

CURRICULUM VITAE (CV)

1. PERSONAL INFORMATION

- Name: Marcel Lacroix
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- Email : marcel.lacroix@usherbrooke.ca
- Website : <http://marcellacroix.espaceweb.usherbrooke.ca/>
- Profession: Professor of engineering (energy), Private engineering consultant (P. Eng., Ordre des Ingénieurs du Québec) and Commissioner, Canadian Nuclear Safety Commission.
- Languages: French and English.

2. ACADEMIC EDUCATION

- Ph.D., Nuclear Engineering, École Polytechnique de Montréal, Canada 1984.
- Master's degree, Nuclear Engineering, École Polytechnique de Montréal, Canada 1981.
- B.Sc., Physics, *Magna Cum Laude*, University of Ottawa, Canada 1979.

3. SIX TANGIBLE ACHIEVEMENTS

3.1 Licensed two of the largest nuclear generating stations in the world: Bruce Power Inc. (6,4 GWe) and Pickering (3,1 GWe). Result: Both these stations generate approximately 45% of the electricity needs of the province of Ontario, Canada.

3.2 Authored books on energy (including nuclear technologies); Example: *Thermodynamique, une approche pragmatique*, Y. Çengel, M. Boles, M. Lacroix, Chenelière-McGraw-Hill (First Edition, 2008; Second Edition, 2014; Third Edition, 2019). Result: This textbook has become a best seller in the field of energy. It is the reference textbook for teaching thermodynamics and energy engineering in French speaking engineering schools in North America and in Europe.
<https://cheneliere.ca/10865-livre-thermodynamique-3e-edition-une-approche-pragmatique.html>

3.3 Developed an innovative computational procedure to predict complex two-phase flows in nuclear fuel channels (Atomic Energy of Canada Ltd.). Result: Most thermal-hydraulics simulation codes used by the North-American nuclear industry rely on this numerical method.

3.4 Developed models and expert systems for the control and the management of industrial high power AC smelting furnaces (QIT Iron & Titanium and Rio Tinto Alcan, in Canada and in South Africa; Metso-Outotec, in Finland and Saudi Arabia). Result: Half of the world's production of titanium dioxide is controlled/managed by these systems. Titanium dioxide is used as a colouring and opacity agent in paints, plastics, dyes, paper, rubber and other materials.

3.5 Designed and built multiple renewable energy storage and management systems (Hydro-Québec, Ministère des ressources naturelles du Québec and Canadian Electricity Association).

Result: These solar collector/heat storage systems, geothermal heat-exchanger storage systems and water heaters are now used in Canada, in Europe and in North Africa.

3.6 Developed computer models and control systems for calcination kilns and pyrolysis/gasification furnaces (ALCAN International and Lafarge). Result: These models and control systems are now used for the production of gas mixtures (H₂, CO, CH₄, etc.) and for the production of activated carbons with high specific surface area. Activated carbons are employed in air filters and catalysts.

4. WORK EXPERIENCE

4.1 Canadian Nuclear Safety Commission (CNSC): *Permanent part-time member (Commissioner), Governor General in Council appointment since 2018.*

(<http://nuclearsafety.gc.ca/eng/the-commission/commission-members/index.cfm>)

Mandate of the CNSC

- To regulate the use of nuclear energy and materials to protect health, safety, security, and the environment;
- To implement Canada's international commitments on the peaceful use of nuclear energy;
- To disseminate objective scientific, technical and regulatory information to the public.

Duties of a commissioner

The Commission is a quasi-judicial independent federal administrative tribunal and a court of record. It comprises five permanent members including the president. The commissioners are appointed by the Governor in Council of Canada. They are independent adjudicators that commit to the highest ethical standards. The commissioners are accountable for authorizing and regulating all nuclear activities in Canada. The main duties of a commissioner are:

- To establish regulatory policy on matters relating to health, safety, security and environment;
- To establish classes of licences for nuclear facilities;
- To make legally binding regulations;
- To make independent decisions on licensing nuclear-related activities;
- To issue, renew, suspend, amend, revoke or replace a licence, or authorize its transfer;
- To approve regulatory documents;
- To participate in public hearings and meetings;
- To review orders of inspectors and designated officers;
- To review administrative monetary penalties;
- To rehear and re-determine matters and to consider appeals;
- To grant exemptions from the Nuclear Safety Control Act and regulations;
- To exercise exceptional powers;

Examples of recent achievements

- Licensing and/or regulatory oversight reviewing of the following nuclear facilities in Canada:
 - (1) Nuclear Generating Stations: Bruce A (4 x 831 MWe units), Bruce B (4 x 872 MWe units), Pickering (8 x 540 MWe units, two shutdown), Darlington (4 x 935 MWe units), Point Lepreau (1 x 705 MWe unit) and Gentilly-2 (1 x 675 MWe unit, shutdown);
 - (2) Waste Management Facilities: Bruce, Pickering, Darlington and Point Lepreau;
 - (3) Canadian Nuclear Laboratories: Chalk River site, Whiteshell site, Port Hope project, Port Granby project, Douglas Point waste facility, Gentilly-1 waste facility and Rolphton Nuclear power demonstration waste facility;
 - (4) Uranium mines and mills: Cigar Lake Operation, McArthur River Operation, Rabbit Lake Operation, Key Lake Operation and McClean Lake Operation;
 - (5) Uranium processing facilities: Cameco Blind River refinery, Cameco Port Hope conversion facility, Cameco fuel manufacturing Inc. and BWXT Nuclear energy Canada Inc.;
 - (6) Nuclear substances processing facilities: SRB Technologies Canada Inc, Nordion Canada Inc. and Best Theratronics Ltd.;
 - (7) Research reactors and accelerators: McMaster Nuclear reactors, Royal Military College of Canada SLOWPOKE-2, Saskatchewan Research Council SLOWPOKE-2, University of Alberta SLOWPOKE-2, École Polytechnique de Montréal SLOWPOKE-2, Tri University Meson Facility accelerators and Canadian Light Source Inc.
 - Orientation sessions, Canadian Nuclear Safety Commission, Ottawa, April 2018.
 - Training program for tribunal members, Council of Canadian Administrative Tribunals, Ottawa, June 2018.
 - Orientation sessions, Canadian Nuclear Safety Commission, Ottawa, March-April 2021.
 - Symposium series, Council of Canadian Administrative Tribunals, Ottawa, April 2021.
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4.2 Université de Sherbrooke: *Full professor of energy engineering since 1991.**Management*

- Management of a multi-cultural and multi-disciplinary research team comprising scientists, engineers, graduate students, technical and clerical staff.

Teaching

- Undergraduate and graduate courses, seminars and forums on energy, thermodynamics, heat transfer and design of energy conversion and management systems.
- Lecturer at the ‘Open University’, Université de Sherbrooke, Canada: a series of public conferences on ‘Energy, society and the environment’.

Research

- Modelling, simulation, control and optimization of thermal processes.
- Modelling of Li-Ion batteries.
- Analysis and prediction of tube fouling of nuclear steam generators.
- Development and applications of inverse heat transfer methods.

- Design and management of renewable energy systems.

Miscellaneous

- Regular appearances in the media (radio, television, newspapers and magazines) across Canada, from Moncton, New Brunswick to Vancouver, British Columbia. I demystify energy technologies, namely nuclear technologies such as nuclear reactors, uranium mining, production of radioisotopes and their applications, Chernobyl and Fukushima accidents, fuel cycles, thorium reactors, small modular reactors, MOX and management of nuclear wastes.
- Public speaker for advocating energy technologies (nuclear, fossil, solar, wind and biomass). See list of publications at <http://marcellacroix.espaceweb.usherbrooke.ca/>.
- Adviser to the Université Aix-Marseille, Marseille, France, on the implementation of a Master's programme in nuclear engineering from 2011 until 2012.
- Vice president for the Professors union at the Faculty of Engineering at the Université de Sherbrooke from 1998 until 2000 and from 2005 until 2010. This professional union comprises 165 members. As an acting vice-president, I worked hand-in-hand with legal advisers on several dossiers such as the negotiation of collective bargaining agreements and settlements, the resolution of conflicts, and the application and the compliance to rules of procedure.
- Chair of the committee on strategic projects on energy efficiency technologies for the Natural Sciences and Engineering Research Council of Canada from 1998 until 2002.
- Chair of the promotion committee at École de technologie supérieure de Montréal from 1998 until 2000.
- Member of the Editorial Board of Mechanics & Industry since 2009.
- Examiner for l'Ordre des ingénieurs du Québec since 1992 (Association of Professional Engineers).
- Associate editor for the International Journal of Thermal sciences, Elsevier, Oxford, England from 1996 until 2000.
- Associate Reviewer for the following scientific journals: International Journal of Energy, Energy Conversion and Management, Nuclear Technology, Solar Energy, International Journal for Energy Research, Energy and Buildings, International Journal of Thermal Sciences, International Journal of Heat and Mass Transfer, Numerical Heat Transfer, Journal of Heat Transfer (ASME), Journal of Solar Energy (ASME), International Journal of Numerical Methods for Heat and Fluid Flow.

Examples of achievements

- Delivered more than 6000 hours of lectures and conferences and supervised over 50 master's theses and 15 Ph.D. theses in engineering.
 - Authored nearly three hundred peer-reviewed publications and technical reports that contributed to the advancement of energy technologies.
 - Authored seven books on thermodynamics, energy, and nuclear science and technologies.
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4.3 Private engineering consultant since 1989.

Management

This engineering firm, founded in 1989, advises companies, governments, law offices and organisations on the utilization and the management of energy technologies. It also designs systems and implements energy programmes and policies. Its main customers are the power industry (nuclear, hydro, thermal, solar and biomass) and the process industry (chemical and metallurgical). The firm comprises professional staff hired on a contractual basis. My main duties consist of:

- leading the strategic planning of the firm;
- establishing and maintaining contacts with government and industry officials;
- writing proposals, negotiating contracts and winning resources;
- recruiting, supervising, coaching and developing a multi-cultural and multi-disciplinary team of professionals;
- managing projects, setting objectives, planning activities, organizing resources and monitoring performance against deadlines and milestones;
- conducting on-site measurements, monitoring systems and processes, collecting and gathering data;
- modelling, simulating, analysing and optimising systems and processes;
- producing and reviewing technical documents and reports;
- providing technical assistance to customers and providing authoritative information and advice to decision makers and stakeholders;
- preparing, implementing and evaluating energy conservation and energy efficiency programmes and policies;
- organizing and chairing meetings, seminars and workshops and delivering oral presentations and lectures.

Examples of technical achievements

- Conduction of safety analyses of nuclear facilities (Atomic Energy of Canada Ltd., Hydro-Québec, Atomic Energy Control Board of Canada and Électricité de France).
- Development of an expert system for the control and the management of industrial AC ilmenite smelting furnaces powered by six aligned open arc electrodes (QIT Iron & Titanium, Rio Tinto, Canada and South Africa).
- Design and construction of renewable energy storage systems (hydro, hybrid, solar and geothermal) (Hydro-Québec, Ministère des ressources naturelles du Québec, Canadian Electricity Association).
- Development of a computational model for predicting the thermal behavior of industrial AC ilmenite cylindrical smelting furnaces powered by three open arc Soderberg electrodes (Metso-Outotec, Finland and Saudi Arabia).
- Development of models for the control of: (1) calcination kilns (ALCAN International Limited); (2) high temperature furnaces for the pyrolysis and gasification of wastes and biomass (Lafarge).

- Assessment of trans-critical carbon dioxide refrigeration cycles and systems (Law Offices of Caza, Marceau, Soucy and Boudreau, Laval, Canada).
 - Development of new thermodynamic cycles for power generation from low temperature industrial waste heat (Rio Tinto Alcan).
 - Implementation of thermal management strategies for the cooling of hydroelectric power generators (Isle Maligne and Chute-des- Passes, Alcan International Limited).
 - Design and construction of hybrid thermal storage units for the simultaneous management of electricity and solar energy (Hydro-Québec and Ministère des Ressources naturelles du Québec).
 - Design of domestic electric water heaters for load management and the elimination of bacterial contamination (Hydro-Québec and Canadian Electricity Association).
 - Technical adviser for the Law Offices Pinsent Masons LLP, London, Great Britain.
 - Technical adviser for the Law Offices Weltchek, Mallahan & Weltchek LLC, Baltimore, USA.
 - Technical adviser for the Law Offices of Dever & Fedstein LLC, Sparks, USA.
 - Technical adviser for the Law Offices of Dunton & Rainville, Laval, Canada.
 - Technical adviser for the Law Offices of Martineau & Walker, Montréal, Canada.
 - Technical adviser for the Law Offices of Caza, Marceau, Soucy and Boudreau, Laval, Canada.
 - Technical adviser for QIT Iron and Titanium Inc., Sorel, Canada.
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4.4 École nationale supérieure des techniques industrielles et des Mines, Albi, Douai and Paris, France: Associate professor and consultant for the Ministry of Industry, Economy and Finance of France from 2003 until 2005;

Université Claude Bernard de Lyon and Conservatoire national des arts et métiers de Paris, France: Full professor and private consultant for the French nuclear power industry from 2000 until 2001.

Management

- Management of a research team.

Teaching

- Undergraduate and graduate courses, seminars and forums on energy, thermodynamics, heat transfer, chemical reaction engineering and material science.

Research

- Modelling, simulation, control and optimization of industrial thermal processes.
- Thermal-hydraulics of nuclear power reactors.
- Gasification of waste and biomass.
- Production of hydrogen.

Miscellaneous

- Chair of the International Master's Programme 'Clean Energy from Waste and Biomass'.
- Chair of the Master's Programme 'Fluid Mechanics and Energy'.
- Member of the committee on the strategic development of the École nationale supérieure des techniques industrielles et des Mines, France.
- Member of the study council of the École nationale supérieure des techniques industrielles et des Mines, France.

Example of an achievement

- Energy adviser to the Ministry of Industry, Economy and Finance led by Mr. Nicolas Sarkozy.
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4.5 Université du Québec à Chicoutimi, Chicoutimi, Canada: Professor of engineering in the Department of Applied Sciences and private consultant for the process industry from 1987 until 1991.*Management*

- Management of a research team.

Teaching

- Undergraduate courses of heat transfer, applied thermodynamics, Newtonian mechanics and nuclear physics.
- Graduate course of applied numerical methods.

Research

- Co-holder of the ALCAN industrial chair on heat and mass transfer inside high temperature industrial furnaces (M. Lacroix, R. Bui and A. Charette).
- Design of thermal energy storage systems.

Examples of technical achievements

- Analyses of convection heat transfer in transonic flows inside high temperature furnaces (Alcan International Limited).
 - Modelling and control of melting furnaces and soaking pits (Alcan International Limited).
 - Heating of ingots with impinging jets (Alcan International Limited).
 - Modelling, simulation and control of coke calcining kilns (Alcan International Limited).
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4.6 Atomic Energy of Canada Limited, Chalk River, Canada: *Professional Engineer and manager in the Advanced Reactor Development Division* from 1985 until 1987.

- Technical management of the *Heat Transfer and Fluid Flow Section*. This section comprises highly qualified professionals from (1) the Chalk River Nuclear Laboratories, Canada; (2) the Harwell Nuclear Laboratories, England; and (3) the National Engineering Laboratory, Scotland. Its mission is to provide technical support and to transfer innovative energy technologies to the power industry (nuclear and thermal) and to the process industry (chemical). The managerial experience that I acquired in this post was a catalyst towards a career as a consultant engineer.
- Conduction of safety analyses, of reliability and risk assessment analyses and of consequence analyses of accidents in (1) CANDU power reactors (CANada Deuterium Uranium); (2) the NRU reactor (the National Research Universal reactor used for the production of isotopes at Chalk River, Canada); and (3) the 10 MWth-SLOWPOKE demonstration reactor (Safe LOW Power Kritical Experiment at Whiteshell, Canada). These analyses were mandatory in order to obtain and to renew the operating licenses of the nuclear facilities.
- Development of safety guidelines for the CANDU Owners' Group, a group of utilities operating CANDU reactors (Ontario Power Generation, Bruce Power, Hydro-Québec and New Brunswick Power).
- Development of a spatial flux control system for large core CANDU reactors fuelled with slightly enriched uranium (Generation-III nuclear power reactor).
- Strategic planning and coordination of the R&D for CANDU Owners' Group.
- Member of the Speakers' Bureau of the Chalk River Nuclear Laboratories. This bureau comprises 10 scientists selected among 2000 employees. Its mandate is to promote public awareness and understanding of nuclear technologies.

Example of a technical achievement

- Development of an innovative computational procedure to predict complex two-phase flows in nuclear fuel channels (Atomic Energy of Canada Ltd.).
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4.7 Hydro-Québec, Groupe d'analyse nucléaire, Montréal, Canada: *Professional Engineer for Hydro-Québec Gentilly-2 Nuclear Power Station* from 1984 until 1985.

- Conduction of safety analyses for the CANDU-675 MWe Gentilly-2 nuclear power reactor.

Example of a technical achievement

- Development and implementation of a new pressurizer model for the thermal-hydraulics code SOPHT. This code is used to perform safety analyses of nuclear power reactors.
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4.8 École Polytechnique de Montréal, Montréal, Canada: *Graduate student and Research assistant in the Department of nuclear engineering from 1979 until 1984.*

- Modelling and simulation of heat transfer and fluid flow in obstructed horizontal nuclear fuel channels.
- Development of an experimental method for monitoring tritium in water and milk.
- Sessional lecturer in nuclear engineering, mechanical engineering and applied mathematics.

Achievements

- Completion of a Doctoral thesis (1984) and of a Master's thesis (1981), both in nuclear engineering.
 - Professional licensee for operating the 20 kWth-SLOWPOKE-2 nuclear reactor.
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4.9 University of Ottawa, Ottawa, Canada: *Undergraduate student and Research assistant in the Department of Physics from 1976 until 1979.*

- Development of second generation Cu₂O photovoltaic cells.
- Sessional lecturer in experimental physics.

Achievement

- Completion of a B.Sc. in Physics, Magna Cum Laude (1979).
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4.10 Canada Packers, Maple Leaf, Hull, Canada: *Hourly rate worker in the meat processing and packaging department from 1973 until 1977.*

5. PROFESSIONAL ASSOCIATIONS

- American Nuclear Society.
- Ordre des Ingénieurs du Québec (Professional association of engineers)

6. FEW DISTINCTIONS

- Appointed *permanent member* of the Canadian Nuclear Safety Commission by her Excellency the Governor General in Council in 2018. The procedure for the appointment comprises written comprehensive technical examinations, interviews, private investigations and security clearances.
- Appointed *Professeur associé* at the *École nationale supérieure des techniques industrielles et*

- des Mines* by the Minister of Industry, Economy and Finance, Mr. Nicolas Sarkozy in 2003.
- Appointed *Professeur des universités de France* by the Minister of National Education, Mr. Jack Lang in 2000.
 - Invited Professor at École Centrale Marseille, France, in 2016.
 - Invited Professor at Université Aix-Marseille, France, in 2014.
 - Invited Professor at Université de Lorraine, France, in 2013.
 - Invited Professor at Université Paul Cézanne, France, in 2012.
 - Invited Professor at the Université de Pau, France, in 2011.
 - Invited Professor at Université de Provence, France, in 2011.
 - Invited Professor at École Centrale Marseille, France, in 2010.
 - Invited Professor at the Université de Limoges, France, in 2009.
 - Invited Professor at the Université de Bretagne, France, in 2009.
 - Associate Professor at the Université Laval, Canada, since 2005.
 - Invited Professor at the École Nationale d'ingénieurs de Tunis, Tunisia, in 2003.
 - Invited Professor at the École Nationale d'ingénieurs de Tunis, Tunisia, in 2002.
 - Invited Professor at the Université de Cergy-Pontoise, France, in 2000.
 - Invited Professor at the Université de Pau, France, in 1999.
 - Invited professor at the Université du Havre, France, in 1994.
 - Recipient of the best teacher award from the Université de Sherbrooke in 2021.
 - Recipient of the best teacher award from the Université de Sherbrooke in 2019.
 - Recipient of the best teacher award from the Université de Sherbrooke in 2018.
 - Recipient of the best teacher award from the Université de Sherbrooke in 2014.
 - Recipient of the best teacher award from the Université de Sherbrooke in 2011.
 - Recipient of the best teacher award from the Université de Sherbrooke in 2008.
 - Recipient of the best teacher award from the Université de Sherbrooke in 2006.
 - Recipient of the best teacher award from the Université de Sherbrooke in 2000.
 - Recipient of the best teacher award from the Université de Sherbrooke in 1994.
 - Recipient of the best teacher award from the Université de Sherbrooke in 1993.
 - Recipient of the best teacher award from the Université du Québec in 1990.
 - Recipient of the best teacher award from the Université du Québec in 1989.
 - Regular keynote speaker invitations at international conferences and at universities in North America, Europe and North Africa.
 - Recipient of prizes for excellence in research and engineering awarded by the Canadian Society for Mechanical Engineering, by the Canadian Institute of Mining and Metallurgy and by the Association québécoise pour la maîtrise de l'énergie.
 - Grant holder of the Natural Sciences and Engineering Research Council of Canada since 1979: From 1979 until 1984, as a graduate student; since 1985, as a Professor/researcher.
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