Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

CMD 18-H6.45

File / dossier: 6.01.07
Date: 2018-05-07
Edocs: 5528959

Oral Presentation

Submission from
Women in Nuclear Canada
WiN Canada

In the Matter of

**Ontario Power Generation Inc.,
Pickering Nuclear Generating Station**

Request for a ten-year renewal of its Nuclear Power Reactor Operating Licence for the Pickering Nuclear Generating Station

Commission Public Hearing – Part 2

June 2018

Exposé oral

Mémoire de
Women in Nuclear Canada
WiN Canada

À l'égard de

**Ontario Power Generation Inc.,
centrale nucléaire de Pickering**

Demande de renouvellement, pour une période de dix ans, de son permis d'exploitation d'un réacteur nucléaire de puissance à la centrale nucléaire de Pickering

Audience publique de la Commission – Partie 2

Juin 2018

Canada

Women in Nuclear (WiN) Canada
c/o Bruce Power L.P., PO Box 1540
177 Tie Rd., R.R. 2, Tiverton, ON, N0G 2T0
519-386-1671 ● www.wincanada.org

May 7, 2018

Canadian Nuclear Safety Commission
c/o Louise Levert, Secretariat and Doug Wylie, Aboriginal Consultation, Participant Funding Program, Policy, Aboriginal, and International Relations Division
280 Slater Street, P.O. Box 1046
OTTAWA, ON
K1P 5S9

Attention: Canadian Nuclear Safety Commission (CNSC) Tribunal Chair and Commission Members

Re: Women in Nuclear Canada Intervention in Support of OPG's application to renew the operating license for the Pickering Nuclear Generating Station (PNGS)

The CNSC has awarded Women in Nuclear (WiN) Canada participant funding for participation in the Application for Licence Renewal for Pickering NGS (PNGS). PCWatson Engineering and Sustainable Policy Inc. has been retained by WiN-Canada to conduct a technical review of the written submission from OPG in support of the Pickering Power Reactor Operating Licence (PROL) CMD H-6 [1] and the submission from the CNSC staff for the Pickering Licence Renewal (CMD 18-H6) [2], focusing on real and perceived issues for women who work at PNGS or are members of WiN.

The objectives of this review by WiN Canada were to:

- Undertake a technical analysis of the Commission Member Documents (CMD 18-H6, and 18-6.1),
- Disseminate information regarding the license renewal at PNGS to WiN Canada members,
- Identify real and perceived risks to female workers at PNGS and the adequacy of personnel training, work organization and job design, and
- Address other WiN concerns.

About WiN

Women in Nuclear (WiN) Global [3] is a world-wide non-profit association of women working professionally in various fields of nuclear energy and radiation applications, established in 1993. WiN Global currently has approximately 25,000 members including national chapters' members and individuals from over 107 countries, with some 30 national, regional and international chapters throughout the world.

Women in Nuclear Canada (WiN-Canada) [4], established in 2004, represents over 1,700 women and men across Canada. While many of the members of WiN Canada are employed in the nuclear energy sector (Bruce, Darlington, Pickering and Point Lepreau), WiN-Canada welcomes members from industries who use nuclear and radiation technologies, such as hospitals and

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medical facilities, mining, academic and research institutions, the wider electricity sector, and the suppliers to all of these industries.

WiN-Canada goals are:

- To develop a dialogue with the public and in particular with other women, to promote awareness around the factual contribution to people and society from nuclear technologies.
- To contribute to knowledge and experience exchange among members and chapters.
- To promote career interest in nuclear engineering, science, technology, the trades and other nuclear-related professions, especially among women and young people.

In our industry, made up of a little less than 20 percent women, our organization works to showcase the vital contribution women are making as leaders in the nuclear industry. WiN members devote a great deal of their volunteer time working with young women and girls introducing them to non-traditional, but rewarding careers in science, technology and the skilled trades. Chapter events enhance knowledge of the nuclear industry among members. A WiN Speakers Clearinghouse provides this information to the public, especially womens' groups.

WiN-Canada believes that knowledge exchange between our members about all aspects of the industry provides them with the information necessary to help educate our family, friends and members of the public. This dialogue provides an opportunity for the public to make an informed decision about whether or not they choose to support the industry.

Women are strong opinion leaders in our country. Because of its efforts to promote the careers of women, WiN-Canada has become a strong, credible voice in the nuclear industry. It is important for our voice to be heard, including our support of all aspects of the nuclear industry, at these Pickering Nuclear Generating Station (PNGS) License Renewal public hearings.

WiN-Durham and PNGS

Some WiN Canada members are PNGS employees and play key roles in the continued safe operation of PNGS; they would be directly affected by the outcome of the PNGS license renewal application. These women include members of the WiN Durham chapter.

PNGS has been supportive of our WiN Durham Chapter including our programs and events. PNGS recognizes the importance of the advancement of women, and highlighting the important role women play in the nuclear industry. We currently have over 550 WiN Durham members. PNGS has supported a variety of events with WiN Durham, including mentoring and networking opportunities among the membership, sponsoring our participation in Skilled Trades networking events for female high school students, opportunities to educate students on careers within the nuclear industry and professional development workshops for members. These events are important because it provides our members an opportunity to achieve the mission of WiN Canada.

In March 2017, OPG signed the Electricity Human Resources Canada Leadership Accord on Gender Diversity in the Electricity Industry. As a signatory on the accord, OPG and PNGS

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committed to action to expand the breadth and depth of the skilled workforce and ensure women are provided with equal opportunities to grow and develop to their full potential.

Nuclear Safety Culture

As you are aware, the nuclear industry is one of the most highly regulated industries in Canada. In accordance with the CNSC regulatory requirements and guidance, various levels of government and the companies who employ our members, we have a very strong nuclear safety culture. With stringent oversight, regular safety audits, international peer review and our members' own personal accountability for the safety of their coworkers, our industry has put the measures in place to ensure a strong safety culture.

WiN-Canada members come from a variety of work experiences and education. They are involved at every level of the operation, from generating electricity to waste management, from maintenance workers, operators, radiation technicians, to name only a few, as well as including all levels of administration and Senior Management.

We are highly skilled workers, who could work in any industry but choose to work in nuclear. We all understand our responsibility to work safely not only to protect the safety of our colleagues, but also to protect the safety of the communities in which our families, our children and our friends reside. We do not take this responsibility lightly and put safety first every day at work. This strong culture of safety carries over to our activities outside of work, and in our volunteer activities in the community.

Many of our members have raised their children within close proximity to the Pickering NGS. As mothers, our members worry about many issues facing the safety and well-being of our children on a daily basis. The fact that we live close to nuclear generating station is not an issue that keeps us up at night. Pickering NGS has a proven track record of being among the safest nuclear power plant in the world. We would not work in this industry, and live in these communities, if we did not believe it was safe to do so.

The safety of our families, friends and communities comes first before our chosen careers. We simply would never put them at risk. We also believe this is the same for future generations. This focus on safety is not just about today, but for those people who will continue to live and work in this community for many years to come.

PNGS has a strong safety performance, safety management systems and safety culture. Stringent oversight and international reviews and audits will ensure the nuclear safety culture does not erode over time and will in fact continue to strengthen through continuous improvement and learning.

Review of Application for Licence Renewal and CMDs 18-H6, 18-6.1

WiN interests in the Pickering NGS licence renewal include:

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1. Health and safety of female workers, including WiN members,
2. Worker and public safety in the event of a severe accident (nuclear or non-nuclear),
3. Environmental management including radioactive and non-radioactive releases
4. Waste management including decommissioning, packaging and transport of waste,
5. Security, safeguards and non-proliferation
6. Socio-economic factors including career opportunities for women in STEM,
7. Continuing dialogue with the public and employees, and
8. Greenhouse Gas emissions – nuclear energy as part of the solution to climate change.

The observations from the WiN Canada review of the CMDs 18-H6 and 18-6.1 [5] are summarized below according to these WiN focus areas.

1. Health and Safety for Female Workers

Safety and Control Areas (SCAs) addressing health and safety for female workers at PNGS include management system (safety culture), human performance, radiation protection, and conventional health and safety.

As WiN represents women working in the nuclear industry, WiN is convinced that the strong nuclear ***safety culture*** protecting its members in their places of employment will continue at PNGS during the proposed continued operation period and transition to safe shutdown state. Women have worked for years in the nuclear field due to the certainty of the impact of a strong nuclear safety culture. The WiN Canada technical review of the CMDs [5] notes that OPG procedures addressing nuclear safety culture, and periodic self-assessments will ensure that PNGS remains a safe workplace for all, including WiN members, during the proposed licence period and end of commercial operation.

WiN Canada concludes that existing regulations and programs in the area of ***human performance*** together with effective training, certification and requalification as well as fitness-for-duty for those in safety sensitive positions at PNGS positively affect the safety of women working at the site.

Radiation Protection (RP) is an area of interest to WiN members. WiN Canada notes that the overall objective of the RP program is to keep the radiation doses as low as reasonably achievable (ALARA), limit doses to less than regulatory limits, limit detrimental stochastic health effects in employees and the public, and prevent detrimental non-stochastic (deterministic) health effects. Dose levels to workers have been well below regulatory levels with no adverse trends, and over the past 3 years, Pickering collective radiation exposure has been reduced despite more radiological work being performed. Actions, such as following existing regulations, the 5-year Collective Radiation Exposure Dose reduction plan, and correcting deficiencies in radiological hazard control (calibrating gamma monitors) will ensure that PNGS' radiation monitoring will control radiation exposure to workers. This review [5] concludes that the radiation protection and monitoring at PNGS during the period of extended operation will provide adequate protection and ensure no overexposure to workers.

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WiN Canada believes that conventional ***health and safety*** is an issue of importance to women employees at PNGS. The technical review of the CMDs by WiN Canada [5] shows that regulations and efforts in performance, practices and awareness have been effective. Accident frequency, accident severity rate, and industrial safety accident rate indicators are extremely low compared to other industries and workplaces in Ontario and Canada. Pickering has a conventional safety record in the industry's top quartile, 11 million hours without a lost time accident in 2014, a best-ever All Injury Rate, and received CEAs Presidents Gold Award of Excellence for employee safety in 2013-2015. The WiN Canada reviewer concludes that that the Conventional Health and Safety will be acceptable for female workers over the proposed licence period.

2. Worker and Public Safety in Severe Accidents

Preventing Accidents
Several SCAs such as physical design, fitness for service, and operating performance are concerned with maintaining the plant in a safe condition to minimize the likelihood of severe accidents.

The technical review of the CMDs by WiN Canada [5] observes that existing regulations, together with programs such as pressure boundary inspection, aging management including the Instrumentation and Control (I&C) and Digital Control Computer (DCC) obsolescence projects, cable management, and fuel inspection and monitoring should ensure that the ***physical design*** at PNGS will be effective in minimizing accidents over the proposed licence period.

The technical review of the CMDs by WiN Canada [5] observes that existing regulations, together with programs to manage equipment aging, monitor the condition of systems, and address maintenance backlogs ought to be effective in ensuring ***fitness for service*** and preventing accidents during the proposed licence period. Periodic inspection programs for the pressure boundary and concrete containment structures, leak-rate tests on the vacuum building, reactor building and pressure relief ducts are performed. Major component life cycle management plans (LCMPs) for fuel channels address ageing such as changes in fracture toughness, LCMPs for feeders require inspections to monitor feeder wall thinning, LCMPs for Steam Generators (SGs) address SG tube degradation and the effect of tube plugging or removal on performance, and LCMPs for reactor components address spacer location and condition, and calandria tube - LISS nozzle interactions. Regarding the proposed increase in operating hours for the fuel channels, from 247,000 EFPH to 295,000 EFPH, there is a specific licence condition requiring OPG to maintain pressure tube fracture toughness sufficient for safe operation by ensuring [Heq] remains below 120 ppm.

According to the WiN Canada review of the CMDs [5], OPG's planned programs and initiatives in the area of ***Operating Performance*** include implementing Fukushima Action Items (FAI) and a Severe Accident Management (SAM) program. Improvements such as installing passive autocatalytic recombiners (for hydrogen), supplying emergency makeup water to the steam generators, heat transport system and calandria vessel, providing emergency power and cooling

water to air conditioning units (ACUs) and emergency power to hydrogen igniters, filtered air discharge and the main volume vacuum pump should prevent future severe accidents of the Fukushima type during the proposed licence period. In addition, operating reliability has been improving with Units 5 and 1 seeing record operational runs, and forced loss rate averaging 4% for the last 3 years.

Managing Accidents

Women seem to be particularly concerned about severe accidents at a nuclear power plant: public opinion research [6] revealed that support of nuclear from women was particularly impacted after the Fukushima accident and, as a result, women have been shown to be less supportive of the nuclear industry due to what they perceive as a higher risk.

SCAs that relate to managing accidents are: Safety Analysis, and Emergency Management and Fire Protection.

The WiN Canada reviewer's conclusions regarding the ***Safety Analysis*** SCA are that existing regulations and new analysis for common mode events (such as the Fukushima accident scenario), and programs to manage the impacts of ageing, will help prevent and limit the effects of severe accidents. Additionally, new Periodic Safety Analysis (PSAs) have been done that include events such as seismic, high winds, internal fires, and internal floods. Revised Hazard Analysis includes these events. It is believed that the additional nuclear safety improvements that were made, based on the 2009 Integrated Safety Review (ISR), and the Periodic Safety Review (PSR2) that has been conducted for the extended period of operation, will enhance PGS's ability to prevent and manage severe accidents during future operation.

WiN Canada research [7] shows that women are particularly concerned about the potential effects of a nuclear accident on their families. One of the most significant social impacts of the Chernobyl accident was the increase in thyroid cancers amongst children. Women have been shown to be more concerned about nuclear emergencies [6], agreeing that "When things go wrong, they go very wrong".

The WiN Canada review of the CMD [5] notes that Health Canada has modelled releases from a postulated severe accident at PNGS, and numerous improvements have been made at PNGS in response to the Fukushima accident. OPG's Consolidated Nuclear Emergency Plan was revised in 2017, full-scale exercises were conducted in December 2017, a new radio system infrastructure ties into the Durham Region public safety radio system, and potassium iodide (KI) pills have been distributed to the entire population within a 10 km radius of Pickering NGS site. The WiN Canada review [5] concludes that the emergency management and fire protection program during the period of extended operation will provide reassurance for its members working at PNGS who have families living in the surrounding area.

3. Environmental Management Including Radiation Releases

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Past studies by WiN Canada and the Canadian Nuclear Association show that women are particularly concerned with the effects of nuclear power on the environment [6, 7], so this aspect is important for their support of nuclear technologies. Hazardous releases to the air can affect the respiratory health of their children; releases to the water can affect the health of those drinking it, eating food from it, or crops watered with it. Although these concerns are not unique to women, it was shown that these risks can more significantly affect women's perspectives of the risks in the nuclear industry [6].

The WiN Canada reviewer is satisfied that if existing regulations are complied with, the environment will continue to be protected during the proposed license extension at the PNGS site. Airborne radiological releases from Pickering NGS are well below their regulatory limits. Monitoring results from 2013-2016 showed concentrations of radionuclides and hazardous substances in the environment are very low, resulting in a very low dose to the public. Environmental samples from different pathways and the food chain are collected from various offsite locations and tested according to the Environmental Monitoring Program [EMP]. Annual fish impingement has been reduced by 80% by use of a fish diversion system barrier net. Groundwater is sampled at over 100 sampling locations across the Pickering site for radionuclides and other contaminants, with tritium the primary contaminant of potential concern; site perimeter concentrations remain low with no off-site impacts.

The review of the CMDs notes that there are independent environmental monitoring programs in the Pickering area through the Ministry of Ontario Environment and Climate Change Drinking Water Surveillance Program, the Ontario Ministry of Labour Ontario Reactor Surveillance Program, and the Health Canada Radiation Monitoring Network, along with a Fixed-Point Surveillance system. An updated Environmental Risk Assessment (ERA) report for 2011-2015 was submitted in 2017 for radiological and non-radiological hazards.

4. Waste Management Including Decommissioning, Packaging and Transport

The WiN Canada reviewer [5] notes that waste management (WM) is an issue of importance to WiN members. The WM program at PNGS includes waste characterization, waste minimization and waste management for radioactive, conventional and hazardous waste. After a 10-year decay period in the irradiated fuel bays, irradiated fuel is placed in dry storage containers at the Pickering Waste Management facility (PWMF)[1]. Low level waste is sorted, compacted where possible and then packed and transported to the Western Waste Management facility (WWMF).

OPG has a preliminary decommissioning plan (PDP) that is updated every 5 years as required by the CNSC. OPG has financial guarantees for decommissioning.

In summary, PNGS appears to have adequate plans for waste management during the proposed extended operating period, and plans for future removal of irradiated fuel and decommissioning. The WiN Canada reviewer concludes that Waste Management will be adequately managed at

[1] The Pickering Waste Management Facility (PWMF) is separately licensed

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PNGS during the future licence period provided regulations are followed and conditions in the PROL complied with.

Packaging and transport of radioactive waste mainly concerns the LLW sent to the WWMF. The WiN Canada reviewer believes that the Packaging and Transport of nuclear waste will be adequately managed during the proposed licence period provided regulations are followed and conditions in the PROL complied with.

5. Security, Safeguards and Non-Proliferation

WiN Global is committed to the further development and peaceful use of nuclear science technologies and has an interest in safeguards and non-proliferation.

According to the technical review of the CMDs, security at Pickering includes maintaining a nuclear response force of armed and unarmed nuclear security officers, conducting regular security exercises and drills, and a cyber security program. There are also programs to prevent loss, theft or sabotage of nuclear material, or sabotage of the nuclear facility. There is state-of-the-art security equipment throughout the site. The WiN Canada reviewer's conclusions are that ***security*** at PNGS will be adequately managed during the proposed extended operating period provided regulations are followed and conditions in the PROL continue to be met.

Canada has a Comprehensive Safeguards agreement with the IAEA to provide annual assurance that all declared nuclear material is in peaceful, non-explosive uses and that there is no undeclared material. At Pickering NGS, there are regulations for nuclear materials accountancy and control, the IAEA performs inspections and verifications, and maintains equipment at the site for fuel monitoring and optical control. OPG maintains accounting of fuel at all times, supports IAEA inspections, and facilitates upgrades to IAEA equipment on site. Therefore, it is believed that the programs and measures taken by PNGS will ensure that Safeguards and Non-Proliferation will be adequately managed in the period of continued operation.

6. Socioeconomic factors including career opportunities in STEM

WiN Canada promotes career interest in nuclear engineering, science, technology, the trades and other nuclear-related professions, especially among women and young people. Increased participation of women in Science, Technology, Engineering and Mathematics (STEM) is a national goal that will allow Canada to utilize more of its human potential to be more competitive internationally.

Continued operation of Pickering NGS will provide many such opportunities in partnership with WiN Durham.

7. Continuing Dialogue with the Public and Employees

Various public groups have expressed opposition to the extension of the Pickering PROL because of concern over the impact of a Fukushima type accident, low level waste storage in the

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Bruce Deep Geological Repository (DGR), option of continuing operation of PNGS compared to the option of importing electricity from Quebec, and immediate as opposed to deferred decommissioning. These issues were to a large extent considered in the technical review of the CMDs and appear to be adequately addressed.

One of WiN's objectives is to communicate information on the nuclear industry to the public. Therefore, WiN appreciates the opportunity to provide input to this PNGS Licence renewal process.

8. Greenhouse Gas and Climate Change – nuclear as part of the solution

The Pickering NGS currently provides 14% of Ontario's electricity needs (20 TWh in 2016). PNGS emits practically no greenhouse gas (GHG). It will be an important source of carbon free electricity during the refurbishment of Darlington NGS.

In 2015, WiN Global signed a *Women In Nuclear Declaration for the Earth Climate* that calls for: "immediate steps to reduce greenhouse gas emissions that include nuclear energy as an option, a view shared by the IPCC and OECD as well as national and international organisations and nongovernmental organisations (NGOs)[2].

Approval of the PNGS PROL extension supports WiN Global's declaration that calls for nuclear energy to be included as a means of reducing greenhouse gas emissions.

Conclusions

The technical review of the CMDs H18-6 and H18-6.1 [5] concludes that the initiatives planned will ensure that continued operation of PNGS is consistent with WiN's interests, provided regulations are followed and licence conditions are met:

- Initiatives in the areas of managed systems and human performance will maintain a strong safety culture for the women working at these facilities.
- Programs and regulations in the areas of radiation protection and conventional health and safety would ensure safety for workers at the plant.
- Programs and regulations in the areas of operating performance, physical design, and fitness-for-service will ensure that there is a low risk of severe accidents for women working at PNGS during the proposed extended period of operation.
- Initiatives in the areas of safety analysis, emergency management and fire protection, will ensure that severe accidents would be prevented or controlled from escalation during continued operation of PNGS.

[2]). " http://www.win-global.org/resources/Nuclear%20for%20Climate%20WIN%20Declaration.pdf

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- Initiatives in Environmental Management and Monitoring will ensure that the continued operation of PNGS should have no adverse effects on the environment that would affect current and future generations.
- Plans for the safe long-term management of nuclear fuel and the safe transportation of waste are in place.
- Continued operation at PNGS will provide skilled employment to women working in the field of nuclear science and technology.
- Enhancing support for nuclear technologies amongst women may increase the support in general for nuclear power, an important source of low carbon energy that will contribute to reducing the extent of climate change.

It is essential for us to stress that WiN-Canada members are highly skilled workers and would not be working in the nuclear industry if we did not believe in the technology and its safety. It is important to all of us that when we leave for work in the morning we know that we will return safely at the end of the day and that our families and friends who live in our communities will be safe every day.

Due to our day-to-day interaction with the nuclear industry and our strong belief in the expertise of PNGS's employees and their proven history of safe operation, WiN-Canada supports the application before the Commission.

Recommended Follow-up

This licence renewal application is an area where continuing dialogue with WiN members and women in the public would be useful. This continuing dialogue could be through WiN chapter meetings and also by providing knowledgeable speakers to womens' groups and to various environmental groups addressing issues that result in public opposition to nuclear power.

Sincerely,

Heather Kleb

Ms. Heather Kleb
WiN-Canada President

References

1. CMD 18-H6.1 – OPG Written Submission in Support of the Renewal of the Pickering Power Reactor Operating Licence, April 2018
2. CMD 18-H6 - Submission from CNSC Staff for PNGS Licence Renewal, January 2018
3. WiN Global http://www.win-global.org/
4. WiN Canada https://canada.womeninnuclear.org/

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5. Women in Nuclear Canada's Input to the Review of CMD18-6 and 18-6.1Regarding the Renewal of the Pickering Power Reactor Operating Licence (attached)
6. Innovative Research Group, National Public Opinion Research: 2015 Nuclear Attitudes Survey, https://cna.ca/wp-content/uploads/2014/05/2012-Public-Opinion-Research-%E2%80%93-National-Nuclear-Attitude-Survey.pdf
7. WiN Canada survey regarding PWMF License Renewal, 2017

Women in Nuclear (WiN) Canada's Input to the Review of CMD 18-H6 and CMD 18-H6.1 Regarding the Renewal of the Pickering Power Reactor Operating Licence

Prepared by:

P. C. Watson, P. Eng.

PCWatson Engineering & Sustainable Policy Inc.

May 2018

CONTENTS

1 INTRODUCTION

The Canadian Nuclear Safety Commission (CNSC) has made funding available through its Participant Funding Program (PFP) [1] to assist members of the public, aboriginal groups, and other stakeholders in providing value-added information to the Commission through informed and topic-specific interventions. This funding was offered to review the OPG application for Renewal of the Pickering Nuclear Generating Station Power Reactor Operating Licence (April 2018).

The (CNSC) has awarded Women in Nuclear (WiN) Canada participant funding for participation in the application for Licence Renewal for Pickering NGS (PNGS).

PCWatson Engineering and Sustainable Policy Inc. has been retained by WiN-Canada to conduct a technical review of the written submission from OPG on [3] and the CNSC staff submission CMD 18 H-6 *C*ommission Member Document (CMD) [4], focussing on real and perceived issues for WiN members in general and female workers at Pickering NGS in particular during the proposed license renewal period.

P. Watson is a professional engineer with over 37 years of work experience in the nuclear industry in Ontario including the areas of condition assessments, ageing management, managed systems, and maintenance integration. This included 22 years with Ontario Power Generation (OPG) prior to 2002, 6 years with AECL and 9 years with AMEC. P. Watson has been active in WiN Canada since 2004 and, has no conflict of interest with OPG (resume is provided in Appendix A).

2 WOMEN IN NUCLEAR (WIN)

Women in Nuclear (WiN) Global [5] is a world-wide non-profit association of women working professionally in various fields of nuclear energy and radiation applications, established in 1993. WiN Global currently has approximately 25,000 members including national chapters' members and individuals from about 100 countries, with over 30 national, regional and international chapters throughout the world. (http://www.win-global.org/about/what)

Membership in WiN Global includes women and men working in medicine and health care, for regulatory authorities, in industry and as independent researchers. The members have a common commitment to provide information and communicate with the public. WiN Global is also committed to the further development and peaceful use of nuclear science technologies, and acknowledges the crucial role of nuclear energy in preserving the earth for future generations.

In 2015, WiN Global signed a ***Women In Nuclear Declaration for the Earth Climate*** that calls for: "immediate steps to reduce greenhouse gas emissions that include nuclear energy as an

option, a view shared by the IPCC and OECD as well as national and international organisations and nongovernmental organisations (NGOs)". [1]

The WiN Canada chapter [6], established in 2004, adopted its founding goals and objectives based on the goals and objectives of the WiN-Global organization. WiN-Canada is the premier networking organization for Canadian women working in all aspects of nuclear energy, science, trades and technology. As a result of its efforts to promote the careers of women, WiN-Canada has become a strong, credible voice in the nuclear industry.

While many of the members of WiN Canada are employed in the nuclear energy sector, WiN-Canada welcomes members from industries who work with nuclear and radiation technologies and many other related applications. This includes hospitals and medical facilities, mining, academic and research institutions, the wider electricity sector and the many suppliers to all of these diverse industries. WiN Durham is the chapter of WiN Canada that specifically includes women working at the PNGS site.

WiN was founded in response to the unique perspective that women have been shown to have on nuclear technologies.

WiN-Canada's ***Vision*** according to its 2014 strategic plan is: *A Canadian public that has the knowledge to make informed decisions about nuclear applications.*

WiN-Canada's ***Strategy*** is to: *Offer a range of learning opportunities to our members, our partners and the Canadian public - particularly women - to raise the level of knowledge of the nuclear industry.*

WiN-Canada ***Mission***:

- *To develop a dialogue with the public, and in particular with other women, to promote awareness around the factual contribution to people and society from nuclear technologies.*
- *To contribute to knowledge and experience exchange among members and chapters.*
- *To promote career interest in nuclear engineering, science, technology, the trades and other nuclear-related professions, especially among women and young people.*

WiN Canada has over 1700 members, mostly women, across the country. Chapter events enhance knowledge of the nuclear industry among members through information exchange and tours of one another's facilities. A WiN Speakers Clearinghouse allows members to share this information with the public, especially women's groups.

[1] http://www.winglobal.org/resources/Nuclear%20for%20Climate%20WIN%20Declaration.pdf

3 CNSC MANDATE

WiN Canada's review of the CMDs relevant to the PNGS Licence Renewal is intended to support the CNSC's mandate [7] under the *Nuclear Safety and Control Act, which includes*:

- Regulation of the development, production and use of nuclear energy in Canada to protect health, safety and the environment,
- Regulation of the production, possession, use and transport of nuclear substances, and the production, possession and use of prescribed equipment and prescribed information,
- Implementation of measures respecting international control of the development, production, transport and use of nuclear energy and substances, including measures respecting the non-proliferation of nuclear weapons and nuclear explosive devices,
- Dissemination of scientific, technical and regulatory information concerning the activities of CNSC, and the effects on the environment, on the health and safety of persons, of the development, production, possession, transport and use of nuclear substances.

4 OVERVIEW OF PICKERING NUCLEAR GENERATING STATION

The Pickering NGS is a CANDU Pressurized Heavy Water Reactor (PHWR) located on the north shore of Lake Ontario just east of the city of Toronto. Of the 8 units, Pickering A (units 1-4) was placed in service in 1971, and Pickering B (units 5-8) in 1983. Units 2 and 3 have been in safe storage since 2010. The request for an extension of the Pickering Power Reactor Operating Licence (PROL) covers units 1,4 and 5-8 for commercial operation to 2024, then transition to safe storage. Pickering units 1-4 were shutdown in 1997. Units 1 and 4 were refurbished, with unit 4 restarting in 2003 and Unit 1 in 2005. After the accident at Fukushima in 2012, a review of safety at Pickering was conducted and numerous Fukushima Action Items (FUI) were implemented.

The Pickering Waste Management Facility (PWMF) is located on the Pickering site, but was subject to a separate licence renewal process that resulted in licence extension of the facility to 2028.

Pickering NGS (PNGS) currently provides 14% of Ontario's electricity needs (20 TWh in 2016). PNGS emits essentially no greenhouse gas (GHG). It will be an important source of carbon free electricity during the refurbishment of Bruce NGS and Darlington NGS (Unit 2 Oct 2016-Feb 2020, Unit 3 Feb 2020-June 2023, Unit 1 July 2021-September 2024, Unit 4 Jan 2023-Feb 2026) http://www.opg.ca/darlington-refurbishment)

The licence renewal application for Pickering NGS (contained in CMD 18-H6) includes commercial operation to the end of 2024, then shutdown and transition to safe storage by 2028. This would be followed by decommissioning according to the Decommissioning Plan.

Application is being made to extend the operation of the PNGS fuel channels from 242,000 effective full power hours (EFPH) to 295,000 EFPH, for the lead unit.

5 LICENCE RENEWAL APPLICATION

OPG is applying for an extension of the Pickering power reactor operating licence (PROL) for September 1, 2018-August 31, 2028. OPG's written submission in support of this (CMD18 H6-1) includes as an attachment, the actual Licence Renewal application documents

To determine if OPG's request for Power Reactor Operating Licence renewal meets the requirements and standards of the CNSC, CNSC staff assessed it against the 14 Safety and Control Areas (SCAs) [8] shown in Table 1. Their assessment is documented in the CMD 18 H-6 [4].

TABLE 1 CNSC SAFETY AND CONTROL AREASS

SCA	Section	Description
Management System	7.4.1	Covers the framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture.
Human Performance	7.4.2	Covers activities that enable effective human performance through the development and implementation of processes that ensure that Licence staff is sufficient in number in all relevant job areas and that Licence staff have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.
Operating Performance	7.4.3	Includes an overall review of the conduct of the Licenced activities and the activities that enable effective performance. ….
Safety Analysis	7.4.4	Covers the maintenance of the safety analysis that supports that overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.
Physical Design	7.4.5	Relates to activities that impact the ability of structures, systems, and components to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.
Fitness for Service	7.4.6	Covers activities that impact the physical condition of structures, systems, and components to ensure that they remain effective over time.
Radiation Protection	7.4.7	Covers the implementation of a radiation protection program in accordance with the Radiation Protection Regulations. This program must ensure that contamination levels and

SCA	Section	Description
		radiation doses received are monitored, controlled, and maintained as low as reasonably achievable (ALARA).
Conventional Health and Safety	7.4.8	Covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.
Environmental Protection	7.4.9	Covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of Licenced activities.
Emergency and Fire Protection	7.4.10	Covers emergency plans and emergency preparedness programs which exist for emergencies and for non-routine conditions. This also includes any results of exercise participation.
Waste Management	7.4.11	Covers internal waste-related programs which form part of a facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. It also covers the planning for decommissioning.
Security	7.4.12	Covers the programs required to implement and support the security requirements stipulated in the regulations, the licence, orders, or expectations for the facility or activity.
Safeguards and Non-proliferation	7.4.13	Covers the programs and activities—required for the successful implementation of the obligations arising from the *Canada/IAEA safeguards agreements as well as all other measures arising from the Treaty on the Non- Proliferation of Nuclear Weapons.*
Packaging and Transport	7.4.14	Covers programs that cover the safe packaging and transport of nuclear substances and radiation devices to and from the Licenced facility

Other matters of regulatory interest that are relevant to the CNSC's assessment [4] are discussed in section 7.4.15.

The CMD 18-H6 [4] contains the CNSC assessment of the OPG Licence Renewal document CMD 18-H6.1 [3] against the requirements of the SCAs (Table 1) and provides a summary of CNSC staff's review of all SCAs. The CMD18 H-6 presents CNSC's evaluation of whether PNGS's past and future performance in each SCA is satisfactory for the proposed continued operation to support the application for licence renewal. It contains CNSC staff's final recommendation in support of OPG's request for the extension for PNGS operation from September 1, 2018 to August 31 2028 [4].

6 OBJECTIVE(S)

The objectives of this review by WiN Canada were to perform a technical review of the written submission by OPG to support the Pickering PROL (which includes the Licence Renewal Application as an attachment) [3] and the CNSC Commission Member Document CMD 18-H6 [4]. The technical review is summarized in section 7.

Through this review WiN Canada can add value to the CNSC's mandate by identifying any issues specifically of concern to females in general, and those working in the industry in particular, related to the continuing operation of PNGS.

The review was based on the documents and reflects the author's work experience, which included most but not all of the SCAs.

Past surveys by WiN Canada [11] and the Canadian Nuclear Association [9] were considered as input to the perspective of female workers in the nuclear field and general members of the public (see WiN's mission, Section 2.0, and Appendix B). Areas of particular interest to WiN Canada are:

- Health and safety of female workers including WiN members.
- Worker and public safety in the event of a severe accident (nuclear and non-nuclear).
- Environmental Management including radioactive and non-radioactive releases.
- Waste Management including decommissioning, packaging and transport of waste.
- Security, safeguards and non-proliferation.
- Socio-economic factors including career opportunities for women in Science, Technology, Engineering and Mathematics (STEM).
- Continuing dialogue with the public and employees.
- Greenhouse Gas emissions – nuclear energy as part of the solution to climate change.

7 Technical Review of PNGS Licence Renewal Application and Commission Member Document

The structure of the CNSC review of the PNGS PROL renewal in CMD 18-H6 is:

- Environmental Assessment
- Periodic Safety Review (PSR)
- End of Commercial Operation
- General assessment of SCAs
- Other issues

The structure of OPG's written submission in support of the Pickering NGS PROL H-6.1 is:

- Overview of Pickering NGS

- Six key commitments: nuclear safety assurance, SSCs fitness for service, qualified and competent staff, impacts of the plant on the public, workers and the environment, public and indigenous engagement, continued investment in the plant
- Review of SCAs from CMD18- H6
- PSR
- Application for licence renewal

7.1 Environmental Assessment

From CMD 18-H6 (section 2.1):

"An Environmental Assessment (EA) under the Canadian Environmental Assessment Act (CEAA) 2012, was not required for this licence renewal application. However, CNSC staff did conduct an EA under the Nuclear Safety Control Act (NSCA) and its regulations. CNSC staff conclude that 'the licensee will make adequate provision for the protection of the environment'.

This EA (included as part of CMD18-H6) focuses on items of current public interest: releases to air, groundwater and surface water. Topics include atmospheric, aquatic, geological, hydrogeological, and terrestrial environments and human health, as well as greenhouse gas (GHG) emissions and regional monitoring.

7.2 PSR

In support of its application for a 10-year operating licence, OPG performed a periodic safety review (PSR), in accordance with CNSC regulatory document REGDOC-2.3.3 *Periodic Safety Reviews*. This PSR identified Integrated Improvement Plan (IIP) actions that are to be completed pending the licence renewal.

7.3 End of Commercial Operation

According to CMD H18-6, all Pickering units will cease commercial operation on December 31, 2024. Following the permanent shutdown of the units, the station will be transitioned to a safe storage state (following CSA N290.4 *Decommissioning of Facilities Containing Nuclear Substances).* The stages planned for deferred decommissioning are:

- 2025-2028: Stabilization
- 2028-2050: Safe storage and surveillance
- 2051-2061: Dismantling and demolition
- 2061-2065: Site restoration

Spent fuel will be moved from the irradiated fuel bays (IFB) to the PWMF during the first 10 years after the end of commercial operation. This deferred decommissioning method has a period

of safe storage and surveillance to allow decay of radioactivity before dismantling. OPG will need to obtain a decommissioning licence for the period beyond 2028.

7.4 General Assessment of SCAs

The following sections give specifics of each SCA at PNGS, and summarize the assessment by the WiN reviewer based on (a) information from the OPG written submission to support Pickering NGS PROL including the Licence Renewal Application CMD 18-H6.1, and (b) the CNSC conclusions related to the SCA from the CMD 18- H6.

7.4.1 Management System

As per Table 1, the management system SCA "covers the framework that establishes the processes and programs required to assure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture". The specific areas related to this SCA at PNGS include:

- Management System
- Organization
- Performance Assessment, Improvement and Management Review
- Problem identification and Operating Experience (OPEX)
- Change Management
- Safety Culture
- Configuration Management
- Records Management
- Management of Contractors
- Business Continuity

Regulations - CSA N286-05 and CSA N286-12 '*Management System Requirements for Nuclear Facilities'*.

From the CNSC submission CMD18- H6:

- Organization – Business Transformation Initiative – the ownership of some programs has been transferred from the nuclear business unit to the corporate business unit.
- Performance Assessment (PA) – some deficiencies were identified in the CNSC 2015 review with respect to internal governance; in 2017 CNSC inspection of OPG's audit and self-assessment programs identified areas of improvement with control of documentation and records.
- OPEX – some areas for improvement were identified in the 2017 CNSC assessment with respect to documentation and records.

- Safety Culture – OPG has procedures addressing Nuclear Safety Culture N-PROC-AS-0077 'Nuclear Safety Culture Assessment'; in the 2015 self-assessment, an INPO survey was sent to PNGS staff, and on the basis of the results some actions for further improvements were taken. A CNSC Monitoring Panel is based on NEI-09-07.
- Configuration Management – a 2016 CNSC review identified areas of improvement related to temporary configuration changes.
- Records Management – OPG plans to have a new records repository by the end of 2020
- Management of Contractors – a 2014 CNSC inspection of supply management identified minor deficiencies in the qualification of suppliers; a subsequent 2017 inspection identified minor deficiencies regarding identification of technical requirements in OPG documentation, review of contractor qualifications and audit reports.
- Business Continuity – this ensures critical safety and business functions remain in place in the event of pandemics, severe weather, or labour actions.

According to the CNSC submission CMD18-H6 this SCA has been rated as 'Satisfactory' through the current licence period.

The OPG written submission to support the PROL, CMD18-H6.1 (section 1.3.1), cites continuous improvement and engagement of the work force as supporting evidence and says that OPG will develop a change management plan for the transition to plant shutdown after the end of commercial operation in 2024 (1.3.4).

7.4.2 HUMAN PERFORMANCE MANAGEMENT

The human performance SCA (Table 1) "covers activities that enable effective human performance through the development and implementation of processes that ensure a sufficient number of licensee personnel are in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties". The specific areas of this SCA at PNGS include:

- Human Performance Program (HPP)
- Personnel Training
- Personnel Certification
- Initial certification examination and requalification tests
- Work Organization and Job Design
- Fitness for Duty

Regulations - CSA N286-05 '*Management System Requirements for Nuclear Power Plants'*, CNSC REGDOC 2.2.2 '*Personnel Training'*, CNSC RD-204 '*Certification of Persons Working at Nuclear Power Plants'*, REGDOC 2.2.4 **'***Human Performance Management – Fitness for Duty: Managing Worker Fatigue' (*2017), CNSC RD 204 '*Certification of Persons Working at*

NPPs', CNSC RD 363 '*Nuclear Security Officer Medical, Physical and Psychological Fitness'*, REGDOC 2.2.*4 'Fitness for Duty Volume II: Managing Alcohol and Drug Use***'** (2017).

From the CNSC assessment CMD18- H6:

- Human Performance Program (HPP) – follows the Institute of Nuclear Power Operators (INPO) program process that relies on Event Free Tools. A CNSC inspection during the current licence period resulted in some recommendations for further improvement.
- Personnel Training – Training is based on a systematic approach to training (SAT) compliant with NSC REGDOC 2.2.2; CNSC inspections and desktop reviews during the current licence period for the training programs for 9 job families concluded that these were compliant with the requirements of SAT and met regulatory requirements.
- Personnel Certification – this applies to the certain job families: health physicist, Authorized Nuclear Operators (ANO), control room shift supervisor, and shift manager. The training program and certification requirements are according to CNSC RD-204.
- Initial Certification Examinations and Requalification Tests – CNSC inspections of simulator-based examinations and requalification testing during the current licence showed these programs met regulatory requirements.
- Work Organization and Job Design - There is a Minimum Shift Complement (MSC) to ensure sufficient qualified staff at the station at all times; a 2014 CNSC training exercise found this to be satisfactory. OPG revised the MSC instruction in 2014. CNSC conducted another inspection in 2017, OPG was found to be in compliance and some opportunities for improvement were identified.
- Fitness for Duty – OPG has hours of work controls applying to workers who perform safety sensitive work as per REGDOC 2.2.4; OPG has committed to its implementation in 2019. A 2017 CNSC review found inaccuracies in the reporting system for example, no auditable system was in place to confirm compliance with limits of hours of work.

According to the CMD18-H6, this SCA has been rated as Satisfactory through the current licence period.

The OPG written submission to support the PNGS PROL CMD18-H6.1 (section 1.3, 1.3.4) gives the Human Performance Initiative as supporting evidence for adequacy of human performance management during continued operation of Pickering to 2024 then end of commercial operation.

7.4.3 Operating Performance

The operating performance SCA (Table 1) includes "an overall review of the conduct of the licensed activities and the activities that enable effective performance". The specific areas that makeup this SCA at PNGS include:

- Conduct of Licensed Activities
- Procedures
- Reporting and Trending
- Outage Management Performance
- Safe operating envelope (SOE)
- Severe Accident Management (SAM) and Recovery
- Accident Management and Recovery

Regulations - CNSC S-99 '*Reporting Requirements for Operating Nuclear Power Plants'*, REGDOC-3.1.1 (which superseded S-99 in 2015), CSA N290.15 '*Requirements for Safe Operating Envelope of Nuclear Power Plants'*.

From the CNSC submission CMD 18-H6:

- Conduct of licensed activities – operational activities are governed by Operating Policies and Principles (OP&Ps). The number and causes of unplanned reactor transients (trips, setbacks, step-backs) is an indicator in this area and these are followed up by the CNSC. The CNSC also conducts field inspections and plant status control has been a recent area of focus (some issues with tags on temporary changes).
- Procedures – in 2015 CNSC conducted an evaluation of severe accident management (SAM) documentation, guidelines (SAMG) and guidelines for use of emergency mitigating equipment (EME).
- Reporting and Trending – These are performed according to CNSC S-99 and REGDOC 3.1.1. The CNSC are informed of any significant reportable events and OPG takes corrective action and conducts root cause analysis where necessary.
- Outage Management Performance – CNSC staff conducts verification activities during planned maintenance outages. Forced unplanned outages to fix or replace equipment are reported to CNSC.
- Safe Operating Envelope (SOE) – OPG has a SOE program in accordance with CSA N290.15. Operational Safety Requirements (OSR) document the limits and conditions defined in the SOE. CNSC staff conduct compliance verification activities.
- Severe Accident Management and Recovery – the CNSC evaluated the SAM program in 2015 following closure of Fukushima Action Items (FAI), resulting in a few followup activities, such as review of the computational aid for hydrogen source term estimation and the filtered venting strategy. CNSC also identified a few areas for enhancement from the COG report COG-JP-4534-02 'Final Report on CANDU Post Fukushima Questions', which were communicated to OPG for follow-up. OPG has installed Passive Autocatalytic Recombiners in all PNGS units, completed phase 1 of the EME to supply emergency makeup water to the steam generators (SGs), heat transport systems (HTS)

and calandria vessels, implemented SAMG to guide staff on preventing a beyond design basis accident from progressing to a severe accident. As per Periodic Safety Review (PSR) Integrated Improvement Plan (IIP), OPG has scheduled implementation of safety enhancement modifications and design changes, e.g. making fire protection system available for steam generators (SGs), heat transport system (HTS) and calandria; providing emergency power and cooling water to air conditioning units (ACUs) in all reactor units and emergency power to hydrogen igniters, Filtered Air Discharge System, and power and support service connections to the main volume vacuum pump. These IIP modifications are to be implemented in 2018, with the fire water cooling piping connection and the vacuum pump emergency power restoration in 2019/2020.

- Accident Management and Recovery – CNSC routinely verifies OPG's Abnormal Incidents Manual and Emergency Operating Procedures.

According to the CMD18-H6, this SCA has been rated as 'Satisfactory' to 'Fully Satisfactory' through the current licence period

The OPG written submission to support the PROL, CMD18-H6.1 (section 1.3) gives supporting evidence of the adequacy of operating performance. Operating reliability has improved with Units 5 and 1 seeing record operational runs. Forced loss rate has averaged 4% for the last 3 years. Improvements to severe accident management guidelines and equipment have been made as a result of the Fukushima accident (CMD18-H6 section 1.3.2): standby generator reliability improvements, stack monitor replacements, portable pumps and generators for the event of sustained loss of ac power, supply of emergency make up water, etc.

7.4.4 SAFETY ANALYSIS

The safety analysis SCA (Table 1) "covers the maintenance of the safety analyses that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards". The specific areas that are included in this SCA at PNGS are:

- Deterministic Safety Analysis
- Probabilistic Safety Analysis
- Hazard Analysis
- Criticality Safety
- Severe Accident Analysis
- Management of Safety Issues

Regulations – RD-327 *'Nuclear Criticality Safety'*, REGDOC 2.3.2, REGDOC 2.4.1 *'Deterministic Safety Analysis'*, CSA N293-12 *'Fire Protection for Nuclear Power Plants'*, REGDOC 2.4.2 *'Probabilistic Safety Assessment for Nuclear Power Plants'*, S-294 *'Probabilistic Safety Assessment for Nuclear Power Plants'*

From the CNSC submission CMD18- H6:

- Deterministic Safety Analysis – OPG performed REGDOC-2.4.1 compliant safety analysis between 2014-2017, including addressing the gap in the PNGS Safety Report (PSR) related to analysis for Common Mode Events (CME). OPG has provided an implementation plan for 2018-2021 for the remaining work for REGDOC-2.4.1. OPG submitted their assessment of a standing flame in containment to CNSC in 2016 and plan to include this in the next revision of the safety report. OPG submitted new Neutron Overpower Protection (NOP) setpoints based on a new Enhanced NOP Extreme Value Statistics methodology which addresses the impacts of aging to the CNSC. In 2015 OPG submitted safety analysis for the impact of aging on safety margins for loss of coolant accidents (LOCA), Loss of Flow (LOF), Loss of Regulation (LOR) for operation to 2019; this will be updated to support continued operation to 2024. OPG plans to update the large LOCA analysis using methodology submitted to the CNSC for review.
- Probabilistic Safety Analysis (PSA) – PSAs compliant with S-294 were submitted for Units 1 and 4 (2014) and units 5 to 8 (2012). Events such as seismic, high winds, internal fires, internal floods and other hazards were included for both at-power and shutdown states. Updated PSAs to account for the enhancements required under the Fukushima Action Plan were submitted for units 5 to 8 in 2017 and are planned for units 1 and 4 by the end of 2018. REGDOC-2.4.2 introduces new requirements, and OPG plans to have these implemented by the end of 2020.
- Hazard Analysis – As part of the S-294 compliance project, OPG reassessed the hazard analysis in 2012 to include seismic, internal fire, internal flood and high wind hazards. OPG also addressed Fukushima Action Items (FAIs) to reassess site specific extreme external hazards (e.g. seismically induced fires and floods) in 2014. OPG has revised its fire safety assessment during the current licence period in accordance to CSA N293-12.
- Criticality Safety – Use of natural uranium fuel prevents criticality of fuel (both new and irradiated) outside the core in air or light water.
- Severe Accident Analysis – REGDOC-2.4.1 and REGDOC-2.4.2 apply. All SAMG related FAIs are closed. Reports on multi-unit severe accident modelling methodologies were submitted to CNSC for review.
- Management of Safety Issues – OPG has a Research and Development (R&D) capability to address emerging issues such as: moderator subcooling requirements, moderator temperature predictions. CANDU safety issues are being addressed at PNGS including 4

open Cat 3 ones at PNGS: analysis for void reactivity coefficient, fuel behaviour in high temperature transients, fuel behaviour in power pulse transients, assessment of high-energy line breaks.

According to the CMD18-H6, this SCA has been rated by the CNSC as 'Satisfactory' or 'Fully Satisfactory' through the current licence period.

The OPG written submission to support the PROL, CMD18- H6.1 (section 1.3.2) gives supporting evidence Additional Nuclear Safety improvements have been made, based on a 2009 Integrated Safety Review (ISR). A Periodic Safety Review (PSR2) has been conducted for the extended period of operation (CMD18-H6.1 section 1.3.3) with results summarized in a Safety Factor Report and Global Assessment Report submitted in February 2018. Improvement Actions are documented in an Integrated Implementation Plan (IIP).

7.4.5 PHYSICAL DESIGN

The physical design SCA (Table 1) "relates to activities that impact the ability of structures, systems and components to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account". The specific areas that are part of this SCA at PNGS include:

- Design Governance
- Site Characterization
- Facility Design
- Structure Design
- System Design
- Component design

Regulations – CSA N286 '*Management System Requirements for Nuclear Power Plants'*, N285.0 '*General requirements for pressure-retaining systems and components in CANDU nuclear power plants'*, ISO 9001 (2008) '*Quality Management Systems'*, CSA N290.12 '*Human Factors in Design for Nuclear Power Plants'*, N290.13 *Environmental Qualification of Equipment for CANDU Nuclear Power Plants*, N290.14 **'***Qualification of digital hardware and software for use in instrumentation and control applications for nuclear power plants'*, CSA N293-07 *Fire Protection of NPPs*, National Building Code of Canada, National Fire Code of Canada.

From the CNS submission CMD 18-H6:

- Design Governance – CNSC conducted a pressure boundary inspection in 2014 to verify compliance with the PROL. CSA N290.12, N290.13, N290.14 were published in 2014,

and OPG is to be compliant by the end of 2017. CSA N290.13 governs OPG's Environmental Qualification (EQ) program. One IIP action will evaluate existing EQ assessments to support operation beyond 2020 by December 2019,

- Facility Design and Structure Design – the CNSC reviews changes to ensure they do not invalidate limits or introduce hazards,
- System Design – Aging management of Instrumentation & Control (I&C) equipment is addressed through the I&C obsolescence project. An OPG report recommends replacement components and replacement strategies for controllers. Digital control computers (DCCs) are subject to ageing management and a screening process. Projects to address obsolescence of DCC equipment include replacement of DCC power supplies, refurbishment of display system computer, replacement of DCC core memory boards, replacement of DCC output cards, replacement of DCC computers. Fire protection design regulations include CSA N293-07,
- Component design – CNSC staff have inspected the cable management program. Fuel performance (defect rate, oxide formation) has been considered by the CNSC to be acceptable, and there is a well-developed fuel inspection and monitoring program at PNGS. One IIP action item is to confirm the seismic capacity of the fuel basket staking arrangement in the irradiated fuel bays over the proposed extended operation.

According to the CMD18- H6, this SCA has been rated by the CNSC as 'Satisfactory' through the current licence period.

The OPG written submission to support the PROL, CMD18- H6.1 (section 1.3) gives supporting evidence.

7.4.6 Fitness for Service

The fitness for service SCA (Table 1) "covers activities that impact the physical condition of structures, systems and components to ensure that they remain effective over time. This area includes programs that verify all equipment is available to perform its intended design function when called upon to do so". The specific areas that are included in this SCA at PNGS include:

- Equipment Fitness for Service / Equipment Performance (reliability)
- Maintenance
- Structural Integrity
- Aging Management
- Chemistry Control
- Periodic Inspection and Testing

Regulations – RD/GD-98 *'Reliability Program for Nuclear Power Plants', REGDOC 2.6.3 'Ageing Management',* S-210 '*Maintenance Programs at Nuclear Power* **Plants**' (superseded by RD/GD-210), REGDOC 3.1.*1 'Reporting Requirements for Nuclear Power Plants',* CSA Standards N285.4 '*Periodic inspection of CANDU nuclear power plant components',* N285.5 *'Periodic inspection of CANDU nuclear power plant containment components',* N287.7 *'In-service examination and testing requirements for concrete containment structures',* N285.8 **'***Technical requirements for in-service evaluation of zirconium alloy pressure tubes in CANDU reactors'* , N286.12 **'***Chemistry Control',* CNSC RD/GD 98 *'Reliability Programs for Nuclear Power Plants'.*

From the CNSC assessment CMD 18-H6:

- Equipment Fitness for Service / Equipment Performance (reliability) – OPG has programs to manage the impact of aging on equipment and monitor the condition of systems, i.e. tests, inspections, assessments and reviews of Operating Experience (OPEX). System and component health reports are produced quarterly. A recent issue with the Low Pressure Service Water Pumps (LPSW) at units 1,4 required modification to the pumps design for cooling of bearings and seals. CNSC RD/GD-98 and OPG's N-PROG-RA-0016 'Risk and Reliability Program' govern the reliability program at PNGS. OPG has reliability targets for systems important to safety and these will be updated in 2017-2018 for the proposed licence period. Pickering submits an annual reliability report for CNSC review according to REGDOC-3.1.1. There has been an issue with the units 5-8 Emergency Power System predicted future availability (PFU) related to maintenance durations on the Emergency Power Generator, (EPG) but as overhaul of the EPGs has been completed, this should not be an issue in the future. In 2017 CNSC reviewed OPG's maintenance strategy and identified some areas for improvement.
- Maintenance – (S-210) Maintenance backlogs and deferrals have been above the industry average and a CNSC review indicated that this was largely due to 'lack of adequate resources' and that OPG was implementing corrective actions. OPG has implemented CNSC RD/GD-210 for the proposed licence period.
- Structural Integrity – "OPG verifies the structural integrity of pressure boundary components, containment components and structures, and safety related civil structures to demonstrate that the margins are not reduced below acceptable levels due to various degradation mechanisms." Periodic inspection for pressure boundary components CSA N285.4 and containment components CSA N285.5 is performed. Leak rate tests are performed on the vacuum building, reactor building and the pressure relief ducts. Major component life cycle plans address aging degradation mechanisms in fuel channels. In-service inspections (CSA N285.8), are done for pressure tube flaw assessments, pressure tube fracture toughness (Heq) limit was raised from 30 ppm to 40-120 ppm, pressure tube/calandria tube contact due to loose-fitting spacers, irradiation material changes in

tight fitting spacers, calandria tube /LISS nozzle contact, pressure tube leak before break (LBB).

- Aging Management – REGDOC-2.6.3 – Other systems structures and components important to safety are also subject to integrated ageing management programs including Life Cycle Management Plans for major components.
    - Fuel channels - Pickering NGS is currently approved to operate to 247,000 Effective Full Power Hour (EFPH) for Pickering Units 5-8 fuel channels. OPG is seeking approval to operate Pickering Unit 5-8 fuel channels up to 295,000 EFPH [1], the maximum operating time expected for the lead unit (Unit 6) before the end of commercial operation. Units 1, 4 pressure tubes were replaced in the 1980s, therefore their accumulated EFPH values are significantly lower." A licence condition (LC 15.3) requires OPG to maintain pressure tube fracture toughness sufficient for safe operation.
    - Feeder LCMP – feeder wall thinning due to flow accelerated corrosion is monitored in scheduled inspections and reflected in updated stress analysis.
    - Steam Generator (SG) LCMP – degradation mechanisms are identified and managed; SG tubes are pulled if necessary and analysis ensures a sufficient number of tubes remain for SG performance.
    - Reactor Components and structure LCMP- issues monitored include sagging of calandria tubes (CT) and LISS nozzles, potential for CT cracking.
    - Containment components LCMP – (CSA N287.7) In-service examinations are performed and leak rate tests are done for concrete containment components.
- Chemistry Control CSA N286.12 - Quarterly Safety Performance Indicators Chemistry Index and Chemistry Compliance Index are reported to the CNSC.
- Periodic Inspection program (PIP) - (CSA N285.4, N285.5, N287.7) includes programs for fuel channels, steam generators, feeders, balance of plant and civil structures.

According to the CMD 18-H6, this SCA has been rated by the CNSC as 'Satisfactory' through the current licence period. IIP actions include: upgrade and update fuel channel LCMP, submit results of gap measurements between CTs and LISS nozzles, complete risk based approach to ageing management, mitigate leakage from PNGS Irradiated Fuel Bays (IFBs). Global Issue 1 relates to gaps in the current knowledge of FC condition. There are licence conditions (LCH) relating to LCMPs and maintaining sufficient pressure tube fracture toughness.

The OPG written submission to support the PROL, CMD 18-H6.1 (sections 1.3, 1.3.3) gives supporting evidence. Section 1.3.3 describes the fitness for service programs for major components including fuel channels for operation beyond 247,000 EFPH to 295.000 EFPH for the lead unit, supported by a fuel channel inspection program and life cycle management plan.

7.4.7 RADIATION PROTECTION

The radiation protection SCA (Table 1) "covers the implementation of a radiation protection program in accordance with the Radiation Protection Regulations. The program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled and maintained as low as reasonably achievable (ALARA)". The specific areas included in this SCA at PNGS are:

- Application of ALARA
- Worker Dose Control
- Radiation Protection Program Performance
- Radiological Hazard Control
- Estimated Dose to the Public

Regulations – CNSC regulatory guide G-129: *'Keeping Radiation Exposures and Doses As Low as Reasonably Achievable"*.

From the CNSC assessment CMD18-H6:

- Application of ALARA – (OPG N-STD-RA-0018: '*Controlling Exposures as Low as Reasonably Achievable'*). Pickering NGS has developed a 5-Year Collective Radiation Exposure dose reduction plan, which includes collective dose performance targets as well as approved current and planned ALARA initiatives.
- Worker Dose Control - A CNSC licensed dosimetry service is used to monitor, assess, record and report doses of ionizing radiation received by employees, visitors and contractors. During the current licence period, radiation doses to workers were below the regulatory dose limits and action levels. There were no adverse trends or safety-significant unplanned exposures. Approximately 81 percent of workers monitored received doses at or below 1 mSv.
- Radiation Protection Program Performance - OPG has N-PROG-RA-0013, '*Radiation Protection Program at Pickering NGS'*.
- Radiological Hazard Control - Measures are in place to monitor and control radiological hazards such as surface and airborne contamination and radiation dose rates. The contamination control process ensures that radioactive contamination is controlled at the source to prevent spreading.
- Estimated Dose to the Public - The reported estimated dose to a member of the public from the Pickering NGS site during the licence period remained well below the annual public dose limit of 1 mSv (1000 μSv/year).

According to the CMD18- H6, this SCA has been rated by the CNSC as 'Fully Satisfactory' to 'Satisfactory' through the current licence period.

The OPG written submission to support the PROL, CMD18- H6.1 (section 1.3) gives supporting evidence; section 1.3.1 states that over the last 3 years Pickering collective radiation exposure has been reduced despite more radiological work being performed.

7.4.8 Conventional Health and Safety

The conventional health and safety SCA (Table 1) "covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment". The specific areas that comprise this SCA at PNGS include:

- Performance
- Practices
- Awareness

Regulations – Ontario Occupational Health and Safety Act, Ontario Labour Relations Act

From the CNSC assessment CMD 18-H6:

- Performance – Performance indicators (accident frequency, accident severity rate, industrial safety accident rate) are extremely low compared to other industries and workplaces in Ontario and Canada
- Practices – CNSC has a Memorandum of Understanding (MOU) with the Ontario Ministry of Labour to exchange information and technical expertise

According to the CMD18-H6, this SCA has been rated by the CNSC as 'Fully Satisfactory' to 'Satisfactory' through the current licence period

The OPG written submission to support the PROL, CMD18-H6.1 (section 1.3.1) gives supporting evidence. Pickering has a conventional safety record in the industry's top quartile, 11 million hours without a lost time accident in 2014, a best-ever All Injury Rate, and received CEAs Presidents Gold Award of Excellence for employee safety in 2013-2015.

7.4.9 Environmental Protection

The environmental protection SCA (Table 1) "covers programs that identify, control and monitor all releases of nuclear and hazardous substances and effects on the environment from facilities or as the result of licensed activities". The specific areas that comprise this SCA at PNGS include:

- Effluent and Emissions Control E&EC (Releases)
- Environmental Management System (EMS)
- Assessment and Monitoring, EMP
- Protection of the Public

- Environmental Risk Assessment (ERA)

Regulations – Canadian Environmental Protection Act, Ontario Climate Change and Low Carbon Economy Act, CSA N288.1-*14 'Guidelines for Calculating Derived Release Limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities'*, CSA N288.4-10 **'***Environmental Monitoring Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills'*, CSA N288.5-11 **'***Effluent Monitoring Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills'* , N288.6-12 *'Environmental Risk Assessment at Class 1 Nuclear Facilities'*, N2888.7-15 *'Groundwater Protection Programs'*, REGDOC 2.9.1 '*Environmental Protection Policies, Programs and Procedures* (2013)', ISO 14001 '*Environmental Management System'*

From the CNSC submission CMD18- H6:

- Effluent and Emissions Control (Releases) – (CSA N288.5-11) Airborne radiological releases from Pickering NGS remained well below their respective regulatory limits (<1% of the derived release limit DRL). A July 2015 CNSC inspection identified some areas for improvement.
- Environmental Management System (EMS) REGDOC-2.9.1, ISO 14001 - Controls and measures environmental releases and wastes to prevent environmental effects.
- Assessment and Monitoring- (CSA N288.4-10) The EMP samples, measures, analyzes, interprets and reports. Results from 2013-2016 showed concentrations of radionuclides and hazardous substances in the environment are very low, protecting both the public and the environment from nuclear substances, hazardous substances, and physical stressors from the operation of Pickering NGS. Environmental samples from different pathways in the food chain are collected from various offsite locations and tested according to the EMP. Public dose is less than the 1 mSv-year public limit (1.1-1.5 μ Sv-year).
- Fish barrier net (monitoring) – After fish impingement problems in 2008, OPG reduced annual fish impingement by 80% by use of a fish diversion system barrier net; exceedance issues in 2015 and 2017 were due to barrier net installation and removal.
- Groundwater monitoring – Groundwater is sampled at over 100 sampling locations across the Pickering site for radionuclides and other contaminants. Tritium is the primary contaminant of concern; tritium concentrations have been high at some locations within the boundaries of the Protected Area, but returned to historical concentrations after corrective measures were taken. The groundwater monitoring program results confirmed the site perimeter concentrations remain low, indicating no off-site impacts.
- Independent (CNSC and others) environmental monitoring program – (EA report section 4.0) There are several other regional monitoring initiatives: *Ministry of Ontario Environment and Climate Change Drinking Water Surveillance Program*, the Ontario

Ministry of Labour *Ontario Reactor Surveillance Program*, and the Health Canada *Radiation Monitoring Network* and *Fixed-Point Surveillance system.*

- Protection of the Public – Systems that discharge conventional (non-radiological) contaminants to the environment are approved under the Ontario Ministry of Environment in the *Environmental Certificates of Approvals* (ECAs).
- Environmental Risk Assessment (ERA) –An updated ERA report for 2011-2015 was submitted in 2017 for radiological and non-radiological hazards. This report identified, quantified and characterized risks posed by contaminants and physical stressors in the environment on biological receptors. Airborne radiological releases including: tritium, noble gases, iodine 131, carbon 14, and particulate, were < 1% of the Derived Release Limit (DRL). Terrestrial soil samples showed tritium, carbon 14, cesium 134 and cobalt 60, and dose was highest for earthworms and redwing blackbirds. Non-radiological contaminants showed copper, lead and zinc. Active liquid waste is purified in the Radioactive Liquid Waste Management System (RLWMS) then sampled and analyzed before discharge. Tritium in the water has been 3.9-5.7 Bq/L, well below the limit of 7000 Bq/L. The summary in the ERA report (ERA Table 2.2) showed no adverse radiological impacts, but some high copper concentrations in surface water. The Predicted Environmental Assessment (PEA) contains predictions and affects assessment for the safe storage period which are expected to be bounded by releases during normal operation. Greenhouse gas emissions from PNGS are below the reporting threshold in the Climate Protection Act.

According to the CMD18- H6, this SCA has been rated by the CNSC as 'Satisfactory' through the current licence period.

The OPG written submission to support the PROL, CMD18- H6.1 (section 1.3.1) gives supporting evidence Radiological releases from the Pickering NGS to air and water are far below regulatory limits. Water, air and soil are regularly sampled for both radiological and non-radiological emissions, and environmental results are posted on OPGs website. A fish diversion system has been in place since 2009, and a fish-authorization was issued by Fisheries and Oceans Canada in 2018. The Environmental Risk Assessment (ERA) was updated in 2017.

7.4.10 Emergency Management and Fire Protection

The emergency management and fire protection SCA (Table 1) covers emergency plans and emergency preparedness programs that exist for emergencies and for non-routine conditions. The specific areas that comprise this SCA at PNGS include:

- Conventional Emergency Preparedness and Response;
- Nuclear Emergency Preparedness and Response;
- Fire Emergency Preparedness and Response.

Regulations – RD-353 '*Testing and Implementation of Emergency Measure's*, REGDOC 2.10.1 '*Nuclear Emergency Preparedness and Response'* (2017), CSA N293 *Fire Protection for Nuclear Power Plants'*, Provincial Nuclear Emergence Response Plan.

From the CNSC assessment CMD18- H6:

- Health Canada has modelled releases from a postulated severe accident.
- Initiatives implemented in response to the Fukushima accident, exercises, distribution of potassium iodide (KI) pills, etc.
- Conventional Emergency Preparedness and Response is in place.
- Nuclear Emergency Preparedness and Response - OPGs Consolidated Nuclear Emergency Plan wss revised in 2017; full-scale exercises were conducted in December 2017.
- Fire Emergency Preparedness and Response – this includes training, equipment, drills and exercises as well as implementing new and updated standards.

According to the CMD18-H6, this SCA has been rated by the CNSC as 'Satisfactory' through the current licence period

The OPG written submission to support the PROL, CMD18- H6.1 (section 1.3.1) gives supporting evidence. OPG has distributed potassium iodide (KI) pills to the entire population in the 10 km radius primary zone, and has new radio system infrastructure that ties into the Durham Region public safety radio system. Emergency exercises have been conducted.

7.4.11 WASTE MANAGEMENT

The waste management SCA (Table 1) "covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This area also covers the planning for decommissioning". The specific areas that are part of this SCA at PNGS include:

- Waste Characterization
- Waste Minimization
- Waste Management Practices
- Decommissioning Plans

Regulations – CSA Standard N292.3-08 '*Management of Low and Intermediate Level Radioactive Waste'*, CSA N294-09 *'Decommissioning of Facilities Containing Nuclear Substances'*, CNSC G-219 '*Decommissioning Planning for Licensed Activities'*, CSA N292.2-13 *'Interim dry storage of irradiated fuel* (2018)'.

From the EA, waste includes used fuel bundles; radioactive solid, liquid and gaseous waste; and non-radioactive gaseous, liquid and solid waste. Used fuel is stored in the IFB for 10 years before being transferred to the PWMF.

From the CNSC assessment CMD18- H6:

- Waste Characterization, Waste Minimization, Waste Management Practices – address radioactive, hazardous and conventional waste.
- Decommissioning Plans – OPG has a preliminary decommissioning plan (PDP) that is updated every 5 years as required by the CNSC; also OPG has financial guarantees for decommissioning (section 7.4.5).
- New updated standards for dry storage of irradiated fuel have been developed CSA N292.2-13.

According to the CMD18- H6, this SCA has been rated by the CNSC as 'Satisfactory' to 'Fully Satisfactory' through the current licence period.

The OPG written submission to support the PROL, CMD18- H6.1 (section 1.3.1, 2.4.5) gives supporting evidence. Section 2.4.5 on Pickering's waste management program covers conventional solid waste, hazardous and chemical waste as well as used fuel, low-level radioactive waste and irradiated fuel. Waste is separated into conventional, hazardous and radioactive streams and handled appropriately. After a 10-year decay period in the irradiated fuel bays, irradiated fuel is placed in dry storage containers at the Pickering Waste Management facility (PWMF)[2]. Low and intermediate level waste is sorted, compacted where possible and then packed and transported to the Western Waste Management facility at the Bruce site (see Packaging and Transport section 7.4.14). Radioactive liquid waste is treated at the Radioactive Liquid Waste Management system (RLWMS). Radioactive gaseous emissions are filtered through high-efficiency particulate air (HEPA) and charcoal filters before release (EA report section 1.2.1). Hazardous waste includes PCBs, which are subject to Pickering's PCB Waste Management program.

7.4.12 SECURITY

The security SCA (Table 1) covers the 'programs required to implement and support the security requirements stipulated in the regulations, the licence, orders, or expectations for the facility or activity'. The specific areas that comprise this SCA at PNGS include:

- Facilities and Equipment
- Response Arrangements

[2] The Pickering Waste Management Facility (PWMF) is separately licensed

- Security Practices
- Drills and Exercises
- Cyber security

Regulations – Nuclear Security Recommendations, Regulatory Guide G-274 '*Programs for Category I or II Nuclear Material of Certain Nuclear Facilities'*, CSA N290.7-14, REGDOC 2.12.1 '*High-Security Sites: Nuclear Response Force'*, CSA N290.7-14 '*Cyber Security for Nuclear Power Plants and Small Reactor Facilities'*.

From the CNSC assessment CMD18- H6:

- Response Arrangements – OPG maintains a Nuclear Response Force according to REGDOC 2.12.1; The security exercise in 2016 was evaluated by the CNSC.
- Security Practices – There is a Site Access Security Clearance program plan.
- Drills and Exercises – drills are conducted every 30 days, major security exercises every 2 years.
- Cyber security – CSA N290.7-14 was issued in 2015.

According to the CMD18- H6, this SCA has been rated by the CNSC as 'Satisfactory' to 'Fully Satisfactory' through the current licence period.

The OPG written submission to support the PROL, CMD18-H6.1 (section 2.6, 3.12) gives supporting evidence. PNGS is maintaining security and enhancing the security monitoring room. Programs are in place to prevent loss, theft or sabotage of nuclear material, or sabotage of the nuclear facility. Security staff consists of armed and unarmed nuclear security officers, state of the art security equipment throughout the site and a cyber security program to protect computer systems and software.

7.4.13 SAFEGUARDS AND NON-PROLIFERATION

The safeguards and non-proliferation SCA (Table 1) "covers the programs and activities required for the. implementation of the obligations arising from the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and bilateral Nuclear Cooperation Agreements".

This SCA includes a safeguards program and a non-proliferation program. The scope of the non-proliferation program includes the tracking and reporting of foreign obligations and origins of nuclear material.

Canada has a Comprehensive Safeguards agreement with the IAEA which provides annual assurance that all declared nuclear material is in peaceful, non-explosive uses and that there is no undeclared material.

The specific areas that are included in this SCA at PNGS are:

- Nuclear Material Accountancy and Control
- Access and Assistance to the IAEA
- Operational and Design Information
- Safeguards Equipment, Containment and Surveillance
- Import and export

Regulations – RD-336 '*Accounting and Reporting of Nuclear Material'*.

From the CNSC assessment CMD18- H6:

- Nuclear Material Accountancy and Control – RD-336 is complied with.
- Access and Assistance to the IAEA – IAEA has performed inspections and verifications, access to spent fuel in irradiated fuel bays is being improved to assist in verification activities.
- Operational and Design Information – required to be submitted to the CNSC and IAEA
- Safeguards Equipment, Containment and Surveillance – IAEA has safeguards equipment at PNGS for fuel monitoring and optical surveillance.

According to the CMD18- H6, this SCA has been rated by the CNSC as 'Satisfactory' through the current licence period.

The OPG written submission to support the PROL, CMD18-H6.1 (section 3.13) gives supporting evidence. OPG maintains accounting of fuel at all times, supports IAEA inspections and facilitates upgrades to IAEA equipment on site.

7.4.14 PACKAGING AND TRANSPORT

The packaging and transport SCA (Table 1) covers 'programs for the safe packaging and transport of nuclear substances to and from the licensed facility'. The specific areas that comprise this SCA at PNGS include:

- Package Design and Maintenance
- Packaging and Transport
- Registration for Use

Regulations – *Packaging and Transport of Nuclear Substances* (2015) and the *Transportation of Dangerous Goods*

From the CNSC assessment CMD18- H6 this SCA has been rated as 'Satisfactory' through the current licence period.

The OPG written submission to support the PROL, CMD18-H6.1 (section 3.14) states that CNSC and Transport Canada requirements are met for transporting LLW to WWMF and transporting spent fuel to the PWMF.

7.4.15 OTHER MATTERS

Other matters of regulatory concern included in the Licence renewal application and CMDs 18-H6, and 18-H6.1 are:

Indigenous Engagement – there have been some issues related to the environment, REGDOC-3.2.2 *Aboriginal Engagement***.**

Financial Guarantees (FG) – CNSC requires a financial guarantee for a licence, CNSC Regulatory Guide *'Financial Guarantees for the Decommissioning of Licensed Activities***'**. OPG has a consolidated FG for decommissioning Ontario assets which exceeds the CNSC FG requirement for 2018. This includes a trust fund for management of used nuclear fuel. The projected value of the Nuclear Funds (2018-2022) exceeds the decommissioning liability. The decommissioning plans an associated cost estimates are to be revised by OPG every 5 years.

Licensee Public Information Program – key areas of public interest include emergency preparedness, PNGS role in Canada's electricity sources, annual environmental monitoring results, and meeting the requirements of NSCA, RDGD-99.3 *Public Information and Disclosure.*

Nuclear Liability Insurance – The Nuclear Liability and Compensation Act (2017) is administered by NRCan.

Fukushima Action Items (FAI) – The last remaining open generic Fukushima Action items were closed in October 2014. A Type II inspection of Fukushima actions by CNSC staff in 2016 was done. One action item 2016-48-7470 related to implementation of emergency mitigating equipment and telecommunications projects had a scheduled completion for the end of 2017. The FAIs were re-assessed for operation of PNGS beyond 2020 resulting in one IIP action item related to protection of containment integrity during severe accidents.

OSART Mission – IAEA Operational Safety Review Team mission in 2016 identified some good practices, suggestions and recommendations, and OPG has developed strategies and action plans for these to be completed by the end of 2018, with the exception of the recommendation related to managing alcohol and drug use testing of key staff in safety important roles.

Fisheries Act Authorization – The Department of Fisheries and Oceans (DFO) and CNSC signed a Memorandum of Understanding (MOU); CNSC will take responsibility for the

assessment and monitoring of environmental impacts on fish. Offset projects have been proposed to balance fish impingement incidents.

8 AREAS OF CONCERN TO WIN CANADA

This section summarizes the areas of special interest to WiN Canada (section 6) in light of the technical review in section 7.

8.1 HEALTH AND SAFETY FOR FEMALE WORKERS

SCAs addressing health and safety for female workers at PNGS include: management system (safety culture), human performance, radiation protection, and conventional health and safety.

As WiN Canada represents women working in the nuclear industry, WiN Canada wants to be confident that the strong nuclear ***safety culture*** protecting its members in their places of employment will continue at PNGS during the proposed continued operation period and transition to safe shutdown state. Women have worked for years in the nuclear field partly due to their faith in the nuclear safety culture. The WiN Canada technical review notes (section 7.4.1) that OPG procedures addressing nuclear safety culture, and periodic self-assessments should ensure that PNGS remains a safe workplace for all, including WiN Canada members, during the proposed licence period and end of commercial operation, provided that areas for improvement identified in assessments are implemented and that continuous improvement and engagement of the work force are encouraged.

The WiN Canada reviewer concludes that existing regulations and programs in the area of ***human performance*** together with effective training, certification and requalification as well as fitness-for-duty for those in safety sensitive positions at PNGS positively affect the safety of women working at the site (section 7.4.2).

Radiation Protection (RP) is an area of interest to WiN Canada members in particular and women in general. The WiN Canada reviewer notes that the overall objective of the RP program is to keep the radiation doses as low as reasonably achievable (ALARA), limit doses to less than regulatory limits, limit detrimental stochastic health effects in employees and the public, and prevent detrimental non-stochastic (deterministic) health effects. Dose levels to workers have been well below regulatory levels with no adverse trends (section 7.4.7) over the past 3 years. Pickering collective radiation exposure has been reduced despite more radiological work being performed. Actions, such as following existing regulations, the 5-year Collective Radiation Exposure Dose reduction plan, and correcting deficiencies in radiological hazard control (calibrating gamma monitors) should ensure that PNGS's radiation monitoring will control radiation exposure to workers. This review concludes that the radiation protection and

monitoring at PNGS during the period of extended operation will provide adequate protection and ensure no overexposure to workers.

WiN Canada believes that conventional ***health and safety*** is an issue of importance to women employees at PNGS. The technical review by WiN Canada (section 7.4.8) shows that regulations and efforts in performance, practices and awareness have been effective. Accident frequency, accident severity rate, and industrial safety accident rate indicators are extremely low compared to other industries and workplaces in Ontario and Canada. Pickering has a conventional safety record in the industry's top quartile, 11 million hours without a lost time accident in 2014, a best-ever All Injury Rate, and received CEAs Presidents Gold Award of Excellence for employee safety in 2013-2015. The WiN Canada reviewer concludes that that the Conventional Health and Safety should be acceptable for female workers over the proposed licence period..

8.2 Worker and Public Safety in the Event of A Severe Accident (Nuclear and Non-nuclear)

Preventing Accidents

Several SCAs such as physical design, fitness for service, and operating performance, should maintain the plant in a safe condition to minimize the likelihood of severe accidents.

The technical review by WiN Canada (section 7.4.5) observes that existing regulations, together with programs such as pressure boundary inspection, aging management including the I&C and DCC obsolescence projects, cable management, and fuel inspection and monitoring should ensure that the ***physical design*** at PNGS will be effective in minimizing accidents over the proposed licence period.

The technical review by WiN Canada (section 7.4.6) observes that existing regulations, together with programs to manage equipment aging, monitor the condition of systems, and address maintenance backlogs should be effective in ensuring ***fitness for service*** and preventing accidents during the proposed licence period. Periodic inspection programs for the pressure boundary and concrete containment structures, leak-rate tests on the vacuum building, reactor building and pressure relief ducts are performed. Major component life cycle management plans (LCMPs) for fuel channels address ageing such as changes in fracture toughness, LCMPs for feeders require inspections to monitor feeder wall thinning, LCMPs for Steam Generators (SGs) address SG tube degradation and the effect of tube plugging or removal on performance, and LCMPs for reactor components address spacer location and condition, and calandria tube - LISS nozzle interactions. Regarding the proposed increase in operating hours for the fuel channels, from 247,000 EFPH to 295,000 EFPH, there is a specific licence condition requiring OPG to maintain pressure tube fracture toughness sufficient for safe operation by ensuring [Heq] remains below 120 parts per million (ppm).

The WiN Canada review notes that OPG's planned programs and initiatives in the area of ***Operating Performance*** (section 7.4.3) include implementing Fukushima Action Items (FAI) and a Severe Accident Management (SAM) program. Improvements such as installing passive autocatalytic recombiners (for hydrogen), supplying emergency makeup water to the steam generators, heat transport system and calandria vessel, providing emergency power and cooling water to Air Conditioning Units (ACUs) and emergency power to hydrogen igniters, filtered air discharge and the main volume vacuum pump should prevent future severe accidents of the Fukushima type during the proposed licence period. In addition, operating reliability has been improving with Units 5 and 1 seeing record operational runs, and forced loss rate averaging 4% for the last 3 years.

Managing Accidents

WiN Canada believes that women are particularly concerned about severe accidents at a nuclear power plant, Section 6. Public opinion surveys revealed that support of nuclear from women was particularly impacted by the Fukushima accident and, as a result, women have been shown to be less supportive of the nuclear industry due to what they perceive as a higher risk [9]. SCAs that relate to managing accidents are: Safety Analysis, and Emergency Management and Fire Protection.

The WiN Canada reviewer's conclusions regarding the ***Safety Analysis*** SCA (section 7.4.4) are that existing regulations and new analysis for common mode events (such as a Fukushima type accident) and impacts of ageing will help prevent and limit the effects of accidents. Additionally, new PSAs have been done that include events such as seismic, high winds, internal fires, and internal floods. Revised Hazard Analysis includes these events. It is believed that the additional nuclear safety improvements that were made, based on the 2009 Integrated Safety Review (ISR), and the Periodic Safety Review (PSR2) that has been conducted for the extended period of operation, should enhance PNGS's ability to prevent and manage accidents during the future operating period.

WiN Canada research [11] shows that women are particularly concerned about the potential effects of a nuclear accident on their families. One of the most significant social impacts of the Chernobyl accident was the increase in thyroid cancers amongst children [12]. Women have been shown to be more concerned about nuclear emergencies [9], agreeing that "When things go wrong, they go very wrong".

The WiN Canada reviewer notes that Health Canada has modelled releases from a postulated severe accident at PNGS, and numerous safety enhancements have been implemented at PNGS in response to the Fukushima accident. OPG's Consolidated Nuclear Emergency Plan was revised in 2017, full-scale exercises were conducted in December 2017, a new radio system infrastructure ties into the Durham Region public safety radio system, and potassium iodide (KI)

pills have been distributed to the entire population within a 10km radius of Pickering NGS site. This review concludes that the emergency management and fire protection program during the period of extended operation will provide reassurance for its female members working at PNGS who have families living in the surrounding area.

8.3 Environmental Management including radiation releases

Past studies by WiN Canada and the Canadian Nuclear Association show that women are particularly concerned with the effects of nuclear power on the environment [9, 11], so this aspect is important for their support of nuclear technologies. Hazardous releases to the air can affect the respiratory health of their children; releases to the water can affect the health of those drinking it, eating food from it, or crops watered with it. Although these concerns are not unique to women, it has been shown that these risks can more significantly affect women's perspectives of the risks in the nuclear industry [9].

The WiN Canada reviewer is satisfied that if existing regulations are complied with, the environment will continue to be protected during the proposed license extension at the PNGS site (section 7.4.11). Airborne radiological releases from Pickering NGS are well below their regulatory limits. Monitoring results from 2013-2016 showed concentrations of radionuclides and hazardous substances in the environment to be very low, resulting in a very low dose to the public.

Environmental samples from different pathways and the food chain are collected from various offsite locations and tested according to the EMP. Annual fish impingement has been reduced by 80% by use of a fish diversion system barrier net. Groundwater is sampled at over 100 sampling locations across the Pickering site for radionuclides and other contaminants, with tritium the primary contaminant of potential concern; site perimeter concentrations remain low with no off-site impacts. There are independent environmental monitoring programs through the Ministry of Ontario Environment and Climate Change Drinking Water Surveillance Program, the Ontario Ministry of Labour Ontario Reactor Surveillance Program, and the Health Canada Radiation Monitoring Network, along with a Fixed-Point Surveillance system. An updated Environmental Risk Assessment (ERA) report for 2011-2015 was submitted in 2017 for radiological and non-radiological hazards.

8.4 Waste Management including decommissioning, packaging and transport

WiN Canada believes that waste management (WM) is an issue of importance to WiN members (section 6). The WM program at PNGS includes waste characterization, waste minimization and waste management for radioactive, conventional and hazardous waste. After a 10-year decay period in the irradiated fuel bays, irradiated fuel is placed in dry storage containers at the Pickering Waste Management facility (PWMF). Low level waste (LLW) is sorted, compacted

where possible and then packed and transported to the Western Waste Management facility (WWMF).

OPG has a preliminary decommissioning plan (PDP) that is updated every 5 years as required by the CNSC. OPG has financial guarantees for decommissioning (Section 7.4.15).

In summary, PNGS appears to have adequate plans for waste management during the proposed extended operating period, and plans for future storage of irradiated fuel and decommissioning. The WiN Canada reviewer believes that Waste Management will be adequately managed at PNGS during the future licence period provided regulations are followed and conditions in the PROL complied with (section 7.4.11).

Packaging and transport of radioactive waste mainly concerns the LLW sent to the WWMF. The WiN Canada reviewer believes that the Packaging and Transport of nuclear waste will be adequately managed during the proposed licence period provided regulations are followed and conditions in the PROL complied with (section 7.4.14).

8.5 Security, Safeguards and Non-Proliferation

WiN Global is committed to the further development and peaceful use of nuclear science technologies and has an interest in safeguards and non-proliferation.

Security at Pickering includes maintaining a nuclear response force regular of armed and unarmed nuclear security officers, conducting regular security exercises and drills, and a cyber security program. There are also programs to prevent loss, theft or sabotage of nuclear material, or sabotage of the nuclear facility. There is state of the art security equipment throughout the site. The WiN Canada reviewer's conclusions are that ***security*** at PNGS should be adequately managed during the proposed extended operating period provided regulations are followed and conditions in the PROL continue to be met (section 7.4.12).

Canada has a Comprehensive Safeguards agreement with the IAEA to provide annual assurance that all declared nuclear material is in peaceful, non-explosive uses and that there is no undeclared material. At Pickering NGS, there are regulations for nuclear materials accountancy and control, the IAEA performs inspections and verifications, and maintains equipment at the site for fuel monitoring and optical control. OPG maintains accounting of fuel at all times, and supports IAEA inspections and facilitates upgrades to IAEA equipment on site.

Therefore, it is believed that the programs and measures taken by PNGS will ensure that Safeguards and Non-Proliferation should be adequately managed in the period of continued operation (section 7.4.13).

8.6 Socioeconomic factors including career opportunities in STEM

WiN Canada promotes career interest in nuclear engineering, science, technology, the trades and other nuclear-related professions, especially among women and young people. Increased participation of women in Science, Technology, Engineering and Mathematics (STEM) is a national goal that will allow Canada to utilize more of its human potential to be more competitive internationally.

Continued operation of Pickering NGS will provide many such opportunities in partnership with WiN Durham.

8.7 Continuing Dialogue with the Public and Employees

Various public groups have expressed opposition to the extension of the Pickering PROL because of concern over the impact of a Fukushima type accident, low level waste storage in the Bruce Deep Geological Repository (DGR), option of importing electricity from Quebec, and immediate as opposed to deferred decommissioning. These issues were for the most part considered in the technical review of the CMDs above, and appear to be adequately addressed.

One of WiN's objectives is to communicate information on the nuclear industry to the public. Therefore, WiN appreciates the opportunity to provide input to this PNGS Licence renewal process.

Consultation with the public and aboriginal communities is discussed in the CMD18-H6.1 [3].

8.8 Greenhouse Gas and Climate Change – Nuclear as Part of the Solution

The Pickering NGS currently provides 14% of Ontario's electricity needs (20 TWh in 2016). PNGS emits practically no greenhouse gas (GHG). It will be an important source of carbon free electricity during the refurbishment of Darlington NGS, which is scheduled for 2016-2026 (Unit 2 Oct 2016-Feb 2020, Unit 3 Feb 2020-June 2023, Unit 1 July 2021-September 2024, Unit 4 Jan 2023-Feb 2026) http://www.opg.ca/darlington-refurbishment

In 2015, WiN Global signed a *Women In Nuclear Declaration for the Earth Climate* that calls for: "immediate steps to reduce greenhouse gas emissions that include nuclear energy as an option, a view shared by the IPCC and OECD as well as national and international organisations and nongovernmental organisations (NGOs). " :

http://www.win-global.org/resources/Nuclear%20for%20Climate%20WIN%20Declaration.pdf

Approval of the PNGS PROL extension supports WiN Global's declaration that calls for nuclear energy to be included as a means of reducing greenhouse gas emissions (section 6).

9 Conclusions

This review of the CMDs H18-6 [4] and H18-6.1 [3] concludes that the SCA initiatives planned should ensure that continued operation of PNGS is consistent with WiN Canada's interests provided regulations are followed and licence conditions are met.

Programs and regulations in the areas of radiation protection and conventional health and safety should ensure safety for workers at the plant.

Initiatives in the areas of managed systems and human performance will maintain a strong safety culture and provide consideration for the health and safety of its employees especially the women working at these facilities.

Programs and regulations in the areas of operating performance, physical design, and fitness-for-service, should ensure that there is a low risk of severe accidents for women working at PNGS during the proposed extended period of operation.

Initiatives in the areas of safety analysis, emergency management and fire protection, should ensure that severe accidents are prevented of controlled from escalation during continued operation of PNGS.

Initiatives in Environmental Management and Monitoring will ensure that the environment is protected for the current and future generations.

Plans for the safe long-term management of nuclear fuel and the safe transportation of waste are in place.

Continued operation at PNGS will provide skilled employment to women working in the field of nuclear science and technology.

Enhancing support for nuclear technologies amongst women may increase the support in general for nuclear power, an important source of low carbon energy that will contribute to reducing the extent of climate change.

In conclusion, WiN Canada supports the Licence renewal application for the PNGS in that areas of interest to WiN appear to be satisfactorily addressed for the Licence extension period provided regulations continued to be followed and licence conditions are met.

10 REFERENCES

1. CNSC Participant Funding Program; http://nuclearsafety.gc.ca/eng/the-commission/participant-funding-program/pfp-.cfm, link accessed January 12, 2017
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5. WiN Global http://www.win-global.org/
6. WiN Canada https://canada.womeninnuclear.org/
7. CNSC Mandate http://nuclearsafety.gc.ca/eng/about-us/our-mission.cfm.
8. SCAs http://nuclearsafety.gc.ca/eng/resources/publications/reports/powerindustry/safety-and-control-areas.cfm
9. Innovative Research Group, National Public Opinion Research: 2015 Nuclear Attitudes Survey https://cna.ca/wp-content/uploads/2014/05/2012-Public-Opinion-Research-%E2%80%93-National-Nuclear-Attitude-Survey.pdf
10. http://nuclearsafety.gc.ca/eng/resources/publications/reports/powerindustry/safety-and-control-areas.cfm
11. WiN presentation at the PWMF Hearing Intervention, April 13, 2017
12. World Health Organization http://www.who.int/ionizing_radiation/chernobyl/backgrounder/en/ accessed 6 May, 2018

11 *APPENDIX* A CURRICULUM VITAE FOR P.C. WATSON

Insert pdf

12 APPENDIX B FEMALE ATTITUDES TO NUCLEAR POWER

https://cna.ca/wp-content/uploads/2014/05/2012-Public-Opinion-Research-%E2%80%93-National-Nuclear-Attitude-Survey.pdf

To enhance WiN Canada's understanding of what areas related to the continued operation of PNGS might be of particular concern to women, the results of the National Public Opinion Research 2015 Nuclear Attitudes survey were reviewed. There were 1240 respondents to the 2015 survey, 49% male and 51% female. Some general results that are considered relevant to this review are that:

- The more people feel they know about nuclear as a means of generating electricity, the more likely they are to support it.
- While almost all currently have an opinion on whether or not they support nuclear, additional probing reveals that 68% would like more information before they finally make up their mind.
- The extent to which Canadians understand radiation is directly related to their support for nuclear and younger Canadians have a better grasp on radiation than older Canadians.

Respondents were asked to agree or disagree with statements related to health and safety:

- I am reluctant to take a chance on nuclear energy because when things go wrong, they go very wrong.
- It's wrong to generate 40 or 50 years of electricity for our generation and then leave nuclear waste for generations to come.
- I worry that we don't understand the health impacts of nuclear power plants on surrounding communities.

Four clusters were developed based on the responses: anti-nuclear, health and safety skeptic, pro-nuclear, economic skeptic and ambivalent. The largest cluster was health and safety skeptics, which contained slightly more females:

- 51% of Females 18-34 health and safety skeptics
- 45% of Females 35-54 were health and safety skeptics
- 39% of Females 55 and over were health and safety skeptics,

By comparison, 43% of males 18-34 were health and safety skeptics, 45% of males 35-54 were health and safety skeptics and 42% males 55+ were health and safety skeptics

The survey also addressed environmental issues. When asked: “Do you believe the overall environmental impact from nuclear power generation –that is, the emissions created from building a nuclear power plant, generating electricity, decommissioning the plant and disposing of waste by-products –is better or worse for the environment than natural gas power generation?” The majority of responses were much worse or somewhat worse (>50%), about 10% don’t know.

When asked about the ethics on Nuclear Waste: over three-quarters agree it’s wrong to leave waste for the future. On “Fear of Disaster”: close to three quarters are still reluctant to take a chance on nuclear.

Female respondents to the CNA survey were also shown to be most worried about known and unknown health impacts.

Female respondents to the CNA survey thought that they were less familiar with the concept of radiation: as only 15% rated themselves as Very familiar women, compared to 31% of men.

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In 2013 I completed an M. Eng. in Engineering and Public Policy from the School of Engineering Practice at McMaster University, and incorporated a business to provide Engineering and Sustainable Policy consulting. This complements my career as a professional engineer with over 37 years of experience providing engineering services and business support to Ontario's electricity generating stations including 9 years with a consulting engineering company and 22 years at Ontario Power Generation (OPG).

PCWatson Engineering & Sustainable Policy Inc., President August 2013- present

Plenary chair for the Canadian Nuclear Society (CNS) Nuclear Waste Management, Decommissioning, and Environmental Restoration Conference, Ottawa, September 2016 (www.nwmder.org)

Prepared a technical review, on behalf of Women in Nuclear (WiN), of the Canadian Nuclear Safety Commission (CNSC) Member Document (CMD: 16-H2) for CNL License Renewal, February 2016.

Prepared a technical review, on behalf of Women in Nuclear (WiN), of the Canadian Nuclear Safety Commission (CNSC) Member Document (CMD: 17-H5) for PWMF License Renewal, March 2017.

Prepared a technical review, on behalf of Women in Nuclear (WiN), of the Canadian Nuclear Safety Commission (CNSC) Member Document (CMD: 18-H2) for CNL License Renewal, December 2017.

Conducted Benefit Cost Assessments for nuclear plant refurbishment projects.

Member of QUEST (Quality Urban Energy Systems of Tomorrow) Ontario

Member of Technical Committee for the Climate Change Technology Conference (CCTC 2015), sponsored by Engineers Canada.

Trained as a Climate Reality Leader in 2015 with the Climate Reality Project with former Vice President of the United States Al Gore.

Volunteered unsolicited policy and program input to various government departments including:

- Input comments to the Ontario Environmental Registry on the Long Term Energy Plan (LTEP),
- Input to town planning departments on sustainable neighborhood design,
- Input on energy conservation programs based on a study in an inner city neighborhood on electricity conservation behavior,
- Input on energy labeling and energy efficiency standards,
- Input on Community Energy Programs, and
- Input comments on planning and siting of large energy infrastructure.

Professional Affiliations

- Licensed with Professional Engineers Ontario (PEO) since 1978.
- Member of council of the Canadian Nuclear Society, 2015-present (extended council as of 2017)
- Women in Nuclear Canada – Board of Directors, member at large, 2013-2017.
- Ontario Society of Professional Engineers (OSPE) – member of Women in Engineering Advisory Committee (WEAC) 2012-2018, member of Environmental Committee 2018-
- Women in Nuclear – Golden Horseshoe West branch –Chair 2011-2013.

Education

M. Eng. (Engineering and Public Policy), McMaster University, Hamilton, Ontario, Canada, Graduated fall 2013

- Final Inquiry: "Policies for Driving Reduced Greenhouse Gas Emissions Behavior in Individuals".
- Courses included: Theory and Practice of Policy Analysis; Systems Engineering and Public Policy; Energy and Public Policy; Emerging Issues in Technology and Public Police; Environmental Economics; Green Engineering, Sustainability and Public Policy; Design of Sustainable Community Infrastructure; Development of Sustainable Local Communities

Doctoral Candidate, Engineering Physics Department, McMaster University, Hamilton, Ontario, Canada, part-time 1989-1997, did not graduate but withdrew in good standing, thesis not completed

- Thesis: Monitoring and Assessing Thermal Fatigue in CANDU Pressure Boundary Components (not completed).
- Courses completed include: CANDU Heat Transport System Design, Flow Induced Vibration, Elasticity Theory, Analytical Electron Microscopy, Reactor Thermohydraulics
- Successfully passed Comprehensive Examination – Part I and Part II

M.A.Sc. (Mechanical Engineering) (part-time) University of Waterloo, Waterloo, Ontario, Canada, Graduated spring 1981

- Thesis: "Finite Difference Solution to Navier-Stokes Equations".
- Specialized in structural mechanics and numerical methods.
- Courses completed include: Introduction to Finite Element Methods, Reliability of Mechanical Systems, Welding Processes, Fatigue and Fracture Analysis, Topics in Pressure Vessel Design, Fluid Mechanics Design Topics

B.Sc. (Mechanical Engineering) with distinction, University of Alberta, Edmonton, Alberta, Canada, Graduated spring 1976

Graduate courses completed: Aerodynamics, Analytical Dynamics, Turbulent Fluid Dynamics

Additional Selected Training

'Two-Phase Flow and Heat Transfer in the Power and Process Industries', Waterloo Centre for Process Development, University of Waterloo 1981; 'Technical Report Writing', Edutran Services 1985; 'Project Management'; Access; Excel, ISO 9001

Publications and Presentations

- Watson, P., 'How Nuclear Energy is Important in Reducing Climate Change', Win Canada Conference 2014, Saint John, New Brunswick
- Watson, P.C., Dam, R, Nickerson, J., Using the System maintenance Data store to Characterize Lifetime Maintenance for PLiM, 25th Annual CNS Conference, June 2004, Toronto
- Dam, R., Watson, P., Yang, X.J., Nickerson J.H., 'Using Systematic Aging Assessments to Improve Effectiveness of Plant Maintenance Programs', 25th Annual CNS Conference, June 2004, Toronto
- Ontario Hydro Nuclear Plant Life Management Activities, presentation to the sixth meeting of the NEA Expert Group on NPP Life Management, Paris, France April 1997
- Watson, P., Maruska C, Andreeff T, 'CANDU Nuclear Plant Life Assurance Program for Pickering NGS A', PLEX 93, Zurich, Switzerland, November 1993

- Chang Y.F. and Watson P.C., ' Reflux Mode Cooling of Fuel at Decay Power Levels in CANDU Nuclear Generating Stations – Applications and Supporting Experiments', 39th Canadian Chemical Engineering Conference, Hamilton, Ontario, October 1989
- Chang Y.F., Watson P.C., Langan M.D., Sermer P., 'Bruce Nuclear Generating Station B Rapid Cooldown Test and Validation of Simulation Model', Nuclear Technology, Vol 70, September 1985

Employment History

AMEC NSS Ltd., Technical Expert ,Engineering and Life Cycle Management, Engineering Directorate, Toronto, Ontario, September 2004 – August 2013 (now AMEC Foster Wheeler)

Ageing Management

- Technical lead for component Condition Assessments in support of nuclear plant refurbishment.
- Project manager and technical lead for the preparation of life cycle management plans and ageing management studies for major components.

Business Case Assessments

- Technical lead for Business Case Assessments in support of nuclear plant refurbishment.
- Prepared information supporting the new International Financial Reporting System (IFRS).
- Developed a prototype Risk Informed Asset Management model that was used in business case evaluations of proposed plant operational strategies.
- Dealt with regulators in the station response to the Canadian Nuclear Safety Commission (CNSC) on ageing management programs, prepared presentations, and provided support at meetings.

Quality Assurance

- Conducted internal ISO 9001 audits.

Atomic Energy of Canada Ltd (AECL), Senior Engineer, Plant Life Management, Sheridan Park Mississauga, Ontario, August 2002 –September 2004

- Developed methodologies for the aging management program for the Life Extension project for the NRU reactor in Chalk River.
- Performed business case evaluations to integrate technical alternatives.
- Prepared level 1 project execution plans (Microsoft Project).
- Prepared work proposals and product development plans.
- Wrote papers on plant life management for conference presentations.

Ontario Power Generation (OPG), Senior Engineer, Operational Business Planning Department Toronto, Ontario, December 1993 – August 2002 (OPG was created from Ontario Hydro)

Business Planning

- Defined the process and managed the development of Access database for project management.
- Used structured analysis techniques to evaluate processes such as an engineering work management system and make business process improvements.
- Developed economic models (Excel) for the analysis of alternative operating scenarios to maximize facility value and enhance strategic planning; the models included evaluation of future fuel costs, electricity price, and maintenance expenditures.
- Interacted with engineering and financial staff at the nuclear plant sites.
- Prepared Nuclear Business Plans and reports for senior executives.

Nuclear Plant Life Management

- Member of the Nuclear Energy Agency expert groups on Nuclear Plant Life Management and Nuclear Plant Refurbishment; attended meetings and presented papers on Ontario Hydro's Life Cycle Management Activities.
- Member of the Electric Power Research Institute (E.P.R.I.) Nuclear Asset Management working group; presented papers at E.P.R.I. workshops.

Ontario Hydro, Technical Supervisor, Toronto, Ontario, May 1980 – December 1993

Ageing Management

- Performed ageing assessments of major plant mechanical components.
- Presented papers on life cycle management at several conferences (e.g. PLiM/PLEX Berlin 1991).
- Represented Canada on the expert group in Nuclear Plant Life Management for the Nuclear Energy Agency, Organization for Economic Cooperation and Development (OECD).

Fuel & Physics

- Used software models to perform thermohydraulic simulations.
- Provided technical coordination for laboratory research projects.
- Developed station commissioning test procedures.

Human Resource Policies

- Served a term as an executive on the professional collective bargaining unit (Society).
- Served 8 years as a Society delegate.

Atomic Energy of Canada Limited, Design Engineer, Mississauga, Ontario, May 1976- May 1980

- Wrote and modified Assembler language programs for Bruce NGS station control computers.
- Worked on the design of various process systems.
- Modified and documented thermohydraulic software.

Interests and Volunteer Activities

- Board of Directors of Citizens for Clean Air (C4CA) 2009-present
- Director of Joshua Creek Residents Association (JCRA) 2010-2013.
- Represented JCRA on the Suncor Public Liaison Committee 2012-2013
- Active in distance running and triathlons (including coaching), and have organized road races, managed relay teams (Jasper-Banff), and held volunteer administrative positions with running clubs and the Ontario Track and Field Association (1980s).