



CANADIAN DECOMMISSIONING CAPABILITIES & EXPERIENCE DIRECTORY

DECEMBER 2020





The Canadian Nuclear Association (CNA) has been the national voice of the Canadian nuclear industry since 1960. Working with our members and all communities of interest, the CNA promotes the industry nationally and internationally, works with governments on policies affecting the sector and endeavours to increase awareness and understanding of the value nuclear technology brings to the environment, economy and daily lives of Canadians.



The Organization of Canadian Nuclear Industries (OCNI) is an association of more than 200 leading suppliers to the nuclear industry in Canada and the international marketplace. OCNI member companies employ more than 15,000 highly skilled and specialized people in Canada who manufacture major equipment and components and provide engineering services and support for nuclear power plants in Canada and around the world. OCNI companies also work on medical and other safe applications of nuclear technology. OCNI also encourages and supports member companies in taking their unique capabilities and high standards of quality and customer value to offshore nuclear markets through partnerships with local suppliers, power plant designers, nuclear utilities and government agencies.

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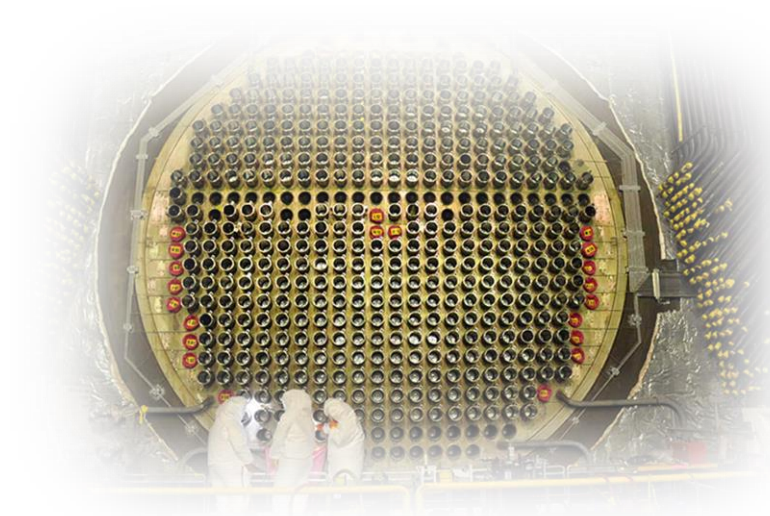
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1.0 Overview of Canadian Capabilities

1.1 A short history

Canada has a vibrant nuclear industry that has been consistently building or refurbishing nuclear plants since the start of the nuclear era. It has also been managing all the wastes produced during the operation of the Canadian fleet and has been heavily involved in supporting the management of wastes from other CANDU stations around the world. This has built a compact and cohesive industry that uses its home base experience to bring cost effective innovative solutions to the rest of the world.

As with many other countries it is entering a new era of decommissioning as its reactors start to come to the end of their useful life after decades of successful service. The timing of reactor retirements and the lack of a weapons program and/or reprocessing in Canada has led to it's decommissioning program starting later than in many other nations. There have however been many precursor decommissioning projects, notably at uranium mines, remediation sites and at the two national laboratories, Chalk River and Whiteshell. These last two have been consistently retiring nuclear facilities as they reached the end of their useful life including research and prototype reactors, laboratories and waste processing facilities. However, although power stations have been retired, none have been decommissioned and Canada's real program is, therefore, just beginning. This provides Canada with the opportunity to learn from the experience of others while having a clean slate that enables and encourages the sort of innovation that will resolve the challenges that those others have experienced.



The CANDU Pressurized Heavy Water Reactor is a differentiated reactor platform that has given rise to its own segregated ecosystem of suppliers.

The fact that the main part of the program is just starting does not mean that there is not a lot of experience and expertise already in the country and its companies. Canadian companies have been actively involved in refurbishing its nuclear stations. For a CANDU reactor that means stripping components from the core. In some ways refurbishment is very different to decommissioning as it must be planned in such a way as to ensure that the remaining infrastructure is not damaged and that involves surgical precision. But replacement of a significant part of the core gives rise to a lot of waste

and once the old component is removed it is just like any decommissioning waste and must be handled, size reduced and packaged for disposal in a cost efficient and timely. Canadian companies have become quite adept at adapting robotic and remote handling equipment from other industries such as automotive manufacturing and aerospace.

Capabilities, such as those developed during refurbishment, will be deployed in the upcoming program which, in the very near future, will include the retirement of the eight units of the Pickering Nuclear Generation Station (PNGS) as they come to the end of their useful life. PNGS will then become the largest nuclear station ever taken out of service and one of the few stations located in an urban environment that has ever been closed. It will be a learning opportunity like no other and its owner, Ontario Power Generation (OPG) is starting out on the exercise with that in mind by initiating a number of measures to stimulate innovation.

The Canadian nuclear industry has largely developed around the development, construction and operational support of the CANDU reactor. This differentiated nuclear platform has given rise to the development of a unique, stand-alone, comprehensive ecosystem comprising companies that are Canadian founded, owned and operated and international companies with specialist local subsidiaries. This ecosystem supports every aspect of the reactor lifecycle from Research and Development, through component supply to waste management and storage and, ultimately, will embrace decommissioning. Because its evolution has paralleled that of the other reactor platforms this relatively compact ecosystem has had to thrive through collaboration and that has created a compact and cohesive supply chain often offering novel solutions. CANDU fuel is, for example, a very different shape to light water fuel and Canadian companies had to develop new approaches to their handling, transport and storage, creating some expert container design and fabrication companies.



The CANDU fuel bundle is a very different shape to light water fuel bundles requiring a separate ecosystem to support its handling and disposal.

While the physical waste forms that arise from CANDU station operations are very similar to those of light water reactors the radiological profile is different with CANDUs creating more Tritium and Carbon-14. This has led to Canadian companies developing specialist expertise and technologies to deal with these isotopes. These have been deployed to deal with specific arising challenges such as those at Fukushima.

The Canadian nuclear supply chain has been fortunate. A consistent stream of new build projects was followed immediately by preparation for and then implementation of the refurbishments. These will then be followed by the decommissioning program. This consistency has enabled the companies to retain their nuclear capabilities and qualifications and to continue to hone their expertise positioning them well to serve the developing international Decommissioning and Waste Management business.

Canada has an active and highly respected program for the management of used fuel that is being run by the Nuclear Waste Management Organization (NWMO). This program is known as Adaptive Phased Management (APM). APM emerged from a three-year dialogue with both specialists and the general public. It is consistent with long-term management best practices adopted by other countries with nuclear power programs, such as Finland, France, Sweden, Switzerland, and the United Kingdom and is both a technical method and a management system.

The end point of the technical method is the centralized containment and isolation of Canada's used fuel in a Deep Geological Repository (DGR) to be placed in an area with suitable geology and an informed and willing host. APM also involves the development of a transportation system to move the used fuel to the new site from the facilities where it is currently stored.

The management system involves realistic, manageable phases, each marked by explicit decision points. It allows for flexibility in the pace and manner of implementation, and fosters the sustained engagement of people and communities throughout its implementation.

Presently NWMO are endeavouring to identify a “willing” community above an appropriate geological formation.

1.2 A developing industry

Canada was one of the first countries to enter the nuclear age. Before nuclear power was even contemplated radium was being mined, transported, processed, stored and used, first in the belief that it could improve health and later for its luminescence. When a pressing need developed during the second world war these early processing routes were quickly modified for uranium production.

When the nuclear power projects began in Ontario, Quebec and New Brunswick, provincial approaches were developed for the management of arising operational wastes. Occasionally one-off projects took place to recover, repackage and remediate these wastes where things didn't quite go to plan. During operation some facilities came to the end of their useful life and were taken out of service and decommissioned.

But decommissioning of large nuclear stations will be different and will require a new mind set. These large-scale projects typically benefit from the international skills and experience of large-scale, full-scope, engineering companies or international nuclear industry service providers that move their skilled resources around the world to where they are needed and then use local employees for implementation. Many of these companies are already actively involved in the Canadian nuclear supply chain and are looking forward to bringing their decommissioning expertise to bear in Canada. The customers for those services are embracing that opportunity. This international expertise will strengthen the existing Canadian supply chain both directly, as it gains experience in decommissioning itself, and indirectly through the import of technologies presently in use elsewhere.

An innovation ecosystem is being developed that will enable Canada to build on the existing international experience and develop new approaches to decommissioning and waste management for deployment at home and abroad. New entities including the Nuclear Innovation Institute and the Canadian Centre for Nuclear Sustainability will act as innovation hubs, bringing together academia, industry, key community stakeholders and customers to identify the issues and develop solutions.



Innovation hubs are developing that will bring together stakeholders to identify issues and develop solutions.

1.3 A Decommissioning and Waste Management Capabilities and Experience Directory

Decommissioning and Waste Management (D&WM) in Canada involves general capabilities such as demolition, nuclearized capabilities such as shielding or radiation monitoring, as well as technologies that are only applied to these specific tasks. It is a rapidly evolving capability.

This directory is a snap shot of that capability for buyers of Decommissioning and Waste Management services both at home and abroad and profiles what the Canadian supply chain can offer both individually and in collaboration. A broader listing of Canadian nuclear capabilities can be obtained from the OCNI and CNA membership lists available on their websites (<https://www.ocni.ca/membership-directory/>, <https://cna.ca/about-cna/members/>). Further details on the nuclear industry in Canada can be obtained from the Canadian Nuclear Association's factbook (<https://cna.ca/wp-content/uploads/2019/08/2020-Factbook-EN-digital.pdf>). The directory is of those aspects of the supply chain that are in some way specifically focused on D&WM and includes capabilities that exist, are planned or could be provided should the demand develop. It includes capabilities rooted in Canada or which are based elsewhere but may be delivered through the Canadian supply chain.

The APM program while being an aspect of waste management involves a very different style of work, especially at this stage of its development in Canada. This directory does not, as a result, cover suppliers to the APM program unless they also provide other D&WM services.

The directory captures the type of service provided and, where there is a specialism, it highlights that specialism. It does not list all the individual capabilities where the service is provided to a spectrum of projects. The companies listed in the directory each have a profile page that gives a more detailed outline of their capabilities, their website address and contact details for their Canadian business.

The directory itself is supported by five backgrounders on the Canadian experience that illustrate work that has been done by the Canadian nuclear supply chain.

2.0 Capability Profiles

- 2.1 New Ideas from a parallel evolutionary line – storage and transport containers
- 2.2 Stretching from sea to sea and beginning at the very birth of the industry – environmental remediation
- 2.3 Where people fear to tread – robotics and remote handling
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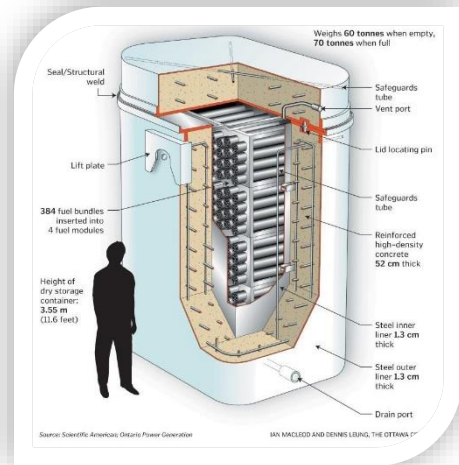
2.1 New Ideas from a parallel evolutionary line – storage and transport containers

When Canada embarked on its nuclear program it did not have the industrial capability to produce the very large-scale forgings needed for a light water reactor but it did have large stocks of heavy water. Thus it was that the CANDU Pressurized Heavy Water Reactor (PHWR) was born, using a natural uranium fuel, online fueling and individual fuel channels rather than a pressure vessel. A short fuel bundle about half a metre long, rather than a Pressurised Water Reactor's 4 metre long bundle, was a further variance that contributed to the success of this highly differentiated nuclear reactor platform.

And so it was that Canada had to develop a capacity to design and build its own radioactive materials storage and waste containers to accommodate these different sizes .

At the start of the program, an approach to dry storage of used fuel had to be developed. Now, as the end of this phase of the program is being contemplated, approaches

are being developed to transport the used fuel to its final resting place and then to place it in a safe and secure manner in a Deep Geologic Repository (DGR). At both ends of this life cycle, inspiration for the containers has been drawn from conventional industry and modified for nuclear use.



The Dry Storage Container has a 50-year design life but is expected to last until the fuel is moved to its final resting place.



Dry Storage Containers are stored in simple warehouse facilities maintaining a suitable environment for long-term storage.

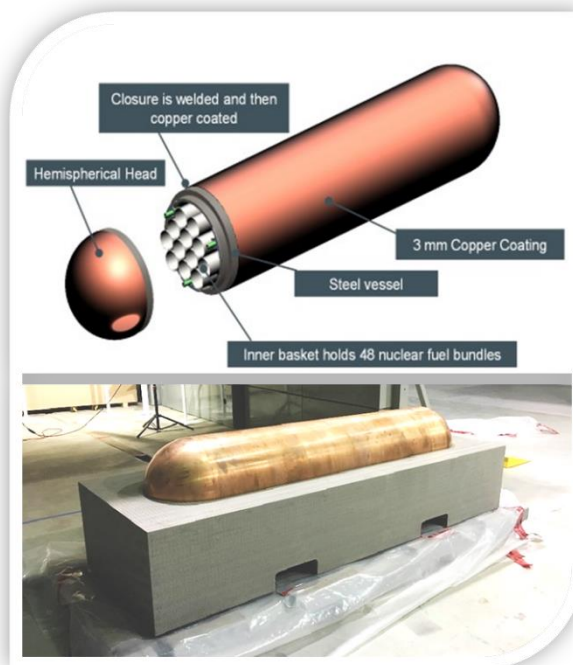
The Dry Storage Container (DSC) was designed by a Canadian utility, Ontario Power Generation (Ontario Hydro at the time) and fabrication contracted to local heavy industry. Fully loaded the DSC weighs 70 tonnes (60 tonnes empty) and is made of 50cm thick reinforced, high density, concrete contained between two 1.3 cm steel plates. It comprises a base unit and a lid and the system includes a capability to drain and vacuum dry the container before using automated welding to seal the lid in place. They hold 384 fuel bundles in 4 modules. Manufacturing was initially a challenge because of the high

tolerances needed for the precise placing of the lid on the container and consistent shielding, but Canadian industry rose to that challenge and the containers have been in use since 1987 and continue to be manufactured by two Canadian companies today. With a 50-year design life they are performing well and are expected to last until the fuel is shipped to the DGR. There are presently more than 3,000 in use.

The challenge for repository disposal is very different with shielding becoming less important and cost and corrosion resistance much more so. This leads to a need to use more exotic materials such as copper and to innovate to keep the costs down.

These new needs led Canada's Nuclear Waste Management Organization (NWMO) to find a way to use materials and techniques, readily available in local industries, to develop a minimally expensive containment but one which will maintain its integrity until the radioactivity has decayed to the levels of natural radioactivity.

The simple container they developed is a standard carbon steel pipe with a spherical head that is welded to the core of the container. Using standard materials that are readily available helps keep the cost down, and important feature when so many containers are needed. This basic structure has the mechanical strength to withstand pressures of the overlying rock and loading from three-kilometre-thick glaciers during a future ice age. The pipe is then protected by a corrosion-resistant copper layer which is thinly but consistently spray-coated onto the surface of the steel using standard, tried and tested, industrial techniques. Each container will hold 48 used fuel bundles in a steel basket in a container that is 2.5 metres long and has a diameter of 0.6 metres.



The Canadian used fuel disposal system includes a copper coated, inexpensive, carbon steel pipe spray-coated with copper using available, tried and tested, processes laid within a compressed

The complete system also includes a buffer box made of highly-compacted bentonite clay into which the container is placed. The bentonite clay is very stable having been laid down in natural formations millions to hundreds of millions of years ago. It will flow to fill any crack that might form and will swell on contact with water, limiting water penetration. Its chemical properties would cause many radionuclides to bind to it in the unlikely event that any were to escape from the container. The transport container needed to get the used fuel to the site is still being developed. Two options are being considered. One is a dedicated new container and the other an overpack that would provide impact and fire resistance to the existing DSC. The new container would carry 192 fuel bundles and would weigh 35 tonnes fully loaded while the overpack would carry a DSC direct from its storage and would weigh 100 tonnes loaded.

Canadian companies have also developed a range of specialist containers, including, notably, containers to store and transport tritium, that enable this waste product of CANDU operation to be processed and provided to industry for use in critical medical research and safety equipment.

The differentiated CANDU platform initially forced a separate evolutionary line for container design and manufacture, an evolutionary line that enables new ideas, based on the cost-effective use of proven manufacturing techniques, to be offered to the international market.

2.2 Stretching from sea to sea and beginning at the very birth of the industry – environmental remediation



On July 28, 1931, the first precious cargo from Gilbert LaBine's new discovery - - consisting of eight tons of rich radium-bearing ore -- is loaded onto a small craft at LaBine Point, on the eastern shore of Great Bear Lake NWT.

Uranium was discovered at Port Radium, Northwest Territories, in 1930. By 1932 it was being mined and the ore was being transported to Port Hope, 5,000 kms away, for processing into radium. Radium was at the time one of the most valuable materials on the planet.

The first 2,200km of the route was waterways and portages from the Great Bear Lake, via a system of lakes and rivers, south to Fort McMurray, Alberta, where there was a railhead. It was known as the Northern Transfer Route.

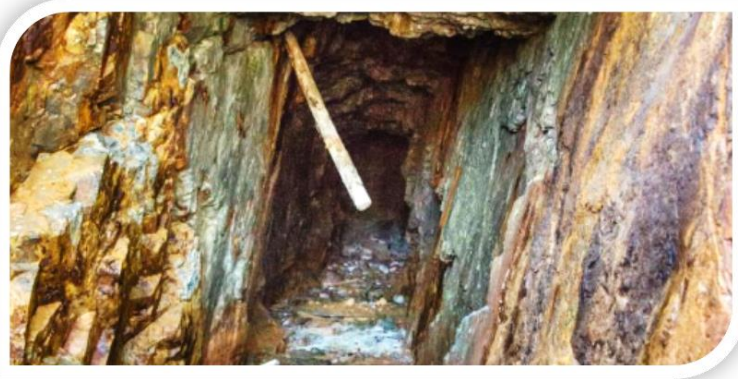
Initially the radium was used for medical purposes and later as luminous paint on military instruments. Uranium was a waste by-product. That changed in 1942 when

Uranium production began. Until 1943 it was the Allies' only source of Uranium and as such was of extreme strategic importance.

It was a time when there was little environmental regulation, the consequences of exposure to radioactive materials were poorly understood and there was a pressing need for both Radium and Uranium. As a result, materials were allowed to spill when the ore was transferred from barge to truck, or vice versa and created the nation's first radioactive materials contamination issue.

At the other end of the route, during the war and for some years thereafter, the Port Hope processing facility not only dumped its contaminated wastes in an uncontrolled way but some were actually used by the people of the town as landfill material. This created not just a technological challenge but a social one as much of the contamination was within a town, often in the yards and properties of the townspeople.

When the radium was first produced it was not controlled and was found in many products including foods, blankets and paints, mostly in small quantities that did not constitute an environmental hazard, but in some larger processing sites a hazard was created. One such site,



In the 1950s and 1960s 37 Uranium mines sites were opened and operated to minimal standards before being abandoned without being properly closed.

a farm where dial painting had been taking place, was discovered just outside Toronto when a subdivision was built next door.

Canada went on to discover many other sites with rich Uranium ores and although rich ore bodies have been found elsewhere in the world, Canada has still supplied more Uranium than any other country. The modern mines operate to very high environmental standards, but during the 1950s and 1960s, 37 uranium mines and small prospecting sites were developed in Saskatchewan and operated by private companies before being abandoned with little consideration for the environment.

Over on the west coast of the country in, Surrey, British Columbia, radioactive materials that had nothing to do with the Nuclear Industry ended up in landfill for a completely different reason. The slag from Niobium smelting concentrated Thorium to the point where it became a hazard but that hazard was not, at the time, controlled and wastes were accidentally blended with sand and gravel.

The timing of Canada's entry into the processing of radioactive materials, and the variety of ways that contamination can be created, has led Canada to deal with a variety of challenges. Dealing with them has established Canada as a leader in managing large-scale remediation projects including extended transport routes, legacy mine sites, dumps and landfills and Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM).



Providing value was an essential part of winning the local communities support for the remediation plan. The mound was shaped to resemble a natural landform and tilted to mimic existing drumlins in the area and walking trails will be incorporated into the remediated land.

That experience is embodied by the Port Hope Area Initiative where two projects, one in the town itself and another in nearby Port Granby are drawing to a conclusion. In Port Hope the project includes remediating land, a harbour and man-made structures and transporting 1.2 million cubic metres of material through the town to an engineered disposal mound. At nearby Port Granby, 450,000 cubic metres of contaminated material will be moved in land so that leaching into the lake can be avoided.

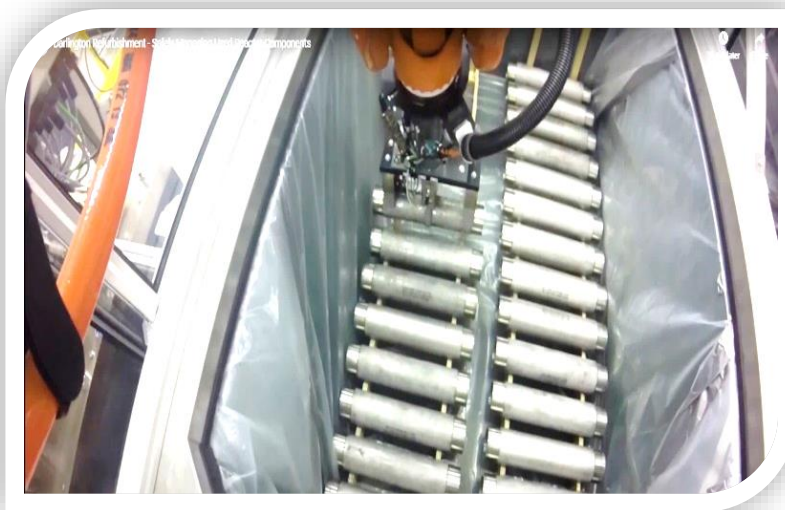
In all of these projects, even at the remote mine sites and northern transfer points, one of the key challenges was winning local community support. This required meaningful engagement with those communities. At both Port Hope and Port Granby, engineered mounds with multiple protective layers are used for safe long-term storage and walking trails and potentially other recreational activities, will be incorporated into the land handed back to the people.

2.3 Where people fear to tread – robotics and remote handling

Canada has yet to decommission a full-scale reactor and is looking forward to working with international expertise and experience when the time comes to do that.

But its hard to better the current Canadian experience when it comes to working near the core of the reactor and managing the radioactive wastes that arise. Presently two major refurbishment/life extension programs, together costing \$26billion, are taking place. The projects involve 10 CANDU units located at the Bruce and Darlington nuclear stations. For all the units, the work includes removing key core components such as pressure tubes and at some units there will also be replacement of large sections of the Balance of Plant such as the 100 tonne steam generators.

Refurbishment differs from decommissioning because it must be undertaken with precision to ensure that the reactor is not damaged and can be restored to use, something a decommissioning contractor does not need to worry about. But once the old component is removed it is waste and can be treated in the same way as decommissioning waste might be treated. Refurbishment waste will normally be more radioactive.



Experience from automotive manufacturing and aerospace were used in the development of automated tooling for handling, size reducing and packing reactors components during the Darlington refurbishment project.

Canadian companies have deployed skills learned from other industries to develop reliable, hardened, fast acting approaches to manage these wastes. The automotive assembly industry contributed ideas that would enable efficient, routine processing while the aerospace industry contributed reliability and precision to deliver machines that would extract components, size reduce and package them.

Similarly, imported ideas in robotics and remote handling equipment have also been used to enable the recovery and repackaging of challenging legacy wastes including those in outdoor standpipes/tile holes. The Fuel Retrieval System and Fuel Packaging and Storage Project entailed the development, fabrication, construction and operation of a comprehensive system to recover wastes and prepare them for long-term storage in a dedicated facility.



The Fuel Retrieval and Packaging System was an integrated system of remote handling equipment that enabled the harvesting of fuel from an outdoor tile array, drying of the fuel and repackaging it for indoor storage.

In the 50's and 60s these outdoor tile holes were used for the storage of used nuclear fuel coming from research reactors. They were very effective in ensuring that no one was exposed to the radiation from the fuel but exposure to the environment eventually led to water ingress and the corrosion of the containers, leading to a need to recover 96 such packages. The lack of certainty regarding the condition of the original

containers meant that the operations had to be remote and the system needed to provide shielding and containment throughout. In the end a team of designers, fabricators, constructors and operators worked together to produce a system that included;

- A shielded transport flask that locked to the tile hole and allowed the containers to be recovered directly into the flask
- A large adapted fork lift truck capable of navigating the outdoor terrain while carry the flask and delivering it to the new facility
- A remote handled system for unloading the flask, drying the contents and repackaging them
- An environment controlled, shielded above ground storage facility

Sometimes though you don't know what to expect and you just need a simple reliable tool to allow you to have a look round and for that Canadian companies have designed and built radiation resistant monitoring systems such as EPOCH that can be deployed on relatively inexpensive commercial platforms such as the CALIBER Mk3 tracked robot by ICOR Technology.



The EPOCH monitoring system mounted on a CALIBER MK3 leads to a cost-effective approach to seeing in those places where people fear to tread.

As these projects have developed Canadian companies have been nuclearizing experience developed while supplying equipment to other industries. Thus, decommissioning and waste management in Canada has benefitted from such things as the finesse and reliability born out of designing and building equipment to go into space and the robust, heavy duty, repetitively operating machinery used in the mass manufacture of cars. The result.....cost effective approaches to decommissioning based on already proven concepts.

2.4 From Canada to the World – Canada Exports its Decommissioning and Waste Management Capabilities



International sales of CANDUs has led to a culture of exporting in the Canadian nuclear supply chain with much of the waste management equipment supplied by Canadian OEMs.

With this international pedigree Canadian expertise has often been used to support other Decommissioning and Waste Management programs including solving challenging problems on other reactor designs or in cost effectively providing equipment for legacy waste programs. The consistent demands on the Canadian nuclear supply chain that have arisen as a result of the sustained and consistent build and refurbishment program has been instrumental in enabling Canadian companies to retain the expertise and qualifications necessary to develop and implement contemporary, state-of-the-art solutions. Examples include;

- Chemical decontamination of Primary Heat Transport (PHT) systems
- Nuclear station decommissioning plans
- Remote recovery of legacy wastes
- Tritium waste treatment
- Tritium recovery technologies
- Welding technologies including technologies for underwater welding of waste containers
- Submersible inspection technology
- Commercial site decommissioning and environmental remediation
- Uranium mine decommissioning plans
- Design and supply of waste handling equipment

The Canadian nuclear supply chain has always been extensively involved in building and then providing support to the CANDU stations around the world and is actively involved in exporting expertise, equipment and support services. Much of the equipment for handling, treating and storing operational wastes, including the used-fuel and tritium handling equipment, have a Canadian Original Equipment Manufacturer (OEM) who has often continued full support for that equipment.

With this international pedigree Canadian expertise has often been used to support other Decommissioning and Waste Management programs including solving challenging problems on other



Fukushima's highly alkaline, tritium contaminated water was sent to Canada for desalination using vacuum distillation.

Canadian expertise became especially relevant in resolving some of the waste management challenges that arose when tritium was generated in the untreated water used to cool the Fukushima Daiichi station during its incident. A variety of challenging contaminated liquids were produced and Canadian companies

were able to advise on safe tritium handling and processes for tritium removal. Some contaminated, highly alkaline, heavy water was shipped to Canada for desalination using vacuum distillation.

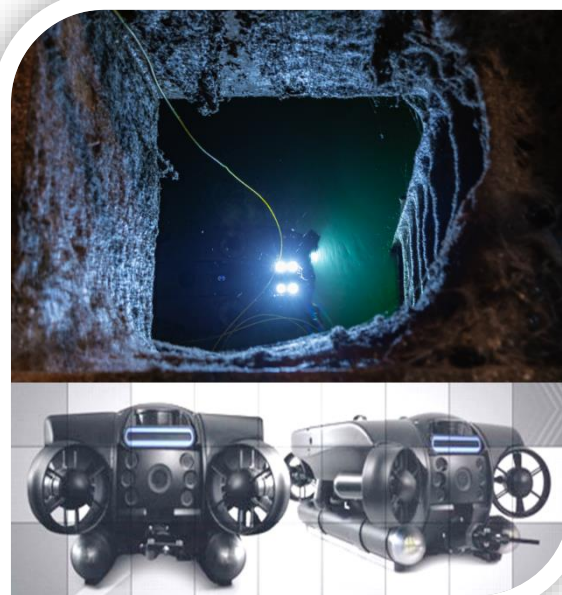


When it was decided that the Lingen prototype BWR should be decommissioned, Canadian expertise was deployed to plan the segmentation of the reactor vessel.

Very often the decommissioning challenge is complicated by inaccessibility caused by the radiation field or the wastes being submerged. Its hard to plan unless you can see what the problem is and hard to do anything about it if you can't get there! With many Canadian companies specialising in remote control, robots and remote arms for solving challenges at home its no surprise they are also helping people abroad. But when things get very wet it is Canadian designed and supplied submersibles that are swimming through fuel pools and other flooded active areas to give a clear view of what will be found there.

The Canadian supply chain has supported the construction and operation of nuclear stations throughout the world and is now ready to help decommission them and to recover, handle, volume reduce and package the arising wastes.

Decommissioning is, though, an international business and Canadian skill and expertise are integrated into bigger teams. When an offshore subsidiary of a major, Canadian owned, Full Scope Supplier won a project to decommission the Lingen prototype Boiling Water Reactor (BWR) in Lower Saxony, Germany, they recognised that segmentation of the reactor was going to be one of the most challenging tasks and looked around for expertise, finding it in Canada. A team of engineers and operational staff were contracted to join the team while the home base will provide manufacturing deployment services.



Canadian submersibles and remote arms are creating the access needed to provide layouts and identify challenges.

2.5 A Fresh Start – The Canadian Innovation Ecosystem for Decommissioning and Waste Management

Canada has been innovating on the peaceful application of nuclear science and technology for seven decades. One notable contribution is CANDU technology that is used in seven countries around the world.

To support the CANDU technology, a rich capability has been developed to continuously innovate on the advancement of nuclear science and technology, including to sustain the continued safe, economic, and efficient operation of the global fleet. This has produced many innovations to extend the operating life and safety of the plants.

The legacy of creative advances in nuclear power, medicine and science was enabled by significant infrastructure that is now aging and, in many cases, reaching the end of its useful

life. Canada has domestic needs to address the decommissioning not only of nuclear power plants such as Gentilly 2 in Quebec and Pickering in Ontario, but also significant research facilities in Manitoba and Ontario that include nuclear Science and Technology (S&T) laboratories, nuclear research and demonstration reactors, and final disposal of legacy waste materials and management facilities. The issues facing Canada are shared not only among CANDU nations, but are common challenges facing any country with nuclear facilities.

The need to decommission facilities is an amassed liability of many organizations in the country on which attention is now being brought to bear. To efficiently address the emerging needs of the DWM activities, Canada's robust nuclear science and technology ecosystem is now engaged in the R&D that will help cost effectively address the liabilities.

This ecosystem includes:

- DWM liability owners who are the customers for procuring DWM services,
- Research coordinators who, acting in the interest of the liability owners, sponsor the research to address the challenges presented by DWM
- S&T Providers who conduct the research and create the innovations to address the challenges
- Academia, who engaged in the basic R&D within universities to advance the state of knowledge that will underpin future innovations

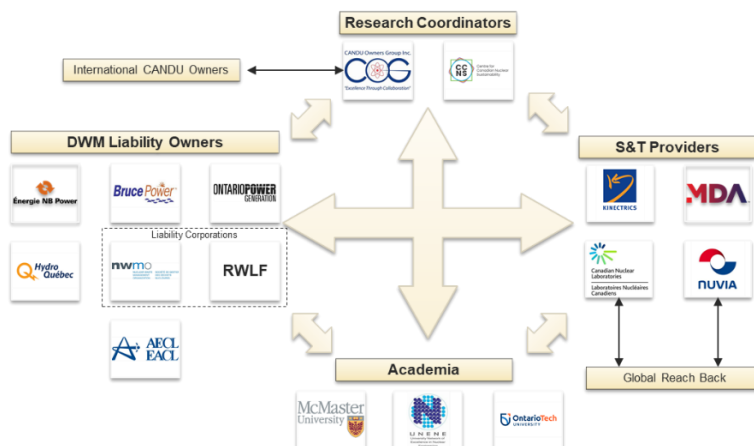
These capabilities are available to support all global DWM initiatives.

The rich S&T capabilities in R&D are being nurtured by the attention of Canada's liability owners. Not only are the nuclear power utilities such as Ontario Power Generation (OPG), Bruce Power (BP), and New Brunswick Power (NBP) actively engaged, Atomic Energy of Canada Limited (AECL) has the need to address research facility decommissioning. These organization collaborate on defining requirements for waste



The Pickering Nuclear Generating Station will be the largest such decommissioning project in the world

disposal routes for the long-term management of waste for both the existing fleet and anticipated advanced reactors. They fund the Nuclear Waste Management Organization (NWMO) who is spearheading the solutions required for final disposal of used fuel and the Radioactive Waste Leadership Forum (RWLF) who is exploring the options for final disposal of other waste streams.



Required research to enable cost-effective decommissioning is driven by additional coordinating bodies such as the CANDU Owners Group (COG), which represents all owners of CANDU based nuclear plants worldwide as well as other organizations interested in DWM activities. As such, COG's collaborative decommissioning program is considering the near-term needs of members such as South Korea and China and brings worldwide research outcomes to the Canadian team. OPG, in addition to research being conducted through COG, has sponsored the Canadian Centre for Nuclear Sustainability (CCNS) to help advance the state of the art in DWM.

The R&D is conducted both through universities in Canada as well as by Canada's nuclear S&T providers, all of which have been engaged in Canada's nuclear S&T and innovation systems for decades.

Canada has two significant university nuclear research programs at McMaster and OntarioTech. The focal, but not exclusive, coordinating body for university research is UNENE which balances the required research across many of Canada's universities ensuring that the best specialists are engaged appropriately to address the pressing research questions. UNENE provides in-person and digital educational programming to build capacity through under and post-graduate education for today's industry professionals and leaders of the future.

Canada's commercial S&T providers are also heavily engaged to create and commercialize innovations to address the challenges faced by DWM liability owners. Canada's preeminent federal nuclear laboratory, the Canadian Nuclear Laboratories (CNL), is a full-service nuclear laboratory capable of exploring any nuclear materials issue. The CNL also has extensive reach-back capabilities to access innovations in the DWM space globally. Several private organizations develop DWM innovations such as Kinectrics, Nuvia and MDA. Specialized Canadian R&D enabled innovations include remote handling and container designs.

3.0 Directory

3.1 Introduction

This is a directory of those companies, currently active in supplying goods and/or services within the Canadian nuclear supply chain that are directly relevant to Decommissioning and Waste Management and that are members of, or are associated with, either the Canadian Nuclear Association or the Organization of Canadian Nuclear Industries.

The expertise and experience of these companies has been categorized into:

- Full Scope Contractors
- Desk-Based Services
- Construction Services
- Fabrication Services
- Specialized Services (with the services listed where appropriate)
- Equipment supply (with the equipment listed where relevant)
- Containers
- Research & Development
- Education & Training

A list of all the relevant companies is provided for each category and the companies may then be looked up in the alphabetically listed directory of companies that follows.

3.2 Full Scope Contractors

Full Scope Contractors will undertake a complete project of a significant size, doing work that will include planning, engineering, acquisition of specialist equipment and tooling and the self-performing or sub-contracting of the site “construction” to implement the work. Many of these organizations are international engineering companies with nuclear divisions and would describe themselves as an EPC (Engineering, Procurement and Construction), but it also includes the larger specialist nuclear services suppliers and nuclear Original Equipment Manufacturers (OEMs). The large engineering companies will take on projects of any size, but the group does include some companies that, while providing a full scope may only do so for a certain scale of project.

- Aecon Nuclear
- Black & McDonald
- BWXT
- Canadian Nuclear Laboratories
- Cavendish Nuclear
- CCN
- CNL
- EnergySolutions
- E.S.Fox
- Fluor Canada
- Hatch
- Jacobs engineering Group
- Kinectrics
- Laurentis Energy Partners
- NUVIA
- Plan Group
- SNC Lavalin/Atkins
- United E&C
- Veolia Nuclear Solutions
- Westinghouse

In most cases Full Scope Contractors also provide services in the other categories, notably desk based and construction services, but also occasionally undertaking fabrication and/or offering specialized services. Where they only provide the other service as part of a Full Scope project they are not included in that category.

3.3 Desk-Based Services

This category includes all organizations undertaking work such as studies, plans, engineering or design.

- ATS
- BWXT
- Calian
- Canadian Nuclear Laboratories
- Cavendish Nuclear
- CCN
- CNL
- EnergySolutions
- Fluor Canada
- Golder Associates
- Hatch
- Kinectrics
- Laurentis Energy Partners
- MDA
- Nuclear Promise X
- Nuvia
- Promotion Nuclear
- Sargent and Lundy
- SNC Lavalin/Atkins
- United E&C
- Veolia Nuclear Solutions
- Westinghouse

3.4 Construction Services

Construction Services includes all work that involves tradesmen working at the customer site whether it is construction per se, equipment installation and maintenance, or deconstruction/demolition. Generally, construction work for any decommissioning or waste management project can be provided by any qualified organization employing tradespeople, as long as appropriate radiological controls and training are in place. These services may be sub-contracted to companies with specific expertise, such as demolition and the radiological overlay provided by a nuclear company.

The companies included in the directory have some further focus on decommissioning and waste management, normally as a result of being listed for the skills in one or more of the other categories. Buyers searching for services that need not come from a nuclear supplier, should consult regular trades catalogues and directories.

- Aecon
- Black & McDonald
- BWXT
- EnergySolutions
- Fluor Canada
- Golder Associates
- Kinectrics
- Laurentis Energy Partners
- United E&C
- Westinghouse

3.5 Fabrication Services

Fabrication services are provided by people that make equipment to a bespoke design either of their own or supplied by the customer. It does not include organizations that manufacture equipment that is kept in stock and ordered from a catalog. The listing here is only of organizations that have some focus on fabrication that would support a decommissioning project or have some specific interest in waste management equipment. Typically, this is because they also exist on one of the other capability lists.

Often the fabrication needed to support a D&WM project could be carried out by any general fabricator, a list of which is available from OCNI membership.

Organizations that specialise in designing and fabricating bespoke tooling and equipment and typically only fabricate in support of their own designs have been shown in bold.

- Aecon
- **ATS**
- Black & McDonald
- BWXT
- *EnergySolutions*
- E.S.Fox
- Fluor Canada
- Hatch Ltd
- Kinectrics
- MDA (primarily robotic and remote handling systems)
- Promotion Nuclear

3.6 Specialized Services

Specialized services include those services that are directly relevant to decommissioning and waste management that are offered separately than the more generic services already listed. They include services presently on offer or organization would offer should the demand exist. Where a company offers specialized services, they are listed on the company profile (and in brackets behind the company name). The services are all on offer in Canada but may be provided from within Canada or abroad.

- Aecon (Volume reduction, decontamination and handling)
- Bucephalus Consulting (Management Consultancy and Marketing)
- Calian (Waste Characterization)
- CCNS (Support for Innovation)
- CNL (Tritiated heavy water management, spent resin management, Sorting & segregation, Characterization & clearance Orphan waste management and Laser & chemical decontamination)
- COG (Information exchange)
- DB2 Consulting (Management Consultancy and Marketing)
- *EnergySolutions* (Decontamination, Incineration, Metal Melt, Compaction, Transportation and Waste sorting)
- FuseRing (Welding technology)
- Golder Associates (Geotechnical Engineering)
- Gowling WLG (Legal Services)
- Hatch (Pyro and hydro metallurgical decontamination and volume reduction and Decontamination and Decommissioning-as-a-Service)

- Kinectrics (Mixed Waste Processing, Waste Solidification Chemical and Mechanical Decontamination and Laundry)
- Liburdi (Welding and Welding equipment)
- NUVIA (Radiation Protection and Surveying)
- PLC Fire Safety Solutions (Fire Protection Planning and Fire Protection Equipment)

3.7 Equipment Supply

This category is of equipment specifically related to decommissioning and waste management that can be purchased “off the shelf” with the minimal design or additional definition. It does not include bespoke equipment built by design/build suppliers and it must be offered by a company in Canada, though it may be made in Canada or imported.

- Deep Trekker (Underwater ROVs)
- L3Harris (Digital twin framework with **Orchid IX** 3D immersion display system and simulators)
- Liburdi (Welding equipment)
- MDA (The EPOCH survey system)
- PLC Fire Safety Solutions (Fire Protection Equipment)

3.8 Containers

Containers have become a specialist area of supply although any company involved in desk-based services may design containers and any fabrication company may build them. The companies listed here have demonstrated specific expertise in the field and have a demonstrated track record in supplying containers.

- Aecon
- BWXT
- *EnergySolutions*
- Niagara Energy Products
- NUVIA
- SNC-Lavalin

3.9 Research and Development

Many companies will undertake Research and Development to support their own activities. The companies listed here provide Research and Development services to third parties.

- CNL
- COG
- Kinectrics
- McMaster University
- Ontario Tech University
- UNENE

3.10 Education and Training

This category includes academic training for students and commercial programs offered as part of professional development. Other universities, typically those that are involved with the University Network of Excellence in Nuclear Engineering (UNENE), also undertake some Research and Development in the field in specialist areas.

- Kinectrics
- Laurentis Energy Partners
- McMaster University
- Ontario Tech university
- UNENE

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Aecon

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Contact: James Gandhi
Director Strategic Development
226 215 3475
jgandhi@aecon.com

Address: 154 Sheldon Drive
Cambridge, Ontario, N1R 7K9



Building Canada for over 140 years, we are Aecon Proud – proud of our storied Canadian heritage, the projects we build, the positive impact we make in the communities in which we live and work, and proud of our first-rate safety culture.

Aecon Nuclear offers a full spectrum of Engineering, Procurement, and Construction (EPC) services. From large component removal and segmentation to waste handling and minimization, Aecon has been helping nuclear clients manage their on-site contaminated materials for the last 50 years

Aecon projects include a wide variety of scope related to the nuclear system's retirement. Typical examples of our past projects include removing large components like steam generators to HEU's packaging, segmenting primary circuit components to constructing and operating an intermediate waste volume reduction facility.

Services: Full Scope Contractor, Desk-Based Services, Construction Services, Fabrication Services, Specialized Services and Containers.

Specialized Services:

- Volume reduction, decontamination and handling



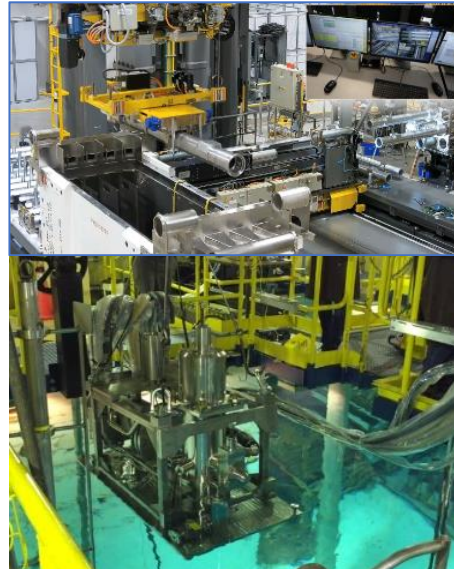
Website: <https://atsautomation.com/automation-and-test-solutions-for-the-nuclear-industry/>

Contact: Narinder Bains
General Manager – Nuclear
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nbains@atsautomation.com

Address: 730 Fountain St N,
Cambridge, Ontario, N3H 4R7

ATS Automation Overview

ATS is an industry-leading automation solutions provider to many of the world's most successful companies.



ATS uses its extensive knowledge base and global capabilities in custom robotics and automation, repeat automation, automation products and value-added services, including pre-automation and after-sales services, to address the sophisticated needs of multinational customers in the nuclear market. Founded in 1978, ATS employs approximately 4,500 people at 22 manufacturing facilities and over 50 offices in North America, Europe, Southeast Asia and China.

ATS dramatically improves timelines, while reducing costs and worker exposure in high radiation environments.

We deliver solutions for dismantling, waste handling/packaging and volume reduction of irradiated components including internal reactor vessel components and reactor vessel segmentation.

Our remote tooling has achieved an extensive track record of safely dismantling and removing highly contaminated reactor components for volume reduction, transportation and preparation for storage.

- Accelerated delivery due to proven methodologies
- Robust tooling for high-risk environments
- Extensive reliability testing in full scale mock-up facilities
- Reusable tools for repeatable success

Decommissioning and Waste Material experience includes: robotics - reactor segmentation - volume reduction – waste packaging – underwater fuel encapsulation – flasks & shielding analysis – remote guided vehicles & transport movers - process systems – remote decontamination – dose calculations

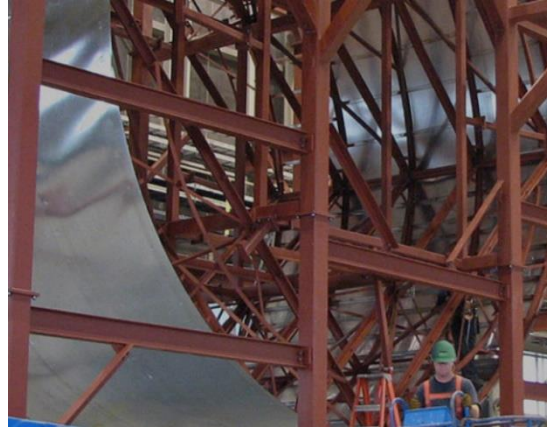
Services: Desk-Based Services, Fabrication Services

Black&McDonald

Website: <https://blackandmcdonald.com>

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Address: 81 Osborne Road, Bowmanville,
ON L1E 0L1



Black & McDonald is a privately owned and operated Canadian company which was established in 1921. We are an integrated, multi-trade prime contractor serving government, institutions, industry, and commerce across Canada, the United States, and overseas. Our services include multi-million dollar construction projects, extensive facility management and operations contracts and planned maintenance agreements and emergency services. Currently, we have more than 5,500 employees operating out of a network of over 25 offices across Canada, the United States, and Bermuda.

Having a long-standing presence in the Canadian Nuclear Industry as an Engineer, Procure and Construct (EPC) contractor, Black & McDonald has successfully delivered over 525 Nuclear projects. We currently hold critical maintenance and project roles at all 3 nuclear stations in Ontario, where we work collaboratively with the operators to deliver on our commitments. We participate in innovation panels and provide experience on how things can be streamlined and made more cost effective. We have enjoyed steady growth in our nuclear projects portfolio based on our highly committed, long term employees who share our strong commitment to nuclear safety, quality and customer satisfaction.

As an official “Industry Catalyst” member of the Centre for Canadian Nuclear Sustainability (CCNS), Black & McDonald continues to stay engaged in innovative, sustainable solutions for the nuclear industry. Black & McDonald actively participates in constructability reviews and provides input regarding decommissioning in support of our nuclear clients Engineering Service Provider’s, with the ability to support the execution plans per the design for these activities as well.

Services: Full Scope Contractor, Construction Services & Fabrication Services



BUCEPHALUS CONSULTING

Taking You To New Territories

Contact: Neil Alexander
Principal Consultant
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Email: Alexander.neil51@gmail.com

Address: Wainfleet, Ontario, L0S 1V0



Bucephalus Consulting provides management and marketing services including;

- Studies of issues where technology and industry intersect, typically involving energy, the environment and uses of radioactivity including medical isotopes
- Market reports, market advice and introductions
- Communications including the development of compelling proposals and grant applications

Dr Neil Alexander, the Principal Consultant, has extensive experience in Decommissioning and Waste Management in both Europe and North America and has undertaken technical and marketing studies on behalf of a number of business and government clients. A former President of the Organization of Canadian Nuclear Industries and of Monserco Ltd (now a part of EnergySolutions) Dr Alexander has strong connections with the Canadian nuclear supply chain and appreciation of the issues surrounding Decommissioning and Waste Management in Canada.

Services: Specialized Services

Specialized Services:

- Management Consultancy and Marketing



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Director, Communications & Government
Relations
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Cambridge, Ontario, N1R 5V3



BWXT Canada Ltd. (BWXT Canada) has over 60 years of expertise and experience in the design, manufacturing, commissioning and service of nuclear power generation equipment. This includes steam generators, nuclear fuel and fuel components, critical plant components, parts and related plant services. BWXT Canada's sister company, BWXT ITG Canada, Inc. (BWXT ITG) provides its customers, who conduct life-saving medical procedures for patients around the world, the benefit of decades of experience in the development, manufacturing, packaging and delivery of medical isotopes and radiopharmaceuticals.

Headquartered in Cambridge, Ontario, BWXT in Canada has approximately 1,500 employees at locations in Cambridge, Dundas, Peterborough, Toronto, Arnprior, Pickering, Port Elgin, Owen Sound, Kanata and Oakville, Ontario and Vancouver, British Columbia. BWXT Canada is a subsidiary of BWX Technologies, Inc. (NYSE: BWXT). Follow us on Twitter @BWXTech and learn more at www.bwxt.com.

BWXT Canada specializes in design, engineering and manufacturing solutions for its nuclear customers. This includes components such as used fuel and low/intermediate level waste containers. BWXT also has a very experienced project management and field services organization to respond to a variety of nuclear site projects.

BWXT Canada has been producing either build-to-print or its own designed nuclear waste containers for many years. The company's Cambridge operations features a dedicated manufacturing cell that specializes in producing waste containers for spent fuel and low/intermediate level wastes. The company is also working to offer solutions in tritium recycling.

Services: Full Scope Contractor, Desk-Based Services, Construction Services, Fabrication Services & Containers.



Website:

<http://calian.com/solutions/nuclear-environmental-services/>

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Director, Nuclear
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ON K2V 1C8



Calian Nuclear is a centre of excellence for the development of technological safety and risk-based solutions. With professionals who are recognized as experts in their respective fields, Calian Nuclear can provide its clients with a wide range of nuclear safety services.

We provide support services to waste management and decommissioning operations including all aspects of waste characterization from assessing hazards associated with a waste stream, development of waste characterization plans and data quality objectives, execution of field work, coordination of sample analysis with certified laboratories and the development of the characterization report. Calian Nuclear continues their status of excellence through participation on the CSA N292.8 technical subcommittee

Calian also performs safety analyses and environmental risk assessment for certification of waste transportation packages to support licensing for waste management facilities and has performed the safety analysis and shielding evaluations of a Type B(U) transportation package to obtain a design certification from the CNSC.

Calian Nuclear has participated in planning, conducting and reporting on final status surveys for facilities at Canadian Force Bases across Canada to facilitate the release of these sites from licensing conditions and to allow demolition.

Services: Desk-Based Services & Specialized Services

Specialized Services:

- Waste Characterization



People who innovate to make nuclear solutions safer, faster, at a lower cost

Website:

<https://babcockcanada.com/cavendish-nuclear/>

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Business Development Director
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Ottawa, Ontario
K1P 5E7



Cavendish Nuclear Canada, is the Canadian arm of Cavendish Nuclear, a leading nuclear services company with a growing national and global presence. Cavendish Nuclear is the nuclear arm of the Babcock International Group.

Drawing on over 60 years of nuclear experience, we provide service solutions in Canada, with global capabilities across the entire nuclear life cycle — from design and build, through operations and maintenance, to decommissioning, waste management and remediation.

Our capability and experience in the complete decommissioning of nuclear-related infrastructure, associated facilities, and equipment allows us to provide fully integrated solutions that can be delivered in-house for both Canadian and international customers. Safety (conventional, nuclear, environmental), quality and security are paramount through all aspects of our decommissioning work.

Cavendish Nuclear, as part of the Parent Body Organisation for Dounreay is contracted by the Nuclear Decommissioning Authority (NDA) of the United Kingdom to safely decommission and restore this legacy nuclear site. It is also delivering on a major decommissioning project at AWE Aldermaston and is supporting the UK MoD in the development of a submarine decommissioning demonstrator at Rosyth.

Cavendish Nuclear Canada delivers its international skills and experience through its local workforce and supply chain partners.

Services: Full Scope Contractor and Desk-Based Services.



Website: www.ccnuclear.ca

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General Manager
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CCN is recognized as a specialized solution provider in the nuclear industry. Our team of experts has extensive experience in the design and development of global solutions for the management of low-, intermediate-, and high-level radioactive waste. We provide our clients with integrated expert services, from the idea to fabrication, implementation, and operation, to reach dry safe storage, decommissioning and deconstruction of equipment, systems, and facilities.

Our expertise spans a large spectrum of waste, such as: spent fuel handling, extracting, packaging and storage both ILW and HLW, under water as well as in dry conditions, including spent ions resins and slurries. CCN also designs and fabricates specialized heavy shielded handling and transportation equipment, containers, process systems, vacuum retrieval systems and Hot Cells for nuclear waste management. CCN also provides field sample and artefact collection, swiping techniques and characterization services for wet or dry nuclear waste, and other ILLW radioactive material.

CCN can further produce comprehensive studies, design tools, and processes for the conditioning, packaging, and transfer to interim dry storage of miscellaneous LILW and HLW radioactive waste in the spent fuel and auxiliary bays, while optimizing the use of current shutdown facility systems.

Services: Full Scope Contractor, Desk-Based Services, Construction Services & Specialized Services



Centre for
Canadian Nuclear
Sustainability

Website: [CCNS Twitter](#), [CCNS LinkedIn](#)

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416-528-2558
Sabrina.nestor@opg.com

Address: 1340 Pickering Parkway
Pickering, Ontario, L1W 4A7



The Centre for Canadian Nuclear Sustainability (CCNS), located in Durham Region – Ontario’s nuclear capital, is an innovation hub that will attract skilled jobs, innovative businesses and economic development to the Durham Region. The Centre will coordinate collaboration and research efforts to identify innovative technologies in the nuclear sector, and advance solutions for minimizing nuclear materials and recycling clean materials. It will also support the work underway to prepare for decommissioning the Pickering Nuclear Generating Station.

The Centre’s vision is for nuclear technology to be adopted as the sustainable energy source for future generations. It will look for new ways of bringing nuclear power to life and break down barriers by changing the way the world sees nuclear power. The Centre will discover research, development and export opportunities for innovative nuclear technology by forming partnerships with the industry, community, local businesses, academia and Indigenous communities, as well as interprovincial and international organizations.

The combined experience between our 30+ CCNS Partners (and counting) will position the CCNS and Canada as a leader in the nuclear industry for innovative technology. The Centre will collaborate with other utilities and international organizations to develop industry best practices and benchmark global experience.

Services: Specialized Services

Specialized Services: Support for Innovation



Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

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Canadian Nuclear Laboratories (CNL) is a globally recognized combined Environmental Remediation Management (ERM) organization and premier nuclear Science and Technology (S&T) laboratory that has led R&D in support of the CANDU fleet for decades.

CNL's ERM team is accelerating the accomplishment of the largest and most complex environmental remediation portfolio in Canadian history. CNL's ERM capabilities range from decommissioning, to environmental remediation, waste management, safety & licensing, and engineering. These capabilities are underpinned by the S&T laboratory as a technical authority and source of cross-cutting CANDU subject matter expertise.

Utilizing domestic and internationally proven and scientifically validated state of the art technologies and processes, CNL will complete significant projects that make a major impact on a sustainable environment for Canadians. As a result of CNL's ERM mission experience, CNL is prepared to offer an array of DWM services to support the broader Canadian and international industry.

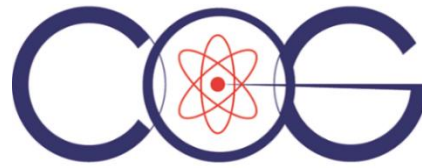
CNL's experience dates back 60 years and ranges from decommissioning planning and execution of both reactors and nuclear R&D facilities; waste management across the spectrum of low, intermediate and high level waste, including spent fuel; and development and testing of niche technologies to safely manage orphan wastes. CNL has multiple nuclear licensed sites in Canada which enables to ability to trial active demonstrators on real projects before bringing them to the market.

Services: Full Scope Supplier, Desk Based Services, Specialized Services & Research and Development

Specialized Services:

- Tritiated heavy water management
- Spent resin management
- Sorting & segregation
- Characterization & clearance
- Orphan waste management
- Laser & chemical decontamination

CANDU Owners Group Inc.



"Excellence Through Collaboration"

Website: www.candu.org

Contact: Stephanie Smith
President and CEO
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Address: 655 Bay St, 17th Floor
Toronto, ON, M5G 2K4, Canada



The CANDU Owners Group (COG) is a private, not-for-profit corporation funded voluntarily by CANDU operating utilities worldwide, Canadian Nuclear Laboratories (CNL) and supplier and program participants. COG's vision is excellence through collaboration for CANDU and advanced nuclear technologies. Together with its members, suppliers, and research and partner organizations, COG is continuously innovating nuclear plant equipment and processes to ensure the highest standard of safety, efficiency and environmental performance. COG is a trusted nuclear industry leader comprised of a highly-skilled team with extensive experience in many facets of CANDU nuclear technology.

The work in decommissioning and waste management spans multiple lines of business at COG including Nuclear Safety & Environmental Affairs, Research & Development, Joint Projects & Services and Information Exchange. COG facilitates the Radioactive Waste Leadership Forum (RWLF), a Decommissioning Peer Group (DPG), a Waste Management Peer Group (WMPG) focused on sharing operational experience and developing strategies, common approaches and solutions. R&D activities are undertaken within two areas. COG's Strategic Research & Development (SRD) program in Decommissioning and Long-Term Waste Management (DLTWM) focuses on long-term development of technology and infrastructure to support safe and cost-effective decommissioning and waste management activities and strengthen public confidence. COG's Health, Safety and Environment Program is aimed at solving near-term challenges in operational waste management with a focus on applied research and minimizing cost, volume and impacts on health and the environment.

Experience in decommissioning and waste management has been long standing at COG. Together, we are building capacity and experience with a vision to create collaborative research that will help the CANDU industry remain sustainable and strong for future operations over the next several decades.

Services: Specialist Services and Research and Development

Specialist Services:

- Information exchange



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Contact: Doug Burton MBA P Eng.
President
289-251-1105 cell
Doug@DB2Consulting.ca

Address: 9398-39 McDougall Rd,
Baltimore, ON K0K 1C0



DB2 Consulting Inc, established in 2015, performs business development and market analysis for clients. In the Decommissioning and Waste Management field DB2 represents an established International firm seeking business in Canada.

DB2 Consulting Inc provides Market Analysis and Business Development services to a variety of clients in several fields including Decommissioning & Waste Management.

Services: Specialized Services

Specialized Services:

- Management Consultancy and Marketing



Website: www.deeptrekker.com

Contact: Andrew Lawrence
Business Development Specialist
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Kitchener, Ontario, N2R 1K4



Deep Trekker, established in 2010, manufactures fully submersible ROVs for observation, inspection, cleaning and light work. We are headquartered in Kitchener, Ontario, Canada, known as the Silicon Valley of the North, a hub for technological engineering and advancements. We have employees globally with 17 dedicated engineers and have sold thousands of our ROVs in over 90 countries. All engineering and manufacturing is completed in house. We pride ourselves on our ability to listen to our customers and to make even the toughest missions easier. We empower our customers to customize their ROVs to maximise effectiveness. We manufacture the most durable, innovative, portable, and affordable underwater ROVs and submersible robots to solve a host of environmental and industrial challenges.

While many of our competitors' systems have bulky control systems or require topside power in the form of a generator, our robots are battery powered so they can be used in confined spaces with no ventilation. Battery powered ROVs are ideal in most parts of the plant, but for use in a reactor or spent fuel pool, Li-on batteries present a hazard, so we're bringing you a topside power option in 2021. Our ROVs are also quite durable in high radiation areas and are easily decontaminated. They're designed with Foreign Material Exclusion in mind. Our Revolution can be fitted with a Caviblaster for surface cleaning of algae and other marine growth and can be fitted with a Zoom camera for close-up inspections in hard-to-reach areas. We also launched our DT640 Max which is a vacuum robot that can be used to remove silt and sand from intakes and other parts of the plant. Our controller is similar to a handheld video game controller, so even the least tech-savvy person can figure out how to fly it in mere seconds. Not only is it easy to use but it's also lightweight, portable and weatherproof.

Deep Trekker is actively looking to find opportunities in decommissioning globally.

Services: Equipment Supply

Equipment Supply: Underwater ROVs



Website: www.energysolutions.com

Contact: Vik Tathe
VP Business Development
905-494-9029
vgtathe@energysolutions.com

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Brampton, ON. L6T4V8.



Located in Brampton, Ontario, the EnergySolutions Canada Walker Operations (ESWO) facility is a radioactive waste and materials management facility that safely manages nuclear material. The facility operates under a broad Canadian Nuclear Safety Commission (CNSC) Waste Nuclear Substance License. EnergySolutions Canada is subsidiary to EnergySolutions, an international nuclear services company headquartered in Salt Lake City, Utah, with operations throughout the United States, Canada and Japan. EnergySolutions is an industry leader in the safe recycling, processing, transportation and disposal of nuclear material. We provide a full range of Decommissioning and Decontamination (D&D) services to shut down nuclear power plants. Our customers include the United States Government, all United States and Canadian Nuclear Power Plants, along with various medical and research facilities.

In order for operating nuclear sites to be sustainable, and for retired sites to be properly decommissioned, there must be safe, reliable solutions in place for radioactive waste and material. This nuclear need is met by our comprehensive waste management services. These services include the safe transportation, processing, and disposal of low-level radioactive waste.

As a nuclear facility reaches the end of its life, our decommissioning services ensure a safe, proven deconstruction method with environmental restoration processes to restore the land. While this is the final phase for the facility, its the start of a new phase for the future. Our comprehensive decommissioning capabilities range from decommissioning planning through site restoration and license termination. With about 30 years of experience as a decommissioning service provider, we have developed a unique Decommissioning Management Model that reflects lessons learned and best practices that can be applied from one project to the next. With the support of our Waste Management division, we safely manage over 80% of the decommissioning waste across America.

Services: Full Scope Contractor, Desk-Based Services, Construction Services, Fabrication Services, Specialized Services & Containers.

Specialized Services:

- | | | |
|-------------------|--------------|------------------|
| • Decontamination | • Metal Melt | • Transportation |
| • Incineration | • Compaction | • Waste sorting |



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Fluor is a global, publicly-traded engineering, procurement, construction and maintenance company. Fluor provides environmental and nuclear program management services including nuclear operations, decommissioning, environmental remediation, laboratory management, nuclear waste management and site closure management at nuclear sites in Canada, the U.S., and UK.

Our skilled personnel leverage their utility experience managing the decontamination and decommissioning of commercial nuclear power plants to develop processes meeting regulatory requirements and client-specific needs. This unique interface with technical, human, political and regulatory challenges has enabled Fluor to build nuclear teams capable of managing the demands of facility retirement.

Fluor's experience in decontamination and decommissioning (D&D) of radiological facilities includes the decommissioning of **32 reactors**. Recent projects include:

- **Ontario Power Generation (OPG) Core Projects and Engineering Support, 2017-Present.** Fluor's team of 200+ EPC personnel support procurement and construction services for nuclear waste storage services and engineering study services on waste stream management.
- **NDA Magnox Decommissioning, 2014-2020.** Fluor Cavendish Partnership scope included defueling, decommissioning and waste management, spent fuel management and transport, and power generation. The team overhauled site life time plans, optimized waste and decommissioning programs, and restructured the program's asset care investment strategy.
- **U.S. DOE Savannah River Site (SRS) Management & Operations, 2008-Present.** Fluor's team has decommissioned three reactors at the SRS. The P reactor area decommissioning scope included complete deactivation and in situ decommissioning of the p reactor, demolishing the fuel basin and all ancillary facilities, remediating multiple contaminated areas, and installing two vadose zone remediation systems.
- **U.S. DOE Hanford Project Management for Environmental Remediation, 1996-2009.** Fluor's scope included maintaining infrastructure; decontaminating, decommissioning, and demolishing; managing waste; and, remediating groundwater. The team executed 4 million hours over 4 years without a lost-day case, and partnered with key stakeholders and regulators to agree on end-state objectives for eight Pu production reactors

Services: Full Scope Contractor, Desk-Based Services, Construction Services & Fabrication Services



The non-linear fusion solution

Website: www.fusering.com

Contact: Paul Cheng
Job title: Inventor / Founder
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Address: 936 Wellington St. N
London, Ont. N6A 3S9



FuseRing delivers flawless welds on the inside of spent nuclear fuel containers in one shot regardless of thickness or dissimilar layers. The weld can be achieved millimeters away from used fuel pellets. No PWHT is required.

The process is truly automated. Once the weld face is checked & aligned the spent fuel can be loaded. The weld is activated remotely and completed in one minute. The integrity of the weld is documented in real time based on electrical power, torque and forge. Nothing else.

The resulting weld is even, fine grained throughout leading from low to no residual stress. There is no heat affected zone. The FuseRing technique is a good candidate for joining irradiated material. The geometry can be flat, curved or tubular. The working temperature is truly solid state, below melting point. There are no fumes and no sparks, only a momentary glow.

FuseRing is open for discussions. Demonstration equipment and a budget is being drafted by Belgian Welding Institute and DENYS (Belgium). The technology is 100% clear title of IPs granted, published and pending.

Services: Specialized Services

Specialized services:

- Welding technology



GOLDER

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Toronto, Ontario, M5H 3R3, Canada



Golder Associates has been employee owned since being founded in 1960. Our more than 7,500 people, operating from 155 offices worldwide, deliver deep technical understanding, cross-disciplinary thinking and a passion to help our clients succeed. Golder provides consulting, design, and construction services in our specialist areas of earth, environment, and energy through technical excellence, innovative solutions and award-winning client service.

Golder has been providing environmental and geo-engineering services to the nuclear industry since the 1970's. We can assist with environmental assessment and permitting, environmental management and compliance, waste facility design and construction, decommissioning and monitoring, long-term performance and safety assessment, and quality management.

Golder supports efforts for the safe management of radioactive waste and has played a significant role in developing waste management solutions for several Canadian and global project sites. Experience includes waste characterization studies, hydrogeological and geophysical investigations, options assessment and cost-benefit analyses, construction monitoring and QA/QC, Engineer of Record, and long-term performance monitoring.

Services: Desk-Based Services, Construction Services & Specialized Services

Specialized Services:

- Geotechnical Engineering



GOWLING WLG

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Gowling WLG is an international law firm built on the belief that the best way to serve you is to be in tune with your world, aligned with your opportunity and ambitious for your success. Around the world in 19 cities across Canada, the UK, Europe, Asia and the Middle East, our 1,400+ legal professionals and dedicated business support teams apply our deep sector expertise to understand your business and help you succeed. The Gowling WLG nuclear team is not only at the forefront of the nuclear industry's decommissioning programs and new-build projects, but is also a leader in waste management in Canada, the UK, Germany, and in Eastern Europe.

Our international team of legal professionals brings years of trusted experience and strategic advice to the myriad issues facing stakeholders in the highly complex and ever-evolving nuclear sector. We are uniquely positioned by having the depth and breadth of experience in the large-scale nuclear project sector, as well as having a significant and diverse track record within the nuclear decommissioning space. This enables our team to provide a comprehensive, multi-faceted advisory approach on decommissioning projects and waste management projects. Our specialist team has an outstanding reputation for acting for governments, regulators and entities charged with decommissioning responsibilities, and we are experienced in dealing with site licence companies and all tiers of the supply chain. Specialised areas of expertise include establishing and administering segregated and independently managed Decommissioning Funds to provide security for Defueling and Decommissioning liabilities and advising on nuclear liability issues for contractors and suppliers working in domestic and international markets.

Services: Specialized Services

Specialized Services:

- Legal Services

HATCH

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Ontario Canada L5K 2R7

- A global multidisciplinary engineering and consulting company with more than 8,000 employees.
- 40 years of nuclear industry experience in providing cradle-to-grave nuclear lifecycle services to clients.
- Renowned for solving very complex industrial problems to generate maximum value for clients.

Hatch nuclear decommissioning and waste management (DWM) team will find and deliver solutions that will: a) reduce the client's nuclear liabilities and monetize them, b) minimize DWM cost and schedule, and c) ensure event-free DWM planning and execution. The DWM team leverages Hatch's presence in multi-industrial sectors to bring innovations and the best practices from nuclear and other industries to make clients' nuclear decommissioning and waste management projects successful.

Decommissioning and Waste Management Planning and Licensing

Decommissioning plan development
Safety analysis
Regulatory licensing support
Optimization and virtual process simulation using state-of-the-art digital innovations
Industrial-scale process automation
Financial modelling and business case development

Project Execution Support

Specialized tooling design, development and testing
Logistics, site deployment and transportation planning and optimization
Site infrastructure management
Operations support and equipment

Radioactive Waste Management and Monetization

Legacy waste retrieval and handling
Aqueous and gaseous rad waste processing
Pyro- and hydrometallurgical decontamination and volume reduction
Interim and long-term storage/disposal facilities (geological and above surface facilities)
Segmentation and sorting, recycling facilities

Environmental and Project Safety

Environmental assessments
Site remediation
Industrial hygiene and clean plant
Particulate and gaseous hazard management

Services: Full Scope Contractor, Desk Based Services and Specialized Services

Specialized Services:

- Pyro and hydro metallurgical decontamination and volume reduction
- Decontamination and Decommissioning-as-a-Service (DaaS)



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Kinectrics is the category leader in providing life cycle management services for the electricity industry, recognized for delivering integrated solutions to the most difficult problems. Trusted by clients worldwide, our expertise in engineering, testing, inspection, and certification is backed by our independent laboratory and testing facilities, a diverse fleet of field inspection equipment and an award-winning team of over 1,000 engineers and technical experts.

Kinectrics has over 40,000 square feet of CNSC approved and licensed facilities, and multiple specialized facilities such as the decontamination & refurbishment facility, active laundry facility, the alpha dosimetry lab, and tritium lab and testing facilities to support client needs. Kinectrics has international offices in USA, Romania, UK, and India.

Kinectrics is able to use its direct experience across all areas of the Decommissioning & Waste Management process and experience with operational and refurbishment services to develop innovative solutions. Example projects include: Pickering Safestor, Wolsong Decommissioning Schedule and Strategy development, Preliminary Design Plan and Radiation Shielding Conceptual design for OPG's Deep Geological Repository, and Endstate Planning for Pickering Nuclear.

Services: Full Scope Contractor, Desk-Based Services, Construction Services, Fabrication Services, Specialized Services, Research and Development & Education and Training.

Specialized Services:

- Mixed Waste Processing
- Waste Solidification
- Chemical and Mechanical Decontamination
- Laundry



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For nearly five decades, L3Harris has worked with utilities, plant designers and research organizations to create superior training simulators, early learning technologies and engineering-assist simulators and has established itself as the world's pre-eminent manufacturer of power plant simulators.

L3Harris' disruptive display technology—**Orchid® IX**—brings photorealistic 3D visualizations of high-value nuclear assets to life in a headset-free environment! **Orchid® IX** is also for real-time control and monitoring, in which user(s) can feel fully immersed in the remote facility/area.

Imagine a full-scale 3D digital reproduction of the entire nuclear site, complete with detailed nuclear plant models – inside and outside and the surrounding terrain. Imagine your team is immersed in the 3D synthetic asset without headsets/goggles and they can take measurements, plan work pathways and get virtual dose readings – all before even entering the actual facility.

With L3Harris' Digital Twin Framework and **Orchid® IX** 3D immersion display system, owners and D&D contractors will be able to save time and money in planning, streamlining work procedures and dismantling the facility, reducing the volume of radioactive components, managing and reducing radiation dose, planning the management of nuclear materials, improving training, facilitating strategic communications with the regulator and conceptualizing site restoration.

L3Harris has developed a full-scale 3D reproduction of an entire nuclear facility at a level of detail that has not been seen before. In addition to the 3D models, the Digital Twin Framework supports transitioning between the models, laser scans and spherical photos, while preserving all engineering data. 3D models can also be coupled with satellite imagery for full terrain considerations.

Services: Equipment Supplier

Equipment Supplied: Digital Twin Framework with **Orchid® IX** 3D immersion display system and simulators.



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Laurentis Energy Partners (“LEP”) has extensive experience in radiation protection, waste handling, fuel channel removal, tooling deployment and project management. LEP is a wholly owned subsidiary of Ontario Power Generation (“OPG”). Through LEP, customers have access to the full suite of skills, capabilities, IP and procedures owned by OPG, and is a recognized leader of asset management services for Canada’s energy industry.

In addition to operating the world’s largest CANDU fleet, LEP’s parent company routinely removes (and replaces) fuel channels on our own reactors and is recognized across the industry as leaders regarding performance and safety for nuclear reactor maintenance. This refurbishment experience provides LEP with the exact skills and experience required for decommissioning.

OPG recently finalized the refurbishment of Unit 2 of our Darlington Nuclear Generating Station, which entailed removing and replacing all 420 fuel channels event free, on time, and under budget. OPG has extensive experience in defueling and dewatering heavy water nuclear reactors from the safe storage of Picking Nuclear Units 2 and 3. OPG owns and operates full-scale mock-ups of our reactor fleet for the purposes of training and testing specialized tooling and equipment.

With teams dedicated to radiation protection, waste handling, fuel channel inspections, LEP demonstrates excellence through our focus on conventional safety, radiation protection, timely completion of outage preparation milestones, and efficient execution. In addition to work at OPG locations, LEP has conducted Radiation Protection services, Single Fuel Channel Replacement, Fuel Channel Inspections on or ahead on critical path at multiple locations including Bruce Power, Point Lepreau, Gentilly 2, and Wolsong 1.

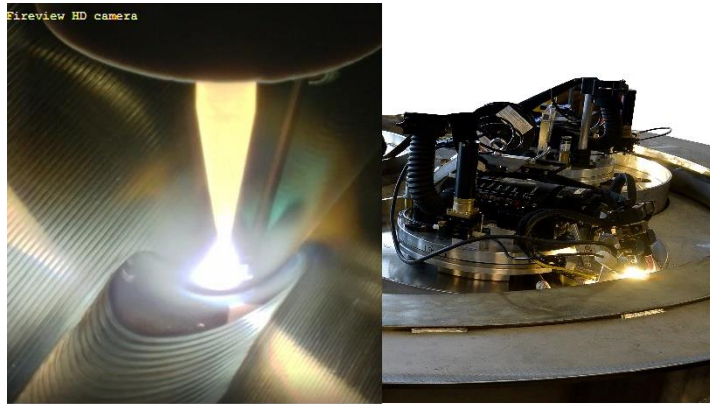
Services: Full Scope Contractor, Desk Based Services, Construction Services and Education & Training



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Contact: Jason Elliott
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Liburdi provides advanced welding systems and services to the Nuclear and Power Generation industries throughout the world. Our unique ability to offer complete solutions from the conceptual phase all the way to the project execution provides the customer with a single vendor option. As a welding equipment supplier, Liburdi offers a full range of pipe and tube welding equipment, as well as custom engineered systems for high radiation environments.

The Liburdi GAPCO group, a CSA N285.0 registered company, uses these advanced welding systems to provide process development, qualification and on-site execution services to a broad range of international clients.

Liburdi has been supporting nuclear waste and decommissioning projects for over 20 years. During this time, we have deployed more than 30 welding systems dedicated to spent nuclear fuel and nuclear waste encapsulation. With applications ranging from conventional fuel to high radiation waste, we have worked with canister OEM's, utilities and government contractors to design and build systems to perform the critical closure welds.

With offices in North America, Europe and Asia, Liburdi is well positioned to take on small and large projects world-wide.

Services: Specialized Services & Equipment Supply

Specialized Services

- Welding

Equipment Supply

- Welding equipment



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Founded in 1969, MDA is one of Canada's most successful technology companies and an internationally recognized leader in space robotics and sensors. With a deep and diverse technology base, MDA's global reach and heritage is unparalleled. MDA operates from locations in Brampton, Richmond, Ottawa, Montreal, Halifax, Houston and the U.K.

MDA has extensive experience developing robotic and automated systems for the nuclear industry. These systems ensure consistency in task performance and protect personnel from radiation intensive operations. MDA's systems function in hazardous environments and are safely and remotely operated. Examples of these applications include the Canadarm2 and Dextre robots used to maintain the International Space Station, and the Calandria Vault Inspection and Repair Manipulator (CVIRM) that was used to inspect the Pickering NGS calandria vault.

MDA has also developed systems for surveying and surveillance, such as the EPOCH system used for mobile surveys and surveillance of chemical, biological, radiological, nuclear, and explosive materials.

MDA has developed processes that effectively use robotics and automation for decommissioning, and has successfully executed projects in this area including the Light Duty Utility Arm (LDUA) system developed for the US Department of Energy. The LDUA system consists of a modular seven-jointed manipulator attached to a telescopic vertical positioning mast and was used to perform inspections and characterize radioactive waste located in underground storage tanks at Hanford and Oak Ridge.

More recently, MDA has performed a detailed cost-benefit analyses of the use of robotics in the decommissioning process for nuclear power plants. MDA has identified a number of tasks where using robotics and automation can result in high return on investment, and is interested in working with prospective clients to advance these ideas.

Services: Desk-Based Services, Fabrication Services & Equipment Supply

Equipment Supply:

- The EPOCH Survey system

NIAGARA ENERGY PRODUCTS

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Canada



Overall description of the company: NEP is a small/medium enterprise (**SME**) headquartered in Niagara Falls, Ontario (ON) with three N299.1-16 (Z299) & ISO 9001:2015 fabrication facilities:

- a 120,000 sq. ft. heavy manufacturing facility in Niagara Falls, ON (**NEP-Heavy**) that has an on-site CNC concrete batching plant for composite self-shielded containers,
- a 90,000 sq. ft. fabrication and storage facility in Fort Erie, ON (**NEP-Secure**), and
- a 20,000 sq. ft. precision machining and assembly shop in Brantford, ON (**NEP-Precision**) co-located with our partner company **Patriot Forge**.

Summary description of what is provided to support decommissioning and waste management:

NEP primarily works in the nuclear sector as a fabricator of dry storage spent (used) fuel, isotope, HLW, ILW, LLW containers and loading structures and holds all the necessary qualifications, codes and quality systems for such activities; all of our facilities are NQA-1 compliant.

Summary description of D&WM experience: NEP has been supplying nuclear waste containers into the Canadian market for 25 years; originally starting with manual manufacture and fabrication that has progressed through process redesign, electronic document management implementation, welding automation and the comprehensive rollout of robotics. This reinvestment in advanced manufacturing signifies a long-term commitment to high quality, low-cost nuclear waste container manufacturing. NEP's long history in managing large scale, complex, 100+ unit per year manufacturing campaigns has allowed the firm to develop robust manufacturing processes and a supply chain built on reliability and quality. Since 1995, NEP has manufactured over 3,000 containers, never delivered a faulty container product nor has the firm missed a delivery date.

Services: Fabrication Services and Containers



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NUVIA is an international nuclear specialist providing solutions in EPC, Engineering, Services and Products. A leading innovator with over 60 years' experience applying nuclear technologies, NUVIA delivers advanced solutions within a culture of Excellence, Safety and respect for the Environment. We work with our clients throughout the life-cycle of their facilities: from design, construction, operations, risk management and maintenance to decommissioning and waste management.

We assist our customers to safely, economically, and successfully plan and undertake nuclear material handling, waste management, facility decommissioning, and site remediation projects. Our services include strategic and technical consultancy, project management, engineered solutions, radiation safety, and project execution support services.

We are a pioneer in the development of strategies and methodologies for the safe and efficient decommissioning, dismantling and disposal of nuclear facilities and management of nuclear waste. Our expertise and practical experience provide invaluable support to customers wishing to decommission redundant plant, particularly where operations are difficult or where novel technologies or methods are required.

Services: Full Scope Contractor, Desk-Based Services, Specialized Services & Containers

Specialized Services:

- Radiation Protection and Surveying



Website: www.nuclear.ontariotechu.ca

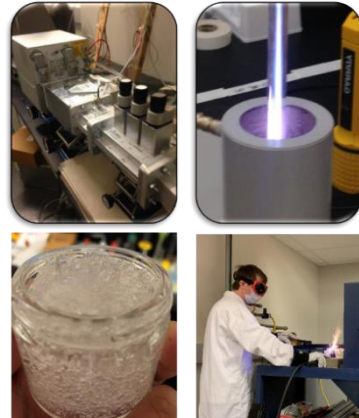
Contact: Glenn Harvel

Professor

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Ontario Tech University has a dedicated Research, Training, and Education programs to support the Canadian Nuclear Industry. Through the Faculty of Energy Systems and Nuclear Science, we provide education at the undergraduate and graduate level in all aspects of nuclear power including waste management and decommissioning activities. We also maintain a set of continuing education courses and training programs and are capable of developing unique training programs in collaboration with industry. We have dedicated research staff for waste management and decommissioning activities and several supporting researchers in the areas of materials, environmental protection, radiation detection and health physics.

Dr. Glenn Harvel is our lead researcher dedicated to decommissioning technologies researching capture of radioactive species, techniques to improve decontamination and dismantling, and methods for improved reduction of waste produced during decommissioning. Dr. Ikeda is our expert in waste management systems (LLW, ILW, HLW), corrosion/electrochemistry, and chemistry related issues for decommissioning. Together, Dr. Harvel and Dr. Ikeda are collaborating with Japan in knowledge exchange and research projects related to decommissioning. Dr. Waller is our certified health physicist and research expert in dose visualization, dose reduction, MARSSIM type analysis, and characterization.

Drs. Harvel, Ikeda, and Waller have more than 50 years of experience in the Canadian Nuclear Industry with respect to design of nuclear reactors, waste management related systems, corrosion issues, site characterization, MARSSIM, environmental remediation, and dose assessment for both civilian and military applications.

Services: Education and Training & Research and Development

PLC

FIRE SAFETY SOLUTIONS

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Since 1983, PLC Fire Safety Solutions has provided professional engineering services related to fire and explosion protection and prevention, to clients across Canada and internationally. PLC's understanding of the engineering fundamentals, enhanced by years of practical experience, means we bring crucial expertise and the right technologies for hazard identification, hazard quantification, and establishing the appropriate loss control measures.

Our quality management program, provides independent confirmation that PLC meets the requirements of ISO 9001, CSA N286.7 Quality Assurance of Analytical, Scientific, and Design Computer Programs for Nuclear Power Plants, CSA N255.1-16 Quality Assurance Program – Category 1 and CSA N286-12 Management System Requirements for Nuclear Facilities.

Nuclear facilities including decommissioning and waste management facilities are incredibly complex, and present unique fire safety challenges. PLC provides a full range of fire and life safety services for managing hazards at these facilities.

Services: Specialized Services, Equipment

Specialized Services:

- Fire Protection Planning

Equipment Supply:

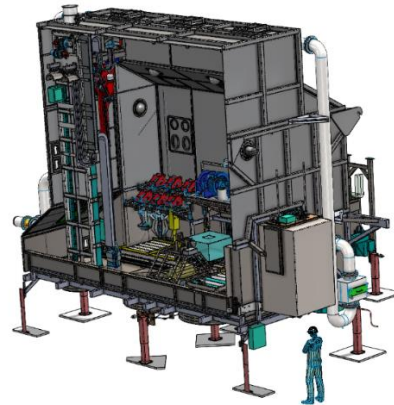
- Fire Protection Equipment

PROMATION nuclear.

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Promation Nuclear is a leading designer and manufacturer of high-quality tooling, automation, and robotic systems. With a strong commitment to excellence and strict conformance to quality management programs, Promation Nuclear has been successfully delivering custom equipment and engineered turnkey systems on time and on budget, while catering to the unique quality and safety requirements of the nuclear industry. Promation Nuclear offers nimble and effective Project Management, Engineering, Quality Assurance and Manufacturing expertise to support our extensive services and capabilities:

- Waste Decommissioning and Handling Equipment
- Remote Robotic Decontamination and Dis-assembly in High Rad and Hazardous Environments
- Custom Reactor Tooling for PT/CT removal
- Rapid Prototyping and Development
- Full Size Mock-ups and Qualification/Testing Coupons
- Additive and Advanced Manufacturing
- Rad Waste Volume Reduction Equipment
- Liquid Rad Waste Filtration and Processing

Promation Nuclear is confident that innovation, industry wide partnerships, and collaborative R&D will help us develop sustainable decommissioning and nuclear material management solutions. We design and build custom robotic equipment to remotely remediate high-level waste storage silos, which requires removal of legacy liquid/solid waste, sorting and filtration and separation.

Promation Nuclear is currently collaborating with Taiga Robotics to develop an Extended Reality (XR) robotic low-level waste sorting station. This pilot demonstration integrates two industrial robots with a custom operator interface to demonstrate the feasibility of remote monitoring and sorting of radioactive waste.

Promation Nuclear, in conjunction with one of our major clients, has developed and is executing a project to complete the remote remediation of a massive nuclear waste site with numerous degraded waste repositories containing an undetermined mix of hazardous gases with radioactive liquid and solid waste. Promation Nuclear is responsible for all aspects of design, engineering, procurement, fabrication and construction of the sophisticated waste retrieval system, and ventilation system to remove, separate, process and transfer the waste in these structures. Promation Nuclear is also experienced in the application of COTS automation and robotics to remotely sort, volume reduce, flask and transport low and intermediate level waste.

Facility Deconstruction, Dismantling,
Demolition Entombment
Desktop design and Manufacture

Specialist Wastes
Desktop design and Manufacture

Waste Management, Volume
Reduction, Decontamination and
Handling

Desktop design and Manufacture

Transportation and Containers
Desktop design and Manufacture

Environmental Remediation
Desktop design and Manufacture

Support Activities
Desktop design and Manufacture

Sargent & Lundy

Website: www.sargentlundy.com

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Sargent & Lundy's nuclear experience began in the 1940s with services provided to the Manhattan Engineering District and continued in the mid-1950s with the design of the world's first BWR at Argonne National Laboratory (1954). Since that time, we have been authorized to design 32 nuclear units, representing approximately 27,000 MW. Our accomplishments in nuclear earned S&L the number one position in Engineering News-Record (ENR) ranking of design firms in nuclear power technology.

Beyond design, our project and construction management experience in building these units are the same skills needed for large scale decommissioning projects. With access to over 1,700 engineers, project/construction managers and designers at S&L, we can leverage S&L resources to offer strategy and value to any decommissioning project or task: from dry fuel storage; to post-defueled and cold and dark system optimization and re-design; to structural stability; shielding and water/power management during demolition; to project scheduling, tracking and monitoring; and environmental restoration.

From early decommissioning efforts at Dresden 1 and Big Rock Point, to more recent work at Lacrosse, Zion, Kewanee, SONGS, Vermont Yankee and Pilgrim, S&L has the experience and knowledge to dismantle the same facilities we helped put together.

Services: Desk-Based Services

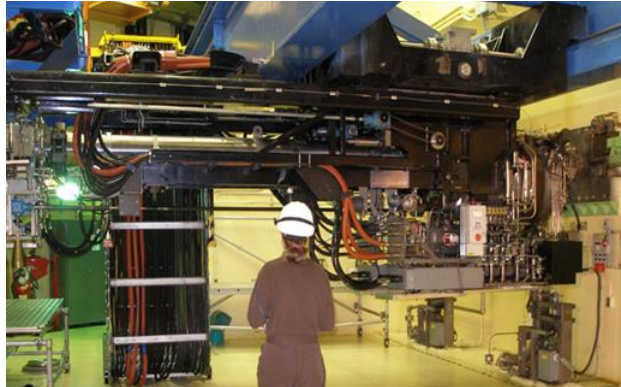


ATKINS

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SNC-Lavalin has over 60 years of global nuclear expertise, delivering nuclear technology products and full-service solutions to nuclear utilities around the world. SNC-Lavalin solves technically complex challenges across the whole nuclear lifecycle from design and new build through asset management and from life extension and late life management through decommissioning and waste management.

As a Tier-1 nuclear vendor with significant experience in life extension, waste management and decommissioning projects, we bring tangible expertise to the table. Whether it's the design and supply of facilities for dry storage of used nuclear fuel, decommissioning plans, environmental assessments and impact assessments or shielding analysis & design and custom tooling we have the expertise and the experience.

SNC-Lavalin operates and manages government nuclear research sites and is the steward of CANDU® nuclear technology. It operates on four continents, and provides advisory and engineering services to other nuclear developers.

Through Comprehensive Decommissioning International (CDI), an SNC-Lavalin joint venture, we return shuttered commercial nuclear reactor sites for future use.

SNC Lavalin and its predecessor companies, have delivered some most the complex decommissioning and waste management projects in the world. These include the Advanced Liquid Waste Processing system (ALPS) at Fukushima Daiichi, developing technology for Vitrification of High Level Waste (HLW) for the US Department of Energy, Calandria retube projects for the CANDU fleet, dry storage of spent nuclear fuel, managing the decommissioning of the UK Magnox gas cooled reactor fleet, decommissioning of PUREX reprocessing plants in the USA and UK, decommissioning Light water Reactors (LWR's) and through CDI the decommissioning & waste management for plutonium processing facilities, uranium tailings projects and medical isotope facilities.

Services: Full Scope Contractor, Desk Based Services, Fabrication Services and Containers



Website: www.UNENE.ca

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For almost 20 years, the University Network of Excellence in Nuclear Engineering (UNENE) has served as a mechanism for partnership between industry and universities to foster nuclear research and development; train and develop highly-qualified personnel to address demographic skill gaps; and to create a sustainable and independent source of expertise for industry and public engagement. These activities are partially supported through partnership with UNENE's industry members, who fund nuclear science and technology in academia, including advancement of decommissioning and waste management (DWM) techniques and innovation. UNENE partners also include design vendors, national labs, regulators, governments and supply chain. UNENE also has strong collaborative relationships with nuclear technical advancement institutions in Canada and internationally, including the CANDU Owners Group, Canadian Nuclear Society, IAEA and OECD-NEA.

UNENE Research Chairs and Principal Investigators are recognized as world-class authorities in their fields and are engaged by UNENE industrial members and other stakeholders in ground-breaking DWM research. Examples include:

- A Research Chair in corrosion resistance of fuel waste storage and disposal containers;
- Research projects in decommissioning planning, via applications of new technology such as advanced robotics, material data analytics and use of multiple drone fleets; and
- Research into the use of novel materials to filter and clean liquid and gaseous waste streams.

UNENE's own educational programming delivered in collaboration with its university members, as well as its network and data management capability, allows it to respond, and to help its members and stakeholders respond, to a quickly changing nuclear industry and educational landscape.

Services: Education & Training and Research & Development



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United offers a full suite of nuclear D&D services, including program and project management, procurement, contract and construction/labor management, licensing and regulatory compliance, ISFSI design & construction, decommissioning planning, large component and system removal, facility dismantling and demolition and ongoing monitoring

United, through its legacy companies, has 30 years of nuclear decontamination and decommissioning experience using a combination of conventional, proven advanced techniques, and remotely operated equipment to decontaminate primary system components for size reduction and removal. Our projects have varied from commercial nuclear power plants, government test reactor facilities, nuclear fuel testing facilities, uranium enrichment facilities, and spent nuclear fuel reprocessing facilities.

Services: Full Scope Contractor, Desk-Based Services & Construction Services



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Veolia Nuclear Solutions (VNS) is the North American nuclear operations company of Veolia – the global leader in optimized resource and facility management. With our industry-leading technologies and waste management expertise, VNS provides a full suite of innovations to assist the nuclear industry with its most challenging legacy waste liability and decommissioning needs.

We provide an integrated value chain to support decommissioning and waste management. This includes a comprehensive range of innovative technologies and robotics, engineering, waste operations and infrastructure and analytical services for facility operations, remediation, decommissioning and treatment of radioactive waste.

VNS regularly delivers the following D&WM services to the North American nuclear industry:

- Characterization & management
- Remote handling & robotics
- Operations & maintenance
- Liquid & solid waste treatment
- Engineering Services

Services: Full Scope Contractor, Desk-Based Services



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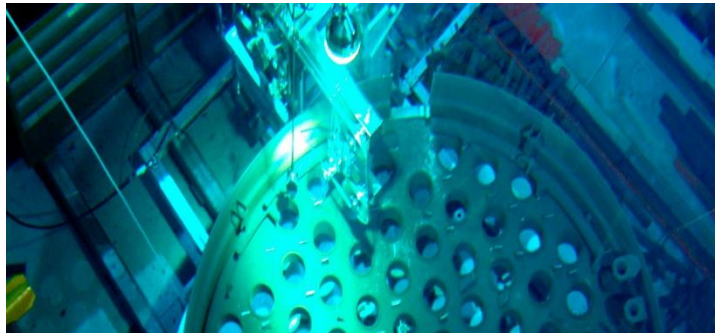
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Westinghouse has completed decommissioning projects for its customers as both a Partner and a Decommissioning General Contractor. It has been in the reactor disassembly business since 1989, having completed almost 60 reactor component dismantlement projects to date.

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