboratories for sample preparation (chemical and biological) and workshops (electronics, fabrication, machine), offices and meeting rooms, and accommodation for visiting scientists. These are in addition to any facilities required for nuclear R&D (*e.g.* hot-cells for fuel and irradiated product handling).

2.2 NRU Reactor and Associated Facilities

The Canadian neutron beam user community currently relies on the NRU reactor as its sole domestic neutron source. To avoid a significant “neutron gap”, which would devastate the Canadian neutron beam user community, the NRU reactor should continue to operate well beyond 2016 to enable an orderly succession and a seamless transition as the new research reactor is built and commissioned (around 2021–2026).

While NRU must continue to operate to supply neutrons to the beamlines, improvements to the operations of the reactor are needed to maximize return on Canada's investment and to set the stage for the effective use of the new facility. This is explored further in the section on governance.

The current neutron beam mission relies on a range of on-site capabilities at CRL that should also be maintained: laboratories for sample preparation (chemical and biological) and examination (*e.g.* hot cells), and workshops (electronics, fabrication, machine), offices and meeting rooms for research staff and visitors. Access to many of these facilities is currently provided for in an agreement between AECL and NRC for common services. Laboratory and office space that is currently dedicated to NRC is consists of Building 459 and with some additional laboratory space for sample preparation in Building 145.

3 Ideas for Governance and Management

CRL is an invaluable asset as an unparalleled research laboratory with a truly unique range of capabilities and expertise. There is experience in fuel design and failure analysis, reactor operations, experience with major repairs in high radiation fields, irradiation and hot-cell facilities for producing and handling a wide range of radioisotopes, facilities for engineering and chemistry research on highly radioactive materials, and a world-class neutron beam research laboratory, to name just a few. While there are aspects of CRL that may be of sufficient interest to private parties to attract some investment or revenues from cost-recovery activities, significant portions of CRL perform national research missions for public benefit, and many others could do so, if they were managed for the benefit of the wider Canadian research community. The neutron beam facility of the NRU reactor, which is open to researchers from across Canada whether from academia, government laboratories or industry, is a clear example of a component of CRL that actively supports Canadian research and would therefore fall under a federal research mandate. Thus, federal funding will continue to be required for some missions of the CRL facility, supplemented by other revenue sources (*e.g.* cost-recovery mechanisms for industry access for proprietary research).

While federal investment in S&T at CRL will still be needed in the future, the restructuring of AECL presents an opportunity to maximize return on that investment by improving both the mission and the governance of CRL in general, and the NRU reactor in particular, using models that are better suited to their S&T missions. CINS would like to participate in developing the broader mission and improved governance structure, and would seek to play a greater role in the oversight of CRL, and especially of the NRU reactor and associated facilities, to ensure that decisions are made with the needs of the user community in mind.

3.1 Historical Context and Problems with the Status Quo

The current culture at CRL reflects the scaling back of S&T programs since the mid-1990's to focus solely on one technology, *i.e.* CANDU power reactors. This narrowing of AECL’s business focus had a clear and negative impact on the utilisation of NRU as a multi-purpose research facility; CRL's position as large-scale research infrastructure for science and industry was degraded, and activities that were not directly related to the core requirements of the nuclear power industry were terminated. The world-class nuclear physics program based around the tandem accelerator (known as "TASSC") was scrapped, a number of commercial in-core activities (*e.g.* transmutation doping of high-purity silicon for the electronics industry) ended, efforts were made to off-load the medical isotope business via the now abandoned MAPLE program, and the neutron beam program was shut down. The national outcry from the Canadian scientific community in response to this last decision led to the rescue of the personnel and equipment by the

National Research Council (NRC) and the reestablishment of the neutron beam laboratory as part of NRC – now called the NRC Canadian Neutron Beam Centre (CNBC).

The damage to the research output of Chalk River Laboratories was immediate and devastating. A search of "web of science" (*apps.isiknowledge.com*) shows that in the 15 years before the narrowing of AECL's focus, the laboratory produced 160–180 peer-reviewed research papers in international journals every year. These papers reported results in fields that ranged from nuclear engineering, site remediation, biological impacts of radiation, key preparative and design work for the Sudbury Neutrino Observatory (SNO), mineralogy, magnetism and theoretical nuclear and high-energy physics. After 1995, the publication rate dropped to ~60 papers per year and the subject coverage became far more restricted (primarily nuclear engineering and site remediation). As a point of comparison, the $4M/year 25-person operation at the Canadian Neutron Beam Centre has maintained and developed an extensive network of external research collaborations and has been able to leverage its modest budget and staffing to produce ~50 peer-reviewed research papers in international journals every year, matching the research output of the rest of the CRL site. We see this as a measure of the *real* value of Chalk River Laboratories if it were to be operated as a user-collaborative research facility. A further measure of the scientific loss caused by the narrowing of the site focus in the mid-90s can be seen in the citation records. Despite the drastic reduction in research output, the papers that were published during the peak of the CRL research years are still heavily cited, garnering over 2,500 citations every year. The research that was being done at CRL was clearly of the highest calibre and continues to have an impact nearly twenty years after the work was stopped. Ending research at CRL converted the site from a centre of internationally recognised Canadian research and reduced it to supporting AECL's former CANDU reactor design and services business in Mississauga (now Candu Energy) and with further reductions possible, it could become little more than a waste-management facility that produces some medical isotopes.

All of these changes produced a culture at CRL that is not conducive to research. Unsurprisingly, the result has been that NRU has not been operated as large-scale research-oriented infrastructure with a goal to maximize S&T impacts and return on investment. While AECL spends about $100M/year to operate the NRU reactor (according to NRCan's cost model in the RFEOI), comparatively little investment has been made in support of the many R&D missions of the facility. As a result, capacity has been lost, capabilities have degraded, systems have been idled. The loops for in-core testing of materials have not been functional for years, and irradiation ports that could provide access to some of the highest neutron fluxes on the planet are idle or inoperable. The capacity for neutron beamlines has never been fully utilized; there are currently only 6 neutron beamlines at the NRU reactor, while 20 or more beamlines are typical for neutron beam facilities around the world. The existing beamlines are operated by a skeleton staff with a shoe-string budget (~$2.1M/year provided by NRC) that must be supplemented by external funding (~$1.5M/year from NSERC, ~$0.3M/year in cost-recovery revenue from industry or other R&D partnerships) to enable 24/7 operations of all beamlines. Other North American neutron beam facilities typically have 5–6 staff per beamline while the NRC Canadian Neutron Beam Centre (CNBC) now has less than 4 staff per beamline. Compared to the national laboratories in the USA, Europe and Australia which operate neutron sources for user access, it is more difficult for researchers to obtain unescorted access to the beamlines at NRU to conduct their experiments. CRL has developed a reputation for being unwelcoming and hard to access, which AECL must now try to reverse if it is to attract users and partners.

There are significant unintended consequences of the cost model described above and the fact that AECL and NRC are distinct agencies reporting to different federal ministries with no formal contact or coordination mandate. There is no motivation for AECL to transfer any savings from efficiencies in operations of NRU or CRL to NRC to be reinvested in the neutron beam laboratory, even though neutron beam research is one of the main missions of the NRU reactor. Similarly, the large-scale investments in the NRU reactor by AECL do not seem to result in corresponding attention and priority for a commensurate investment in the neutron beam laboratory by NRC. While CINS is grateful to AECL for operating the reactor and to NRC and NSERC for having preserved the neutron beam capability, we need to move beyond the survival model. Simply operating the CNBC at a subsistence level is a poor use of both the physical capital and the substantial running costs of NRU. A proper return on Canada's investment in hardware and personnel can only be obtained through full utilisation of this resource. We need to ramp up the capacity to maximize return on the investment in the reactor – a need that is certainly not being met by the status quo.

While our research activities are internationally visible and provide a significant part of the case for continued operation of NRU, the user community represented by CINS has no formal mechanism to voice its concerns to AECL about the operations of the NRU reactor or of CRL that may affect the reactor or the neutron beam mission. CINS's formal role in oversight is currently limited to oversight of the NSERC funds for the CNBC.

Beyond investment in the reactor and beamlines and facilitating user access, other operational questions that affect the neutron beam mission include the reactor power and reliability of scheduling. To maximize the capacity of the reactor for neutron beam experiments, the reactor must operate at as high a power as possible so as to increase the flux of neutrons at the sample. This decreases the amount of beam time required per experiment, thereby allowing more experiments to be conducted.

Furthermore, the reactor must be operated on a reliable and sustainable schedule. A reliable operating schedule for NRU is essential if the CNBC is to run effectively as a user facility. The CNBC staff needs to schedule user experiments several months in advance, coordinating availability of ancillary equipment (furnaces, cryostats, sample tables, *etc.*) and technical resources to ensure that the facility is ready to receive and support the users when they arrive. Users, who may be coming from anywhere in Canada or be international visitors, need to be able to plan their trips with reasonable assurance that the facility will be available when they arrive for their scheduled experiment so that they can make effective use of their allocated beamtime.

The operating schedule for NRU must also be sustainable. Shutdowns for maintenance that are planned several months in advance and that provide adequate time to carry out essential work will prevent unplanned shutdowns due to system failures. This is greatly preferred over the operating schedule of the past decade where the brief shutdowns did not permit sufficient time for inspection and maintenance of critical systems, leading ultimately to a corrosion failure of the reactor vessel and a 15–month unplanned shutdown of the NRU reactor in 2009–2010 for major repairs. One of the root causes of this failure can be traced back to a governance structure in which the demands of a single mission – isotope production, primarily Mo-99 – were allowed too much influence over the scheduling process, at the expense of the other missions of NRU, and even, in hindsight, over the basic needs of the machine for proper maintenance.

Proper balance between the users and operators of NRU in the operational decision-making process would have made such a situation impossible. Any new governance structure established at CRL must strike a proper balance between stakeholders, with formal channels of communication and responsibility, and with a meaningful division of funding flow-through so that proper weight is given to the needs of the users and operators of the facility.

3.2 Recommended Governance and Funding Model

To facilitate the S&T missions of both the NRU reactor and its eventual successor, the mission and governance of CRL as a whole (not just the reactor itself) must reflect a greater emphasis on science and technology than in the recent past. CINS would be willing to participate in an advisory panel for CRL, or more formally in a consortium of stakeholders responsible for overseeing CRL, as a member of a board of directors.

A dramatic but cost-neutral change to the governance and funding models of the NRU reactor will be an essential component of any restructuring of Chalk River Laboratories. Not just for the sake of improving S&T impacts from that facility for the remaining period of its life, but also to enable Canada to learn lessons from a different model that can then be implemented at a new domestic research reactor in the future. If the restructured CRL is to host a new research reactor, then we must establish and test the governance and funding structures well before the new facility is commissioned.

An envelope of funds corresponding to the attributed cost of operating CRL for the neutron beam mission should not be given directly to whatever party is responsible for the other missions of CRL following the restructuring of the site (as is the case now with AECL). Rather, the funds should flow through a research institution (*e.g.* a consortium of universities as is done for TRIUMF in British Columbia, or an independent agency as is done for the Canadian Light Source in Saskatchewan) or a federal body, such as NRC, that would be responsible for ensuring that the funds are used to maximize the return on investment in the neutron beam mission. This will demonstrate unequivocally that there is a genuine federal commitment to the neutron beam research mission as a viable activity and will prevent it from being perceived as an optional add-on. It is only by having direct control of an appropriate fraction of the operating funds that the neutron beam research mission of the facility will have any effective say in the operation of NRU.

NRCan's RFEOI provides a high-level cost estimate based on a model in which the CRL site costs of $150M/year are divided among each major activity of CRL. This full-cost model estimates that NRU operations cost about $100M/year. In the early stages of the restructuring, three main missions will be supported by NRU (Medical Isotopes, Nuclear R&D, and Neutron Beams) and equal division suggests that about $33M/year be attributed to each mission, making the real costs of medical isotope production more transparent. After 2016, with the expected phase-out of medical isotope production, the $100M/year operating costs will have be divided among the two remaining missions: nuclear R&D and neutron beams. Again, assuming an equal division of costs, this yields an estimate of $50M/year as the cost to provide neutrons to the neutron beam laboratory.

A reallocation of $50M/year from AECL to an agency responsible for the neutron beam mission will have a dramatic effect by introducing a powerful accountability mechanism to ensure that AECL (or whatever body emerges to manage CRL) actively considers the needs of the neutron beam user community. The importance of this transparency in funding and cost modeling should not be underestimated. In fact, a lack of transparency in costs has been identified as a significant contributor to the global medical isotope crisis: *"In many cases, the full costs for Mo–99 provision were not transparent to or appreciated by governments who were subsidizing the production"* (OECD Nuclear Energy Agency. *The supply of Medical Radioisotopes*, 2010).

This funding model would explicitly recognise the value of neutron beam research to the larger CRL operation. It would encourage commensurate investments in upgrades and improvements in support of each mission on site, and would permit savings from improvements in operations efficiency to be allocated fairly between missions. For example, under this model, a savings of just 10% in the overhead costs of CRL and the NRU reactor at CRL would correspond to $5M/year in savings to the $50M/year funding envelope for the neutron beam mission. A re-investment of that $5M/year in the neutron beam laboratory would more than double the current operating budget of the neutron beam laboratory (currently less than $4M/year) and would go a long way toward maximizing the S&T capacity and impacts from the reactor.

With such changes to the funding model, the governance model would have to be adjusted in a corresponding manner. Formal mechanisms for CINS to voice the concerns of the user community would have to be established, and these mechanisms would have to be linked to the use of the funding envelope for the neutron beam mission. CINS already plays a similar oversight role in the use of the NSERC MRS grant to maintain the neutron beam laboratory in a state of readiness for access by the user community. In this model, the President of CINS, in collaboration with several other CINS members from universities across Canada, applies to NSERC for the funds as the principal applicant, and the funds are given to McGill University (as the home university of the CINS President) to be released by McGill to the CNBC on approval of CINS. CNBC reports annually through CINS to NSERC and in addition, a CINS oversight committee meets with the CNBC Director twice each year and provides its independent opinion to NSERC on the performance of CNBC and use of the funds. A similar model could be developed for the oversight of the $50M/year contribution to reactor operations for the neutron beam mission.

3.3 Other ideas on Governance and Funding

In the past, AECL has been a single entity that reports to NRCan because it has responsibility for long-term nuclear liabilities, use of natural resources (*i.e.* uranium) and energy. In the future, the S&T missions of CRL and especially the NRU reactor and its successor, could be viewed in the context of Canada's large-scale research infrastructure such as the Canadian Light Source, TRIUMF, SNOLAB, Ocean Networks Canada, Compute Canada and NRC astronomy facilities, all of which report ultimately to Industry Canada for funding. As Canada considers a framework for management of these facilities, the research reactor and associated facilities could be made an entity separate from the rest of CRL and managed in a manner similar to these other elements of large-scale research infrastructure. For example, the Jenkins report recommended creating "*a non-profit organization mandated to manage what are currently NRC major science initiatives and potentially other such research infrastructure in Canada*" (Innovation Canada: *A Call to Action. Review of Federal Support to Research and Development* – Expert Panel Report. 2011).

The NRU reactor, and its ultimate successor, could be operated as an independent entity from the rest of the site through contracts that recognize its operational and management independence. The nuclear S&T programs at CRL which need access to in-core irradiation would then be users of the nuclear R&D mission of the reactor along with other users from academia and industry.

CINS supports the multi-purpose nature of CRL and especially of the NRU reactor to achieve a balance of cost and benefits; but it will be essential to establish a governance arrangement that respects the requirements of each user community and is able to balance the operation of the facility so as to satisfy them all to the extent possible. Thus, the mission of the NRU reactor should be entrusted to an arms-length board of directors. To ensure that individual strategic initiatives are being carried out, individual sub-committees representing the scientific and industrial missions should report to the board.

There are two reasonable approaches to the composition of the board:

(1) The board members are representatives of major stakeholders, such as CINS, Canadian universities, industry, and federal and provincial governments; or

(2) The board members do not represent the stakeholders directly, but are instead paid members who are selected to provide a balance of competencies covering operations and the main missions of the reactor.

For example, in the first option, companies such as CANDU Energy or SNC Lavalin might be entitled to appoint a representative to the board, while in the second option, a qualified individual with experience in the line of business that these companies represent (but not currently employed by them) would be selected in order to represent the broader mission of nuclear energy R&D. While the first option provides the most direct avenues for stakeholder input, the second option minimizes conflicts of interest.

Whatever governing body emerges, it is important that it be familiar with the goals of a neutron beam laboratory, including being a powerful neutron source that is accessible by all, participating in a global network of neutron beam facilities, supporting academic, government and industrial users as they apply neutron beam methods to their research, and operating at full power on a reliable schedule.

The governing body of the NRU reactor would also be an appropriate entity to receive a mandate to consider Canada's needs for a future facility to surpass the NRU's capabilities and to provide some leadership in the national dialogue on this issue. Furthermore, its mandate should include making operational decisions that prepare to make maximum use of a new facility and to manage the transition from an NRU-centred laboratory to one based around the new CNC. This work would include developing a new, more inclusive governance structure, opening up contacts with potential users and clients and expanding capacities at the NRU reactor that could be transferred to the new facility, including operational, scientific and technical expertise, as well as facilities and equipment (*e.g.* beamlines and ancillary equipment, data acquisition and instrument control systems, sample preparation facilities).

While it is unclear in what form AECL will exist in the future, it is possible that such an organisation might be contracted to operate the research reactor, given its long history and experience base. However, without a dramatic change to both the mission and culture of AECL (which could take a decade or more to fully implement), for AECL to own and operate the reactor and thereby have sole control over its mission as in the past, is not advised.

CINS recognizes that there may be some nuclear licensing concerns to solve to implement a model where NRU is operated as an independent facility, but these can likely be overcome.

Over the longer term, if the S&T missions of CRL are re-invigorated and CRL becomes a successful user-oriented national resource for science, industry, and government, Canada might benefit from the experience of the USA's national laboratories. The NRC Canadian Neutron Beam Centre is one of 5 neutron beam facilities in North America, the other facilities being:

- Spallation Neutron Source (SNS) at Oak Ridge National Laboratory, USA
- High-Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory, USA
- Lujan Neutron Scattering Center at Los Alamos National Laboratory, USA
- NIST Centre for Neutron Research (NCNR) at the National Institute of Standards and Technology (NIST), USA

The first three are at national laboratories under the Department of Energy which contracts out management (the GOCO model), while the fourth is managed by a federal agency (NIST) under the Department of Commerce. For all of these facilities, both the neutron sources and the neutron beam laboratories are fully funded federally and managed as a unit within a larger S&T organization (*i.e.* NIST, or a national laboratory hosting other S&T facilities).

Although these American facilities are generally successful, hosting active user programs – the largest neutron beam user program is at NIST, which reports over 2000 research participants per year and is still growing – CINS does not advocate moving to this model for CRL immediately. A Canadian parallel would see CRL given a renewed S&T mandate and focus, the NRC Canadian Neutron Beam Centre eventually absorbed back into the rest of CRL, while CRL is managed by a larger S&T agency (*e.g.* NRC) or its management is contracted out.

In the short and medium terms, CINS does not wish to see the NRC Canadian Neutron Beam Centre (CNBC) re-join the rest of CRL because its organizational culture represents a small island of scientific creativity within CRL that must not be lost. It would take a decade or more of concentrated efforts to alter the organizational culture of CRL before it would be sufficiently consistent with those of the other laboratories for CRL to be able to adopt their governance models. Furthermore, there are several other considerations in the restructuring process that must be resolved (*i.e.* what to do with waste management functions, CANDU support, and other functions of CRL) which may impact the overall mission of the laboratory. Finally, unless there is an active commitment to building a successor to NRU on the CRL site, it is extremely unlikely that either CRL or the CNBC will survive in a meaningful form for long enough for the culture change to occur, or to be needed.

The funding and governance models that CINS recommends above are designed to drive the necessary changes forward and these recommendations can proceed in parallel with other restructuring activities at CRL. Thus, CINS advocates a wait-and-see approach about the possibility of re-absorbing the CNBC into CRL, and that this should be done when and only if CRL becomes a national laboratory for S&T both in mission and in practice.

4 Participation and Investment in the Laboratories

4.1 Direct participation by CINS

CINS has described the ways in which it wishes to participate in CRL in sections 2 and 3. In brief, CINS represents the neutron beam user community and therefore it seeks a stronger voice in the operations of CRL as decisions regarding its priorities affect the ability of the NRU reactor and the NRC Canadian Neutron Beam Centre to provide access to neutron beams and maximize S&T impacts. While many CINS members depend exclusively on the NRU reactor, CINS also represents users with significant experience accessing other neutron beam facilities in North America or around the world and can bring their observations of best practices from these facilities to inform decision-making at CRL.

Thus, CINS seeks to participate in an advisory panel for CRL, or more formally in a consortium of stakeholders responsible for overseeing CRL, as a member of a board of directors. Regarding the NRU reactor, CINS is interested in providing oversight of a funding envelope as a contribution to the reactor operations on behalf of the neutron beam community, as described above. Whatever governance model is selected for operating NRU going forward, the interests of the neutron beam community must be properly represented in decision-making. Looking forward toward a new research reactor, CINS must be actively involved at all steps of the process, beginning with the development of a business case, as described above.

4.2 Ideas on Additional Investment

Although this EOI argues that a strong federal role in funding is essential, there are opportunities for provincial partnering. Looking to other examples of large-scale research infrastructure in Canada, provincial governments have often provided contributions toward capital costs of building or upgrading new facilities (*e.g.* British Columbia has made major contributions to TRIUMF and Ocean Networks Canada; three provinces have made substantial contributions to the Canadian Light Source (CLS); and Ontario contributed greatly to the construction of the Sudbury Neutrino Observatory (SNO) and its successor SNOLAB). At the NRC Canadian Neutron Beam Centre (CNBC), the construction of the D3 beamline completed in 2007 provides a precedent for provincial partnering at CRL, where the Ontario Innovation Trust (OIT) provided matching funds for Canada Foundation for Innovation's (CFI) capital contribution.

There is also a precedent for the host province providing contributions toward operating costs (*e.g.* Saskatchewan in the CLS). The Government of Ontario could provide funds from its existing research funding bodies. If a new reactor is planned in Saskatchewan, the government of Saskatchewan might be invited to invest in the CNBC for the purpose of ramping up activities that can be transferred to the new facility.

The operation of a neutron beam facility can attract industry revenues and investment. Currently, NRC Canadian Neutron Beam Centre already attracts revenues from industry in cost recovery fees for access to neutron beams, usually for analysis of residual stress in metallic components where failure of the materials may have high costs, warranting the certainty that only neutron beam measurements can provide (*e.g.* aerospace, nuclear energy, natural gas pipelines, automotive, defense). Although CNBC is a world-leader in this area, it lacks the capacity to effectively market these services to industry and is limited by government policies on advertising. Further consideration of how to grow these revenues is needed.

Other services to industry are also possible. The clearest example is neutron radiography, which is a means to take images of objects with neutrons (similar to x-ray imaging). Neutron radiography was developed at the NRU reactor and spun-off as a private business, NRay Services Inc., which is now hosted at the McMaster reactor, and takes neutron images of airplane parts for quality assurance. The original beamline at NRU where this imaging technique was developed has been idle for nearly twenty years despite having far more available flux than the beamline at McMaster. The capacity for neutron imaging in Canada could be greatly expanded by re-opening the beamline at the NRU reactor for for this purpose, perhaps in partnership with NRay Services. We would envisage this leading to a permanent imaging presence at the successor facility in due course.

5 Benefits to AECL and Government

Access to a nuclear S&T laboratory is needed to maintain a presence in the global nuclear business and it will be essential for Canada's participation in generation IV power reactor development. World energy demands require the construction of new nuclear power plants, despite the fears generated by the incident at Fukushima, Japan. The US is now building reactors again while China has an active construction program to meet its rapidly growing energy needs. The UK is currently struggling to get back into the nuclear energy business after having lost much of its capability in this area. Although Japan and Germany have downgraded prospects for nuclear energy, "*much of the nuclear skepticism that other governments have signaled does not represent an erosion of enthusiasm for atomic power. Rather, it has more to do with showing tact in front of a jittery public*" (Economist Intelligence Unit. *The Future of Nuclear Energy: One step back, two steps forward*. June 2011).

The S&T centerpiece of CRL is the NRU reactor, and thus to maximize impacts from investment in CRL, the capabilities of the NRU reactor must be leveraged. In this EOI, CINS has described how the neutron beam mission of NRU can best be leveraged by including the neutron beam user community in oversight of funding and in governance, and that a new research reactor will be needed to surpass the capabilities of NRU.

A strong voice for the neutron beam user community will result in better governance, transparency, and clarity of mission for CRL and especially the NRU reactor. The benefits will be to maximize the S&T impacts and return on investment by driving the necessary changes forward to operate the NRU reactor as a productive world-class scientific facility. For example, much of CRL's resources are consumed by overhead activities; in contrast, environments conducive to scientific creativity have less focus on bureaucracy, and more on mission. Thus, the CRL of the future envisioned by CINS would have reduced overhead activities in favor of more S&T activities, including new collaborations through mission-focused outreach to industry.

Furthermore, the Government of Canada can accelerate the AECL restructuring timelines and be better prepared to make restructuring decisions by facilitating a national dialogue (including CINS and all other stakeholders) that will lead to the the production of business case for a new research reactor in parallel with the other studies that will inform the restructuring process, rather than waiting for the outcome of these other processes. The approach advocated by CINS will assist the Government of Canada in its fiscal and S&T policy objectives. It will help meet the plan to eliminate the deficit by 2016. CINS advocates a cost-neutral approach to the restructuring, by reallocating existing funds for reactor operations rather than providing new funds, and finding savings in the overhead at CRL to ramp up S&T activities. Furthermore, the long lead time required to plan and build a new research reactor suggests that even if the preparation of the business case described above began today, the major investments required for construction would occur after the 2016 target.

The Government of Canada identifies its S&T policy objectives in the Federal S&T Strategy. Canada's vision is to "*build a sustainable national competitive advantage based on science and technology and the skilled workers whose aspirations, ambitions, and talents bring innovations to life*" (Industry Canada. *Mobilizing Science & Technology to Canada's Advantage*. 2007). The strategy's four core principles are world-class excellence, focusing on priorities, fostering partnerships, and enhancing accountability. CINS' recommendations for governance and funding of the NRU reactor are meant to enhance its performance in each of these areas:

- To maximize return on investment in the substantial capital and operating costs of the NRU reactor, it is necessary to utilise it at a world-class level that is focused on Canada's priorities.
- Neutron beams are and can be used to study and develop materials that underpin the technological advances in all four of Canada's areas: Health and related life sciences, Information and communication technologies, Environmental science and technologies, Energy and natural resources. R&D for nuclear energy was explicitly identified in the 2009 update to the strategy as a specific priority within the general area of energy.

- Accountability will be enhanced by identifying an explicit envelope of funds, for which the reactor operator would be accountable to the neutron beam user community as well as the federal government.
- Partnerships and collaborations will be fostered by giving strong voices to the users communities in governance, who will push the operator to be much more responsive to the needs of the user communities and thereby to maximize its ability to leverage the research programs at universities, government laboratories, and industry.

Beyond these core principles, CINS's recommendations will promote the vision of the strategy not just by providing a facility but by ensuring that it is operated in way that will foster the talent and creativity envisioned by the strategy. The large-scale research infrastructure at CRL has the potential to inspire many Canadians toward careers in S&T and foster an S&T culture in addition to being a training ground for many individuals.

By placing NRU or CRL in the context of other large-scale large-scale research infrastructure under Industry Canada (*e.g.* Canadian Light Source, TRIUMF, SNOLAB), the Government of Canada will be better positioned to apply lessons learned from managing these facilities across its portfolio of these facilities, perhaps leading eventually to a policy framework for better planning from initial concept to their final decommissioning.

Governments are often perceived only as *supporters* of science: They build major infrastructure for research, they establish and fund research-intensive universities, they set up and fund granting agencies, they give tax credits to companies that engage in research, they operate national laboratories. However, in reality, governments are also some of the largest *consumers* of science. Our modern technology-driven economies demand science-based policies. How do you: Regulate a new industry? Evaluate a new technology? Ensure safety of a new product? Identify and mitigate environmental impacts? Set exposure limits? Establish design standards? Do you accept other people's claims or verify them in your own laboratory? The diverse capabilities embodied by a revitalised Chalk River Laboratories will have the capacity to not only generate new knowledge, but also to inform government decisions as legislators seek to understand issues of technology and develop definitive, science-based policies. In this effort, the Canadian Government will have the support of independent, expert advice from a world class research facility.

6 Implementation Timeline

The recommended changes to the funding model for the NRU reactor could likely be implemented in the 2013 budget. CINS would be happy to work with the federal bodies involved to design an oversight mechanism for the funds contributed to the reactor operations on behalf of the neutron beam user community within this time constraint. Further changes to the governance model such as setting up the NRU reactor as an independently managed facility from the rest of the site might take longer, but could certainly be done in a few years.

In parallel, the national dialogue leading to the development of a business case for a new reactor should begin shortly after all EOIs are received. All parties that submitted EOIs with respect to the S&T at CRL should be invited to participate in an initial consultation to determine interest in participating in this process. The final report including recommendations should be completed before the end of 2014 in order to inform decision-making about CRL restructuring.

To avoid a "neutron gap", the NRU reactor must continue to operate until a new research reactor can be built and commissioned (around 2021–2026).

7 Risk Management

The most effective way to manage risks associated with investment in S&T activities at CRL is to ensure that all stakeholders are engaged and that CRL is responsive to their needs through partnerships, transparent funding models, clear mechanisms to voice concerns and participate in its governance, as recommended by CINS herein. This will ensure that the government has access to the broad range of expertise required to manage CRL effectively and that the laboratories deliver value to stakeholders.

It must be noted that in contrast to the MAPLEs, a modern, safe, high-flux research reactor is not experimental or untried technology. Comparable reactors are already in operation around the world. There is very little risk that the CNC will not work as designed. However, one of the purposes of the national dialogue and business case is to identify and reduce any risks that might be involved. Having all stakeholders at the table from the initial concept stage will ensure that the final facility, once built, will truly meet Canada's needs during its long operational life.

8 Future Procurement Processes

The procurement of a new research reactor will not be a simple process and will be spread over about a decade. The Government of Canada might look to lessons learned from its shipbuilding strategy, which represents another long-term procurement commitment. In this strategy, all stakeholders are represented at the table from the beginning concept and design stages to ensure that the final products will meet Canada's needs.