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nwmo news

Nuclear Waste Management Organization

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IHLRWM CONFERENCE RECAP

Depth of NWMO's expertise evident at international conference



NWMO specialists at international waste management conference provided the latest science contributing to Canada's plan

The wide range of expertise contributing to implementing Canada's plan for used nuclear fuel was showcased in April at the International High Level Radioactive Waste Management (IHLRWM) Conference in Charlotte, N.C.

The NWMO's experts presented 19 papers at the conference, which was hosted by the American Nuclear Society.

Together, these papers formed a comprehensive overview of the many technical aspects of the project. They reflected not only the complexity and broad scope of the project, but also the numerous possible scenarios that need to be taken into account when testing the safety of each stage.

"Canada achieved a sort of 'critical mass' at this conference and we took full advantage to boost the profile, understanding, and appreciation of the Canadian program," says Dr. Erik Kremer, Senior Engineer and Technical Expert at the NWMO, who coordinated the organization's participation. "We were clearly on the radar of all the other countries; conference participants were fully engaged with NWMO delegates."

Besides Canada, the conference included delegates from the Czech Republic, Switzerland, China, Germany, Finland, France, the United Kingdom, Hungary, Japan, South Korea, Poland, Sweden, Taiwan, and the USA; delegates from the International Atomic Energy Agency also attended.

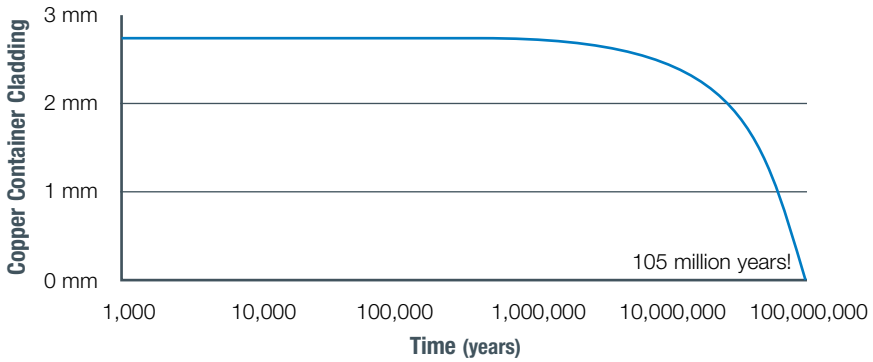
NWMO presentations focused on many aspects of the project, from the multiple barriers designed to contain the used nuclear fuel while protecting people and the environment, the meticulous care with which the fuel will be placed deep into the rock, to the detailed calculations of what could happen millions of years after the repository is sealed.

IHLRWM CONFERENCE RECAP

New Canadian Container Design Proving Robust in Rigorous Analyses

Rigorous testing demonstrates that the new Canadian-designed used fuel container is proving it will be effective in isolating the material from people and the environment in the very long term.

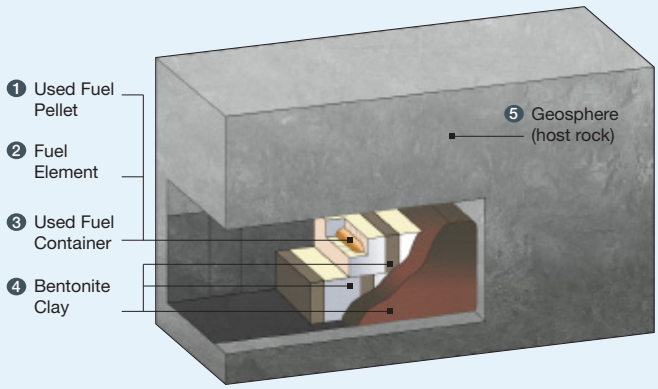
"Placed deep within the rock, inside the Canadian engineered-barrier system, it will take several million years for the container to lose even a hair's width of its copper cladding to corrosion," says Dr. Erik Kremer, Senior Engineer and Technical Expert at the NWMO, who presented several papers at the recent International High Level Radioactive Waste Management (IHLRWM) Conference in Charlotte, N.C.



Based on multiple models and laboratory tests, calculations show that the container's copper cladding will remain intact for millions of years

The copper-coated container Dr. Kremer and colleagues are studying is part of an engineered-barrier system (EBS) designed by the NWMO specifically to manage used CANDU fuel in a deep geological repository. The multiple barriers include:

- Ceramic nuclear-fuel pellets, fired at about 1700 °C in an argon-hydrogen kiln. Ceramic is among the most durable of engineered materials.
- The nuclear fuel bundle, made of Zircaloy, an extremely durable and corrosion-resistant metal.
- The steel container, clad in corrosion-resistant copper.
- The buffer box, made of highly compacted bentonite clay.
- A stable rock formation, roughly a half kilometre underground.



Experts at the NWMO are conducting exhaustive analyses of how effective the EBS system will be within a repository that has been filled, sealed off, and closed.

These analyses are called post-closure safety assessments, simulations that calculate repository performance for one million years or longer.

The NWMO recently conducted analyses that assume, due to simultaneous failures in manufacturing and inspection, some of the containers are placed in the repository with defects in the copper coating that have not been detected.

Even when this unlikely scenario is factored into safety assessments, calculations show that the time required for groundwater corrosion to perforate the container wall would exceed tens of millions of years, according to Dr. Kremer.

"From these results," he says, "we find that used fuel containers are expected to remain intact essentially forever, with no releases (and no dose consequences) of radioactivity within the one million year timeframe of the post-closure safety assessment."



PhD student Thalia Standish and Senior Engineer Dr. Erik Kremer are pictured at the IHLRWM conference in Charlotte, N.C.

Research Looks Far, Far into the Future

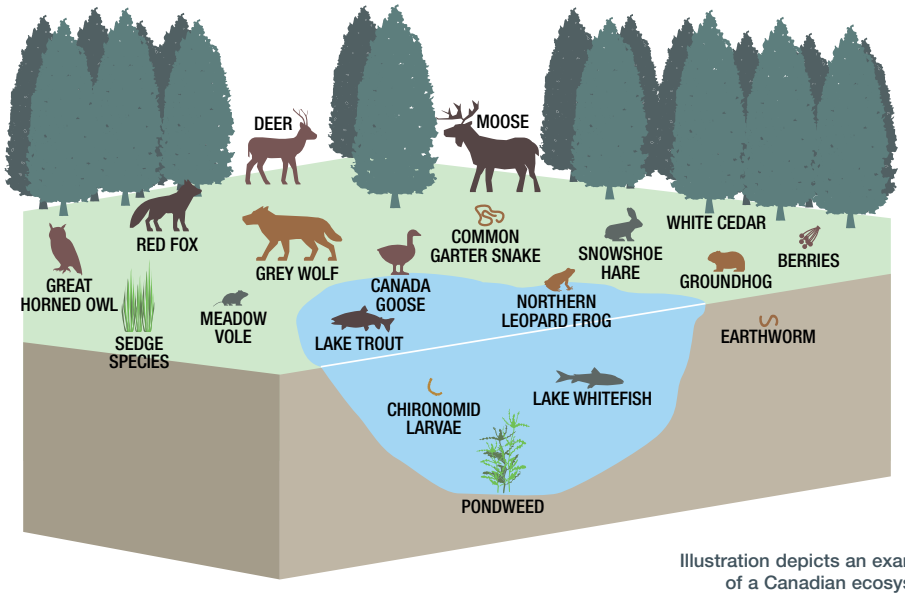


Illustration depicts an example of a Canadian ecosystem

An important element of implementing Canada's long-term plan for safely managing used nuclear fuel is ensuring plants and animals living above a future repository remain safe hundreds of thousands of years from now.

To cover a very wide range of eventualities, simulations are conducted by NWMO scientists testing the design of the repository over different time frames, locations, and circumstances.

Recently, two sets of 100,000 simulations were conducted for hypothetical repositories in two different rock types. If the repository performs as designed, results show that no radioactivity leaves the repository and reaches the biosphere above. In the extremely unlikely circumstance of a serious failure of the repository, the amount of radioactivity that reaches the biosphere would be negligible – only a small fraction of the radioactivity that occurs naturally in the environment – even as far into the future as 10 million years.

"Our results show that all populations of plants and animals are protected, even for the very unlikely, worst-case scenario where we assume that all containers fail simultaneously in the repository at some point in the far future," says Chantal Medri, Associate Technical Officer at the NWMO, who presented her team's findings at the recent International High Level Radioactive Waste Management (IHLRWM) Conference in Charlotte, N.C.

In order to calculate long-term consequences to ecosystems, Mrs. Medri and colleagues use models that are based on present-day behavior of plants and animals. "What animals and plants would we expect to see? What and how much do animals eat? What are the food chains? Where do they spend their time – in water or on land? Do they migrate?" she asks.

Eventually, these analyses are compared to internationally derived benchmarks to ensure that exposure to radiation is well below levels that would cause harm.

Mrs. Medri is one of many NWMO specialists contributing to pre- and post-closure safety assessments, detailed documents that explore the potential consequences of a repository under a range of hypothetical conditions. These safety assessments inform the NWMO's siting and design programs.

MEET THE EXPERT

Chantal Medri



Health and Radiation Physics

Canada's plan for the safe, long-term management of used nuclear fuel is powered by people in a wide variety of professions. People like Chantal Medri.

Mrs. Medri's research calls to mind a family like hers. They are active and spend a lot of time outdoors. They appreciate simple pleasures and the land around them – the trees, plants and wildlife.

But the family that Mrs. Medri studies is only hypothetical. They inhabit a time that is far beyond what most people can even imagine – millions of years in the future.

Mrs. Medri is a specialist in health and radiation physics, ensuring people are protected from harmful radiation. She studied Physics at Queen's University and went on to earn a Master's in Health and Radiation Physics from McMaster University.

Using international scientific practices, she is well qualified to determine that the hypothetical future family she studies remains safe from radiation as they grow their own vegetables, raise animals, and draw water from a well above a repository.

A researcher at the NWMO for more than eight years, Mrs. Medri is passionate about her work. "I love being a part of this big, broad team, for such an important project for Canada. There is such a wide variety of skills and expertise, spanning so many fields, that there is always something new to learn," she says.

When not working, Mrs. Medri and her own family enjoy their outdoor environment. "In my free time you'll find me biking, camping, running or skiing with my husband and two young kids in tow," she says.

Indigenous Cultural Awareness Training Deepens Understanding by NWMO Staff



Lyndon Linklater teaches NWMO staff a deeper understanding of Indigenous culture

Inclusion of Indigenous perspectives is an essential element of the NWMO. One of the manifestations of this value system is employee involvement in Indigenous cultural awareness training. A recent day of training in Toronto – the third such session – provided staff at all levels with a deeper understanding of Indigenous beliefs and history.

"It is very important that we have a good understanding of the complex history of First Nations and Métis people here in Canada," said Laurie Swami, president and CEO of the NWMO, who opened the day's event. "Internalizing these teachings is vital, not only to our project, but also to us as Canadian citizens."

The session featured Lyndon Linklater from Thunderchild First Nation, SK. Through story-telling, humour, music and interactive exercises, he encouraged the NWMO staff to see Canada through an Indigenous perspective. Themes included Indigenous worldview, spiritual teachings and ceremonies, treaties, residential schools, and Truth and Reconciliation. The educational session was hosted by the NWMO's Indigenous Relations department, which is led by Vice President Bob Watts.

By providing cultural awareness training, the NWMO is also following a call to action made by the Truth and Reconciliation Commission of Canada in 2015. The Commission called upon the corporate sector in Canada to commit to meaningful consultation, building respectful relationships, and obtaining the free, prior, and informed consent of Indigenous people before proceeding with economic development projects. It also called upon corporations to provide education for management and staff on the history of Indigenous people.

Indigenous Cultural Awareness Training (Continued from page 4)

Esther Pitchenese, Chief of Wabigoon Lake Ojibway Nation, who was a guest at the recent cultural awareness training session, saw the impact the training had on staff. "Lyndon used humour and visual examples to make our worldview understandable," she said. "I think people here today really absorbed the messages."

Danine Chief, the Nuclear Liaison Coordinator from Wabigoon Lake Ojibway Nation, was also a guest at the session. She noted that respect for Indigenous culture is woven into daily decisions at the NWMO. Other ways this is reflected is through oversight by the Indigenous Relations team, advice from the Council of Elders and Youth, and guidance drawn from the NWMO's Aboriginal Policy and Indigenous Knowledge policy.

"I have to give credit to the NWMO. Every step in the process has used our ceremony and traditional teachings and as a result we are working with them."

Indigenous awareness training has had a significant impact on staff members at the NWMO in a myriad of roles. For Charlene Easton, Manager of Community & Public Engagement, it was enlightening from a social perspective. "The concept of 'seeing through the eyes of another' is a fundamental premise of true dialogue, a cornerstone of our work," she says. "Cultural awareness training is a moment in time for us to reflect on our own practice, on our own history, and to ask ourselves, 'What might we miss?' 'How might we interpret?' and, 'How might we truly connect to best advance the emergent NWMO narrative?'"

> *"It is very important that we have a good understanding of the complex history of First Nations and Métis people here in Canada. Internalizing these teachings is vital, not only to our project, but also to us as Canadian citizens."*
>
> **- Laurie Swami**
> President and CEO of the NWMO

For Senior Technical Engineer Melissa Mayhew, it awakened a new way of looking at land, water, wildlife and rock. "The Western science that I practise as an ecologist is complementary in many ways with Indigenous knowledge, and the inter-weaving of these knowledge systems can greatly contribute to decision-making when trying to understand something as complex as an ecosystem," she says. "On a personal level, I've found a deep admiration for the commitment to protecting Mother Earth that Elders, Youth, and community members demonstrate each time we meet to learn together."

Staff training is an important step in a journey, believes Elder Debbie Plain, Aamjiwnaang First Nation and a member of the Council of Elders and Youth, who travelled from her community to observe the training. "I believe it created a better understanding of who we are as a people, our values, and our view of Mother Earth. A lot of eyes were opened. Cultural awareness training is like planting a seed so that a flower can grow. With full respect and awareness, we'll be able to walk side by side, not one in front of the other."



The educational session was hosted by the NWMO's Indigenous Relations department, led by Vice President Bob Watts

Expansion of Proof Test Facility Enables Enhanced Engagement and Technical Testing



The NWMO's proof-testing facility is used to test and showcase the full-sized components that are being designed to manage used fuel

The NWMO's proof test facility in Oakville, Ontario has been expanded to include new areas for community engagement and experimental testing. A number of visitors who are involved in the learning process have attended tours there in 2017, and provided positive feedback.

"The expansion is meeting two crucial objectives," says Chris Boyle, the NWMO's Director of Engineering. "One is the ability to demonstrate and showcase the full-sized components and technologies to people who are interested in our project and explain the details of how it all works. The other is to conduct scientific experiments to ensure our designs and materials are optimal in managing the used nuclear fuel over almost-indefinite time periods."

On the engagement side, a large display area, or Learn More Centre, has been created. Visitors can now see displays showing what used nuclear fuel is; how the NWMO is implementing Canada's plan for its safe, long-term management; how used fuel is stored in the interim; ways in which communities, First Nations and Métis people are engaged in the site selection process; how the used fuel will be managed in a deep geological repository; and how it will be transported in a safe manner.

On the technical side, the expanded facility meets the NWMO's engineering requirement for a large space to conduct full-scale experiments and to store prototype equipment.

Canada's plan involves placing used nuclear fuel bundles into large, specially designed steel containers that are coated with copper on the external surface for corrosion protection. The containers will, in turn, be set into bentonite clay buffer boxes and carefully placed more than 500 metres underground within a stable rock formation. This multi-barrier system is designed to prevent radionuclides in the fuel from escaping into the underground environment.

Engineering work underway at the facility focuses primarily on advancing the manufacturing technology for the bentonite clay buffer box and related emplacement trials. Alan Murchison, Manager of Fuel Handling and Sealing System Design, fills us in on highlights:

Expansion of Oakville Facility (Continued from page 6)





Dave Doyle, Manager of Used Fuel Container Design, explains the multiple barrier system to guests

- The NWMO will install a bentonite shaping cell that uses robotics to precisely shape the 4,000-kg bentonite blocks into the correct dimensions for the deep geological repository. This is scheduled to be completed by the end of 2017.
- Engineers are fabricating a full-scale mock-up of an emplacement room that will be used to demonstrate the emplacement technology in the repository environment. Work will continue in this area, including receiving upgraded emplacement equipment in 2018. After that, a number of rehearsals will be performed, culminating in an emplacement trial in 2019.

The proof test facility also houses prototype containers and an array of samples from the manufacturing and testing programs carried out by the NWMO's external partners, including Canadian universities, national research laboratories, and industry. Dave Doyle, Manager of Used Fuel Container Design, fills us in on the progress related to the container program.

- In 2017, the Oakville facility is being outfitted with purpose-built equipment to facilitate the inspection of the structural steel core and copper coating of the containers for quality assurance.
- An updated version of the equipment that is used to hold and rotate the used fuel container during closure welding was designed earlier this year. This equipment (named the ROTEQ 2.0) is currently being manufactured and is scheduled to be delivered to the NWMO's welding technology vendor in the next few months.
- Work is continuing on optimizing the application of copper to the steel container by the electrodeposition process. A small pilot study performed in the first quarter of 2017 revealed a new, state-of-the-art innovation that dramatically improves the surface finish of the coating. This innovation is being scaled up, and fabrication of this tank is scheduled for completion by mid-2018.

New Interactive Exhibit Travelling to Communities



The NWMO's mobile exhibit – designed to increase awareness of Canada's plan for the long-term management of used nuclear fuel – has been redesigned to be more engaging, accessible and tactile.

The new exhibit has already been used in several community Open Houses. It allows visitors to explore the many aspects of Canada's plan by walking around or even inside eight colourful modules.

"This exhibit is all about touching, playing, listening and seeing," says Alejandro Covarrubias, Multimedia Communications Supervisor at the NWMO, who led the redesign. "It assists people to translate a complex concept into something more 'real' that they can understand, and helps them envision what this project might mean for their community."

Subjects included in the eight modules are:

- An introduction to the NWNO and Canada's plan for the safe, long-term management of used nuclear fuel
- What nuclear fuel is and why we have it in Canada
- What radiation is and where it exists
- The multiple barrier system that has been designed to protect the used nuclear fuel from people and the environment
- The deep geological repository where the used fuel will be managed
- How the used fuel will eventually be transported in a safe manner
- Community benefits, such as wellbeing and employment
- The importance of the NWMO's Indigenous Knowledge policy in every aspect of the organization's work

New Interactive Exhibit (Continued from page 8)



Interactive elements include a Geiger counter that measures radiation levels from household products





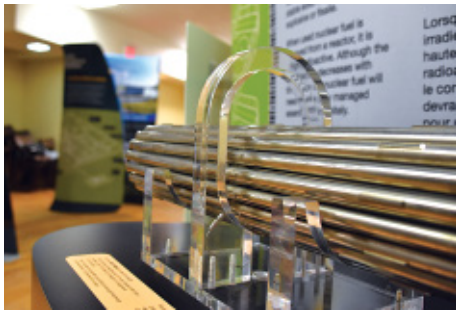
There are several interactive elements included in the exhibit. One is the ability to hold a sample of a used fuel bundle to feel its "real" weight of 24 kg. Another is to touch models of the various barriers that have been scientifically designed to keep the used fuel isolated from people and the environment once it is deep underground.

Visitors can watch short videos through iPads embedded in the exhibit, including one on transportation safety and another on Indigenous Knowledge.

They can also use a turntable attached to a Geiger counter to find out visibly and audibly, how much radiation is in products we are exposed to daily.

These interactive elements are designed to be at a height that is reachable for children and people with disabilities.

The new exhibit is versatile and can be revised as feedback is received, new information becomes available and the needs of communities evolve. "If there is a better way to show something, we will do it," says Mr. Covarrubias.



Analysis of Early CANDU Bundles Will Enhance Safety of Project

To enhance safety for the future, the NWMO is taking a look into the past. It is undertaking an unprecedented analysis of decades-old CANDU fuel bundles.

Laboratory tests will reveal the contents of 21 unused fuel bundles, some dating back as far as the 1960s and the birth of the CANDU program in Canada. Knowing what trace elements or impurities early CANDU bundles contain is part of understanding Canada's entire inventory of used nuclear fuel – currently about 2.7 million bundles in total – and managing it safely in a deep geological repository.

"This is a great opportunity for us to learn about the history of the CANDU fuel bundle composition, and see how the trace elements in the fuel pellet and the bundle material itself have changed over time," says Kelly Liberda, Associate Engineer and technical expert at the NWMO.

"The data will contribute to our safety assessment by improving our understanding of the used fuel. The amount of some long-lived radionuclides, and some hazardous elements, is dependent on trace elements in the original unirradiated fuel pellet and fuel bundle material itself," she adds.

The NWMO is working cooperatively with BWXT Nuclear Energy Canada Inc., manufacturers and handlers of CANDU nuclear fuel, which has provided a variety of samples from a range of fuel bundle ages.

The measured values arising from these analyses will be used in the NWMO's safety cases – the comprehensive, detailed studies that evaluate the safety of a deep geological repository over a time frame of up to one million years.



Kelly Liberda, Associate Engineer and technical expert at the NWMO, is looking forward to receiving data on fuel bundles that date back to the birth of the CANDU program

Field Studies Now Focused on Fewer Communities

The NWMO announced on June 23 that it is narrowing its focus to fewer communities as it prepares to further advance the next set of activities in the selection process for a deep geological repository for Canada's used nuclear fuel.

The Municipality of Central Huron and the Township of White River will no longer be considered a potential host for the project. Both will continue to play a role as activities continue in nearby communities of Huron-Kinloss and South Bruce in the southwest, and to the northwest in the vicinity of Hornepayne and Manitouwadge.

"As we work toward identifying a single preferred site, we need to increasingly focus on specific locations that have strong potential to meet safety requirements and a foundation for sustained interest in exploring the project," said Dr. Mahrez Ben Belfadhel, Vice-President of Site Selection. "Central Huron and White River have each made a significant contribution to this project on behalf of Canadians, and their continued leadership will be invaluable as we work together to plan next steps in their regions."

The next activities in the areas of Huron-Kinloss and South Bruce; and Hornepayne and Manitouwadge will involve planning for more geological studies and initial discussions about visioning and partnership. Regional engagement will continue, as the project will only proceed with interested communities, potentially affected First Nation and Métis communities, and surrounding communities working in partnership to implement it.

Studies continue in areas around Ignace, Blind River and Elliot Lake, Ontario, which are also engaged in the process for siting the national infrastructure project. Ongoing field activities and engagement with municipal, First Nation and Métis communities in those regions are not affected by the decision.

The NWMO will continue the process of narrowing down potential sites to host the project until it arrives at one preferred safe and socially acceptable site as the focus of more detailed site characterization. The preferred site must have a suitable rock formation in an area with an informed and willing host.

High School Students Come to Learn About the Safe Management of Nuclear Waste



Chris Lawrence, a transportation design engineer at the NWMO, shows Toronto students the plan for safely transporting used nuclear fuel to the deep geological repository

Grade 11 and 12 students from both Ignace and Toronto recently visited the NWMO to learn more about Canada's plan to manage used nuclear fuel. Engagement with young people is a priority because the project we're implementing will span multiple generations.

A group of science students from Ignace travelled to both the NWMO's Learn More Centre in Toronto and proof testing facility in Oakville. They heard from specialists about how used nuclear fuel will be safely transported to and managed in a deep geological repository. They chose an area of interest – transportation, communications, geology or engineering – and spent time with an NWMO employee learning about careers and career pathways in that area.

Their visits to NWMO facilities were part of a larger tour. They also went to the Darlington Waste Management Facility and Darlington Visitors' Centre to hear about the history of OPG, how CANDU reactors create energy, and how used nuclear fuel is presently stored.

Students from Malvern Collegiate Institute also came to the NWMO's Learn More Centre in Toronto.

Their excursion was part of the Specialist High Skills Major program, a specialized program that enables students to gain sector-specific skills and knowledge in engaging workplace environments and to prepare in a focused way for postsecondary education, training, or employment.

Students received an introduction to the NWMO and why it exists. They learned about CANDU nuclear fuel and how Adaptive Phased Management was selected as Canada's plan for its safe, long-term management. They were encouraged to think about the social, economic and practical impacts of having a deep geological repository in their own community.

Our young visitors were particularly fascinated by details of how used nuclear fuel will be transported safely to the selected site. They heard from NWMO design engineer Chris Lawrence about the used fuel transportation package, made of solid stainless steel and weighing 35 metric tonnes. He described how the package has undergone a series of tests, including the drop test, penetration test, thermal test, and water immersion test, clearly demonstrating its robust design.



Rachelle Davenport from the NWMO (far left) accompanies a group of high school students and teachers from Ignace as they visit the proof test facility

Western PhD Students Working on NWMO Project Win Awards

Two PhD students from Western University who are working on NWMO programs recently won awards to enhance their research.

Both Mojtaba Momeni and Ryan Morco work within the Industrial Research Chair (IRC) in Nuclear Fuel and Waste Container Corrosion at Western University. The IRC is a Natural Sciences and Engineering Research Council of Canada program, supported by the NWMO.



Award winners Mojtaba Momeni (left) and Ryan Morco, both PhD students at Western University, point to the particular element on the periodic table they are studying in NWMO-funded research. Mr. Momeni specializes in nickel and Mr. Morco is a copper expert

Using computer modelling and other experiments, the lab at Western is testing the NWMO's multi-barrier system's ability to withstand corrosion in harsh deep geological repository conditions.

Mr. Momeni won the 2017 Canadian Nuclear Society R.E. Jervis Award. This award is given to graduate students from around the world for their research accomplishments in Nuclear Engineering or related fields such as radiation chemistry, or chemistry in nuclear systems. He will be presented with $1,000 cash and a plaque at the annual CNS conference. "I was honored when notified of the award," says Mr. Momeni. "This means a lot to me. It means that my research results contribute to an important project that influences the public's everyday life. Achieving this accolade would have seemed difficult without the NWMO's support."

Ryan Morco won the 2017 Roy G. Post Foundation Scholarship, which is designed to provide scholarships to students so they can develop careers in the safe management of nuclear materials. The award came with U.S. $5,000 cash and an all-expense paid trip to the WM2017 Conference in March in Phoenix, AZ. "I consider myself blessed to work with supportive supervisors in partnership with a great organization such as the NWMO. I can see the direct impact of our research on the real-life scenario," says Mr. Morco.

NWMO Releases Triennial Report for 2014 to 2016

The Nuclear Waste Management Organization (NWMO) submitted Progress Through Collaboration – Triennial Report 2014 to 2016 to the Honourable James Gordon Carr, Minister of Natural Resources Canada.

The report outlines progress in implementing Adaptive Phased Management (APM), Canada's plan for the long-term management of used nuclear fuel. The report was made public at the same time as it was submitted to the Minister; this is a requirement of the Nuclear Fuel Waste Act (NFWA).

Progress Through Collaboration – Triennial Report 2014 to 2016 was tabled in both houses of Parliament on May 4, 2017.

The five-year strategic plan, Implementing Adaptive Phased Management 2017 to 2021, was also released.

The NWMO welcomes public views on the contents of its reports, and encourages all interested Canadians to learn more about Canada's plan.



nwmo
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