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## **President's Message**



Dear fellow CNS members,

Welcome to the 2nd issue of the 2024 CNS Newsletter and the first newsletter for the current council year. Throughout this council term, the importance of communications has stood out as a significant area of focus. Our communications serve several purposes to meet the CNS mission, vision and values including, but not limited to, (a) keeping our membership informed of important news items; (b) enhancing visibility of the CNS and ensuring a consistent message; (c) ensuring a consistent branding or visible image for the CNS; and, (d) promoting the CNS as a valuable source of scientific, factual and technical information related to all applications of nuclear science and technology. In that light, several communications guidance and policy documents have been created and are undergoing review for presentation and approval at an upcoming Council meeting.

Since the last issue of the Newsletter, the CNS has hosted or contributed to several conferences including the highly successful 43rd Annual CNS Conference and 48th Annual CNS/CNA Student Conference in Saskatoon, Saskatchewan; NUTHOS-14, the 14th International Topical Meeting on Nuclear reactor Thermal-Hydraulics, Operation and Safety (the first time this event was held in Canada); MCFD 2024, the 3rd International Conference of Materials, Chemistry and Fitness-For-Service Solutions for Nuclear Systems; G4SR-5, the 5th International Conference on Generation IV and Small Reactors; and, DIET 2024, on Disruptive, Innovative and Emerging Technologies. Please go to https://www.cns-snc.ca/cns-events/ to see upcoming exciting and interesting conferences and courses. Many thanks and appreciation goes out to our volunteers and contributors to each of these worthwhile endeavours.

The CNS council meetings (CM) were held on July 26, 2024 (CM218), September 13, 2024 (CM219) and October 18, 2024 (CM220). CM220 was a full-day, in-person meeting to discuss strategic CNS planning for our future.

CNS Organizational Effectiveness Project, lead jointly by Business Support (Keith Stratton) and Strategic Planning (Jacques Plourde) has been developed and builds upon the following four pillars. This is an important agent linking many Strategic Plan initiatives to each other;

1. Membership strategies, driven by Guy Hotte (Chair), Tracy Primeau, Reeghan Osmond and Cheryl Tasker-Shaw; 2. Branches, driven by Arthur Situm (Chair), Raphael Schirrer, and Doddy Kastanya;

3. Events, driven by Keith Stratton (Chair), Guy Marleau, Paul Spekkens, Wei Shen, Daniel Gammage and Rudy Cronk; 4. Relations with Interested Parties, driven by Jacques Plourde (Chair), Neil Alexander, Derek Mullin, Khashayar Ghandi and John Roberts.

Stay tuned for more newsletters as we communicate the outcomes of these important initiatives aimed towards sustaining an effective society long into the future.

In closing, I would like to extend a special recognition to Cheryl Tasker-Shaw for her ongoing support and preparation of the CNS newsletters. Her effort and insights are invaluable in producing high-quality newsletters for the interest and enjoyment of all CNS members. If you have any interest in participating in the development of our newsletters or contributing content, please reach out to the CNS office at cns\_office@cns-snc.ca.

Sincerely,

Derek Mullin, P. Eng CNS President, 2024-2025

# **Recent and Upcoming Events**



January 27-29, 2025 Holiday Inn Downtown, Toronto 30 Carlton Street, Toronto, Ontario M5B 2E9

The aim of this CNS course is to provide an understanding of CANDU fuel design, fuel manufacturing, fuel operations and performance, and how the fuel interacts with interfacing systems. The course will also provide an overview of fuel physics, thermal-hydraulics, fuel handling, coolant chemistry, materials, fuel safety, and disposal of spent fuel. The course will also include talks on continuous improvements/R&D, SMR Fuels, and advanced fuel cycles.

CNS CANDU Fuel Technology Course 2025 - Canadian Nuclear Society - CNS



Organized by: The Canadian Nuclear Society **Nuclear Science & Engineering** Division

2025 March 24-26 (Mon-Wed) Courtyard by Marriott Downtown Toronto 475 Yonge St. Toronto, ON M4Y 1X7

This CNS course will present an extensive overview of the important disciplines in CANDU reactor technology and safety. The course provides an introduction to the basic design, technology, and operation of nuclear reactors. It will also present the major systems in a nuclear plant, as well as the important CANDU reactor safety principles and systems. How to prepare and execute safety analysis to meet licensing demands will also be discussed. The CNS is presenting this course to enhance

the professional and technical capabilities of its members (and non-members) working in, or interested in, the nuclear industry. The course is ideally suited for beginning professionals, but also beneficial to experienced professionals. Come broaden your nuclear knowledge beyond your specific area of work and your own area of expertise.

This course is eligible for Continuing Education Units in the context of the Engineering Institute of Canada Continuing Education program.

www.cns-snc.ca CANDU Technology & Safety Course 2025 - Canadian Nuclear Society - CNS



## 44th Annual Conference, 49th CNS/CNA Student Conference Where: Toronto ON | When: June 8 – 11

The tripling of worldwide nuclear capacity, called for at COP28, requires the build-out of reactors both large and small, factoring in design, fuel availability, fuel recycling, and safe disposal of nuclear material. AnnCon2025 brings together a comprehensive overview of their interrelationships.

**Accommodations** 

Individual Call-In: Guests may call 1-888-627-8559 and provide group code "NS6" to reserve at the negotiated group rate.

Web Link: Guests may use the web link below to reserve directly in the group block

at the group rate. https://book.passkey.com/e/50925110 Last day to receive the CNS room block rate is May 16th, 2025.

#### **Technical Program Topics**

- SMR Technologies
- Improved Safety Analysis, Security, and Regulatory Issues • Operational Experience of Current CANDU
- Next Generation Large Reactors
- Applications of Radioisotopes Fusion

• Other

- Basic Nuclear Science and Technology
- Thermal Hydraulics
- Reactor and Radiation Physics - Fuel and Fuel Cycles Nuclear Education

#### **Plenary Program Topics**

- 1. Updates from Utilities
- 2. Industry Updates
- 3. Future Fuel Supply if Nuclear is Tripled 4. Overview of Advanced Reactor Technologies
- 5. Innovation and the Value of Nuclear

Registration will be coming soon! For conference updates, keep an eye on this year's website CNS Annual Conference 2025 (cns-anncon.ca)





**28th International Conference on** Structural Mechanics in Reactor Technology (SMiRT28)

Theme: Harnessing Nuclear Technologies and Innovation as a Path to Net Zero by 2050

<u>When:</u> August 10th – 15th, 2025 Where: The Westin Harbour Castle, Toronto, ON

#### Here is what you need to know!

Registration is now open! The early bird rate is available until July 31, 2025. Act now to secure your spot at a discounted rate. Register for the conference here!

https://smirt28.com/registration/

Accommodations are now open! Guest rooms are available in the room block at the following rate: \$279 + tax. Guests are able to make their own reservations by calling in or booking through the SMiRT website. More information can be found here:

https://smirt28.com/registration/#Accommodation

#### Technical topics include the following:

- · Mechanics of Materials, • Fracture Mechanic and Component Structural Integrity,
- · Computation, Simulation and Visualization of Components and Structures, • Hazards and Load Characterization: External and Internal,
- Response Characterization Using Testing and Analysis Techniques,
- Design Codes, Standards and Issues, • Reliability, Risk and Safety Margins,
- Aging and Plant Life Management (PLiM), Monitoring, Inspection and Maintenance,
- Fuel Cycles, Facilities, Waste Management and Decommissioning, • Constructability and Construction Management and
- New Technologies (Additive Manufacturing, AI, Digital Twins)
- Plenary topics include the following:
- Nuclear Power A Key to Achieving Net Zero Carbon Emissions by 2050, • Expediting and Harmonizing Regulatory Process,
- Policy Leaders and Drivers for Nuclear Deployment,
- Nuclear Beyond Energy Nuclear Power for Off-Grid Applications, Social Acceptance and Indigenous Relationship and
- Expediting Nuclear Construction

#### Sponsorship Opportunities: Take advantage of an outstanding opportunity to

showcase your company, products and services at SMiRT28. Both excellent sponsorship opportunities and great exhibitor spots are still available. Connect and network with clients, customers, colleagues and peers. Don't delay! Please communicate your interest and any questions to SMiRT Sponsorship & Exhibits Chair Madhoumithaa today.

madhoumithaa@quantumevents.ca

For general inquiries, please contact Rachael Callaghan, rachael.callaghan@quantumevents.ca Event Manager and Conference Coordinator.

Conference updates and information will always be posted on the SMIRT28 website, to stay in the know, please check the Home Page - SMiRT28 https://smirt28.com/

We encourage you to share this information with your colleagues and peers who might be interested in participating. For additional inquiries, contact the Conference Coordinator, Rachael with Quantum Events, at: smirt28@quantumevents.ca



#### G4SR-5: International Conference on **Generation IV and Small Reactors**

The Fifth International Conference on Generation IV and Small Reactors (G4SR-5), hosted by the Generation IV and Small Reactors Technology Division of the Canadian Nuclear Society, took place in Ottawa from October 1-4, 2024. The conference theme, "Accelerating progress: advancing SMR deployment and collaboration for the net zero future," underscored the crucial role of small modular reactors (SMRs) in meeting the world's climate goals.

The event brought together 395 participants, including industry leaders, researchers, and policymakers. While the majority of attendees were from Canada, there was notable international participation from 16 other countries, reflecting growing global interest in SMR deployment.

The program featured plenary and technical sessions, workshops, innovation, and networking opportunities. The plenary sessions addressed various topics, including the role of SMRs and advanced reactors in expediting Canada's decarbonization efforts, Canada's three-stream strategy, international partnerships, regulatory progress, workforce enhancement, and the shift towards deploying advanced nuclear technologies in the United States.

Key takeaways from the plenary sessions included that demand projections for electricity by mid-century continue to grow, driven by new power intensive applications like AI-server farms. At the same time, demands for non-variable clean power and heat for industrial and residential need nuclear to achieve net zero. Work force availability and supply chain readiness are critical and potential limiting factors - even risks - to successful nuclear build outs at the scale required globally based on COP commitments. Finally, Indigenous people want to be involved in nuclear and other energy developments, on their terms, participating as partners with equity stakes and in the work force.

The technical sessions covered topics such as SMR deployment, reactor safety and security, core simulations, regulatory activities, skill development and supply chains, and public policy and engagement.

The program also incorporated optional workshops focusing on digital innovation, hydrogen production, Indigenous engagement, pan-Canadian nuclear R&D, and frameworks for microreactor deployment, providing hands-on learning experiences.

Innovation Night featured a student poster competition and pitch session that paired student presenters with leaders from across the nuclear sector. The conference banquet with live entertainment offered further networking opportunities. The combination of diverse sessions, interactive workshops, and social events contributed to a well-rounded conference experience.

The G4SR-5 conference received robust support from a diverse group of sponsors and exhibitors, reflecting the high level of interest in advancing SMR technologies and Generation IV reactors. Their contributions were crucial in delivering a high-impact conference experience for all attendees. Canadian Nuclear Laboratories (CNL) served as the host sponsor, leading the way in support for the conference. CNL's involvement was central to the event's success, contributing to high-level discussions on nuclear innovation and collaboration. Other sponsors included Hatch Ltd., Bruce Power, GE Vernova, AECL (Atomic Energy of Canada Limited), Curtiss-Wright, Kinectrics, Westinghouse Nuclear, Accuris Technology, BWX Technologies, NB Power and Ontario Power Generation (OPG).

The exhibition space featured an additional 16 exhibitors, including key players in the nuclear and energy sectors. This diverse group of exhibitors showcased cutting-edge solutions and innovations, offering attendees valuable insights into the latest advancements in the industry.

G4SR-5 successfully fostered discussions on innovative technologies, promoted knowledge sharing, and facilitated collaboration among industry professionals, academics, and policymakers. The conference played an essential role in driving progress in SMR technology, supporting the development of sustainable energy systems for the future. The Generation IV and Small Reactor Technology Division is now looking forward to the next G4SR conference in the fall of 2026.



**Registration Area** 

**Plenary Program** 







Innovation Night Expert Panel



Innovation Night



G4SR-5 Organizing committee (From left to right: Sonia Iqbal, Larisa Logan, Arthur Situm, Chuk Azih, David Hummel, Hazem Mazhar, Rachael Callaghan, Ben Rouben, and Matthew Dalzell)

## DIET 2024: Building Futures - A Resounding Success

The fifth annual DIET (Disruptive, Innovative, Emerging Technologies) Conference, held from November 27-29, 2024, at the Courtyard Toronto Downtown, was a hybrid event that brought together 216 attendees from across academia, industry, and government. This year's theme, "Building Futures," captured the conference's spirit of innovation and collaboration, addressing advancements in artificial intelligence, digitalization, adaptive manufacturing, and more.

With 41 plenary speakers, 6 keynote speakers, and 42 technical talks, DIET24 delivered a robust and thought-provoking program. Key discussions explored topics like AI's transformative role in the nuclear sector and regulatory frameworks for emerging technologies.

DIET24 was made possible by the generous support of our sponsors. Gold Sponsors-Bruce Power, Ontario Power Generation, and AECL—along with Silver Sponsors including Kinectrics, Canadian Nuclear Laboratories, and NPX. As well as our Exhibitor Big Red Oak, our General Contributors CNL, the CNSC and finally, our in-kind sponsor OCNI. All these companies showcased their leadership and commitment to advancing nuclear innovation.

Vibrant networking sessions, a student poster competition, and exhibitions further enriched the conference experience, offering attendees opportunities to build meaningful connections and share insights. DIET24 embodied its mission to prepare for the future by building advanced technologies, inclusive workforces, and agile regulatory systems for the nuclear sector.

Participants left the event inspired and equipped with actionable insights to drive innovation in a rapidly evolving industry. Save the date for DIET 2025 as we continue the journey of building a sustainable, technology-driven future!



# **Core Business Blog**

by Neil Alexander



#### Keeping up the pressure

I woke up this morning to: Society of United Professionals Congratulates the Green Party of Ontario on Nuclear Resolution, a press release from the Society of United Professionals regarding a resolution made by the Green Party of Ontario about Nuclear Power.

The press statement focuses on the issue that the Society is interested in, the use of CANDU, and so it's not clear what the full resolution was. My search on the Green Party website didn't help but I did find a post on X where it identifies one motion that was passed as " BE IT RESOLVED that the Green Party of Ontario would support the continued use of nuclear power alongside other forms of low carbon emission energy production, in the case when it is the most environmentally and fiscally responsible option and with respect for the sovereignty of indigenous nations".

It's actually a very muted statement, really just a confirmation of the current position. The resolution about CANDU may go further. But regardless its huge.

I do not know why nuclear ended up with such a bad rap with the environmental community. I hear stories that it started because of the connection to weapons and their frightening ability to do harm. Some say it was just that nuclear looked like "big business" and environmentalists at the time hated big business. I have a personal belief that it was because we started becoming aware of the significance of cancer at the same time nuclear power was being developed and those things became conflated. There is no doubt that fossil fuel barons invested a lot in creating fear about nuclear power in whatever way they could and that before that smear campaign, many environmental organizations were pro-nuclear. The China Syndrome did not help and nor did Three Mile Island, but my (admittedly shaky) recollection is they built on existing fears and did not create them. I may be wrong. Oh and then there is the Simpsons.

Likely it's a combination of all these issues and maybe a few more.

What I do know is the bad rap from environmentalists was not justified and not rooted in either fact or evidence. Nuclear power and weapons are very different technologies with very different end uses. While radiation can cause cancer the levels produced by the civil nuclear industry make little to no difference and ironically radiation is used to detect and treat cancer where it does many orders of magnitude more good than it has ever done harm. Three Mile Island had no noticeable environmental consequences and the China Syndrome was a movie about corporate greed and only used nuclear because it would capture the public's imagination.

The bad rap has however, had an incredibly harmful effect on the deployment and use of nuclear power. The harm isn't just seen in overt statements but in the way it created an acceptable "implied bias" whereby the nuclear industry was just accepted as being bad even though the people involved had no real idea why they thought that. The problem with implied bias is that it's insidious and hard to fight.

This is how implied bias works. I used to get to speak about nuclear power at environmental conferences where the wind and solar representatives were introduced as environmentalists, and I was introduced as "from the nuclear industry". Everything that was said was true, but the unnecessary implication was very damaging. I still see it every day in the media with simple things like the use of quotation marks around comments made by the nuclear industry suggesting they may be questionable without saying so while questionable statements made by "environmentalists" are presented without them as though they are fact. (see how it works?).

That's why I think this move by the Green Party of Ontario is so significant even though its muted. It's significant because the implied bias that would previously have stopped the Green Party even discussing the issue, is losing its power.

People are listening to us. We should grab this opportunity while people are listening to expose implied bias wherever we see it. Watch for it. Point it out. Correct it. There is no reason why the Green Party of Canada should not first align with their Ontario cousins and in the longer term become nuclear advocates, after all they want to preserve the environment and the nuclear industry can help them do that.

# **Dispatch from the Danube**



Reprocessing and non-proliferation

#### **Jeremy Whitlock** Nov 8, 2024

Since its discovery plutonium has symbolized the Faustian bargain of nuclear fission: the unshackling of energy from the dirt and politics of fossil fuels, shackling it instead to the dirt and politics of nuclear weapons.

Plutonium itself does not exist naturally on earth in any practical quantity, but is spawned abundantly in nuclear reactors as a byproduct of the fission process: some uranium splits in half; some becomes plutonium. This turns out to be quite fortuitous, since commercial nuclear power would have been much more difficult otherwise: between one-

third and one-half of the energy from conventional power reactors (depending on the design) comes from plutonium self-generated in the fuel.

Maintaining the Faustian symmetry, plutonium's discovery was also fortuitous to nuclear weaponry, being generally easier to acquire

than weapons-grade uranium, and enabling more efficient, modern warheads.

But double-edged though this sword may be, it's important not to lose sight of plutonium's immense potential as an equalizer of wealth on this planet: we can do without nuclear war, but we can't do without sustainable development (the end result is actually strikingly similar).

At stake is the potential extension of nuclear fission resources by a factor of 100, essentially making it limitless - or at least a healthy bridge to the next big solution.

And yes, the fact that our current usage of uranium is less than 1% efficient may surprise some, but these are the cards that nature dealt us - and it's a long reach to the remaining 99%. Much more complex reactors are needed to convert the non-useful fraction of uranium to useful plutonium, followed by chemically reprocessing the irradiated fuel in order to turn this plutonium into new fuel. Although the technology for both has existed for over half a century, getting this to work commercially and securely is a feat only now being widely pursued by governments and private companies, emboldened by the twin global crises of climate change and energy security.

Reprocessing - the chemical separation of plutonium (and other useful nuclides) from irradiated fuel - presents a challenge from both a technical and policy standpoint.

The far easier route is to avoid this recycling step altogether and dispose of used fuel in a geological repository - letting Nature protect future generations from the radioactive material the way she has done for billions of years.

This long-term repository route is being followed by several countries (the first movers including Finland, Sweden and Canada), but this practical step doesn't take reprocessing off the table by any means.

Reprocessing's policy challenge stems from proliferation concerns: any time you pry open the self-protecting tomb of irradiated nuclear fuel, extracted plutonium becomes intrinsically more attractive for nefarious purposes: this is unavoidable since it's been taken one further step towards weapons usefulness.

Is the process overall less proliferation resistant? This is a more complex question, which can't be answered without analysis of the larger system.

Many advanced reprocessing technologies propose a measure of intrinsic protection by pulling out plutonium (and other useful nuclides) alongside non-useful nuclides - typically enabled by a reactor design that can run economically on such impure fuel mixtures. Regardless of the intrinsic features however, safeguards will be needed.

The International Atomic Energy Agency has the capability to impose measures to objectively verify - to a global standard - that all plutonium remains where it was declared (and no undeclared plutonium is secretly created).

These safeguards underpin the global non-proliferation regime, supporting for over half a century every country's inalienable right to pursue peaceful uses of nuclear energy under the Non-proliferation Treaty (NPT).

Today's non-proliferation regime grew from a failed U.S. policy of nuclear secrecy immediately following WWII, as it became increasingly recognized that robust international safeguards drive sustainable development and not handouts in front of a barricaded barn door.

More complicated systems demand more complicated safeguards, but this can be mitigated immensely by working with technology developers well ahead of a first-build project, ensuring that safeguards are built efficiently into the system as much as possible. This 'safeguards by design' approach is underway today, taking advantage also of synergies with measures already needed for safe operation and nuclear security (a so-called '3S' approach).

In this light, the steps taken to ensure the safeguarded (and safe and secure) operation of advanced nuclear systems, if affordable and effective, become necessary enablers of historically unprecedented access to abundant energy for a world where most lack this - and where the minority that has enjoyed it to date has almost destroyed the world doing so.

The policy of secrecy returned in 1977 when President Carter famously banned reprocessing in the U.S. out of proliferation concerns. President Reagan subsequently lifted the ban four years later, and although U.S. policy then wavered back and forth through subsequent political regimes, reprocessing was never banned outright again.

Going forward, the important question of nuclear reprocessing will be a matter for objective technical and sociopolitical assessment that must include the capabilities of international safeguards - which are considerable.

Any technology with the potential to extract 100 times the energy from a waste material at least deserves this.

## Simulating Water Ingress during Long-Term Storage of **Spent Sodium-bonded SMR Fuel**

Canadian Nuclear Society - Undergraduate Student Research Scholarship, 2024 C. J. E. Arsenault<sup>1</sup>, H. El Hajjaoui1, O. Y. Palazhchenko1, X. Pang<sup>2</sup>

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ABSTRACT

The long-term storage of spent sodium-bonded fuel from Small Modular Reactors (SMRs) presents unique challenges, particularly with respect to water ingress into deep geological repositories (DGRs). This research focuses on the behavior of HT9 cladding, a ferritic-martensitic stainless-steel alloy, when exposed to simulated groundwater conditions in a DGR. Utilizing experimental methods developed in collaboration with CanmetMATERIALS, HT9 coupons are coated with sodium and subjected to controlled tests simulating water ingress. Additionally, a porewater recipe developed by the GeoEngineering Centre of Queen's University and Royal Military College simulates the groundwater chemistry in a DGR. These experiments aim to investigate the chemical reactions and material degradation that occur when groundwater interacts with sodium-bonded fuel cladding. A custom sodium testing apparatus is being constructed to monitor the effects of water ingress under anaerobic conditions. The findings from this study will provide insights into the corrosion mechanisms of sodium-bonded SMR fuel cladding, informing the long-term safety and integrity of nuclear waste storage. KEYWORDS: sodium-fast reactor, deep geological repository, small modular reactor, spent nuclear fuel, sodium-water interactions

> For the complete paper, please click this link: Undergraduate Summer Research Papers - Canadian Nuclear Society - CNS

## **Reactor Core Monitoring at the McMaster Nuclear reactor with** Nitrogen-16 Gamma and Neutron Flux Measurement

Joseph Fishman **McMaster University** 

Hamilton, Ontario

fishmj1@mcmaster.ca Joseph Fishman won an undergraduate scholarship.

With contributions from: Adriaan Buijs, Bafrin Ali, Danny Purnomo, Robert Pasuta, Bryan Van der Ende, Andrew Erlandson, Bindiya Chana, Bhaskar Sur

ABSTRACT

Three power measurement systems at the McMaster Nuclear Reactor are compared: i) Thermohydraulic measurement involves measuring the difference in coolant temperatures of inlet and outlet as well as the mass flow rate; ii) Neutron flux measurements outside the core, which is proportional to the core neutron flux; iii) Nitrogen-16 (N-16) gamma measurements that measure the amount of N-16 produced by from the oxygen in the coolant at the exit pipe. The amount of gamma radiation measured from the N-16 will be proportional to the power. Data from these three measurement systems were taken simultaneously at the McMaster Nuclear Reactor and analysed. Thermohydraulic power measurements are shown to be reliable for steady state operation due to their small uncertainty, but not for quick changes in power. Ex-core neutron-based power measurements are imprecise due to low neutron counts but respond to changes immediately. N-16 gamma measurements respond quickly and are precise but have other unique challenges due to the finite N-16 lifetime.

> For the complete paper, please click this link: Undergraduate Summer Research Papers - Canadian Nuclear Society - CNS

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- Membership is free for students, and discounted rates are available for retirees! Receive access to daily News Briefings on topics concerning the nuclear industry!
- Get access to the CNS Member's Directory to help you network with others in the field.

Receive early notices by e-mail of many other items of interest. https://cns-snc.ca/join-or-renew-cns-membership/



Membership fees:

\$92.00 for regular members, and \$86.40 for each additional year \$54.10 for retiree members, and \$48.40 for each additional year

\$31.00 for student members from outside Canada

Free for Canadian students! As part of the registration process, you will be asked to confirm your full-timestudent status (student card or other institution documents) in the current year. Once that confirmation is received, your membership will be approved. Note: to be eligible for the student fee for CNS conferences and courses, you must be a CNS student member in good standing.



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