Canadian Nuclear Safety Commission

Commission canadienne de sûreté nucléaire

Record of Proceedings, Including Reasons for Decision

In the Matter of

Applicant	Ontario Power Generation Inc.
Subject	Application to Renew the Nuclear Power Reactor Operating Licence for the Darlington Nuclear Generating Station
Public Hearing Dates	August 19, 2015 and November 2 to 5, 2015

e-Doc 4817567 (Word)
e-Doc 4920689 (PDF)

Canada

RECORD OF PROCEEDINGS

Applicant:	Ontario Power Generation Inc.
Address/Location:	700 University Avenue, Toronto, Ontario M5G 1X6
Purpose:	Application to renew the Nuclear Power Reactor Operating Licence for the Darlington Nuclear Generating Station
Application received:	December 13, 2013 and January 30, 2015
Dates of public hearing:	August 19, 2015 and November 2 to 5, 2015
Locations:	Part 1 (August 19, 2015): Canadian Nuclear Safety Commission (CNSC) Public Hearing Room, 280 Slater Street, 14th Floor, Ottawa, ON Part 2 (November 2-5, 2015): Hope Fellowship Church, 1685 Bloor Street, Courtice, ON
Members present:	M. Binder, Chair A. Harvey — R. Velshi Dr. R. J. Barriault — M. J. McDill D. D. Tolgyesi
Secretary:	M. A. Leblanc
Recording Secretaries:	S. Dimitrijevic and M. Young
Senior General Counsel:	L. Thiele

Applicant Represented By	Document Number
• J. Lyash, President and Chief Executive Officer • G. Jager, President, OPG Nuclear and Chief Nuclear Officer • B. Duncan, Senior Vice President, Darlington Nuclear • D. Reiner, Senior Vice President, Nuclear Projects • L. Swami, Senior Vice President, Decommissioning and Nuclear Waste Management • S. Woods, Senior Vice President, Nuclear Engineering and Chief Nuclear Engineer • R. Manley, Director, Nuclear Regulatory Affairs & Stakeholder Relations • J. Vecchiarelli, Manager, Nuclear Safety and Technology Department	CMD 15-H8.1 CMD 15-H8.1A CMD 15-H8.1B CMD 15-H8.1C

<table>
<tr><td colspan="2">

- K. Powers, Director, Corporate Relations and Communications
- R. McCalla, Acting Vice President, Environment Department
- P. Nadeau, Vice President, Security and Emergency Services
- B. Fichman, Senior Manager, Computer and Control Design
- J. Wong, Senior Manager, Cyber Security

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<tr><td colspan="2">CNSC staff</td><td>Document Number</td></tr>
<tr><td>

- R. Jammal
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</td><td>CMD 15-H8
CMD 15-H8.A
CMD 15-H8.B
CMD 15-H8.C
CMD 15-H8.D</td></tr>
<tr><td colspan="2">Intervenors</td><td>Document Number</td></tr>
<tr><td colspan="2">See Appendix A</td><td></td></tr>
<tr><td colspan="2">Others</td><td></td></tr>
<tr><td colspan="2">

- Environment and Climate Change Canada, represented by N. Ali and D. Kim
- Fisheries and Oceans Canada, represented by J. Wright, T. Hoggarth and S. Eddy
- Natural Resources Canada, represented by J. Adams
- Office of the Fire Marshal and Emergency Management, represented by T. Kontra, D. Nodwell and A. Suleman
- Ontario Ministry of Transportation, represented by M. Morton
- Health Canada, represented by B. Ahier
- Australian Radiation Protection and Nuclear Safety Agency, represented by S. Solomon and G. Hirth

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Licence: Renewed

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1.0 INTRODUCTION

1. This Record of Proceedings follows the *Summary Record of Proceedings and Decision* that was issued on December 23, 2015 and provides the reasons for the Commission's decision.

2. Ontario Power Generation Inc. (OPG) has applied to the Canadian Nuclear Safety Commission[1] for the renewal of the Nuclear Power Reactor Operating Licence (PROL) for its Darlington Nuclear Generating Station (NGS) located in the Municipality of Clarington, ON. The nuclear facility consists of four CANDU pressurized heavy water reactors and a tritium removal facility. The site is also home to the Darlington Waste Management Facility, which became operational in 2008 and is subject to a separate Class IB Waste Facility Operating Licence (WFOL). The WFOL was renewed by the Commission in 2013 for a period of 10 years.

3. OPG's licence renewal application includes the proposed mid-life refurbishment of the four Darlington NGS reactors to extend the station's life for an additional 30 years. This refurbishment is planned as a multi-year program to enable the replacement of life-limiting components such as fuel channels, and to make safety improvements to the plant, programs, and processes. In 2013, the Commission rendered a decision on the environmental assessment (EA) of the proposed refurbishment and continued operation of the Darlington NGS, and concluded that the proposed project was not likely to cause significant adverse environmental effects, taking into account mitigation measures identified in the EA Screening Report[2]. At the same time, the Commission renewed the Darlington NGS PROL for a period of 22 months to allow OPG sufficient time to complete the necessary studies for the proposed refurbishment outages. This PROL was set to expire on December 31, 2014[3].

4. To allow additional time to provide more comprehensive documentation, reflect new CNSC expectations relative to probabilistic safety assessment (PSA) and facilitate public engagement at the hearing, the PROL was subsequently amended by the Commission so that the operating licence, PROL 13.01/2015, would expire on December 31, 2015[4]. In the current application, OPG requested a renewal of the licence for a period of 13 years, to cover life extension activities including refurbishment of the reactors. In support of the licence application, OPG has completed an Integrated Safety Review (ISR), a Global Assessment Report (GAR), and established parameters for the Integrated Implementation Plan (IIP) in accordance with CNSC regulatory document RD-360, *Life Extension of Nuclear Power Plants*.

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[1] The *Canadian Nuclear Safety Commission* is referred to as the "CNSC" when referring to the organization and its staff in general, and as the "Commission" when referring to the tribunal component.
[2] Refer to the Record of Proceedings and Reasons for Decision on the Environmental Assessment Screening Regarding the Proposal to Refurbish and Continue to Operate the Darlington Nuclear Generating Station in the Municipality of Clarington, Ontario, hearing date December 3 to 6, 2012.
[3] Refer to the Record of Proceedings and Reasons for Decision on the Application to renew the Power Reactor Operating Licence for the Darlington Nuclear Generating Station, hearing date December 3 to 6, 2012.
[4] Refer to the Record of Proceedings and Reasons for Decision on the Application to Amend the Power Reactor Operating Licence for the Darlington Nuclear Generating Station, hearing date July 23, 2014.

5. After reviewing the application and OPG's past performance, as well as information submitted in supporting documents, CNSC staff recommended that the Commission renew the PROL for a period of 10 years, and include a condition requiring OPG to implement a periodic safety review (PSR). CNSC staff was of the view that the recommended transition to a 10-year licence and introduction of the licence condition related to the PSR was in line with the international practice of longer licence terms. Many intervenors recommended a shorter licence period, expressing concerns that a longer licence would reduce opportunities for public input.

Issue

6. In considering the application, the Commission was required to decide, pursuant to subsection 24(4) of the *Nuclear Safety and Control Act*[5] (NSCA):

   a) if OPG is qualified to carry on the activity that the licence would authorize; and

   b) if, in carrying on that activity, OPG will make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

7. The Commission was also required to decide whether to authorize OPG to operate the Darlington NGS units 1-4 beyond 210,000 equivalent full power hours (EFPH), up to a maximum of 235,000 EFPH.

Public Hearing

8. The Commission, in making its decision, considered information presented for a public hearing held on August 19, 2015 in Ottawa, ON and November 2 to 5, 2015 in Courtice, ON. The public hearing was conducted in accordance with the *Canadian Nuclear Safety Commission Rules of Procedure*[6]. During the public hearing, the Commission considered written submissions and heard oral presentations from OPG (CMD 15-H8.1, CMD 15-H8.1A, CMD 15-H8.1B and CMD 15-H8.1C) and CNSC staff (CMD 15-H8, CMD 15-H8A, CMD 15-H8B, CMD 15-H8C and CMD 15-H8D). The Commission also considered oral and written submissions from 283 intervenors (see Appendix A for a detailed list of interventions). Thirteen additional requests to intervene were received after the deadline and were denied. Two requests were denied in accordance with Rule 19 of the *CNSC Rules of Procedure.* The hearing was webcast live via the CNSC website, and video archives are available for a three-month period following the release of the decision.

[5] Statutes of Canada (S.C.) 1997, chapter (c.) 9.
[6] Statutory Orders and Regulations (SOR)/2000-211.

9. Up to $75,000 in funding to participate in the licence renewal process was made available to Aboriginal groups, not-for-profit organizations and members of the public through the CNSC's Participant Funding Program. A Funding Review Committee, independent of the CNSC, recommended that up to $73,162.48 in participant funding be provided to eight applicants who were required, by virtue of being in receipt of the funding, to submit a written intervention and make an oral presentation at the public hearing.

10. On August 19, 2015, the Canadian Environmental Law Association (CELA) submitted a Request for Ruling, on its own behalf and on behalf of other allied organizations, asking that the Commission require that CNSC staff release the results of the *Study of Consequences of a Hypothetical Severe Nuclear Accident and Effectiveness of Mitigation Measures* (SARP study), by September 15, 2015. The CNSC published the final version of the study, as planned, on August 21, 2015. As was indicated in an August 26, 2015 letter of response to CELA, the Commission was satisfied that the publication of the study had addressed the request. CELA expressed that, in its view, the release of the final version of the study did not address its request.

Mandate of the Commission

11. Several intervenors expressed their views about the operation and refurbishment of the Darlington NGS in relation to energy policy. The Commission notes that it is the Ontario provincial government that must address fundamental energy policy questions. The CNSC does not have this statutory authority, nor will it consider questions that are of a political nature. If the Ontario provincial government decides that nuclear power is part of its energy plan, the role of the CNSC is to ensure that it is done safely.

2.0 DECISION

12. Based on its consideration of the matter, as described in more detail in the following sections of this *Record of Proceedings*, the Commission concludes that OPG is qualified to carry on the activity that the licence will authorize. The Commission is of the opinion that OPG, in carrying on that activity, will make adequate provision for the protection of the environment, the health and safety of persons, and the maintenance of national security and measures required to implement international obligations to which Canada has agreed. Therefore,

> the Commission, pursuant to section 24 of the *Nuclear Safety and Control Act*, renews the Nuclear Power Reactor Operating Licence issued to Ontario Power Generation Inc. for its Darlington Nuclear Generating Station located in the Municipality of Clarington, Ontario. The renewed licence, PROL 13.00/2025, is valid from January 1, 2016 until November 30, 2025.

the Commission authorizes OPG to operate the Darlington NGS Units 1-4 beyond 210,000 equivalent full power hours up to the proposed refurbishment outages, to a maximum of 235,000 equivalent full power hours.

13. The Commission includes in the licence the conditions as recommended by CNSC staff in CMD 15-H8, with the following modification:

    Licence condition 3.4 is modified from

    The licensee shall prepare and conduct a periodic safety review in support of its subsequent power reactor operating licence application.

    to

    The licensee shall ***implement*** *a periodic safety review in support of its subsequent power reactor operating licence application.*

14. With respect to licence condition 3.2, the Commission delegates the authority for consent to restart a reactor after a serious process failure to the following CNSC staff:
    - Director, Darlington Regulatory Program Division;
    - Director General, Directorate of Power Reactor Regulation; and
    - Executive Vice-President and Chief Regulatory Operations Officer.

15. With respect to licence condition 15.4, the Commission delegates the authority to remove regulatory hold points for the return to service of each unit undergoing refurbishment to the Executive Vice President and Chief Regulatory Operations Officer.

16. The Commission notes that CNSC staff can bring any matter to the Commission as necessary. The Commission directs CNSC staff to inform the Commission on an annual basis of any changes made to the Licence Conditions Handbook (LCH).

17. With this decision, the Commission directs CNSC staff to provide annual regulatory oversight reports on the performance of the Darlington NGS and on the status of the refurbishment project and emergency planning, as part of the CNSC's annual *Regulatory Oversight Report for Canadian Nuclear Power Plants* (Regulatory Oversight Report). CNSC staff shall present these reports at public proceedings of the Commission. The Commission requests that CNSC staff provide updates on the setting of emission limits and effluent discharge limits as part of CNSC staff's regular reporting to the Commission. The Commission also requests that CNSC staff provide an update to the Commission on the report from CANDU Owners Group on issues raised by Dr. Nijhawan, once the report is finalized.

18. The Commission expects updates from OPG on the status of the refurbishment project following the return to service of each reactor unit. Furthermore, the Commission

directs OPG and CNSC staff to provide a more comprehensive update to the Commission on the status of the refurbishment project following the return to service of the first reactor unit or by no later than the mid-term of the licence period. This update will be considered in a public proceeding of the Commission, with public participation. The Commission looks forward to public participation and is of the view that both the annual Regulatory Oversight Report and the more comprehensive update to the Commission after the return to service of the first reactor unit or at the mid-term of the licence period will provide opportunities for interested persons to participate in Commission public proceedings.

3.0 ISSUES AND COMMISSION FINDINGS

19. In making its licensing decision, the Commission considered a number of issues relating to OPG's qualification to carry out the proposed activities and the adequacy of the proposed measures for protecting the environment, the health and safety of persons, national security and international obligations to which Canada has agreed.

20. CNSC staff noted that, although the current licence period dates back to February 2013, trending data were presented for the previous licence periods since 2008.

3.1 Management System

21. The Commission examined OPG's management system, which covers the framework that establishes the processes and programs required to ensure that the Darlington NGS achieves its safety objectives and continuously monitors its performance against these objectives, and fosters a healthy safety culture.

22. CNSC staff informed the Commission that their assessment of OPG's management system focused on the following specific areas:
    - management system and organization;
    - change management;
    - safety culture;
    - management of contractors;
    - configuration management; and
    - records management.

23. CNSC staff rated OPG's performance for this safety and control area (SCA) as satisfactory throughout the period of 2008 to 2014.

3.1.1 Management System and Organization

24. In its submission, OPG described the nuclear management system (NMS) in place at the Darlington NGS and stated that it is compliant with CSA standard N286-05,

Management system requirements for nuclear facilities. OPG explained that the NMS provides a framework that establishes the processes and programs required to ensure that OPG achieves its safety objectives and continuously monitors its performance against these objectives. OPG noted that it monitors its performance at several levels of the organization and that it has a well-established corrective action program that incorporates self-assessments, benchmarking and independent audits.

25. OPG submitted that it was revising a large number of program documents as part of its transition to the 2012 version of CSA N286, and stated that this would be complete by the end of 2015. OPG noted that most of the remaining changes were administrative in nature. CNSC staff confirmed that the adoption of the 2012 version of CSA N286 did not represent a fundamental change to OPG's current management system.

26. OPG also submitted that the implementation of its Business Transformation Initiative (BTI) and its program to transform the company into a centre-led matrix organization would result in increased efficiency and agility, while maintaining safety and quality. Based on its review of OPG top-tier governing documents, CNSC staff identified that the NMS documentation required re-alignment to better reflect the BTI. CNSC staff noted that OPG had revised its governance, where necessary, to provide greater clarity in this regard. CNSC staff reported that OPG had provided the records to indicate that the BTI would be implemented through OPG's organizational change control process.

27. In response to Commission inquiries, OPG provided a chart showing the organizational structure of the Darlington NGS during Part 2 of the hearing. OPG also explained the relationship between the two divisions of the organization: operation and refurbishment.

3.1.2 Safety Culture

28. OPG submitted that its safety culture is represented in its Nuclear Safety Policy, which is established by the OPG's Board of Directors and reflects the guidance of the Institute of Nuclear Power Operators (INPO) document INPO 12-012, *Traits of a Healthy Nuclear Safety Culture, Rev 1*. OPG explained that the fulfillment of the requirements of the Nuclear Safety Policy is ensured by a Nuclear Safety Review Board that includes external members and provides the Chief Nuclear Officer with an independent annual assessment of the activities at each station that may impact safety and performance. OPG noted that it periodically evaluates its safety culture through external and internal evaluations and stated that a February 2015 safety culture assessment conducted at the Darlington NGS concluded that OPG has a healthy nuclear safety culture.

29. OPG added that the Darlington NGS has a performance improvement process that is aligned with industry best practices and results in an organization oriented toward preventing events and in a culture of continuous improvement. OPG explained that the performance improvement process encompasses the corrective action program,

operating experience (OPEX), and self-assessment and benchmarking. OPG also explained that corrective actions are taken to correct issues and noted that reports are analyzed for potential trends. OPG further explained that it conducts causal analysis or root cause evaluations for more significant events. OPG noted that its Corrective Action Review Board, consisting of senior managers at the Darlington NGS, monitors the quality of these evaluations.

30. OPG informed the Commission that, in January 2013, it implemented the Nuclear Energy Institute's NEI-09-07, *Fostering a Healthy Nuclear Safety Culture*, and established a Nuclear Safety Culture Monitoring Panel to identify potential concerns that would merit additional attention and actions. OPG noted that this process for monitoring safety culture was recognized as industry-leading and was benchmarked by international peers.

31. CNSC staff reported that it was satisfied with OPG's self-assessment of safety culture, and noted that OPG had implemented corrective actions for the identified areas for improvement.

3.1.3 Management of Contractors

32. CNSC staff informed the Commission about an inspection conducted in 2013 wherein deficiencies were identified regarding interactions between OPG technical staff and supply chain staff. CNSC staff noted that OPG had adequately addressed the inspection findings and that all actions had been closed.

33. The Commission enquired about OPG's supply chain quality assurance. The OPG representative explained the measures that OPG takes to assure the quality of components supplied by manufacturers and the quality of work done by contractors, and emphasized the importance of this issue in light of the foreseen refurbishment and increased quantity of replacement parts and other components. OPG intends to audit vendors in order to maintain good oversight and assure the high quality of purchased material. CNSC staff added that they had assessed OPG's supply chain and control of suppliers. CNSC staff stated that OPG verifies its supply chain for potential intrusion of counterfeit items into their system.

3.1.4 Configuration Management

34. CNSC staff informed the Commission that an inspection conducted in 2013 had revealed weaknesses related to configuration management that were not safety significant or systemic. CNSC staff reported that OPG had adequately addressed the inspection findings and that all actions have been closed.

3.1.5 Records Management

35. CNSC staff stated that the implementation of records management at the Darlington NGS is effective and that OPG meets regulatory requirements. CNSC staff noted that OPG had resolved the specific areas for improvement in the management of records that were identified during an inspection conducted in 2012.

3.1.6 Conclusion on Management System

36. Based on all the information on the record, the Commission concludes that OPG has appropriate organization and management structures in place and that OPG's operating performance at the Darlington NGS during the licence period provides a positive indication of OPG's ability to adequately carry out the activities under the proposed licence. The Commission is satisfied that OPG's management system meets regulatory requirements.

3.2 Human Performance Management

37. Human performance management encompasses activities that enable effective human performance through the development and implementation of processes that ensure licensee staff are sufficient in number in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

38. OPG's submissions included information regarding OPG's Human Performance Program and the Darlington NGS Human Performance Strategic Plan. OPG explained that while the Human Performance Program is focused on the requirement to proactively identify and address latent organizational weaknesses, the Human Performance Strategic Plan deals with individual and departmental accountability regarding human performance best practices. OPG also described its human performance initiatives.

39. CNSC staff reported that its assessment of OPG's human performance management focused on the following specific areas:
    - personnel training;
    - personnel certification;
    - initial certification examinations and requalification tests;
    - human performance programs;
    - work organization and job design; and
    - fitness for duty.

40. CNSC staff rated OPG's performance for this SCA as satisfactory for each year from 2008 to 2014 and noted that OPG continues to perform satisfactorily at the Darlington NGS.

3.2.1 Training

41. In its submissions, OPG explained that its Certified Staff Training Program is based on the systematic approach to training required by CNSC regulatory document RD-204, *Certification of Persons Working at Nuclear Power Plants*. OPG described its programs for training of personnel, certified staff and leadership training.

42. With respect to recruitment, resourcing and succession planning, OPG described its co-op/internship, Aboriginal recruitment, outreach and other programs, as well as its partnerships with local colleges and universities. OPG noted that it established agreements with three preferred staffing agencies to provide short-term temporary workers. OPG also described its company-wide succession planning process and emerging talent program to systematically identify high potential staff in key areas of the business to ensure a continuing supply of leaders. OPG noted that knowledge management is embedded in its succession planning process to address risks associated with the loss of unique knowledge through departures and retirement.

43. In its submissions, CNSC staff reported that an inspection conducted in 2014 had revealed that OPG's nuclear operator training program did not fully adhere to its systematic approach to training-based training system, and that OPG had been issued action notices requiring corrective action plans to address the discrepancies. CNSC staff further reported that OPG had developed and was implementing corrective action plans to the satisfaction of CNSC staff. CNSC staff noted that the CNSC had recently issued regulatory document REGDOC-2.2.2, *Personnel Training*, and that OPG was required to take the appropriate actions to ensure that its training system met the requirements of the new regulatory document. OPG affirmed that it would be compliant with REGDOC-2.2.2 by January 1, 2016.

44. The Canadian Coalition for Nuclear Responsibility, in its intervention, expressed concerns regarding the adequacy of worker and manager training at the Darlington NGS. The intervenor noted that training manuals and information on radiological training provided to workers and managers were not posted on the Internet to assure the public that the workers are being properly trained and informed. The Commission asked for more information concerning OPG's training programs. Representative from OPG described OPG's training activities for both normal operations and for refurbishment. The OPG representative discussed OPG's mock-up training facility where workers have the ability to practice certain activities using all protective measures required by real-time operations or refurbishment. An OPG representative stated that a member of the public could obtain detailed information about training material; however, requests for this information had not been made that could lead OPG to consider publishing all available material on its website. CNSC staff confirmed that they inspect OPG's training activities and validate the competency of trainers, and noted that OPG's training programs meet internationally recognized standards.

45. The Commission enquired about the training of temporary or contracted workers with

respect to safety procedures, protective measures, emergency measures and evacuation. The OPG representative responded that, in addition to security checks, all of these workers must complete basic training before they are allowed to enter the facility. The OPG representative noted that activities that involve these workers are usually scheduled around outages and refurbishment. The OPG representative added that OPG had established a training facility at the Darlington Energy Complex that is used for security checks and training.

3.2.2 Examination and Certification

46. OPG submitted that its continuing training program for certified staff includes refresher training, update training and formal evaluations of knowledge and performance. For operations staff, OPG noted that it implemented a new initial certification program selection and development process, which includes classroom and simulator training and evaluation.

47. CNSC staff reported that OPG has sufficient numbers of competent personnel for all certified positions at the Darlington NGS. CNSC staff found that OPG's examination program and requalification test program met the regulatory requirements for the initial certification and renewal of certification of workers.

3.2.3 Human Factors

48. OPG described its Fitness for Duty Program and noted that, as part of this program, OPG has a Continuous Behaviour Observation Program that trains supervisors and managers on how to monitor workers for signs of fatigue or other factors that could adversely impact worker performance. OPG also described its procedure to document hours of work requirements for employees. OPG noted that this procedure sets limits for the number of hours within a specified time period that staff can work.

49. Regarding the minimum shift complement, OPG stated that it had completed validation exercises to confirm that minimum shift complement staffing numbers meet CNSC requirements identified in G-278, *Human Factors Verification and Validation Plans*, and G-323, *Ensuring the Presence of Sufficient Qualified Staff at Class 1 Nuclear Facilities*, and added that the Darlington NGS utilizes a computer-based program to ensure compliance with the requirements.

50. In its submissions, CNSC staff indicated to the Commission that it had verified that OPG has effective procedures in place to manage the risks of fatigue on worker performance and has adequate fitness for duty measures in place. CNSC staff noted that it carried out an inspection on hours of work in 2013 and found that OPG was maintaining compliance with its internal hours of work governance at the Darlington NGS. CNSC staff further stated that OPG had conducted a systematic and comprehensive analysis to determine its minimum shift complement, and implemented

an effective process at the Darlington NGS to ensure that a sufficient number of qualified staff are available at the facility at all times.

3.2.4 Conclusion on Human Performance Management

51. Based on its consideration of the presented information, the Commission concludes that OPG has appropriate programs in place and that current efforts related to human performance management provide a positive indication of OPG's ability to adequately carry out the activities under the proposed licence. The Commission is satisfied that OPG has adequate programs to train and certify staff, as well as to monitor fitness for duty. The Commission observes that OPG staff training material not being available on the Internet does not affect its conclusion that appropriate programs are in place, and notes that OPG endeavoured to make this material available to the public upon request.

3.3 Operating Performance

52. Operating performance includes an overall review of the conduct of the licensed activities and the activities that enable effective performance, as well as improvement plans and significant future activities at the Darlington NGS. CNSC staff informed the Commission that their assessment of OPG's operating performance had been focused on the following specific areas:
    - conduct of licensed activity;
    - procedures;
    - reporting and trending;
    - outage management performance;
    - safe operating envelope;
    - accident management and recovery; and
    - severe accident management and recovery.

53. CNSC staff rated OPG's performance for this SCA as fully satisfactory for each year from 2008 to 2014.

3.3.1 Conduct of Licensed Activity

54. In its submissions, OPG described its Operations Program, which comprises a series of standards and procedures and establishes safe operating practices and processes within its nuclear facilities. OPG pointed out that, in the case that reactor operation deviates from normal, the Darlington NGS has in place abnormal incident manuals, emergency operating procedures, Emergency Mitigating Equipment (EME) Guidelines and Severe Accident Management Guidelines (SAMG).

55. CNSC staff submitted that it conducts routine inspections to verify operational activities at the Darlington NGS against the Operating Policies and Principles (OP&Ps)

that outline the operating boundaries within which the stations are operated safely. Based on those inspections, CNSC staff reported that the OP&Ps are adequately implemented at the Darlington NGS. CNSC staff also provided information regarding monitoring of unplanned reactor trips, stepbacks and setbacks, and stated that OPG had followed approved procedures, investigated or evaluated the root causes of the events and taken appropriate corrective actions.

3.3.2 Procedures

56. CNSC staff reported that OPG had developed procedures to support the safe operation and maintenance of the Darlington NGS, and has a standard that specifies the requirements for technical procedures. CNSC staff added that OPG had documented expectations for procedural use and adherence, and had implemented a structured process for the development, review and approval of technical procedures.

3.3.3 Reporting and Trending

57. In its submissions, OPG stated that it was reporting to the CNSC in accordance with CNSC regulatory document S-99, *Reporting Requirements for Operating Nuclear Power Plants,* as well as REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*, which came into effect at the Darlington NGS on January 1, 2015 and replaced S-99. CNSC staff confirmed that OPG had continued to submit reports for the Darlington NGS in accordance with CNSC regulatory documents. CNSC staff added that all reportable events had been addressed by OPG's corrective actions.

3.3.4 Operating Experience

58. OPG provided information about the Darlington NGS performance and presented forced loss rate data as a representative indicator of the overall reactor performance for all units of the station. The presented data indicated that all of the Darlington NGS units had operated with a minimal number of unplanned transients and reactor trips. OPG added that it performs external benchmarking to improve the essential knowledge, behaviours, and practices of operating crews, as well as the operating performance of the Darlington NGS. In addition to external benchmarking, OPG stated that it uses Operator Fundamentals, integrated into training, to further improve the performance of operating crews. OPG further stated that it establishes safe work conditions by creating a safe work area, oversight of which is provided by the Nuclear Work Protection Review Board at the corporate level, and Local Work Protection Review Board at the site level. OPG noted that this oversight includes the monitoring of significant trends or events and their associated Corrective Action Plans, and is focused, at the local level, on key lessons and required corrective actions from work protection events.

59. OPG described fuel handling at the Darlington NGS and highlighted that preventive and corrective maintenance on fuelling machine equipment had resulted in significant improvements of the fuel handling system and a reduction of unplanned equipment degradation. With respect to fuel reliability, OPG stated that post-discharge fuel inspections had indicated that the fuel condition had remained within the design basis compliance envelope during the last five years of operation. OPG added that a minor modification in fuel design to enhance cooling had resulted in an overall improvement in the safety margin, and that it improved reliability by controlling chemical parameters to minimize corrosion and performance degradation. OPG stated that the Darlington Chemistry Laboratory operations comply with the requirements of ISO/IEC 17025, *General Requirements for the Competence of Testing and Calibration Laboratories*.

60. CNSC staff informed the Commission that OPG maintains an effective OPEX program that gathers and disseminates operational experience, and noted that OPG stations have databases of information regarding identified problems for ongoing reporting and trending that are accessible to OPG staff at all levels of the organization. CNSC staff also submitted information about OPG's outage management performance and provided data about the number of planned maintenance outages and unplanned outages. CNSC staff stated that OPG had conducted appropriate follow-up actions for these outages.

61. With respect to the safe operating envelope, CNSC staff stated that CSA standard N290.15, *Requirements for the safe operating envelope of nuclear power plants*, had been successfully implemented by OPG at the Darlington NGS.

3.3.5 Accident and Severe Accident Management and Recovery

62. OPG submitted information regarding the management of design basis accidents (DBA) and beyond design basis accidents (BDBA), and noted that BDBA management is for managing a very low frequency but potentially high impact event sequence that is not included in the plant design basis. OPG explained that the analyses of both groups of events are included in OPG's Reactor Safety Program and the Risk and Reliability Program respectively, and are part of OPG's safety analysis that supports the overall safety case for the Darlington NGS.

63. OPG described the implementation and refinements of the SAMG as part of its post-Fukushima follow-up project. OPG explained that updates to this program would address multi-unit severe accidents, irradiated fuel bay (IFB) severe accidents, lessons learned from Fukushima, and severe accidents from shutdown/low power states. OPG noted that completion was expected by December 2015, and stated that the program would comply with the 2013 version of REGDOC-2.3.2, *Accident Management: Severe Accident Management Programs for Nuclear Reactors*. CNSC staff stated that OPG's commitment to implement REGDOC-2.3.2 by December 31, 2015 was acceptable.

64. OPG submitted that a major emergency preparedness exercise, “Exercise Unified Response”, involving integration of provincial, national and municipal entities in response to a postulated severe accident scenario, was carried out in May 2014, and demonstrated that OPG has a robust emergency preparedness program that is well integrated with external emergency response organizations.

65. CNSC staff informed the Commission that it performs routine verification to ensure that up-to-date manuals and emergency operating procedures are available to reactor operators to mitigate situations and return the plant to a safe and controlled state and to prevent potential escalation of the abnormal incident into a more serious accident. CNSC staff reported that OPG had met regulatory requirements in this regard.

66. CNSC staff noted that the SAMG program provides an additional layer of defence against the consequences of BDBAs. The SAMG ensure that personnel involved in managing a BDBA have the information, procedures and resources necessary to carry out effective onsite actions. CNSC staff stated that OPG had implemented SAMG for single unit events and that OPG would address the final enhancements to the SAMG documentation, required training and drills and will include multi-unit SAMG and SAMG for IFBs by December 2015. CNSC staff added that it was satisfied with OPG’s use of SAMG procedures during emergency drills and exercises, including during Exercise Unified Response.

3.3.6 Conclusion on Operating Performance

67. Based on the above information, the Commission concludes that the operating performance at the facility during the current licensing period provides a positive indication of OPG’s ability to carry out the activities under the proposed licence. The Commission is satisfied that the improvements made by OPG in the area of fuel handling and modification in fuel design had resulted in an overall improvement in safety margins and reliability. The Commission is also satisfied that the severe accident management program provides an additional layer of defence against the consequences of beyond design basis accidents.

3.4 Safety Analysis

68. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or the operation of a facility, and considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards. It supports the overall safety case for the facility.

69. CNSC staff stated that it had reviewed OPG’s performance in the area of safety analysis and that its assessment had been focused on the following specific areas:
    - deterministic safety analysis;
    - probabilistic safety analysis;

- hazard analysis; and
- management of safety issues (including R&D programs).

70. CNSC staff rated OPG's performance for this SCA as satisfactory for each year from 2008 to 2014.

3.4.1 Deterministic Safety Analysis

71. OPG informed the Commission about its activities associated with OPG's Reactor Safety Program that encompasses the Safety Analysis Basis that includes the analysis and assessments of design basis accidents (DBAs), safe operating envelope that is defined by the safety-related limits and system credits that ensure operation within the safety analysis basis, and the BDBA Management. The results of safety analyses are used for internal annual updates of the Safety Report, which is formally updated every five years as per REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*.

72. OPG further informed the Commission about its safety analysis improvements conducted as part of the implementation of CNSC REGDOC-2.4.1, *Deterministic Safety Analysis*, and added that OPG's detailed plan for the implementation of REGDOC-2.4.1 had been submitted to CNSC staff. OPG noted that it was systematically reassessing the status of designs and analysing safety issues for CANDU reactors.

73. CNSC staff informed the Commission that OPG's plan for the implementation of CNSC regulatory document RD-310, *Safety Analysis for Nuclear Power Plants*, for the Darlington NGS had been reviewed in 2013. In May 2014, RD-310 was superseded by REGDOC-2.4.1 to reflect the lessons learned from the Fukushima event and to address the findings from the CNSC's Fukushima Task Force Report. In May 2014, OPG provided CNSC staff with its implementation plan for REGDOC 2.4.1. As part of the implementation of REGDOC-2.4.1, OPG has updated the Darlington NGS loss-of-moderator heat sink analysis. CNSC staff reviewed the pilot analysis and concluded that the adopted approach was consistent with REGDOC-2.4.1.

74. CNSC staff stated that OPG has an adequate aging management program in place at the Darlington NGS that includes systematic monitoring of aging-related parameters important to safety, and analysis and assessment of the impact of the aging parameters on existing safety margins. CNSC staff noted that aging management related issues would be addressed through the refurbishment of the Darlington NGS. CNSC staff will continue to conduct regulatory oversight in this area and will report to the Commission on an annual basis through the Regulatory Oversight Report.

3.4.2 Probabilistic Safety Assessment

75. OPG informed the Commission about the Darlington 'A' Risk Assessment (DARA) –

a Probabilistic Safety Assessment (PSA) performed in 2011 for the Darlington NGS in accordance with CNSC standard S-294, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants.* OPG added that the DARA was updated in 2015 using methodologies previously accepted by CNSC staff, and provided the numerical results of this update. OPG described the PSA framework in which risk is characterized in terms of a frequency of "severe core damage" and "large release", and explained that it would implement REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*, to complete the PSA work and a full DARA update within five years, in accordance with the transition plan it provided to the CNSC in 2014.

76. The issue of "whole-site PSA" has been raised by intervenors in this and other Commission proceedings. OPG stated that it was collaborating with other members of COG to develop a whole-site PSA methodology. OPG noted that it had submitted a COG report entitled *Development of a Whole-Site PSA Methodology*[7] to CNSC staff and posted the document on the OPG website. Further actions would be discussed and planned among COG members. OPG plans to provide an update on whole-site PSA plans for the Darlington NGS by June 2018.

77. CNSC staff informed the Commission that the risk and reliability program at the Darlington NGS establishes a framework for the development and use of the PSA as a means to manage radiological risk and contribute to safe operation of the facility. CNSC staff confirmed that, in 2011, OPG had submitted a detailed and comprehensive PSA for the Darlington NGS as required by the licence. CNSC staff stated that the submitted PSA had followed the accepted methodologies and that the Darlington NGS was compliant with the requirements of S-294. CNSC staff was also satisfied with OPG's additional analysis of seismic events leading to consequential fires and floods, demonstrating that the facility could withstand events of greater impact than those recorded historically.

78. CNSC staff detailed the modifications made in the 2015 PSA update. CNSC staff added that REGDOC-2.4.2 is being gradually implemented for existing facilities and that OPG had committed to fully implement REGDOC-2.4.2 for the next PSA update in 2020. CNSC staff reiterated that the Darlington 2015 PSA update was satisfactory and met CNSC regulatory requirements.

79. Several intervenors submitted the view that a comprehensive risk assessment for the Darlington NGS had not been performed and enquired about the PSA update results crediting EME, as well as the methodology used to derive the whole-site PSA results. CNSC staff responded that it had accepted the methodology on crediting EME that had been submitted by OPG. CNSC staff stated that an ecological risk assessment and human health risk assessment were performed and accepted by CNSC staff as part of the Darlington Refurbishment and Continued Operations Environmental Assessment. CNSC staff added that OPG had developed an implementation plan to ensure the previous assessments meet the requirements outlined in CSA standard N288.6-12, *Environmental risk assessments at Class I nuclear facilities and uranium mines and*

[7] COG-13-9034-r0: "Development of a Whole-Site PSA Methodology", CANDU Owner's Group, February 2014.

mills. This plan includes a gap analysis to compare the requirements of N288.6 against the assessments from the Darlington Refurbishment and Continued Operations CEAA EA. Based on the outcome of the gap analysis, OPG will revise its environmental risk assessment by December 2016. CNSC staff also reiterated that two regulatory documents related to deterministic and probabilistic safety analyses were recently updated, and that both of them envisaged analysis updates in five-year cycles. CNSC staff added that the Commission reviews the performance of reactor plants and sites, including safety and risk related issues, on a yearly basis through the Regulatory Oversight Report.

3.4.3 Hazard Analysis

80. CNSC staff informed the Commission about its analysis of safety hazards in the areas of fire protection and seismic hazards. CNSC staff reviewed and assessed OPG's updated Fire Hazard Assessment (FHA) and Fire Safe Shutdown Analysis (FSSA) for the Darlington NGS that are in accordance with CSA standard N293, *Fire protection for nuclear power plants*, and industry best practices. CNSC staff reported that OPG's FHA and FSSA meet regulatory requirements, and noted that identified areas for improvement had been mostly addressed and that the outstanding areas for improvement did not represent an increased risk to nuclear safety. CNSC staff added that it had retained the services of Natural Resources Canada (NRCan) to review OPG's Probabilistic Seismic Hazard Analysis (PSHA) for the Darlington NGS. CNSC staff stated that, based on NRCan's review, the Darlington NGS PSHA is adequate, and that identified follow-up actions were being satisfactorily addressed.

81. Mr. C. Bennett, in his intervention, expressed concerns regarding hazards of potential damage caused by "strong penetrating electromagnetic fields." The Commission asked for submissions on whether there was cause for concern regarding the building code being inadequate or regarding the Darlington NGS's compliance with such risk. CNSC staff responded that the plant had been built to satisfy building codes with respect to electromagnetic fields. CNSC staff added that a screening of various aspects of electromagnetic interference and associated potential hazards had been completed, and that, if there were disruptions to the electromagnetic environment of the plant, the main safety systems, which are failsafe on loss of any kind of connectivity, would put the plant into a safe state. The OPG representative confirmed that the existing safety systems would safely shut down the plant, and added that mechanical systems would not be affected by such interference.

82. Some intervenors expressed concern regarding the potential hazards associated with airplane crashes into the Darlington NGS. The OPG representative responded that airplane crashes had been considered in the PSA for the Darlington NGS, for different sizes of airplane and the frequency of flights in the area. OPG noted that the hazard had been screened out, following international practice, as the calculated probability of striking a critical part of the plant was very low. CNSC staff presented their assessment in CMD 15-H8 and noted that their deterministic analyses had shown that the reactor

would be safely shut down if this type of event were to occur.

83. Some intervenors raised concerns regarding potential hazards resulting from seismic events. The Commission invited OPG to respond to these concerns. An OPG representative responded that the Darlington NGS is located in an area of low seismic activity and that OPG has had expert assessment of possible seismic sources around the station, including geotechnical surveys, as part of its seismic hazard assessment. The OPG representative stated that, taking into account the frequency of occurrence and analyses of the margins of the plant components' ability to withstand a specified event intensity, OPG believes that there is an adequate margin against events beyond the design basis. CNSC staff confirmed OPG's statement and added that a recent assessment had shown that the seismic qualification for the Darlington NGS corresponded to an event that is more powerful than an event expected to occur once in 10,000 years.

84. A number of intervenors expressed concerns regarding earthquakes caused by fracking and similar activities. The Commission asked if there were any fracking activities near the Darlington NGS. Both CNSC staff and the OPG representative responded that there were no such activities in the area.

3.4.4 Management of Safety Issues

85. CNSC staff provided the Commission with its assessment of several safety issues managed by OPG and noted that the progress on Fukushima Action Items was included in the annual Regulatory Oversight Report. CNSC staff added that it had completed an assessment of the Composite Analytical Approach (CAA), which is a new large loss of coolant accident (LLOCA) analysis framework proposed by industry to resolve certain CANDU safety issues. CNSC staff noted that it had communicated the results of its review to OPG and that OPG responded to staff findings in April 2015. CNSC staff stated that it was reviewing OPG's response and planned to update the Commission in early 2016.

86. The Commission asked CNSC staff to explain the safety of CANDU reactors relating to a sudden reactivity insertion (power increase) that might occur during severe accidents, and about the amount of water present in reactor buildings. CNSC staff explained that the reactivity insertion is much slower in CANDU reactors than in light water reactors, and that the existing shutdown systems perform efficiently, as observed during extensive studies of different postulated design basis accidents. CNSC staff confirmed that the amount of water present in a CANDU facility is an order of magnitude larger than in light water reactors, and, in a case of a loss of coolant accident (LOCA), the designed emergency core injection and containment systems would provide more time for operators to react to the event than was possible during the Fukushima event.

3.4.5 Conclusion on Safety Analysis

87. On the basis of the information presented, the Commission concludes that the systematic evaluation of the potential hazards and the preparedness for reducing the effects of such hazards is adequate for the operation of the facility and the activities under the proposed licence. The Commission is satisfied that OPG, in its development and modification of the PSA, evaluation of potential hazards and management of safety issues is compliant with regulatory requirements.

3.5 Physical Design

88. Physical design includes activities to design the systems, structures and components to meet and maintain the design basis of the facility. The design basis is the range of conditions, according to established criteria, that the facility must withstand without exceeding authorized limits for the planned operation of safety systems. The specific areas that comprise physical design at the Darlington NGS include design governance, system design, and component design. CNSC staff rated OPG's performance for this SCA as satisfactory for each year from 2008 to 2014.

3.5.1 Design Governance

89. OPG informed the Commission about its design program, which ensures the ability of systems, structures and components to meet and maintain their design basis function at the Darlington NGS. OPG explained that the program encompasses a series of processes, standards, and procedures for performing engineering work in a consistent manner, and complies with CSA standard N286.0-92, *Overall quality assurance program requirements for nuclear power plants*. OPG further informed the Commission about improvements to the Engineering Change Control (ECC) process and the supporting design management processes to incorporate enhancements identified through the Corrective Action Program, OPEX and benchmarking. OPG also informed the Commission that its transition plan for CSA standard N290.0-11, *General Requirements for Safety Systems of Nuclear Power Plants*, had been submitted to CNSC staff, and that the Darlington NGS would be in compliance with N290.0-11 by December 2015, as scheduled.

90. OPG stated that the Darlington NGS maintains a Pressure Boundary Certificate of Authorization from the Technical Standards and Safety Authority to carry out pressure boundary (PB) activities as required by CSA standard N285.0, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*. OPG noted that it routinely conducts Nuclear Oversight Audits, independent external audits, as well as internal self-assessments to ensure compliance with relevant requirements, and that it schedules a Pressure Boundary Oversight Meeting every month with stakeholders to review the Darlington Pressure Boundary Health Report. OPG stated that all areas of concern are addressed through its Corrective Action Program.

91. CNSC staff assessed this specific area focussing on OPG's Environmental Qualification (EQ) program, human factors in design and PB program. CNSC staff confirmed that OPG's EQ program had been implemented and maintained in accordance with CSA standard N290.13-05, *Environmental qualification of equipment for CANDU nuclear power plants*. CNSC staff noted that a 2014 inspection determined that OPG's EQ program met regulatory requirements, and that OPG had satisfactorily addressed the few minor findings of low safety significance. CNSC staff added that OPG had developed a number of procedural tools to improve its processes for incorporating human factors when modifications are made to the station, and that CNSC staff was satisfied with OPG's ECC process.

92. CNSC staff stated that, in 2013, OPG implemented a transition plan for the update from CSA N285.0 Update No. 1 to N285.0-08 Update No. 2, and noted that OPG would be adopting the latest CSA N285.0-12 Update No. 1 Annex N, *Pressure Boundary Program Document*, in 2015 to improve the documentation of the PB program. CNSC staff added that, in 2013, it had conducted an inspection to verify the implementation of the PB program processes for system code classification, reconciliation and registration. CNSC staff found that the implementation, for both the code classification and design registration reconciliation process, met regulatory requirements.

3.5.2 System Design

93. CNSC staff informed the Commission about its findings regarding the following systems:
    - electrical systems;
    - instrumentation and control (I&C) including software;
    - fire protection – design;
    - seismic qualification; and
    - robustness design.

94. CNSC staff reported that it completed its most recent inspection of the electrical system at the Darlington NGS in September 2014 and stated that CNSC staff was satisfied with OPG's performance. CNSC staff noted that OPG had improved the performance of the Darlington NGS I&C systems and associated software. CNSC staff further stated that OPG had carried out a code compliance review of the Darlington NGS for compliance with CSA standard N293, *Fire Protection for Nuclear Power Plants*, as well as key standards referenced therein, and that the code compliance review for the Darlington NGS is in compliance with the requirements of this standard.

95. OPG informed the Commission that the reactors and safety systems at the Darlington NGS were designed and constructed to withstand a severe seismic event. OPG explained that the Darlington NGS has dedicated equipment, systems and procedures for ensuring safe reactor shutdown and continuous fuel cooling during seismic events.

96. CNSC staff reported that it had performed a seismic qualification inspection at the Darlington NGS in 2015, and found that OPG has effective processes in place to ensure the preservation of system seismic qualification. CNSC staff introduced the standards CSA N289.1-08, *General requirements for seismic design and qualification of CANDU nuclear power plants*, and CSA N291-08, *Requirements for safety related structures for CANDU nuclear power plants*, as compliance verification criteria in the draft LCH for the physical design SCA and noted that the Darlington NGS meets the requirements contained in these standards.

97. CNSC staff informed the Commission that OPG had submitted analyses of robustness against anticipated threats, including aircraft impact assessments, and demonstrated that vital areas and critical systems and components are protected to the extent that no offsite consequences are expected.

3.5.3 Component Design

98. CNSC staff described its review of component design, including the modified 37-element fuel bundle, electrical power cables and the fuel inspection program. CNSC staff stated that the use of the modified 37-element fuel bundle would optimize and improve thermo-hydraulic performance at the Darlington NGS, improve the safety margins over the current fuel design, and partially offset safety margin erosion due to plant aging. CNSC staff also stated that OPG has a well-developed and robust reactor fuel inspection program, and noted that OPG had investigated the causes of, and developed and implemented corrective actions for, fuel defects found in operating units. CNSC staff added that it was satisfied with OPG's progress in its testing and monitoring of electrical power cables, as well as in implementing cable surveillance and cable aging programs.

99. Northwatch, in its intervention, expressed concerns regarding the defective fuel bundles. The Commission asked for more information concerning the defects. A representative from OPG described the origin of the defective fuel and stated that the defects did not represent a risk. The OPG representative further described the corrective actions taken with fuel suppliers to correct the issue and noted that the fuel at the Darlington NGS had been defect-free across all four reactors since September 2014.

100. The Commission sought more information about the installation of passive autocatalytic recombiners (PARs), which are designed to mitigate levels of hydrogen gas that may be created during an accident, and which was one of the Fukushima action items. This issue was also raised by intervenors, some of whom also spoke of the issue of separation of hydrogen and deuterium, and was discussed during a previous public hearing for a different licensee[8]. CNSC staff responded that OPG had installed PARs

[8] Refer to the *Record of Proceedings, Including Reasons for Decision* regarding the "Application to Renew the Power Reactor Operating Licences for Bruce A and Bruce B Nuclear Generating Stations", CNSC, 2015.

and that, in terms of the Fukushima action items, CNSC staff considered this particular issue to be closed. Regarding hydrogen and deuterium separation, CNSC staff stated that large-scale tests were planned to explore the effectiveness of PARs using mixtures of these two gases. CNSC staff noted that preliminary studies had been done and that the results showed slight differences in behaviour, which indicated that there was a need for large-scale tests. CNSC staff stated that they were continuing with a longer-term research program on the topic of deuterium and hydrogen generation in collaboration with the Canadian Nuclear Laboratories (CNL) and added that nuclear industry was also following up on this matter.

101. Dr. S. Nijhawan, in his intervention, praised the original design and operation of the Darlington NGS, but expressed the view that it had become obsolete. The intervenor proposed design enhancements for potential design vulnerabilities such as the insufficient capacity of PARs, a problematic estimation of the amount of hydrogen produced and problems related to the formation of deuterium, and the inadequacy of pressure relief valves in the primary heat transport system. The Commission invited CNSC staff and OPG to comment on the intervenor's statements. CNSC staff stated that it took the concerns raised by the intervenor very seriously and noted that they had been addressed several times in Commission public hearings. CNSC staff further stated that no new information had been presented and that CNSC staff's position on these matters remained unchanged[9].

102. CNSC staff commented on specific issues raised by the intervenor. With respect to availability of reaction time during a complete station blackout, CNSC staff stated that the key conclusion of every analysis was that the operator would have enough time to undertake actions to provide additional time for the application of other mitigation measures. OPG representative explained that the Darlington NGS provides enough water to cool the system during a full station blackout, and also discussed the operator's ability to depressurize the boilers when the power is out. With respect to the hydrogen/deuterium formation issue, CNSC staff added that the differences in hydrogen and deuterium properties were not substantial enough to challenge the overall conclusion on the performance of the PARs. CNSC staff noted that this conclusion was supported by small scale tests and that the industry would continue with larger scale experimental work. CNSC staff noted that there are multiple design and operational provisions to handle the hydrogen risk, PARs being only one of them, and stated that this issue did not affect the safe operation of the Darlington NGS.

103. The intervenor also raised concerns regarding the role of feeders in generating large amounts of hydrogen during an accident, which could lead to large radioactive releases and explosions. The Commission invited submissions regarding this concern. CNSC staff stated that it had been possible to reproduce the intervenor's calculations only by making extreme assumptions, and explained that the amount of hydrogen generated would be significantly less under more realistic conditions. OPG representatives

[9] *Record of Proceedings, Including Reasons for Decision* regarding the "Application to Renew the Power Reactor Operating Licences for Bruce A and Bruce B Nuclear Generating Stations", Paragraphs 102 –105, 134 – 137, 279 and 375, CNSC, 2014..

disagreed with the amount of hydrogen generated that was presented by the intervenor and stated that OPG had analyzed effects of the formation of large amounts of hydrogen, taking into account oxidation of the feeder material and radiolysis of water. The OPG representative explained that, for a BDBA, , the results of a level 2 PSA showed that, although more hydrogen would form than for a DBA, the risk was still acceptably small.

104. The OPG representative further stated that there was no evidence that would quantitatively support the intervenor's statement regarding the insufficient capacity of the PARs and noted that the preliminary tests done by the industry, with the support of COG, had suggested that the PARs would be effective. An OPG representative added that COG had met with the intervenor in July 2015 to examine the intervenor's concerns in detail and to discuss generic issues that had been raised. The OPG representative noted that a draft report dealing with some of the key issues had been prepared and distributed to the interested utilities for comments, with the finalized report expected to be distributed to the intervenor and CNSC staff by the end of 2015. CNSC staff stated that, at this time, it was satisfied with the measures in place to address hydrogen build-up in accident scenarios.

3.5.4 Conclusion on Physical Design

105. On the basis of the information presented, the Commission concludes that the design of the Darlington NGS is adequate for the operation period included in the proposed licence. The Commission is satisfied that the issues raised by intervenors are being attentively approached by OPG, COG and CNSC staff, and acknowledges the clarifications and explanations offered by OPG and CNSC staff.

106. The Commission agrees that the meeting between COG and Dr. S. Nijhawan was an appropriate step in reviewing the concerns raised and expects that this process and any other appropriate measures will be accelerated. The Commission directs CNSC staff to provide an update to the Commission when the COG report is finalized.

3.6 Fitness for Service

107. Fitness for service covers activities that are performed to ensure that the systems, components and structures at the Darlington NGS continue to effectively fulfill their intended purpose. CNSC staff informed the Commission that specific areas reviewed within this SCA included the following:
    - maintenance;
    - reliability;
    - aging management;
    - periodic inspection and testing; and
    - chemistry control.

108. CNSC staff rated OPG's performance for this SCA as satisfactory for 2008, 2009, 2013 and 2014, and fully satisfactory from 2010 to 2012.

3.6.1 Maintenance

109. OPG informed the Commission that it performs routine on-power maintenance activities on a daily basis, while other, more complex tasks, inspections and repairs are done during planned and forced outages. OPG explained that the Darlington NGS has a Conduct of Maintenance Program and noted that the reliability of equipment is achieved through immediate corrective maintenance in conjunction with proactive preventive and predictive maintenance strategies. OPG provided details of its maintenance activities and stated that they are categorized and prioritized based on the nature of the deficiency and the importance of the affected equipment to system operation. OPG noted that this categorization is based on the guidance of industry standard INPO AP-928, *Work Management Process Description*, which is also used for determining maintenance backlog targets. OPG further submitted that, in an attempt to reduce station backlog and increase overall maintenance and operations efficiency, OPG undertook a new initiative to add on-line work into the planned outage scope and had constructed a new maintenance facility on site to provide maintenance staff with improved facilities and state-of-the-art equipment.

110. OPG further informed the Commission about the management of planned outages, as well as for forced outages in the event that a unit is unexpectedly taken offline or if it is determined that an outage is required prior to the end of the planned operating cycle. OPG explained that its Work Management Program ensures that maintenance, modification and testing activities are identified, prioritized, planned, scheduled and executed to protect plant operational integrity. To illustrate the efficiency of its efforts in maintenance, OPG stated that the latest scheduled outage at the Darlington NGS had been completed six days prior to the original committed date with more than 97 percent completion of the scoped activities.

111. CNSC staff stated that OPG continues to meet regulatory requirements for maintenance at the Darlington NGS, and that OPG's maintenance program meets CNSC requirements and expectations as set out in RD/GD-210, *Maintenance Program for Nuclear Power Plants*. CNSC staff added that OPG's preventive maintenance completion ratio at the Darlington NGS is consistently above the industry average and confirmed that the small corrective maintenance backlog at the Darlington NGS is improving and is in the industry top quartile.

112. The Commission sought more information about the maintenance of the Darlington Tritium Removal Facility. An OPG representative responded that the Darlington Tritium Removal Facility had been put into a maintenance outage and noted that OPG expected to invest in sustaining its operational reliability until 2025.

3.6.2 Reliability

113. OPG informed the Commission about its improvement plans to address equipment reliability and stated that specific initiatives would focus on maintenance backlog reduction, preventive maintenance indicators, and system health improvements. OPG explained that reliability was affected primarily by equipment aging, particularly in the area of electrical and electronic equipment, and added that the oversight of equipment reliability was performed weekly by its Plant Health Committee, which consists of senior managers from Operations, Engineering, Maintenance, and several other organizations. OPG also informed the Commission that it has a Component and Equipment Surveillance Program that ensures the reliable, safe and economic operation of components and performance of equipment in OPG facilities.

114. CNSC staff stated that OPG's reliability program continues to meet the requirements of RD/GD-98, *Reliability Programs for Nuclear Power Plants*. CNSC staff noted that, in accordance with REGDOC-3.1.1, licensees are required to report annually on the reliability of the multiple special safety systems that provide protection against rare but possible process system failures. CNSC staff added that it reports to the Commission on the special safety system performance for the Darlington NGS through the annual Regulatory Oversight Report.

3.6.3 Aging Management

115. OPG informed the Commission that its Integrated Aging Management Program is comprised of a set of programs and activities to ensure that performance requirements of critical equipment are met on an ongoing basis. OPG stated that its program is aligned with the International Atomic Energy Agency (IAEA) Safety Guide NS-G-2.12, *Ageing Management for Nuclear Power Plants.* OPG committed to complete its implementation of CNSC REGDOC-2.6.3, *Aging Management*, which was published in March 2014 to replace CNSC regulatory document RD-334, *Aging Management for Nuclear Power Plants*, by July 2017.

116. CNSC staff confirmed that OPG continues to implement and maintain an integrated aging management program at the Darlington NGS. CNSC staff assessed OPG's aging management activities and determined that OPG has a well-established integrated aging management program that is aligned with RD-334. CNSC staff also confirmed that OPG was implementing REGDOC-2.6.3. CNSC staff stated that it was satisfied with OPG's specific aging management programs for pressure boundary components, such as pressure tubes, feeders and steam generators, as well as for concrete containment structures. CNSC staff noted that OPG's programs are updated on a regular basis to incorporate new operating experience and operational and safety goals.

117. OPG presented information regarding its Major Components Program, which establishes a formal and systematic process for the life cycle management of major components including fuel channels, feeders, steam generators, and other reactor

components and structures. This program provides a framework for integrating and reporting component performance, condition and compliance with design basis documents. OPG noted that it participates in the industry Fuel Channel Life Management Project and other fuel channel research and development activities. OPG explained that, through the implementation of fuel channel aging management processes and strategies, OPG had obtained the information required to assess fuel channel pressure tube fitness for service and predict the change in component properties throughout their life. OPG noted that, within the life cycle management plan for steam generators, OPG determined that the steam generators did not need to be replaced during the Darlington NGS refurbishment.

118. CNSC staff reported that it conducted technical reviews of OPG's inspection reports and the disposition of findings, and confirmed that the structural integrity of feeders had been maintained with sufficient safety margins. CNSC staff noted that the steam generators are inspected and maintained on a three-year outage cycle.

119. With respect to containment structures, OPG stated that an aging management plan for containment structures had been developed based on OPEX from CANDU plants and other industry leaders. OPG explained that the concrete containment structures at the Darlington NGS are periodically inspected in accordance with CSA standard N287.7-08, *In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plant components*. OPG noted that leak rate test results from the 2009 Vacuum Building outage were within specification, confirming that this structure was leak-tight. CNSC staff confirmed that OPG's periodic inspections and testing of the concrete containment structures were conducted in accordance with the requirements of CSA N287.7-08. CNSC staff also provided details regarding concrete integrity, including alkaline-aggregate reaction, leak rate tests and concrete inspection results, and stated that it had not identified any compliance issues affecting safety in this area.

120. The Commission enquired about the concrete integrity of containment structures and the processes involved in the deterioration of its properties. The OPG representative responded that the alkali-silica reaction affecting some concrete projects was well understood before the construction of the Darlington NGS, and noted that the concrete structures at the Darlington NGS used materials to prevent these issues. The OPG representative stated that no evidence of concrete structure deterioration had been observed at the Darlington NGS, and that monitoring activities and pressure tests have shown that the structures remain solid and that the concrete is aging as expected. The OPG representative noted that OPG communicates and exchanges experience with other companies that maintain large concrete structures.

3.6.4 Periodic Inspection and Testing

121. OPG submitted information regarding periodic inspections and testing. OPG explained that component and equipment health is evaluated and trended by means of technical

evaluations, inspections, maintenance and testing in accordance with licensing codes and standards.

122. CNSC staff informed the Commission that it had reviewed and accepted OPG's periodic inspection programs at the Darlington NGS for the major pressure boundary components, containment structures and their components, and confirmed that those programs are in compliance with the requirements of CSA standard N285.4, *Periodic inspection of CANDU nuclear power plant components*, CSA standard N285.5, *Periodic inspection of CANDU nuclear power plant containment components*, and CSA N287.7-08. CNSC staff added that it monitors OPG's activities regarding the balance of plant pressure boundary systems and civil structures that can impact safe operation through reviews of REGDOC-3.1.1 reports (formerly S-99 reports) and the conduct of inspections. CNSC staff stated that OPG meets current regulatory expectations and has developed periodic inspection program documents for the balance of plant safety-related civil structures in accordance with CSA standard N291, *Requirements for safety-related structures for CANDU nuclear power plants*.

3.6.5 Chemistry Control

123. CNSC staff reported that, based on an inspection conducted in 2014, OPG's chemistry control program at the Darlington NGS is implemented in a satisfactory manner, and that OPG has a well-developed chemistry program that meets CNSC requirements and expectations.

3.6.6 Pressure Tube Service Life

124. OPG submitted that, based on results from inspections and the life cycle management plan strategy, the fuel channel components were safe for continued operation beyond the current licence limit of 210,000 equivalent full power hours (EFPH) to at least 235,000 EFPH, as established in OPG's business plan target for the pre-refurbishment life of the Darlington NGS units. OPG stated that it was confident that the components would perform within required parameters until the time that each unit would be removed from service for refurbishment. As such, OPG requested that the Commission approve the operation of the pre-refurbishment Darlington NGS units up to 235,000 EFPH.

125. OPG explained that it has mitigation strategies in place for the active degradation mechanisms that affect fuel channel components and stated that it would continue to confirm the fitness for service of pressure tubes and spacers through ongoing aging management inspection and maintenance activities. OPG noted that it would continue to provide inspection and assessment reports to CNSC staff.

126. Some intervenors questioned whether OPG would be able to complete its proposed refurbishment before the reactor units reach 235,000 EFPH. The Commission asked

OPG whether 235,000 EPFH would be sufficient to accommodate OPG's proposed refurbishment schedule. A representative from OPG responded that, based on OPG's planning, it would be sufficient. CNSC staff stated that if OPG was authorized to operate up to 235,000 EFPH, then OPG would not be permitted to exceed that limit without additional authorization from the Commission.

127. CNSC staff recommended that the Commission authorize OPG to operate the Darlington NGS units beyond 210,000 EFPH, up to the proposed refurbishment outages to a maximum of 235,000 EFPH. CNSC staff stated that OPG has established programs in place to monitor the fitness for service of pressure tubes and spacers, and has developed appropriate engineering methodologies and inspection and maintenance programs to support the continued safe operation for the pre-refurbishment service life of the Darlington NGS to 235,000 EFPH. CNSC staff noted that 235,000 EFPH was not a cliff-edge limit but an indicator of when further assessment would be necessary. CNSC staff stated that, given OPG's plans to refurbish the Darlington NGS before the units reach 235,000 EPFH, further assessment to demonstrate the feasibility of operating beyond that point was not required. CNSC staff stated that it was satisfied that OPG adheres to the requirements of CSA N285.4.

128. CNSC staff further submitted that it would continue to follow up on OPG's activities related to maintaining the fitness for service of the pressure tubes at the Darlington NGS, including continuing research and development on pressure tube aging effects. CNSC staff noted that it would continue its regulatory oversight to ensure the continued safe operation of the Darlington NGS units, and stated that it would update the Commission on fitness-for-service monitoring via the annual Regulatory Oversight Report.

129. The Commission asked about assessments performed to validate the extension of pressure tube life from 210,000 to 235,000 EFPH. CNSC staff responded that OPG and other industry members had conducted a Fuel Channel Life Management Project, an in-depth research project exploring the life of pressure tubes. The results were presented at a meeting of the Commission in March 2014. An OPG representative noted that the lifecycle management program in place includes regular testing and periodic inspections, and that OPG's Fuel Channel Lifecycle Management Plan outlines all of the requirements to manage the aging of fuel channel components. The OPG representative added that its assessment had been based on OPG's operating experience and included extensive research and development evidence, in-service inspection, predictive models and fitness-for-service assessments.

3.6.7 Conclusion on Fitness for Service

130. The Commission is satisfied with OPG's programs for the inspection and life-cycle management of key safety systems. Based on the above information, the Commission concludes that the equipment as installed at the Darlington NGS is fit for service.

131. The Commission is satisfied that OPG has adequate programs in place to support operation beyond 210,000 EFPH up to the proposed refurbishment outages, to a maximum of 235,000 EFPH. The Commission is of the view that the information presented demonstrates that the Darlington NGS components will remain fit for service and perform safely, and that ongoing maintenance and inspections will continue to validate this conclusion. The Commission authorizes OPG to operate the Darlington NGS up to the proposed refurbishment outages, to a maximum of 235,000 EFPH.

3.7 Radiation Protection

132. As part of its evaluation of the adequacy of the measures for protecting the health and safety of persons, the Commission considered the past performance of OPG in the area of radiation protection. The Commission also considered the radiation protection program at the Darlington NGS to ensure that both radiation doses to persons and contamination are monitored, controlled and kept as low as reasonably achievable (ALARA), with social and economic factors taken into consideration[10]. Specific areas reviewed within this SCA were the following:

- application of ALARA;
- worker dose control;
- radiation protection program performance;
- radiological hazard control; and
- estimated dose to the public.

133. CNSC staff rated OPG's performance for this SCA as satisfactory for 2009, and fully satisfactory for 2008 and the period from 2010 to 2014.

3.7.1 Application of ALARA

134. CNSC staff submitted that OPG has a documented ALARA program, which integrates ALARA into planning, scheduling and work control, and which identifies the strategies in place at the Darlington NGS to control doses and minimize exposures. CNSC staff noted that OPG's five-year ALARA plan includes current and long-term dose reduction initiatives. CNSC staff reported that it had conducted an inspection of occupational ALARA planning and control at the Darlington NGS in 2014 and found that OPG was compliant with regulatory requirements; minor issues identified during the inspection were corrected by OPG.

3.7.2 Worker Dose Control

135. OPG provided information on its worker dose control program, explaining that worker

[10] Refer to CNSC regulatory guide G-129 rev. 1, *Keeping Radiation Exposures and Doses "As Low as Reasonably Achievable (ALARA)"*.

exposures are managed to ensure that doses are kept well below regulatory limits and to avoid unplanned exposure. OPG stated that no radiation exposures at the Darlington NGS exceeded regulatory or administrative dose limits during the licence period, and noted that radiation exposures had been reduced to levels significantly below these limits.

136. CNSC staff informed the Commission that OPG operates a CNSC-licensed dosimetry service to monitor, assess, record and report doses of ionizing radiation received by employees, visitors and contractors. CNSC staff confirmed that, from 2008 to 2014, there were no radiation exposures exceeding the annual regulatory dose limit for a nuclear energy worker of 50 millisieverts per year (mSv/y) reported at the Darlington NGS, and that an average of 88 percent of monitored workers had received less than 1 mSv/y. CNSC staff reported that it had conducted an inspection focused on worker dose control at the Darlington NGS in 2013 and determined that the Darlington NGS was compliant with regulatory requirements. CNSC staff noted that identified areas for improvement of low safety significance were satisfactorily addressed by OPG.

137. Some intervenors, including the Canadian Coalition for Nuclear Responsibility and Port Hope Community Health Concerns Committee, expressed concerns regarding the health of workers affected by elevated doses of radiation, latent effects and lack of follow-up of delayed effects of irradiation. The Commission invited submissions from OPG and CNSC staff on this subject. The OPG representative responded that OPG uses a tracking system that records the work, type of exposures and doses received by the workers. OPG representative noted that OPG meets regulatory requirements regarding the radiation protection program, dose record and reporting to the National Dose Registry, and follows the health of those workers on a long-term basis. The OPG representative added that OPG has a program for reporting any unusual events or occurrences to the CNSC but noted that OPG had not had any dose-related injuries and that doses are maintained ALARA. CNSC staff stated that a large number of studies have been conducted over a long period of time on cohorts of nuclear workers in Canada, including workers with different types of exposures, both internal and external, in nuclear power plants, at AECL, and uranium mines. CNSC staff noted that the studies were performed by professionals from Cancer Care Ontario, the Public Health Agency of Canada, the University of California in San Francisco and other international experts; were published in peer-reviewed, high-quality, high-impact journals; and have been quoted internationally in major summary studies. CNSC staff added that Canada had also collaborated with the International Agency on Research for Cancer (IARC) when they had conducted multi-cohort studies of nuclear workers.

138. The Port Hope Community Health Concerns Committee submitted that the United States has a compensatory scheme that provides monetary compensation to individuals exposed to radiation, and suggested that Canada should have similar legislation. The Commission notes that such a policy decision could only be made by the Government of Canada and is not relevant to the Commission’s regulatory mandate. Nonetheless, the Commission does take note of the American statute dealing with this issue, the

Radiation Exposure Compensation Act (RECA)[11]. This legislation appears to serve quite a different purpose in the United States than the intervenor had understood.

3.7.3 Radiation Protection Program Performance

139. OPG informed the Commission that the Radiation Protection Program at the Darlington NGS establishes control of occupational and public exposure to radiation, and has the following implementation objectives:
    - keeping individual doses below regulatory limits;
    - preventing unplanned exposures;
    - keeping individual risk from lifetime radiation exposure to an acceptable level; and
    - keeping collective doses ALARA, social and economic factors taken into account.

140. OPG stated that its Radiation Protection Program prevents the uncontrolled release of contamination or radioactive materials from the site by controls and monitoring of people and materials.

141. CNSC staff stated that it was satisfied that OPG's Radiation Protection Program at the Darlington NGS meets all applicable regulatory requirements. CNSC staff reported that, in 2013 and 2014, it verified the effectiveness of OPG's implementation of the Radiation Protection Program at the Darlington NGS, and determined that the program documents and the oversight applied to this program have been effective in protecting workers.

3.7.4 Radiological Hazard Control

142. OPG stated that, since 2010, the contamination control program at the Darlington NGS has been enhanced through several implemented improvements. CNSC staff confirmed that OPG has adequate measures to control the radiological hazards at the Darlington NGS. CNSC staff reported that OPG had completed corrective actions that were implemented at the Darlington NGS during the last licence renewal in order to resolve two radiological hazards of low safety significance. CNSC staff noted that OPG had satisfactorily resolved the areas for improvement that were identified during compliance inspections.

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[11] According to the relevant US Justice Department website, the RECA exists to compensate individuals who have become ill due to involvement in U.S. nuclear weapons activities. It established an administrative program for claims relating to atmospheric nuclear testing and claims relating to uranium industry employment. The Act delegates authority to the U.S. Attorney General to establish procedures and make determinations regarding whether claims satisfy statutory eligibility criteria. RECA presents an apology and monetary compensation to individuals who contracted certain cancers and other serious diseases following their specific exposure to radiation released during the atmospheric nuclear weapons tests, or following their occupational exposure to radiation while employed in the uranium industry during the Cold War arsenal buildup.

3.7.5 Estimated Dose to the Public

143. OPG stated that, in terms of protecting the public, OPG's compliance with the Radiation Protection Program prevents the uncontrolled release of contamination or radioactive materials from the site by controls and monitoring of people and materials.

144. CNSC staff provided to the Commission its assessment and analysis of the methodology used by OPG to calculate the maximum effective dose to a member of the public resulting from operations at the Darlington NGS. According to the presented data, the maximum effective dose received by a member of the public in the period 2010 to 2014 was 0.6 microsieverts per year (µSv/y), which is well below the regulatory limit of 1000 µSv/y (or 1 mSv/y), as well as below the effective dose of natural background radiation of 2300 µSv/y.

145. Several intervenors, including individuals, expressed concerns regarding effects of released tritium on the health of the population living in the vicinity of nuclear power plants. The Commission asked CNSC staff to provide more details regarding this issue. CNSC staff stated that the tritium concentrations measured in Municipality of Clarington drinking water plants ranged from 5 to 8 becquerels per litre (Bq/L), which is well below the Canadian drinking water standards for tritium (7000 Bq/L), as well as below the Californian standard referenced by intervenors (California Public Health Goal of14.8 Bq/L, which is not enforceable). CNSC staff noted that the corresponding doses to members of the public from drinking water around the Darlington site are 0.6 µSv/y, which is well below the regulatory limit of 1000 µSv/y. CNSC staff noted that the tritium concentrations in Lake Ontario measured near Kingston, ON were mainly residual tritium from weapons-testing fallout, with a small contribution from the Pickering and Darlington facilities.

146. CNSC staff further stated that, although several interventions implied that these tritium releases represented a health concern, these implications did not have a factual scientific basis. CNSC staff explained that effects on human health related to tritium releases are observed at tritium concentrations that are several orders of magnitude higher than those that have been measured during environmental monitoring. CNSC staff explained that a dose of 100 µSv/y, used as a basis for the drinking water standard as pointed out by the intervenors, corresponds to a risk of tritium-linked adverse effects of 340 in 1 000 000, taking a non-threshold approach. However, the acceptable risk level for the drinking water standards for a variety of chemicals and metals in Canada is of the order of 1 in 10,000, and not 1 in 1 000 000, as suggested by intervenors.

147. A CNSC consultant , Dr. Demeter[12], further explained that the incremental dose to the critical (most exposed) person living in the vicinity of the Darlington NGS corresponding to the measured tritium concentration of 5.1 Bq/L is 0.6µSv/y, and very

[12] Dr. Demeter is an MD with experience in both public health (1996 to 2002) and as a nuclear medicine physician (2002 to present). In 2013 Dr. Demeter was appointed as a member of International Commission on Radiological Protection, Committee 3 (protection in medicine).

low when compared to the natural background exposure of 2000 to 3000 µSv/y. The consultant also explained that the linear non-threshold dose is a theoretical model that is used for providing regulatory mechanisms to make the doses ALARA, and that, from an epidemiological point of view, the risks of very low dose chronic exposures are difficult to prove. The consultant added that the doses administered in nuclear medicine through radiopharmaceuticals are much higher than the doses received through exposures to the concentrations of tritium mentioned by the intervenors, and that these doses are considered to be safe.

148. Some intervenors stated that the 'adult male' had been used as the basis for radiation protection standards, while the most sensitive population included pregnant women, children and children *in utero*. The Commission sought more information regarding this issue. CNSC staff responded that the statement was not factual. CNSC staff explained that the information that had been used to establish the public dose limit was based on evidence from all available epidemiological and laboratory studies. CNSC staff noted that the main study that had been used in the development of public dose limits was the so-called life span study, which included survivors of the Nagasaki and Hiroshima bombings, thus representing essentially an entire population of males, females and children of all ages. CNSC staff further noted that two studies conducted by the Medical Officer of Health of Durham showed that the risks of cancer, congenital diseases, Down's Syndrome and other health effects were similar in the region to those in the rest of the province. Health studies conducted by the CNSC also found no evidence of increased cancer risk in children around the Pickering, Darlington and Bruce facilities. CNSC staff agreed that, at higher dose rates, cancer rates are higher in children. CNSC staff pointed out that recent studies conducted after the Fukushima event had shown disagreement regarding the correlation between exposure during accidents and the number of childhood thyroid cancer cases, and that this issue was an object of scientific debate. CNSC staff stated that, with respect to other types of cancer, based on the measurements of radiation from the Fukushima event rather than on modelling, the consensus amongst the scientific community is that the number of cancer cases caused by the event cannot be distinguished from the cancer cases attributed to other causes.

149. The Commission noted that, during many CNSC public hearings, a number of intervenors presented results of the KiKK[13] study conducted in Germany, and asked CNSC staff for a comment on the results presented in this study. CNSC staff explained that the study had attracted the attention of scientists in both Germany and internationally; however, to date, there was no explanation for those findings. CNSC staff noted that a number of international committees had looked at this study and made conclusive statements on it, including that it was clearly demonstrated that a relationship with radiation doses had not been established, since similar clusters of the same diseases had been identified in regions with no nuclear facilities.

[13] Kaatsch, P.; Spix, C.; Schmiedel, S.; Schulze-Rath, R.; Mergenthaler, A.; Blettner, M.: Epidemiologische Studie zu Kinderkrebs in der Umgebung von Kernkraftwerken, Int. J. Cancer: 1220, 721–726 (2008) and Spix et al., Eur. J. Cancer. 44, 275-284 (2008) – (German acronym KiKK study)

150. With respect to the KiKK study, the Commission is of the view that the results of this study are not widely accepted by the scientific community and have been subject to serious criticism. Experts that were appointed to review the KiKK study noted several limitations in the study such as the lack of information on exposure and on other risk factors known to be related to childhood leukemia. They stated that the distance from a NPP used in the study as a proxy for exposure was not suitable for establishing a correlation between childhood leukemia and radiation exposure from nuclear power plants. An assessment of the study by the German Commission on Radiological Protection[14] states that "The natural radiation exposure within the study area, and its fluctuations, are both greater, by several orders of magnitude, than the additional radiation exposure caused by the relevant nuclear power plants" and that "If one assumes that the low radiation exposures caused by the nuclear power plants are responsible for the increased leukaemia risk for children, then, in light of current knowledge, one must calculate that leukaemia due to natural radiation exposure would be more common, by several orders of magnitude, than they are actually observed to be in Germany and elsewhere." Without entering the scientific debate regarding the value of the results of the KiKK study, the Commission maintains a position that its decisions cannot be based on a single study, the results of which are not confirmed by other studies, are controversial and still debated, and are not widely accepted by the scientific community.

151. Dr. F. Greening, in his intervention, expressed concerns regarding occurrences of spikes in airborne tritium releases caused by accidental spills of heavy water. According to the intervenor, reporting the average doses to the public, as is typically done, is not appropriate since spikes in airborne tritium releases could lead to an increased dose to residents living near the facility. The Commission sought more information regarding spikes of tritium concentrations in air and asked about the actions taken to address this issue. The OPG representative stated that tritium releases from the Darlington NGS are small fractions of the regulatory limits, and that these emissions are monitored daily and compared to self-imposed daily, weekly, monthly and annual limits. The OPG representative noted that short-lasting spikes occur as a result of different activities, such as maintenance activities, and that OPG takes mitigation measures to manage and minimize these spikes. The OPG representative explained that the reported values for annual emission is not obtained by simply averaging monitored daily values per year, but rather by accounting for all main contributors of the emission, which are then averaged per second for the entire year. The obtained values are used in a model to determine doses for the identified critical groups, i.e. the population potentially more exposed than average members of the public. CNSC staff added that OPG's monitoring program had been reviewed and approved to ensure that the monitoring is conducted properly, for the right contaminants at the right locations. CNSC staff confirmed that all information and data, including spikes, are used to calculate doses to the public and to identify critical

[14] Assessment of the Epidemiological Study on Childhood Cancer in the Vicinity of Nuclear Power Plants (KiKK Study), (Original title "Bewertung der epidemiologischen Studie zu Kinderkrebs in der Umgebung von Kernkraftwerken (KiKK-Studie)", in "Berichte der Strahlenschutzkommission, Heft 57", Verlag H. Hoffmann GmbH, Berlin 2008.

groups specifically. CNSC staff added that radionuclides with concentrations that are too low to be detected in the atmosphere are sampled at the stack and included in the model to account for the total emissions and dose calculations. With respect to the intervenor's comment that the model underestimates the dose because of the use of the wrong dispersion factor, CNSC staff stated that the dispersion factor used in calculations had been validated through extensive work performed all of the CANDU facilities in Canada, and that model validation has shown that the monitored contaminants' concentrations are approximately 50 percent lower than the values obtained by the model.

152. Some intervenors expressed the view that the derived release limits (DRL) were unrealistically high, and did not offer an adequate level of protection to members of the public. The Commission asked CNSC staff to explain the rationale for the appropriateness of the established values for the DRL. CNSC staff explained that the DRLs were commensurate with the annual public dose limit of 1 mSv/y and that, while they are intended to demonstrate compliance with the *Radiation Protection Regulations*[15], they are not intended to control emissions. CNSC staff stated that there are other mechanisms for controlling emissions for them to remain below the DRL, such as action levels and internal administrative levels that operators set below the action levels, and noted that it was planning to review how emission limits and effluent discharge limits are set. CNSC staff added that Environment and Climate Change Canada was involved in the development of the regulations and that recommendations were expected to be formulated and presented to the Commission in 2016. CNSC staff reiterated that, over the current licence period, OPG had not exceeded any action levels, which are set at 10 percent of the DRL.

153. Dr. Greening also expressed a concern regarding alpha emissions and criticized OPG's assessment of the risk of alpha radiation, referring to the alpha-contamination incident in Bruce NGS Unit 1 in 2009. An OPG representative explained that the intervenor's comparison between the Bruce NGS unit and the Darlington NGS was not correct, and stressed that the operating history of these two power plants was very different. The OPG representative added that the data presented in the intervention were out of date, and that, since the incident at the Bruce NGS, monitoring and surveying of alpha radiation at the Darlington NGS had improved and had been conducted routinely, and that the results have been archived in a database. CNSC staff confirmed OPG's explanation and stated that they inspected OPG's radiological hazard control program in September 2015 and found that OPG was in compliance with regulatory requirements.

154. Several intervenors expressed concerns regarding an increase in cancer incidence in the population since 1950, and attributed this increase to the use of nuclear energy. The Commission asked CNSC staff to comment on this statement. CNSC staff and a CNSC consultant, Dr. Demeter, responded that the increase in cancer incidence was due to the increasing age of the population. They explained that the current lifetime incidence of cancer is about 46-47 percent and has remained relatively constant when age-corrected.

[15] S.O.R./2000-203.

CNSC staff also pointed out that the cancer fatality rate has declined over time due to interventions and therapies.

3.7.6 Conclusion on Radiation Protection

155. The Commission is of the opinion that, given the mitigation measures and safety programs that are in place or will be in place to control radiation hazards, OPG has provided, and will continue to provide, adequate protection to the health and safety of persons and the environment. The Commission is satisfied with the measures taken by OPG to minimize the exposure of workers as well as that of members of the public, and notes that the doses received by workers and estimated doses to members of the public are well below regulatory limits. The Commission is satisfied with the explanation provided by CNSC staff regarding the potential health impact of the doses received by members of the public.

3.8 Conventional Health and Safety

156. Conventional health and safety covers the implementation of a program to manage workplace safety hazards. This program is mandatory for all employers and employees in order to reduce the risks associated with conventional (non-radiological) hazards in the workplace. This program includes compliance with Part II of the *Canada Labour Code*[16] and conventional safety training. CNSC staff had reviewed OPG's performance in this area, focussing on performance, practice and awareness. CNSC staff rated OPG's performance for this SCA as fully satisfactory for the 2008 - 2013 period, and as satisfactory for 2014.

157. OPG informed the Commission that, in 2014, it had moved to a centre-led single OPG Health and Safety Management System (HSMS). OPG explained that the best practices adopted in the new HSMS included the formalization of the full Safe Work Planning Process to encompass worker understanding of assigned work activities, identified hazards, safe work expectations and mitigating efforts. OPG noted that its first independent third-party audit of the corporate-wide HSMS was scheduled for 2015 and that the findings would be reviewed and incorporated into the continuous improvement of OPG's HSMS. OPG added that it had been awarded the Canadian Electricity Association President's Bronze Award for Safety Excellence in 2013 and had also been recognized for its safety performance in 2011 and 2012. OPG further informed the Commission that the Darlington NGS injury rate was lower than the target since 2010, and that the site had reached 4 million hours without a lost-time injury. OPG also informed the Commission about its successful "slips, trips and falls" initiative, and stated that it had launched its Total Health Initiative in 2014 to provide resources and information to support OPG employees and their families in achieving an optimal level of physical and mental health and well-being.

[16] R.S.C., 1985, c. L-2

158. CNSC staff submitted that OPG has a highly effective health and safety program that provides safe work practices and a high level of personnel safety at the Darlington NGS. CNSC staff added that OPG's conventional health and safety program is regulated by the Ontario *Occupational Health and Safety Act*[17] (OHSA) and *Labour Relations Act*[18], as a result of the fact that the federal legislation governing these issues has incorporated provincial law. CNSC staff assessed OPG's reports on accident severity and frequency rates at the Darlington NGS since 2008, and determined that they were extremely low when compared with other Ontario workplaces. CNSC staff added that all performance indicators for the conventional health and safety SCA are reported annually to the Commission as part of the Regulatory Oversight Report. CNSC staff also added that the CNSC has a Memorandum of Understanding (MOU) with the Ontario Ministry of Labour (MOL) to cooperate and exchange information and technical expertise related to occupational health and safety practices at nuclear facilities.

159. The Commission noticed that OPG's rating for this SCA had regressed from fully satisfactory to satisfactory and asked for the reasons leading to such outcome. The OPG representative responded that the lower rating stemmed from an inconsistency in tagging scaffolds used across the plant to access equipment for maintenance, inspection and repairs. The OPG representative added that OPG had taken actions to improve the scaffold tagging process in all OPG stations. CNSC staff clarified that the issue had been deemed important since numerous CNSC inspections had observed that OPG had had a sustained failure to comply with its own scaffolding program procedures. CNSC staff noted that it had reviewed all of the corrective actions taken to address the identified issue and was satisfied with OPG's response.

160. Based on the information presented, the Commission is of the opinion that the conventional health and safety of workers was adequately protected during the operation of the facility for the current licence period, and that the health and safety of persons will also be adequately protected during the continued operation of the facility.

3.9 Environmental Protection

161. Environmental protection covers OPG's programs that identify, control and monitor all releases of radioactive and hazardous substances, and which seek to minimize the effects on the environment that may result from the licensed activities. Environmental protection includes effluent and emissions control, environmental monitoring and estimated doses to the public, fish impingement and entrainment, and thermal emissions.

162. OPG stated that it has an Environmental Management System (EMS) in accordance with CNSC regulatory document REGDOC-2.9.1, *Environmental Protection Policies, Programs and Procedures*, and that it is registered to the ISO 14001: 2004 Standard,

[17] R.S.O. 1990, c. O.1.
[18] 1995, SO 1995, c. 1, Sched. A.

Environmental Management Systems –Requirements with Guidance for Use. CNSC staff noted that, while registration under this standard is not required by the CNSC, the registration indicated the recognition of the OPG's EMS by a third party. CNSC staff stated that OPG's EMS and its supporting governing documents establish the provision of the protection of the environment at the Darlington NGS and continual improvement of environmental performance as required by REGDOC-2.9.1.

163. CNSC staff reported that, based on its assessments of OPG's licence application, supporting documentation and past performance, the implementation of OPG's environmental protection program at the Darlington NGS continues to meet regulatory requirements.

3.9.1 Effluent and Emissions Control

164. OPG stated that it controls and monitors radioactive and hazardous substances, identifies and monitors discharge pathways for releases to the environment, and maintains releases below regulatory limits and action levels (10 percent of the regulatory limits). OPG noted that it implements and maintains an effluent monitoring program at the Darlington NGS, as required by the *Class I Nuclear Facilities Regulations*[19].

165. OPG submitted that all radioactive emissions to air and water during the licensing period were less than 0.5 percent of station DRLs, established in accordance with CSA standard N288.1-08, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities*. OPG further submitted that it has consistently maintained the annual public dose resulting from station operations at a level that is equivalent to 0.1 percent of the regulatory dose limit of 1 mSv/y, and less than 0.1 percent of the estimated annual average background radiation dose around the Darlington NGS.

166. CNSC staff reported that OPG's emission control programs are well-developed and in compliance with regulatory requirements. CNSC staff noted that OPG adequately addressed areas for improvement identified by CNSC staff during the current licence period.

167. Several intervenors, including individuals, the Mohawks of the Bay of Quinte, Citizens for a Safe Environment and the Committee for Safe Sewage, expressed concerns relating to tritium emissions to Lake Ontario. Several intervenors expressed the view that the Ontario drinking water standard tritium limit of 7,000 Bq/L was too high, and noted that the Ontario Drinking Water Advisory Council had recommended a tritium limit of 20 Bq/L. CNSC staff stated that tritium in drinking water in Ontario did not represent a health risk. CNSC staff explained that 7,000 Bq/L was equivalent to an annual dose of 0.1 mSv/y, which is 10 percent of the annual public dose limit. CNSC staff further stated that the actual measured tritium concentrations in local municipal

[19] SOR/200 -204.

drinking water plants were in the range of 5 to 8 Bq/L, well below 7,000 Bq/L.

168. Several intervenors expressed concerns regarding the efficiency of the Darlington Tritium Removal Facility. The Commission sought more information related to the management of tritium. The OPG representative explained that tritium is produced in CANDU reactors in both the primary heat transfer and the moderator systems and provided a summary of the removal process. The OPG representative noted that the Darlington Tritium Removal Facility provides detritiation services for the entire Ontario reactor fleet. CNSC staff added that, from a regulatory standpoint, OPG is held to the derived release limit, and that the Darlington NGS consistently performs at about 0.01 percent of that limit.

3.9.2 Environmental Monitoring

169. OPG submitted that it maintains its Environmental Monitoring Program in accordance with the requirements of CSA standard N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*, and noted that it was in the process of updating its Environmental Emissions Monitoring Program to be consistent with the requirements of CSA standard N288.5-11, *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*. CNSC staff stated that OPG's commitment to implement CSA N288.5-11 by December 2015 was acceptable. The Commission is satisfied that OPG meets the requirements of CSA N288.4-10 and accepts the committed timeline for the implementation of CSA N288.5-11.

170. CNSC staff stated that its Independent Environmental Monitoring Program (IEMP) verifies that the public and environment around CNSC-regulated nuclear facilities are not adversely affected by releases to the environment. CNSC staff noted that the IEMP confirmed that the public and the environment in the vicinity of the Darlington NGS are protected from the emissions from the facility.

171. Several intervenors, including the Mohawks of the Bay of Quinte and Lake Ontario Waterkeeper, stressed the importance of protecting Lake Ontario. Lake Ontario Waterkeeper recommended that the Commission require OPG to develop and implement a regular stormwater monitoring regime. The Commission requested additional information concerning stormwater monitoring. A representative from OPG responded that stormwater monitoring is regulated under Ontario environmental regulations and stated that OPG complies with those requirements. CNSC staff stated that OPG was required to provide a detailed stormwater sampling plan as part of its EA follow-up monitoring program for the Darlington Refurbishment Screening EA, and noted that this program would be put in place to confirm the predictions of the EA. A representative from Environment and Climate Change Canada concurred with CNSC staff, noting that Environment and Climate Change Canada had recommended that there be more frequent stormwater monitoring.

172. The Commission asked for more information concerning stormwater management. CNSC staff responded that the best way to control stormwater quality is to have best management practices on site, such as minimizing the use of road salt and having spill response programs. An OPG representative noted that OPG has stormwater management ponds for areas on the Darlington NGS site, including parking areas. CNSC staff stated that it was satisfied with OPG's stormwater management on site, and noted that OPG would be required to implement additional mitigation measures if the EA follow-up monitoring program were to demonstrate that the EA predictions were not being met.

173. Lake Ontario Waterkeeper also recommended that OPG be required to take corrective actions to ensure that on-site and near-site water bodies, such as Coot's Pond on the Darlington NGS site, meet provincial water quality objectives. A representative from OPG explained that Coot's Pond is a settling pond for the landfill that was created when the Darlington NGS site was initially excavated and stated that OPG analyzes its water quality on a quarterly basis and reports annually to the Ontario Ministry of Environment and Climate Change. The OPG representative noted that the results have met Ministry requirements and have been consistently stable. The OPG representative further noted that settling ponds are not required to meet provincial surface water quality objectives. CNSC staff concurred with OPG's statement that surface water quality objectives are intended for natural surface waters and not stormwater management ponds. CNSC staff noted that surface water quality objectives are to be used as a screening tool to determine if further risk assessments are required.

174. The Commission asked CNSC staff for its views on the feasibility of monitoring conventional contaminants as part of its IEMP. CNSC staff responded that, while its analyses had been focused on radionuclides, it would be possible for CNSC staff to take samples and analyze them for other contaminants.

175. One intervenor expressed specific concerns relating to zebra mussels and the measures required to manage them, including the use of sodium hypochlorite. The intervenor suggested that these measures were contributing to increased algae in Lake Ontario. A representative from OPG responded that, while OPG uses chlorination to manage the zebra mussels, the water is dechlorinated before it is discharged to the lake. The OPG representative explained that the increase in algae was due to zebra mussels clarifying the lake, which allows light to penetrate deeper into the lake. The OPG representative further explained how OPG manages the algae through intake filters. CNSC staff commented that it had reviewed OPG's chlorination practices, which are also regulated by the Ontario Ministry of Environment and Climate Change, and noted that no issues were identified.

176. OPG highlighted that, in 2014, it performed supplementary studies focused on total residual chlorine concentrations and morpholine concentrations in Lake Ontario to confirm and/or clarify environmental risk assessment predictions. OPG stated that the results of both studies indicated that none of the lake water samples approached the conservative benchmarks established for all receptors; therefore, no ecological effects

were expected from the low emission rates associated with ongoing plant operations.

177. OPG stated that it has an established groundwater monitoring program designed to ensure that there are no adverse off-site impacts from contaminants in groundwater. OPG noted that there is minimal groundwater contamination around the Darlington NGS site.

178. OPG noted that its water supply was upgraded to be fully connected and in service from both the east (Bowmanville) and the west (Oshawa). OPG explained that the new sewer system is connected to the Courtice Water Pollution Control Plant, allowing OPG to disconnect and dismantle the Darlington Sewage Treatment Plant.

3.9.3 Spill Management and Response

179. OPG stated that it has extensive and effective programs to manage the risk of spills to the environment, focussing primarily on prevention. OPG noted that it had improved its spill management performance over the past five years, with no significant spills. Regarding a 2009 tritium spill, OPG stated that no measurable change in drinking water quality was measured in Lake Ontario or at the nearest drinking water supply plant. OPG noted that it had two minor spills in 2014 that were reported to regulatory authorities; however, neither of the spills resulted in a measurable effect on the environment. OPG also described its liquid emergency response protocol in case of an abnormal waterborne tritium release.

180. The Mohawks of the Bay of Quinte, in its intervention, noted the importance of spill prevention and mitigation, and expressed that they would like to be notified of major spills at the Darlington NGS site. The Commission enquired about OPG's approach to this matter. A representative from OPG responded that OPG was working to build its relationship with the Mohawks of the Bay of Quinte and noted that this would include such communications.

3.9.4 Fish Impingement and Entrainment, and Thermal Emissions

181. The Commission heard submissions regarding fish impingement, entrainment and thermal emissions associated with the cooling water system for the Darlington NGS. Some intervenors, particularly Lake Ontario Waterkeeper, expressed concerns regarding the number of fish killed by this system. OPG stated that its once-through cooling water system intake and discharge systems are located near the lake bottom in order to minimize impingement and entrainment of fish. OPG explained that the Darlington NGS's design includes a diffuser-type discharge duct to dissipate water from the station, thus reducing the impact of thermal emissions on Lake Ontario.

182. CNSC staff noted that the EA on the Refurbishment and Continued Operation of the Darlington NGS determined that the once-through cooling water system at the

Darlington NGS results in relatively low estimated losses of fish from impingement and entrainment, and that the residual adverse effect was minor in nature and not significant. During the EA process, OPG committed to applying for an authorization under the *Fisheries Act*[20] for the ongoing fish loss. CNSC staff reported that, on June 24, 2015, the Minister of Fisheries and Oceans Canada (DFO) issued a paragraph 35(2)(*b*) *Fisheries Act* authorization to OPG for the authorization to continue activities that result in serious harm to fish, arising from the continual intake of cooling water and the impingement and entrainment of fish from Lake Ontario[21]. CNSC staff further noted that the authorization, which is valid from its date of issuance until December 31, 2027, included compliance conditions with respect to mitigation and offsetting measures and standards, monitoring and reporting.

183. OPG stated that it was implementing the elements of the Darlington Refurbishment Screening EA follow-up monitoring program consistent with the appropriate timeframes accepted by the CNSC and committed to in the IIP. OPG further stated that it implemented a habitat restoration project to address requirements established by DFO to address the potential ongoing effects of continued operations of the Darlington NGS. OPG explained that it undertook the restoration of aquatic habitat in the Big Island Wetland, managed by the Quinte Conservation Authority, and that monitoring in 2014 demonstrated that the improvements to the aquatic habitat produced more fish annually than are potentially affected by the ongoing operation of the Darlington NGS.

184. Lake Ontario Waterkeeper expressed the view that past impingement and entrainment data may not be predictive of future trends. Lake Ontario Waterkeeper also expressed the view that OPG had not been complying with, and would not be able to comply with, the terms of its *Fisheries Act* authorization, particularly with respect to the amount of fish impinged and entrained, and to the effects on aquatic species at risk.

185. The Commission sought clarification concerning the effects of the operation of the Darlington NGS on fish. CNSC staff stated that it had determined that the operation of the Darlington NGS ensured the protection of the environment under the NSCA and did not result in significant adverse environmental effects, taking into consideration mitigation measures under the *Canadian Environmental Assessment Act*[22] (CEAA 2012), in that it did not result in population-level effects to aquatic biota. CNSC staff explained, however, that a *Fisheries Act* authorization from DFO was required to address the residual fish loss, which constitutes serious harm as defined in the *Fisheries Act*. CNSC staff noted that the CNSC and DFO have an MOU affirming the role of the CNSC in compliance monitoring and verification in relation to the *Fisheries Act* authorization.

186. Regarding the *Fisheries Act* authorization from DFO, a representative from DFO noted that, in 2007, DFO came out with a position statement specifying that it would work with existing facilities that were not compliant with the *Fisheries Act* in order to bring

[20] R.S.C., 1985, c. F-14.
[21] *Paragraph 35(2)(b) Fisheries Act Authorization*, Fisheries and Oceans Canada, June 24, 2015.
[22] S.C. 2012, c.19, s. 52.

them into compliance when the opportunity arose. The DFO representative explained that, in the case of the Darlington NGS, the Darlington Refurbishment Screening EA represented this opportunity. A DFO representative stated that DFO was satisfied with OPG's application for the authorization and the measures in place to offset fish losses. A representative from OPG explained that the authorization was granted under the understanding that round goby, an invasive species accounting for the largest proportion of fish loss, would not be included in the impingement and entrainment amounts. The OPG representative added that OPG was maintaining and enhancing the habitat bank in the Bay of Quinte as an offset for any residual effects from its operations.

187. Lake Ontario Waterkeeper expressed the view that the *Fisheries Act* authorization was not sufficiently clear regarding the conditions of the authorization, such as the exclusion of round goby. A representative from DFO explained that the text of the authorization does not contain all of the terms and limits of the authorization that are provided for in the application, and confirmed that round goby was not included.

188. Lake Ontario Waterkeeper recommended that the Commission require OPG to develop and implement a robust impingement and entrainment monitoring program. The OPG representative stated that OPG considered the authorization and the IIP to be sufficient to address the concerns raised by intervenors. Representatives from DFO concurred with OPG, stating that DFO was satisfied with OPG's proposed monitoring.

189. The Commission asked representatives from the Environment and Climate Change Canada (ECC) to address thermal effects. A representative from ECC noted that they had no concerns regarding thermal effects from the Darlington NGS, referring to the review that ECC had conducted as part of the Darlington Refurbishment Screening EA. ECC further stated that, as part of the EA follow-up monitoring program, it was working with CNSC and OPG on programs elements such as the Thermal Monitoring Program and an Effluent Characterization Program.

190. OPG stated that it continues to participate in the Round Whitefish Action Plan with the CNSC, Natural Resources Canada, DFO and E. OPG further stated that, as part of this effort, OPG has confirmed to federal and provincial agencies that thermal emissions from the Darlington NGS are a low risk to Round Whitefish eggs and larvae and that no further mitigation or offsetting measures are warranted going forward. OPG noted that, under the leadership of the Ontario Ministry of Natural Resources and Forestry, it continues to participate in an ongoing meta-population study of Round Whitefish to better understand the population dynamics of this species in Lake Ontario.

3.9.5 Conclusion on Environmental Protection

191. Based on its evaluation of the application and the information provided at the hearing regarding environmental protection, the Commission is satisfied that, given the mitigation measures and safety programs that are in place to control environmental

hazards, OPG will provide adequate protection to the health and safety of persons and the environment. The Commission is satisfied that environmental releases are significantly below regulatory limits and is of the view that they will continue to remain low during the next licence period.

192. The Commission appreciates the intervenors' concerns regarding surface water quality and notes that the EA follow-up monitoring program includes stormwater monitoring. The Commission directs CNSC staff to work with ECC to include non-radiological contaminants in the IEMP for surface water.

193. With respect to the *Fisheries Act* authorization, the Commission is satisfied that OPG has fulfilled its commitment to apply for and be in compliance with the DFO authorization. Recognizing that both the CNSC and DFO have a statutory mandate related to the protection of the aquatic environment, the Commission notes that it is not the role of the CNSC to enforce the *Fisheries Act*. Under the Memorandum of Understanding with DFO, CNSC staff will, in its regulatory activities, verify OPG's compliance with the *Fisheries Act* authorization and share information with DFO. As such, the Commission requests that CNSC staff inform the Commission of any non-compliance with the *Fisheries Act* authorization. While it is not the role of the Commission to evaluate how DFO administers the *Fisheries Act*, based on the comments received from intervenors, the Commission suggests that DFO look at the content of *Fisheries Act* authorizations so that the terms of such authorizations are clear to members of the public.

194. The Commission requests that CNSC staff provide an update on the setting of emission limits and effluent discharge limits as part of CNSC staff's regular reporting to the Commission.

3.10 Emergency Management and Fire Protection

195. Emergency Management and Fire Protection cover OPG's measures for preparedness and response capabilities which exist for emergencies and for non-routine conditions at the Darlington NGS. This includes conventional emergency preparedness and response, nuclear emergency management, and fire protection and response. CNSC staff rated OPG's performance for this SCA as fully satisfactory for the 2008 and 2009, and as satisfactory for the period 2010-2014. This section also includes information relating to the *Study of Consequences of a Hypothetical Severe Nuclear Accident and Effectiveness of Mitigation Measures* (SARP study).

196. CNSC staff informed the Commission that OPG had conducted a number of initiatives including the following:

- in response to the Fukushima event, OPG has acquired portable EME and infrastructure to ensure water and power can be supplied in an emergency situation;
- participation in a major exercise (Exercise Unified Response or ExUR) which

was completed in May 2014;
- support for acquisition and installation of public alerting equipment;
- distribution of potassium iodide (KI) pills; and
- installation of an automated near boundary gamma monitoring system.

3.10.1 Conventional Emergency Preparedness and Response

197. CNSC staff reported that the Darlington NGS emergency response personnel are available on site 24 hours per day to respond to any type of emergency. CNSC staff noted that OPG personnel are trained and equipped for medical response, hazardous materials and other conventional hazards that may be present.

198. The Commission asked about plans related to a public alerting initiative. A representative from the Office of the Fire Marshal and Emergency Management (OFMEM) responded that the system would be similar to a system currently used in the United States and that messages would be sent to cellular phones within a specific geographic area. The OPG representative added that OPG was working with multiple agencies on this initiative and that the public alerting system would be used for nuclear events as well as a wide range of emergency conditions.

3.10.2 Nuclear Emergency Preparedness and Response

199. Nuclear emergency preparedness was a key topic of discussion in this hearing, with concerns being raised by many intervenors. The Commission heard submissions throughout the hearing on this matter, notably on the distribution of KI pills and on the response to worst case scenarios in the event of a severe accident.

200. OPG informed the Commission that OPG's Nuclear Emergency Preparedness program is documented in its Consolidated Nuclear Emergency Plan (CNEP), which serves as the basis for site-specific nuclear emergency preparedness and response arrangements at OPG's NGSs. OPG explained that this plan provides a framework for interaction with external authorities and defines OPG`s commitments under the Provincial Nuclear Emergency Response Plan (PNERP). OPG also presented a schematic of interactions between the Darlington NGS and local, provincial and federal emergency response agencies. OPG stated that the Darlington NGS maintains an extensive Emergency Preparedness drill and exercise program that validates emergency plans and procedures, and provides OPG's Emergency Response Organization the opportunity to improve and sustain its emergency response capability. OPG further described the results and lessons learned from ExUR.

201. OPG also informed the Commission about the its readiness to respond to a BDBA, notingthat EME is available, BDBA emergency procedures are in place and that its staff is trained for BDBAs at both the Darlington NGS and the Pickering NGS sites. OPG further informed the Commission that the public alerting system used to alert and

inform the public under the PNERP includes sirens, media broadcasts and a telephone dialing system. OPG explained other aspects of the program, including the OPG Monitoring and Decontamination Unit, evacuation and reception centres, equipment needed for an emergency response, and public information materials.

202. CNSC staff informed the Commission about its review of the facility equipment upgrades and about an emergency preparedness inspection conducted at the Darlington NGS in 2014. CNSC staff confirmed that OPG performed satisfactorily according to regulatory requirements. CNSC staff reported that it had witnessed emergency response and EME deployment during an August 2013 exercise and during ExUR in 2014.

203. Some intervenors suggested that the Government of Canada should consider inviting an international peer review mission for emergency preparedness and response. CNSC staff noted that Health Canada was coordinating Canada's request for an IAEA Emergency Preparedness Review Service mission. CNSC staff added that an IAEA Integrated Regulatory Review Service mission took place in 2009, with a follow-up mission in 2011; the 2011 mission evaluated CNSC's Fukushima response and the emergency program.

Study of Consequences of a Hypothetical Severe Nuclear Accident and Effectiveness of Mitigation Measures

204. CNSC staff updated the Commission on the SARP study, a study of the consequences of a hypothetical severe nuclear accident that examined the potential health effects of larger radiological releases. CNSC staff reported that the SARP study, which was published on the CNSC website, concluded that, in the unlikely event of a radioactive release, there would be no detectable increase in the risk of cancer for most of the population, with the exception of an increase in childhood thyroid cancer risk. CNSC staff reminded hearing participants that the SARP study had been conducted to assess the consequences and possible preventative mitigation of a hypothetical severe nuclear accident in Canada, and that the study addressed concerns raised during public hearings in December 2012 on the EA for the Darlington NGS refurbishment project. CNSC staff noted that some of the severe accident scenarios predicted doses comparable to actual doses measured at Fukushima.

205. Several intervenors, including Greenpeace, the Canadian Coalition for Nuclear Responsibility, the Canadian Environmental Law Association (CELA) and Dr. Nijhawan, expressed concerns regarding the adequacy of the postulated parameters and the level of environmental impact used in the SARP study modelling and suggested that a more severe accident scenario, in line with an International Nuclear Events Scale (INES) Level 7 event, should have been studied. According to these intervenors, the study did not accurately simulate an event of a scale similar to that of the Fukushima event with respect to the outcome and level of releases to the environment and did not provide the quantity and quality of data that would be required for OPG to make an

adequate decision on its severe accidents emergency planning and management. CNSC staff provided a brief review of the study and noted that it had followed the directions of the Commission to examine more severe accident scenarios and the environmental and human health consequences. CNSC staff noted that it had presented preliminary results of the study to the Commission and received feedback from the Commission, the provincial and federal governments, non-government organizations and other stakeholders prior to completing the study. Several intervenors suggested that the study should have tried to emulate the radiological releases after the Fukushima event. CNSC staff explained that, in order to most adequately represent the impact on human health and on non-human biota, the SARP study focused on effective doses received by the exposed population, which were similar to those associated with the Fukushima event. CNSC staff considered the approach taken to be more appropriate for the purpose of the study, given the evident differences between the Fukushima event and credible severe accident scenarios at Canadian NGSs, including different reactor types, different construction and configuration of IFBs, the location of the NGSs, and the geographical and meteorological features surrounding the NGSs.

206. CNSC staff further explained that, to respond to concerns regarding a potential multiple unit event, it multiplied the source term by four to reflect the number of reactors at the Darlington NGS. To address comments about the timing of the release, CNSC staff used a hold-up period of 24 hours, which was similar to the hold-up period for the Fukushima event. Furthermore, to address concerns about human health, CNSC staff included a detailed human health risk assessment in alignment with the international best practices that were used after the Fukushima event; these results were peer-reviewed by an international third-party expert. The obtained results indicated that there were no detectable increases in cancers, with the exception of the childhood thyroid cancer. CNSC staff reiterated that the doses obtained in the SARP study were comparable to those measured at Fukushima, which was a INES Level 7 accident. CNSC staff stated that, based on the feedback from members of the public and non-government organizations, they had requested that two authors of the portion of a United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) report[23] review and compare the doses and exposures from the SARP report to the doses from the Fukushima accident. In comparing the conducted study with the doses estimated or measured during the Fukushima event, CNSC staff stated that, in some cases, the doses used in the SARP report were considerably higher than the doses measured at Fukushima. In the SARP study, the highest dose to the adult thyroid was 5,470 millisieverts (mSv); comparatively, the highest dose to a child's thyroid measured at Fukushima was 507 mSv.

207. The two above-mentioned authors of the UNSCEAR report, Dr. S. Solomon and Dr. G. Hirth of the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), who reviewed CNSC staff's study and submitted their opinion, were also invited to participate in the public hearing. In a letter submitted on November 4, 2015, Dr. S. Solomon stated that the event modelled in the SARP study was of a theoretical

[23] UNSCEAR 2013 Report to the General Assembly with Scientific Annexes: *SOURCES, EFFECTS AND RISKS OF IONIZING RADIATION*, UNITED NATIONS New York, 2014.

nature and used hypothetical severe accident scenarios with a number of conservative assumptions. The authors also expressed the opinion that the scenario under which the accident progresses for 24 hours before a short one-hour release to the atmosphere, the so-called generic large release scenario GLR24-01, was the most conservative of the scenarios in the SARP study and the most amenable to comparison with one particular release event during the Fukushima accident.

208. Dr. Solomon provided more details about their assessment of the SARP study and stated that the 24-01 scenario was a good representation of what had occurred during the Fukushima event on one particular day. Dr. Solomon stated that the 24-01 scenario provided estimates of doses that were similar to those in the UNSCEAR report, and that it would be appropriate to consider that particular model in setting up emergency planning zones and implementing emergency planning arrangements.

209. The Commission noted the concern expressed by many intervenors that the releases simulated in the study were not the same as those in the Fukushima event and asked for further information on this matter. Dr. Solomon responded that it was important to understand the doses received by particular groups; effective doses are compared to criteria for evacuation and sheltering and thyroid doses are compared to criteria for iodine prophylaxis. Dr. Solomon explained that, where the source term is important for driving the model and the modeling is important for determining the doses, it is the doses that affect emergency planning and preparedness, in particular for protective measures.

210. CELA, Greenpeace, Durham Nuclear Awareness and Northwatch submitted their comments and observations on the letter filed by Dr. Solomon and stated that Dr. Solomon's submission in no way addressed the concerns raised by their organizations regarding the SARP study. Consequently, these organizations remained of the opinion that a proper study on the consequences of a severe release following an accident at the Darlington NGS was still lacking and that the Commission did not have sufficient information to satisfy itself that the public and the environment would be adequately protected from radioactive exposures.

211. Several intervenors claimed that an inadequate source term had been used to assess the impact of a potential severe accident and the hazard of multi-unit accidents was misrepresented. Intervenors further expressed concerns regarding the transparency of the CNSC with respect to scoping the releases to be assessed in the SARP study and implied that certain scenarios had been suppressed and not considered in the study. They stated that the Release Category 1, which is a multi-unit sequence of events, is 20 times larger than the SARP study release and much larger than the postulated CNSC multi-unit scenario. The Commission gave CNSC staff the opportunity to clarify these issues. CNSC staff denied any attempt to suppress information and explained that all established accident scenarios were the results of an extensive internal debate that had resulted in a choice of the most credible events being included in the SARP study and used for modelling. CNSC staff explained that, during the debate and before the selection, all draft documents had been discussed and all scenarios were challenged.

Such debates, where elements and indicators had been examined, were encouraged within the CNSC in order to ensure a comprehensive approach and transparency, both internally and externally. CNSC staff noted that it was this transparency that allowed intervenors to gain insight into the CNSC internal discussions.

212. With respect to the implied inadequacy of the source term used in the study, CNSC staff stated that one of the post-Fukushima lessons learned, supported recently by the Japanese authorities and the international community, was that the use of source term modelling during an emergency as an indicator for making evacuation decisions is not appropriate; rather, these decisions should be made based on actual, measured doses during the event. CNSC staff explained that the scenario considered in the SARP study was comparable to an INES Level 7 event. CNSC staff further explained that the INES scale is a communication tool, and should not be used to make regulatory decisions, since a regulator can increase the level of an event based on estimated public safety consequences, regardless of the source term.

213. In his intervention, Dr. Waller of the University of Ontario Institute of Technology pointed out a misunderstanding regarding the use of the INES scale. The intervenor stated that the INES scale was intended to be retrospective and to be applied after an accident is over. During the Fukushima event, its level on the INES scale changed continuously as the event progressed, causing a lot of confusion. In order to rectify some of the misunderstandings with application of the INES scale, the IAEA International Experts' Meeting, IEM 9, held in April 2015, had specifically addressed the issue of how to assess accidents, how to evaluate accident development, and how to apply the INES scale after an event has concluded.

214. The Commission asked CNSC staff to comment on whether the scenarios not included in the final report of the SARP study had been assessed and analyzed. CNSC staff responded that, at the outset of the study, more scenarios had been assessed. However, CNSC staff reiterated that the SARP study had been initiated shortly after the EA for the proposed refurbishment of the Darlington NGS was completed and the decision to start with a large source term, reflective of a more severe accident than what was assessed in the EA, was made. CNSC staff noted that accident progression and release category for the scenario were based on the large release safety goal rather than PSA values. To achieve that, the radionuclides in the source term were scaled to the estimated cesium values, and the source term was multiplied by 10. CNSC staff explained that, after examining different scenarios and the feedback that had followed the presentation of preliminary results, it had been decided that there was no scientific basis for the multiplication of the source term by 10, other than a desire to represent a large-scale accident, and that it would be more appropriate to continue and carry forward the assessment with a factor of four, which would be more reflective of a four-unit accident. To illustrate the specific value for the source term available and the possible releases from CANDU reactors, CNSC staff explained that Release Category 1, as well as all other release categories (RCs), had been assessed as part of the PSA; to provide a stronger test at the fifth level of defence-in-depth with respect to the emergency response capability and preparedness. The obtained values were very low

for all RCs (RC1 to RC8) and RC1 had a probability of occurrence of $5x10^{-7}$. CNSC staff reminded the Commission that the EA considered events with frequencies of occurrence that were more frequent than once in a million years ($1x10^{-6}$). CNSC staff also stressed that the SARP study included the source term, the source term multiplied by four and the average doses before implementation of emergency mitigation measures, such as evacuation, sheltering and the distribution of KI pills. The study also presented the doses expected after emergency response actions and protective actions, and it assessed the consequences, such as cancer risk.

215. The Commission's enquired about the intervenors' suggestion that the study had been based mostly on PSA and that this kind of assessment needs to move away from a simple probabilistic approach. CNSC staff responded that some points raised by the intervenors stem from the results of the EA, which was not done to represent the current state of the plant and its vulnerabilities, but rather to represent the state of the plant after refurbishment and the implementation of significant improvements to safety. CNSC staff noted that PSA was regarded by CNSC staff, among other methods of analyses, as a powerful tool used to identify areas of potential improvements in all levels of defence.

216. The Commission sought comparative information about measures taken by other countries to address severe accidents. CNSC staff responded that they had examined the measures taken in Switzerland and Germany, which were cited by the intervenors as positive approaches to addressing potential consequences of a severe accident, as well as the measures taken in the United States and other countries. CNSC staff reported that a Swiss study considered the existing planning basis in Switzerland and examined the dose consequences and the probabilities for scenarios one, two and three orders of magnitude larger than the existing Swiss planning basis. The result of this action was a small change made to the Swiss study's planning basis, which had been adjusted to recognize that longer releases could occur, and the originally assumed two-hour release had been revised to consider a prolonged 48-hour release. CNSC staff explained that, following this planning basis adjustment, the Swiss concept of operations remained unchanged with one exception where, instead of pre-stocking KI pills to 50 kilometres (km), a decision had been made to pre-distribute the KI pills to 50 km. CNSC staff summarized that the Swiss authorities had looked at various extreme scenarios, but had not used those extreme scenarios for emergency planning. CNSC staff added that no other countries had used these extreme scenarios to make emergency planning decisions. CNSC staff further reported that, based on its experiences during the Fukushima event, Japan had revised its emergency planning arrangements and had implemented a 5-km emergency planning zone for evacuation and a 30-km zone for sheltering.

Emergency Planning and Exercises

217. CNSC staff informed the Commission that it had assessed OPG's Emergency Plan and Preparedness Program, as well as the results of simulated emergency exercises. CNSC

staff reported that all components of the OPG's CNEP, other supporting programs and plans, as well as the results of all emergency exercises, meet regulatory requirements and expectations contained in CNSC regulatory document RD-353, *Testing the Implementation of Emergency Measures* and CNSC regulatory guide G-225, *Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills*. CNSC staff further reported that ExUR, the major national and multi-jurisdictional exercise conducted in 2014, demonstrated a number of best practices and identified opportunities for improvement for nuclear emergency response. An update on the ExUR was presented to the Commission at the Commission meeting held on November 5, 2014.

218. The Green Party of Ontario, in its intervention, suggested that OPG was not in compliance with emergency planning requirements. The Commission asked OPG and CNSC staff to comment on this statement. The OPG representative responded that OPG had met all of the fundamental elements of the new REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response*, and noted that only the implementation of minor items, that did not affect OPG's ability to manage emergency preparedness, remained to be completed. CNSC staff stated that the term "non-compliance" had been used inaccurately and confirmed that OPG was in compliance with its licensing requirements. CNSC staff noted that it had accepted OPG's plan to develop program updates based on a gap analysis regarding the new requirements in REGDOC-2.10.1. CNSC staff further specified that REGDOC-2.10.1 is specifically directed toward licensees and their on-site preparedness, with two specific aspects related to off-site preparedness: one related to KI pill distribution and the other requiring OPG to provide off-site authorities with the information necessary for their emergency planning. CNSC staff confirmed that OPG was in the process of completing those requirements. CNSC staff emphasized that it would not recommend the renewal of the operating licence for the Darlington NGS if it was not satisfied that OPG was meeting requirements.

219. The Canadian Association of Nuclear Host Communities and the Municipality of Clarington in their interventions, supported the licence renewal and mentioned that Clarington Emergency and Fire Services regularly participate with OPG and the Durham Region in various exercises and drills, evacuation planning, and off-site training at the Wesleyville facility. They informed the Commission that the Municipality of Clarington had recently opened a modern Emergency Operation Centre in Newcastle, demonstrating the commitment by both OPG and the Municipality of Clarington to emergency preparedness and public safety. The Commission asked if the Municipality of Clarington had been involved in emergency preparedness activities and in the evacuation time estimate study. A representative from the Municipality of Clarington responded that it had been part of the process and was involved with the Durham Emergency Management Office and with the local Durham Regional Police Services. These intervenors expressed their satisfaction with the planning, noting that the emergency plan updated in 2014 is all-encompassing for natural emergencies as well as nuclear emergencies, and that the plan would be further updated by the end of 2015.

220. Several other intervenors noted that, during the Fukushima event, hot spots with elevated contamination had been observed as far as 200 km from the Fukushima power plant and expressed concerns about the potential development of similar hot spots in the event of a severe accident that may occur at a Canadian NGS. The Commission asked if hot spot formation had been taken into account in OPG's emergency plans. The OPG representatives responded that meteorological elements that could lead to these hot spots had been taken into account as a potential consequence of severe accidents. CNSC staff confirmed that the potential formation of these hot spots had been taken into account and that arrangements for such situations had been tested during ExUR.

221. The Commission asked if the OFMEM had used the results of the SARP study in reassessing its emergency plans for severe accidents. A representative from the OFMEM responded that the study was helpful in terms of assessing the planning basis for the PNERP.

222. CELA submitted its dissatisfaction that the public had not been consulted regarding the development of provincial planning basis documents for off-site emergency management. The Commission enquired about off-site emergency management and planning. The representative from the OFMEM noted that its daily activities for emergency management include response and consequence management, not only to nuclear but to any one of the 39 hazards that are considered possible in Ontario. The OFMEM representatives informed the Commission about their analyses of the Fukushima accident, including the UNSCEAR and other IAEA reports, as well as the broader impacts of the event on public safety, and noted that the results of these analyses were used to review the planning basis. The OFMEM representative explained that the objective of the planning basis review was to validate the plan against a severe accident related to CANDU reactors[24]. The OFMEM representative added that the OFMEM had started to update the PNERP to include the incorporation of international best practices and in alignment with CSA standard N1600, *General requirements for nuclear emergency management programs*, and noted that a stakeholder review of the updated PNERP was expected in the first quarter of 2016. The OFMEM representative stated that the public would have the opportunity to review and provide comments on those documents, including the planning basis, in the second quarter of 2016. The OFMEM representative added that the decision to conduct public consultation on the updated PNERP was based on a request from Greenpeace, CELA and Durham Nuclear Awareness.

223. The Commission asked for the timeline for the finalization of the PNERP update and the status of updating of the local emergency plans. The OFMEM representatives responded that, after the public review of the documents in the second quarter of 2016, the updated PNERP would be presented to the Government of Ontario, which would then make a decision on OFMEM's recommendations.

[24] The planning basis document was to be presented to the Nuclear Emergency Management Coordinating Committee on December 10, 2015, and to be shared with the CNSC by that date.

224. The Commission asked if the updated planning basis in the PNERP took into account events that are more severe than those encompassed by the SARP study. The OFMEM representatives responded that they were examining all scenarios from the various studies.

225. Many intervenors expressed concerns regarding the efficiency of evacuation plans and expressed the view that the 10-km primary zone was too small. The Commission noted that evaluating off-site emergency planning in the areas surrounding the Darlington NGS is not a responsibility of the CNSC. However, in order to evaluate consequences of a potential accident, the Commission asked for an update on a new transportation study that had been done for this particular region. A representative from the Ontario Ministry of Transportation (MTO) responded that the Office of Emergency Management within the MTO is one of the implementers of the PNERP and is engaged in the development of traffic management plans for each of the areas covered under the PNERP, including the control of traffic movement and evacuation. Based on knowledge of the area and on detailed modelling, the MTO was confident that, in optimal conditions at night, it would be possible to carry out an evacuation of the primary zone in approximately four hours, and that the maximum estimated time during rush-hour would be 11 to 12 hours. The MTO representative further stated that the modelling was also done for an evacuation zone of 20 km and that the estimated time for evacuation of this less populated zone was approximately12 hours. Modelling was also completed using population projections until 2021 and the estimated evacuation times did not significantly change with the planned increase in transportation capacity.

226. Some intervenors had concerns regarding the modernization of public alerting systems. The Commission asked about the possibility of using wireless technology for alerts during an emergency. The OPG representative responded that, along with the sirens and telephone dialling systems, the PNERP includes the use of radio, television and social media. An OPG representative noted that a trial of wireless alerting was planned for 2016.

227. In its intervention, CELA stated that the independent evaluation of ExUR reported that, during the exercise, the CNSC experienced serious delays in obtaining important technical data to support decision-making from OPG. The intervenor stated that the independent evaluator's report included the recommendation to install a direct data feed of plant information and important technical data from NGSs to the CNSC since, during the exercise, the data was telefaxed and a communication disruption had prevented this data transfer. CNSC staff confirmed that the concerns stemming from the report were identified as a weakness, but noted that there had been other ways to obtain information, including continuous communication with CNSC inspectors at the site; as a result, CNSC staff had had all the information needed to fulfill its mandate during the exercise. CNSC staff stated that the CNSC had been working with OPG to establish preliminary systems to allow CNSC staff direct access to plant information. The OFMEM representative added that there were a number of redundant systems for communication with participants in the event.

228. The Commission noted that a majority of interventions included concerns regarding the planning basis for the emergency plan. The Commission suggests that the OFMEM involve members of the public in consultation activities related to the planning basis as early as possible. The OFMEM representative stated that legal considerations are required before it can release the draft planning basis, and added that it would seek opportunities to engage with stakeholders where appropriate and also allow equal access to all stakeholders. CNSC staff expressed its readiness to use public proceedings of the Commission and the Regulatory Oversight Report to address the planning basis for emergency preparedness and planning.

External Agencies

229. The Commission enquired about the involvement of other agencies in off-site emergency planning. CNSC staff responded that Health Canada had consulted with public stakeholders and updated its guidance for emergency response. CNSC staff further stated that the Health Canada guidance document was being finalized for publication and was in line with the new International Commission on Radiation Protection recommendations for emergency response and preparedness and the IAEA framework.

230. The Commission asked about the OFMEM's outreach program. The OFMEM representative responded that its outreach and public education programs are coordinated through regional public education committees that include representatives from the province, municipalities and OPG. These committees are present in Bruce County, Amherstburg, Chalk River, the Regional Municipality of Durham and at OPG. The OFMEM representative added that these committees use different methods to provide information to the public, and that the Regional Municipality of Durham and OPG were working together to customize the information being provided to residents in the Durham region.

231. The Commission sought more information regarding OFMEM's resources involved in nuclear emergency planning, and regarding the level of collaboration and support from OPG and CNSC staff. The OFMEM representative responded that six people from the OFMEM work on nuclear emergency planning with a significant portion of their time dedicated to the planning basis and to the review of the PNERP. The OFMEM representative also spoke about plans to increase its capacity in response to the increasing demands on this issue. CNSC staff stated that the CNSC has sufficient capacity to offer support to the OFMEM on this matter and expect to be involved in the future consultations regarding the planning basis. An OPG representative stated that OPG works closely with the OFMEM and other provincial and municipal agencies and authorities.

Potassium Iodide (KI) Distribution

232. Several intervenors also noted that, after modelling an INES Level 7 accident, Switzerland had arranged for KI pill distribution out to 50 km, and suggested that this was an international best practice. The Commission asked for clarification regarding this statement. CNSC staff confirmed that Switzerland had extended their pre-distribution of KI pills to 50 km, and noted that in Ontario KI pills had been procured and were available for residents of the 50-km secondary zone. CNSC staff noted that pre-distribution to 50 km was not common around the world, and that it was one of the longest distances for pre-distribution.

233. The Commission asked for an update on the distribution of KI pills in the Durham region and other municipalities. The representative from the OFMEM stated that the municipality and OPG were actively engaged in establishing a program that meets the specifications of REGDOC-2.10.1 as well as some of the provincial requirements, and noted that the KI pills Distribution Working Group, assembled in June 2013, has been implementing the program, with completion anticipated by December 2015. The OFMEM representative further stated that KI pills would be distributed by mail and supported by a strong public education campaign that would precede the actual distribution. The OFMEM representative further informed the Commission that the distribution of KI pills in other jurisdictions has been almost completed and that work was being done on the provision of KI pills in secondary zones to those residents who want them, and on stockpiling KI pills for distribution in a larger zone in emergency situations.

234. OPG informed the Commission on the progress in the distribution of KI pills to the public in the vicinity of the Darlington NGS, and noted that, in response to REGDOC-2.10.1, it had completed the pre-distribution of KI pills to all residents, businesses and institutions within the 10-km primary zone. OPG added that KI pills were also available to residents within the secondary zone of 10 to 50 km radius, and that stockpiles of pills were available for distribution by public authorities in an emergency, should it be required.

235. Some intervenors asked for more instructions regarding the use of KI pills. The Commission asked about the actions taken to inform and educate the public on the use of KI pills. An OPG representative responded that OPG works with its partners in emergency preparedness and supports the efforts on education around the emergency plan. The OPG representative added that, as part of the program to distribute KI pills, there was more communication on the purpose of KI pills and how to use them, and noted that this information was also included in the brochure provided with the pills.

Food Contamination

236. The National Farmers Union, Waterloo-Wellington Local expressed concerns regarding the potential contamination of produce during accidents that would require

emergency measures. The Commission sought more information regarding the responsibility to inform farmers about the potential effects of accidents on their activities and the potential contamination of their products. CNSC staff responded that, in case of an emergency, the province has those responsibilities and that the PNERP has specific measures relating to agriculture and food contamination. CNSC staff added that there are specific responsibilities laid out by the provincial and federal food and agriculture agencies that include guidance to farmers and the agriculture industry on how to prepare for and respond to an emergency in order to protect and manage feed, animals, and ingestion control by the population. The OPG representative noted that approximately one half of the members of the Darlington Community Advisory Councils are farmers, and that OPG consults with farmers and other stakeholders from the agricultural sector. The OPG representative added that drills and exercises performed by OPG include the agricultural community.

237. Some intervenors, including individuals, had concerns regarding food contamination and a lack of information on food safety during or after a nuclear emergency. The Commission asked about the food supply in potentially affected areas and plans to inform the public in those areas about food safety. CNSC staff responded that guidance, available from international organizations such as the Food and Agriculture Organization and the World Health Organization, includes levels of contaminants in food that are considered safe. CNSC staff noted that, in an attempt to develop a more uniform way of expressing levels of radioactivity that are considered safe in food, the IAEA's Radiation Safety Standards Committee has compiled various guidance documents. In Canada, the Canadian Food Inspection Agency at the federal level, and Ministry of Agriculture, Food and Rural Affairs at the provincial level, have clearly defined responsibilities and functions under the emergency plans for the provision of advice, guidance and directives related to food and agriculture. CNSC staff added that the CNSC has a crisis website where all of this information is available and would be made available during a nuclear emergency, noting that this information would also be available from provincial authorities.

Sheltering versus Evacuation

238. Several interventions commented on the differences between sheltering (remaining indoors) versus evacuation during a severe accident. The Commission sought clarification on this issue. CNSC staff responded that, based on the lessons learned from the Chernobyl and Fukushima events, decisions on implementing protective actions need to be carefully weighed in terms of the health benefits from protecting people against radiation versus the risks of taking certain protective measures. CNSC staff explained that, in some cases, the health benefits are greater when sheltering at first and allowing more information to become available before evacuating in a more careful manner. CNSC staff noted that, usually, sheltering is a short-term measure and is rarely used on its own; it can reduce the external radiation hazard from gamma and beta radiation, depending on the construction and materials used for buildings. CNSC staff noted that Health Canada was conducting a study to measure the effectiveness of

Canadian homes in shielding radiation.

239. The Commission enquired about guidelines for sheltering and evacuation. CNSC staff responded that Health Canada was updating its guidance on protective action levels and noted that the PNERP includes the dose bands that would be used to aid in decisions regarding evacuation, sheltering and thyroid blocking. The OFMEM representative stated that the OFMEM was using basic guidelines for planning purposes and stressed the importance of taking actions according to real conditions developing during an event rather than relying entirely on the results of modelling; this stems from one of the lessons learned from the Fukushima event. A representative from Health Canada informed the Commission that the Federal Nuclear Emergency Plan had been revised significantly following the Fukushima event and that updates had been fully integrated with the Federal Emergency Response Plan. The Health Canada representative noted that the Federal Nuclear Emergency Plan was tested during the ExUR and best practices were identified. The representative from Health Canada added that, after two rounds of consultations with their partners, Health Canada was in the process of finalizing its guidelines, which include experience from the Fukushima response and the latest international guidance from the International Commission on Radiological Protection and the IAEA.

3.10.3 Fire Emergency Preparedness and Response, and Fire Protection Program

240. OPG informed the Commission about improvements made to its Fire Protection Program during the current licence period and stated that the Darlington NGS FHA, FSSA, and fire protection Code Compliance Review reports had been submitted to the CNSC. OPG stated that the Darlington NGS was in compliance with CSA N293, *Fire protection for CANDU nuclear power plants*, and that OPG has continued its participation in the technical committees of CSA N293 and CSA N393, *Fire protection for facilities that process, Handle, or Store Nuclear Substances*. OPG also informed the Commission about OPG's Fire and Emergency Services training facility.

241. CNSC staff reported that OPG has a fire response program at the Darlington NGS that satisfies regulatory requirements and expectations, and uses firefighting equipment that meets requirements. CNSC staff noted that drills and exercises, including mutual aid exercises with municipal responders, are performed on a regular basis. CNSC staff further reported that fire protection at the Darlington NGS is achieved through the implementation of a comprehensive fire protection program that meets regulatory requirements, and added that there were no reportable events during the licence period. CNSC staff further stated that an independent third-party audit of the fire protection program and annual plant condition inspections did not result in findings that could have an impact on the performance of the fire protection program.

3.10.4 Conclusion on Emergency Management and Fire Protection

242. Based on the above information, the Commission concludes that the fire protection measures and emergency management preparedness programs in place and that will be in place at the Darlington NGS are adequate to protect the health and safety of persons and the environment.

243. The Commission is satisfied that the SARP study has met its objectives. The Commission accepts the clarifications provided by CNSC staff and is satisfied that the approach taken of looking at doses to the workers and public in the event of a severe accident, instead of source term, is protective of the health and the environment, and in line with international norms. The Commission recognizes that it does not have primary jurisdictional authority over off-site emergency planning; however, it is involved in nuclear emergency management and will take all appropriate measures to ensure the health and safety of persons. The Commission is of the opinion that the established emergency zones and pre-distribution and availability of KI pills are adequate in case of a nuclear emergency situation.

244. The Commission is also satisfied that OPG is in compliance with CNSC emergency management requirements, and exhorts all interested parties to work together and collaborate in setting up an emergency plan and communicating it in clear language to the affected community.

3.11 Waste Management

245. Waste management covers the licensee's site-wide waste management program. CNSC staff evaluated OPG's performance with regards to waste minimization, segregation, characterization and storage. CNSC staff rated OPG's performance for this SCA as satisfactory for the period 2010-2013 and as fully satisfactory for 2014.

246. Several intervenors, including Northwatch, expressed concerns regarding nuclear waste management at the Darlington NGS. The Commission enquired about the current condition of the IFBs and about the management of irradiated (used) fuel. OPG representative informed the Commission about improvements made in anticipation of continued operation at the Darlington NGS, including moving more used fuel to dry storage to increase the storage capacity of the IFBs, and replacing the heat exchangers that cool the IFBs. An OPG representative further informed the Commission about several types of inspections that are conducted periodically to assess the condition of the IFBs and stated that they are in good condition.

247. OPG informed the Commission about its in-plant waste management and its activities related to used fuel management. OPG stated that the condition of the Darlington IFBs was evaluated and found to be fit for service, and noted that used fuel is stored in the IFBs for an appropriate cooling period and then moved into Dry Storage Containers (DSCs) for interim storage on site. OPG added that it intends to eventually transfer its

used fuel to a long-term disposal facility to be developed via the Nuclear Waste Management Organization (NWMO) Adaptive Phased Management (APM) process.

248. CNSC staff noted that it had recently reported to the Commission[25] on the regulatory performance of OPG's waste management facilities (Darlington, Pickering and Western) and stated that the Commission had determined that OPG's waste management facilities meet regulatory requirements. CNSC staff introduced CSA standard N292.3, *Management of low-and intermediate-level radioactive waste*, in the draft LCH as compliance verification criteria for the waste management SCA, and reported that OPG's nuclear waste management program meets the requirements set out in CSA N292.3. CNSC staff added that OPG has effective processes in place to manage hazardous waste. A CNSC staff inspection conducted in 2012 confirmed satisfactory performance.

249. CNSC staff discussed used fuel management, explaining that after a period of sufficient cooling in the IFBs, used fuel is transferred to DSCs and stored at a facility, on the Darlington NGS site that is managed and operated under a separate licence issued to OPG. CNSC staff pointed to the specifics of the CANDU reactor fuel elements, and noted that this fuel generates only about 10 percent of the heat from irradiated fuel generated by non-CANDU reactors. As a consequence, CANDU fuel is less likely to catch fire if exposed to air. Due to these facts, the management of used CANDU-type fuel elements is intrinsically safer than other types, such as the used fuel stored in the Fukushima station. CNSC staff noted that the location of the IFBs is another advantage in the management of used fuel at the Darlington NGS because they are at ground level, whereas the IFBs were located above the reactors at Fukushima and in several other reactor designs. CNSC staff added that they had assessed the condition and structural integrity of the IFBs at the Darlington NGS and reviewed their seismic qualifications. CNSC staff confirmed that the capacity of the IFBs, amount of available water, and cooling were adequate to assure the safe storage of the used fuel during the required cool-down period. CNSC staff added that the IFBs had been included in the safety analysis and noted that the PSA would be updated to include them.

250. The intervenors noted that the used fuel has been kept in the IFBs longer than 10 years, and expressed concerns regarding used fuel aging management. The Commission asked CNSC staff whether there was any regulatory requirement that limits the storage of fuel elements in the IFBs to a period of less than 10 years. CNSC staff responded that there is no such requirement; instead, there is a requirement to ensure that used fuel has been sufficiently cooled in the IFBs before it is transferred to dry storage. CNSC staff clarified that, after the Fukushima event, CNSC staff requested that all licensees look at the possibility to expedite the removal of the fuel from the pool to dry storage. CNSC staff noted that this work was ongoing and the licensees were examining the safety case for the storage of used fuel in DSCs following a shorter cool-down period. With respect to aging management, CNSC staff confirmed that the aging management of the IFBs is as rigorous as the aging management of the reactor itself.

[25] Refer to the Minutes of the Canadian Nuclear Safety Commission Meeting held on June 17, 2015.

251. CNSC staff noted that information on nuclear waste management is available to the public through a variety of sources, including during the licence renewal process for the Darlington Waste Management Facility and in CNSC staff's regulatory oversight reports of OPG's waste management facilities. In addition, CNSC staff noted that Canada's most recent report to the Joint Convention on the Safety of Spent Fuel Management and of Radioactive Waste Management from May 2015 was available on the CNSC website.

252. Northwatch also expressed concerns regarding the management of defective fuel in the IFBs. The Commission enquired about the management of defective fuel. The OPG representative noted that the storage of defective fuel in the IFBs did not affect the storage capacity or contribute to additional contamination, and noted that the defective fuel elements can also be transferred to DSCs after a period spent in the IFBs. The OPG representative added that the defective fuel elements had not yet been transferred to DSCs and were kept in the IFBs to be inspected in order to better understand the source of the defects.

253. The Commission asked about the difference between the management of defective fuel waste and non-defective fuel waste. CNSC staff explained the complete procedure for the treatment and inspection of fuel elements, and responded that high-level waste remains in the same category regardless of defects. CNSC staff noted that defective fuel waste is segregated in a different portion of the IFBs.

254. Based on the above information and considerations, the Commission is satisfied that OPG is safely managing waste at the Darlington NGS. The Commission is satisfied with OPG's activities aiming to optimize the time that the used fuel is kept in the IFBs before being transferred into the DSCs.

3.12 Security

255. Security covers the programs required to implement and support the security requirements stipulated in the relevant regulations and the licence. This includes compliance with the applicable provisions of the *General Nuclear Safety and Control Regulations*[26] and the *Nuclear Security Regulations*[27]. CNSC staff rated OPG's performance for this SCA as satisfactory for the period 2008-2012 and as fully satisfactory for 2013 and 2014.

3.12.1 Security Program

256. A number of intervenors expressed concerns over terrorist attacks, missile strikes and similar events, and noted a lack of information regarding these issues in the OPG

[26] SOR/2000-202
[27] SOR/2000-209

submissions, reports and safety analyses. The OPG representative responded that analyses have been done to satisfy regulatory requirements and emphasized that the sensitive nature of these topics influences the amount of information that is presented to the public. CNSC staff confirmed that the physical robustness of the site had been addressed in the safety analyses with respect to potential terrorist activities. CNSC staff added that, in terms of physical security, including the ability of facilities to withstand terrorist attacks, the Canadian regulatory program and licensed facilities had been recently assessed by an IAEA-International Physical Protection Advisory Service mission and received high ratings.

257. OPG informed the Commission that it had established a comprehensive nuclear security program that utilizes a security-in-depth model encompassing equipment, personnel and procedures. OPG participates in an Inter-Utility Security Working Group which includes all power reactor operators in Canada, and continues to use external benchmarking, consultative services and shared operating experience to ensure that the security program meets or exceeds industry standards. OPG conducts drills, with both armed and unarmed members of its security force, to validate security practices, ensure regulatory compliance, and identify areas for improvement in security operations. OPG also informed the Commission that Performance Testing Program exercises had been executed in 2011, 2013 and 2015 to assess the integrated response capabilities of the OPG Nuclear Security armed and unarmed elements, against adversaries equipped and performing within the Design Basis Threat. OPG has an off-site response arrangement with the Durham Regional Police Service which was part of the incident command structure during these exercises.

258. CNSC staff informed the Commission that OPG's security program accords with the following CNSC regulatory documents:
- REGDOC-2.12.1, *High Security Sites: Nuclear Response Force*;
- REGDOC-2.12.2, *Site Access Security Clearance*;
- RD-321, *Criteria for Physical Protection Systems and Devices at High-Security Sites*;
- RD-361, *Criteria for Explosive Substance Detection, X-Ray Imaging and Metal Detection Devices at High-Security Sites*; and
- RD-363, *Nuclear Security Officer Medical, Physical, and Psychological Fitness*.

259. CNSC staff added that OPG had improved its security program over the current licence period at the Darlington NGS and continues to improve its security program with the introduction of enhanced technologies. CNSC staff noted that it inspects OPG's security programs annually and that major exercises are conducted biennially. CNSC staff confirmed that the nuclear response force (NRF) program at the Darlington NGS is fully satisfactory and that OPG continues to maintain a NRF program through the implementation of an effective training program. As well, OPG has in place a MOU with Durham Regional Police Service that supports the off-site response force.

260. The Commission asked if OPG had security concerns regarding drones. The OPG representative responded that OPG had considered them and that it would continue to

consider them in its security assessments.

3.12.2 Cyber Security

261. With respect to cyber security, OPG submitted that it had implemented a risk-based cyber security program to protect the computers and software used to monitor and control the NGS. OPG explained that, in order to minimize the threats from external sources, real-time process computers are architecturally segregated from other information systems. OPG further stated that it documents cyber security incident reporting and response processes in procedures, and that it uses automated tools and periodic log reviews to detect cyber security threats and events. OPG added that, by the end of 2015, all staff and contractors would be required to complete a new computer-based training module outlining common cyber security threats and how to avoid them.

262. CNSC staff explained that, in 2008, it directed OPG to conduct a self-assessment of its cyber security provisions and to make improvements as required. CNSC staff reported that, after the self-assessment, OPG initiated the implementation of cyber security governance for sustaining its cyber security program and completed the implementation of a systematic cyber security program at the Darlington NGS in 2012.

263. Some intervenors expressed concerns regarding cyber security of the systems and software implemented at the Darlington NGS. One intervenor advocated open-source software so that the public could assess it and contribute to the safe operation of the system. The Commission enquired about protection against cyber-attacks, international practice, and potential benefits of the use of open-source software. CNSC staff responded that they were focusing their attention on the most safety-critical parts of the plant, such as the shutdown systems and the digital control system for the reactor regulating system, and noted that the CNSC does not have a position about open- versus closed-source software at this time. CNSC staff noted that the standards CSA N290.7, *Cyber security for nuclear power plants and small reactor facilities*, and CSA N290.14, *Qualification of digital hardware and software for use in instrumentation and control applications for nuclear power plants*, are used for the qualification of hardware and software in instrumentation and control systems for nuclear power plants. CNSC staff added that a deterministic safety analysis, which assumes that the software will not operate effectively, was carried out by the licensee and verified by the CNSC, and determined that the equipment in which the software operates will still shut down safely.

264. Both CNSC staff and the intervenors agreed that there are no nuclear facilities in the world using open-source software. CNSC staff added that the organization involved in developing standards in this field did not get into a discussion regarding open- versus closed-source software. CNSC staff noted that, with open-source software, even though it is not precluded in the standard, a potential attacker with access to the source code would potentially be able to manipulate the system to operate unsafely. CNSC staff further stated that, even though the CSA Group and the CNSC have not directed that

software for use at NGSs be closed-source software, the current view is that the use of proprietary or closed-source software is a more secure option.

265. The OPG representative explained OPG's measures to protect its networks, and added that the software currently used by OPG is highly reliable. The OPG representative noted that the control systems are architecturally and physically separated from external networks, and that vulnerability assessments had been performed as required by regulatory expectations and requirements. The OPG representative stated that OPG follows CSA N290.7 and CSA N290.14 and that OPG classifies its software using a risk-based approach and applies quality assurance of the highest degree to the systems that operate the reactors. The OPG representative also added that an independent review of the software included code reviews. The OPG representative stressed that a complex and sensitive enterprise, such as operation of a nuclear power plant, must not rely on the public to detect and resolve problems by being able to access critical systems of the operation, as proposed by the intervenor. The OPG representative added that there would be no benefit in releasing a large amount of software without detailed information about all the surrounding hardware, and its setting around the software, so as to allow someone to analyze the whole system correctly.

266. The Commission asked CNSC staff to comment on the statements of a Chatham House report on cyber security cited by two intervenors. CNSC staff stated that they had read the report in depth, reviewed the list of recommendations in the report, and compared it to the situation in Canada. The conclusion was that, besides some useful recommendations, some of them categorically did not apply in Canada, such as the implied lack of a strong regulatory basis and standard, or the lack of information-sharing between the operational technology and the information technology sides of the facility. CNSC staff also pointed out that in Canada, through COG, there has been an inter-utility cyber security working group that has been established to share operating experience. The OPG representative agreed with CNSC staff's statement and noted that OPG staff had been involved in the Chatham House report, with IAEA governance producing both design documentation and training documentation, and noted that OPG would be involved with international training. The OPG representative added that the CSA standard was not limited by Canadian experience, but included elements of the United States Nuclear Regulatory Commission and IAEA controls.

3.12.3 Conclusion on Security

267. The Commission is satisfied that OPG's performance with respect to maintaining security at the facility has been acceptable and in compliance with CNSC requirements. The Commission concludes that OPG provides for the physical security of the facility, and is of the opinion that OPG will continue to provide for it during the proposed licence period. The Commission is also satisfied that more attention has been paid to cyber security, as this area becomes more important for safe operation and overall security of nuclear power plants.

3.13 Safeguards and Non-proliferation

268. The CNSC's regulatory mandate includes ensuring conformity with measures required to implement Canada's international obligations under the Treaty on the Non-Proliferation of Nuclear Weapons[28]. Pursuant to the Treaty, Canada has entered into safeguard agreements with the IAEA. The objective of these agreements is for the IAEA to provide credible assurance on an annual basis to Canada and to the international community that all declared nuclear material is in peaceful, non-explosive uses and that there is no undeclared nuclear material or activities in this country. CNSC staff rated OPG's performance for this SCA as fully satisfactory for 2008, and as satisfactory for the period of 2009-2014.

3.13.1 Safeguards

269. OPG informed the Commission that it had implemented a Safeguards Program to ensure compliance with the Safeguards Agreement and Additional Protocol made between the Government of Canada and the IAEA. OPG submitted that its Safeguards Program is fully compliant with CNSC regulatory documents RD-336, *Accounting and Reporting of Nuclear Material*, REGDOC-3.1.1, as well as the NSCA and its Regulations. OPG noted that it completes an annual Physical Inventory Taking of fuel at the Darlington NGS as part of licence conditions pursuant to the implementation of safeguards by the IAEA. OPG further informed the Commission about its initiatives to further support the Safeguards Program at the Darlington NGS, including close coordination with IAEA technical staff to install upgrades to the Units 1 and 2 Core Discharge Monitor equipment in the reactor vault.

270. CNSC staff reported that OPG has an effective safeguards program at the Darlington NGS that conforms to measures required by the CNSC to meet Canada's international safeguards obligations.

3.13.2 Non-proliferation

271. The scope of the non-proliferation program for OPG is limited to the tracking and reporting of foreign obligations and origins of nuclear material. CNSC staff added that the import and export of controlled nuclear substances, equipment and information identified in the *Nuclear Non-proliferation Import and Export Control Regulations*[29] require separate authorization from the CNSC, done on a transactional basis.

272. The Commission enquired about the use of Nuclear Materials Accountancy Reporting

[28] Information circular of the IAEA, INFCIRC/140, *Treaty on the Non-Proliferation of Nuclear Weapons (NPT)*, United Nations (1970).
[29] SOR/2000-210.

(NMAR), and asked when the system was expected to be in place. CNSC staff responded that they were working with all licensees that are affected by this type of reporting and assisting them with adopting the necessary technology in order to be able to use the system as soon as possible. CNSC staff added that, by the compliance verification criteria listed in the LCH, the expectation was for OPG to be in full compliance by January 1, 2016.

3.13.3 Conclusion on Safeguards and Non-proliferation

273. Based on the above information, the Commission is satisfied that OPG has provided and will continue to provide for adequate measures in the areas of safeguards and non-proliferation at the Darlington NGS that are necessary for maintaining national security and measures necessary for implementing international agreements to which Canada has agreed.

3.14 Packaging and Transport

274. Packaging and transport covers the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility. The licensee must adhere to the *Packaging and Transport of Nuclear Substances Regulations*[30] and Transport Canada's *Transportation of Dangerous Goods Regulations*[31] for all shipments to and from the facility. CNSC staff rated OPG's performance for this SCA as satisfactory throughout the current licence period.

275. OPG informed the Commission about its Radioactive Material Transportation Program, which establishes controls and procedures for handling, packaging, shipment and receipt of radioactive material. OPG noted that the program includes verification that emergency response for transportation incidents is appropriately established, and that the program is both self and independently assessed on a routine basis, while Transport Canada and the CNSC conduct periodic inspections of the program and its performance. OPG also noted that it provides a high quality training program so that an adequate complement of trained and qualified personnel is maintained to ensure compliance with the radioactive material transportation program and procedures.

276. OPG submitted that it has a Transportation Emergency Response Plan, accepted by Transport Canada, designed to respond to an incident involving the transportation of any radioactive material. OPG stated that, in an average year, OPG transports approximately 800 consignments of radioactive material and travels approximately 500,000 km. OPG stressed that it has been safely transporting radioactive materials from its nuclear stations and other licensed nuclear facilities for over 40 years, and has never had an accident resulting in a radioactive release or a serious personal injury.

[30] SOR/2000-208
[31] SOR/2001-286

277. CNSC staff stated that OPG met CNSC requirements and expectations for the packaging and transport of nuclear substances. CNSC staff confirmed that, during the current licence period, there were no significant events reported for consignments transported to and from the Darlington NGS. CNSC staff reported that they had conducted packaging and transport inspections in 2012 and 2013, and that there were no issues identified.

278. Based on the above information, the Commission is satisfied that OPG is meeting regulatory requirements regarding packaging and transport.

3.15 Environmental Assessment

279. In March 2013, the Commission reached a decision on the EA of the proposed refurbishment and continued operation of the Darlington NGS under the *Canadian Environmental Assessment Act*[32] (CEAA 1992). The Commission concluded that the proposed project was not likely to cause significant adverse environmental effects, taking into account mitigation measures identified in the EA Screening Report[33]. Although the CEAA 1992 was repealed when the CEAA 2012 came into force on July 6, 2012, the Minister of the Environment designated the Darlington NGS Refurbishment and Continued Operation EA to be completed under the requirements of the CEAA 1992.

280. OPG developed an EA follow-up monitoring program to verify the accuracy of the EA and determine the effectiveness of the mitigation measures. OPG stated that the EA follow-up monitoring program activities included thermal monitoring and effluent characterization, a benthic invertebrate community study, and monitoring of fish eggs, larvae and invertebrates entrained by the cooling water intake structure.

281. CNSC staff stated that the EA follow-up monitoring program developed by OPG in consultation with CNSC staff, DFO and other stakeholders would confirm that the predictions of environmental effects in the EA were accurate and that mitigation measures have been effectively implemented. CNSC staff further stated that it would ensure that OPG's environmental protection programs continue to protect the public and the environment during refurbishment activities.

282. For the purpose of the licence renewal application, CNSC staff conducted an EA under the NSCA and its regulations, and is of the opinion that OPG has made, and is committed to continue to make, adequate provision for the protection of the environment and the health and safety of persons. CNSC staff submitted an EA

[32] S.C. 1992, c. 37.

[33] The Commission's decision on the EA was upheld by the Federal Court following an application for judicial review. The Federal Court decision is currently under appeal. The Commission notes that the appeal of the Federal Court decision relates only to the refurbishment activities sought to be authorized in this licence application, and would have no bearing on the renewal of the Darlington NGS. Should the Federal Court of Appeal allow the appeal, the Commission is of the view that such a decision would not affect the Commission's decision to renew the Power Reactor Operating Licence as it pertains to the operation of the Darlington NGS.

Information Report detailing its assessment, which included radiological releases to the environment, public doses and updates on actions previously requested by the Commission with respect to specific environmental components. CNSC staff's findings from this EA under the NSCA included that:

a. OPG's environmental protection programs meet CNSC regulatory requirements;
b. the maximum effective dose to a member of the public from activities conducted at the Darlington NGS site remains less than 1 percent of the regulatory limit of 1 mSv/y;
c. OPG's radiological releases to the environment (air and water) remain well below the derived release limits; and
d. the results of the CNSC's IEMP confirm that the public and the environment in the vicinity of the Darlington NGS site are protected from the releases of the facility.

283. One intervenor expressed concerns that changes to the environment due to climate change may affect the future operation of the Darlington NGS. In response to a question from the Commission, CNSC staff stated that the effects of climate change, such as severe weather, were included in the EA for the refurbishment project, including the sensitivity of the project to changes in parameters affected by climate change, as well as the potential effects on the environment and human health. CNSC staff noted that in addition to the EA, its ongoing licensing and compliance assessments also incorporate climate change.

284. The Commission is satisfied that the refurbishment and continued operation of the Darlington NGS is not likely to cause significant adverse environmental effects, taking into account mitigation measures, and that OPG has developed an EA follow-up monitoring program to confirm the predictions of the EA. The Commission notes that the NSCA provides a strong regulatory framework for environmental protection and that the CNSC regulatory system ensures that adequate measures are in place to protect the environment and human health in accordance with the NSCA and its regulations.

3.16 Refurbishment and Life Extension

285. OPG's application included the proposed refurbishment of the Darlington NGS, which would be a multi-year program to enable the replacement of life-limiting components such as fuel channels, and to make safety improvements to the plant, programs and processes. OPG explained that the mid-life refurbishment of the four Darlington NGS reactors would extend the life of the Darlington NGS by an additional 30 years.

3.16.1 Aspects of Refurbishment

286. OPG described the refurbishment process and explained the various aspects that would need to be managed under the refurbishment project, including supplier and contractor relationships and the management system. OPG also described the timeline for refurbishment. OPG explained that it was planning on staggering the proposed

refurbishment outages at the Darlington NGS with Unit 2 being refurbished first, starting in October 2016, followed by Unit 3 in 2019, Unit 1 in 2021, and Unit 4 in 2022. OPG further explained that the primary refurbishment work would be the replacement of pressure tubes, calandria tubes, end fittings and feeders.

287. OPG explained that aspects of the refurbishment of each reactor unit would include:
- reactor shutdown;
- removal of fuel and heavy water;
- islanding the refurbishment unit from the operating units;
- replacing reactor components;
- rebuilding or replacing the turbine generator systems;
- inspecting and maintaining the steam generators;
- conducting balance of plant repair and maintenance; and
- returning the reactors to service.

288. Several intervenors, including individuals and New Clear Free Solutions, expressed concerns that OPG was not going to replace the steam generators during the refurbishment, suggesting that this could result in those components being a weak link in the heat transport system. An OPG representative stated during the hearing that OPG was confident that the steam generators would not need to be replaced due to the material used to construct the steam generators, OPG's inspection and maintenance programs, and its chemistry control in the heat transport system. The OPG representative explained that the steam generators were in good condition and noted that their expected design life of 60 years was in line with the operating life of the refurbished reactors. Some intervenors, including the Society of Professional Engineers and Associates, agreed with OPG that the steam generators did not need to be replaced.

289. The OPG representative further noted that, during the refurbishment outage, OPG would clean and modify the steam generators to facilitate future maintenance activities, and stated that the steam generators would continue to be monitored as part of OPG's aging management program. The OPG representative added that the steam generators did not represent a significant safety risk, and stated that any problems with the performance of the steam generators, such as a leak, could be identified and corrected. CNSC staff concurred with OPG, noting that OPG was required to demonstrate that the steam generators are fit for service.

290. The Commission asked OPG to explain its process for determining how other reactor components that are not replaced during refurbishment would remain fit for service. A representative from OPG responded that OPG would undertake a thorough inspection and assessment of components during the refurbishment to ensure that the components would remain fit for service. CNSC staff confirmed that OPG's aging management program was sufficient to maintain the fitness for service of reactor components.

3.16.2 Regulatory Expectations for Refurbishment

291. CNSC staff stated that the CNSC's regulatory expectations for proposed projects to refurbish and extend the life of a nuclear power plant are contained in CNSC regulatory document RD-360, *Life Extension of Nuclear Power Plants*. CNSC staff noted that, as described in RD-360, once a licensee decides to undertake a life extension project, the licensee must systematically identify and address all environmental and safety concerns and integrate them into an Integrated Implementation Plan (IIP). To do this the licensee must:
    1. participate in the EA process;
    2. carry out an Integrated Safety Review (ISR); and
    3. incorporate the results of these assessments into a Global Assessment Report (GAR) and IIP.

292. CNSC staff reported that the assessments performed by OPG in support of the Darlington refurbishment and life extension met the expectations set out in RD-360.

Environmental Assessment

293. As previously described in this *Record of Proceedings*, the Commission concluded that the proposed refurbishment and life extension was not likely to cause significant adverse environmental effects, taking into account mitigation measures identified in the EA Screening Report. OPG described the measures to implement the EA follow-up monitoring program in the IIP. OPG further noted that the IIP also included design enhancements that were committed to through the EA, and noted that these enhancements would further increase safety margins and reduce risks. CNSC staff confirmed that the EA mitigation and follow-up activities were included as commitments in the IIP.

Integrated Safety Review

294. CNSC staff stated that, as outlined in RD-360, an ISR is a comprehensive assessment of plant design, condition and operation. CNSC staff explained that an ISR, performed by the licensee, involves an assessment of the current state of the plant and plant performance to determine the extent to which the plant conforms to modern codes and standards, and to identify any factors that would limit safe long-term operation. CNSC staff noted that this would enable the determination of reasonable and practical modifications that should be made to the plant or operational programs to enhance the safety of the facility to a level approaching that of a modern NPP, and to allow for safe long-term operation. CNSC staff further noted that guidance on the ISR can be found in the IAEA Specific Safety Guide No. SSG 25[34].

[34] IAEA Safety Standards, Specific Safety Guide No. SSG-25, *Periodic Safety Review for Nuclear Power Plants* (2013).

295. CNSC staff reported that OPG submitted its ISR for the Darlington NGS refurbishment and life extension in October 2011. CNSC staff noted that the ISR was carried out in accordance with OPG's ISR basis document, which had been submitted to and accepted by CNSC staff as the methodology for performing the ISR. CNSC staff explained that the ISR addressed 103 modern codes, standards and best practices considered most likely to apply to a new NPP, including CNSC regulatory documents, CSA Group and other Canadian standards, and codes and international standards and practices, including IAEA safety requirements and guides. CNSC staff further stated that the ISR addressed the 14 safety factors described in IAEA guidance plus an additional 3 safety factors as recommended by RD-360, as well as the additional CNSC SCAs, including Conventional Health and Safety, Waste Management, and Packaging and Transport.

296. OPG stated that it conducted a systematic and comprehensive assessment of the plant design and actual condition, and of the management system used to operate and maintain the Darlington NGS. OPG further stated that the ISR demonstrated that the Darlington NGS conformed closely to modern standards and international practices; OPG did not identify any safety-significant gaps. OPG noted that this review confirmed that the licensing basis for the Darlington NGS would remain valid over the extended operating life and that there were adequate measures in place to maintain plant safety for long-term operation to approximately 2055.

297. CNSC staff reported that, overall, the ISR process:
- was conducted in accordance with RD-360;
- met all of the objectives of the ISR;
- identified no issues that would impede safe long-term operation; and
- resulted in an IIP with proposed safety improvements, which, when implemented, would continue to enhance the current strong performance at the Darlington NGS.

298. CNSC staff noted that it conducted an extensive review of the ISR over a two-year period, which resulted in requests for modifications to OPG's ISR findings. As a result, OPG produced an addendum to the final ISR report to address CNSC staff's review of the ISR. CNSC staff noted that, in February 2014, OPG submitted an ISR emerging issues review which addressed ISR basis codes, standards and practices that had been updated since the original ISR assessment, as well as any new significant industry operating experience. CNSC staff stated that OPG's ISR emerging issues review confirmed OPG's findings and confirmed that the review methodology had been followed correctly.

299. Some intervenors, including Dr. Nijhawan and the Canadian Coalition for Nuclear Responsibility, expressed concerns regarding the CANDU design's ability to withstand a severe accident and suggested that further design improvements could be made during refurbishment, such as changing pressure tube materials to reduce hydrogen generation during a severe accident and increasing the pressure-retaining capacity of the moderator vessel. The Commission sought insight regarding these suggestions. A

representative from OPG expressed confidence in OPG's assessment of the design and its proposed improvements. CNSC staff responded that they reviewed Dr. Nijhawan's submissions and disagreed that the suggested changes were necessary. CNSC staff acknowledged that different engineers can have different points of view, but reaffirmed its review of OPG's ISR and stated that the refurbishment would result in a significant improvement to safety.

Global Assessment Report and Integrated Implementation Plan

300. RD-360 requires that the results of an EA and the ISR be incorporated in a GAR and IIP. CNSC staff explained that the GAR presented the results of the EA and the ISR in an integrated manner and provided an overall risk judgment on the acceptability of continued operation for the proposed extended plant life, and that the IIP presented the proposed environmental and safety improvements resulting from the EA and the ISR, and included timeframes for implementation.

301. OPG stated that it submitted the GAR and IIP for the Darlington NGS refurbishment and life extension to CNSC staff in December 2013 and made the documents publicly available on its external website. OPG explained that the GAR summarized the Darlington NGS's overall plant performance, the results of the EA and ISR, the basis for continued operation for the proposed extended life, and an overview of the IIP. OPG noted that the GAR included a cross-reference table to demonstrate how the applicable expectations of RD-360 were addressed.

302. OPG stated that the scope of the IIP resulting from the EA included mitigation measures, committed safety improvement opportunities and follow-up program elements, and noted that the mitigation measures and safety improvements addressed potential environmental effects. OPG explained that IIP work that was reactor unit-specific would be performed during that unit's refurbishment outage and the period up to and including the first scheduled post-refurbishment maintenance outage. OPG further noted that the IIP timeline was to complete the IIP implementation during the requested 13-year licence term, including the conduct of a periodic safety review (PSR). OPG stated that the remaining IIP actions would be completed either at-power or during other planned maintenance outages. OPG committed to perform the safety improvements with the highest safety benefit as early as possible, and no later than the next planned maintenance outage following each unit's refurbishment outage. OPG noted that the completion of all activities outlined in the IIP for all units was planned by 2028.

303. CNSC staff stated that the GAR confirmed the conclusions of the EA and the ISR. CNSC staff noted that the GAR demonstrated that the Darlington NGS, with planned safety improvements including refurbishment, would meet, to the extent practicable, the regulatory design requirements of a new NPP.

304. CNSC staff stated that the IIP presented the proposed safety improvements resulting

from the EA and the ISR and included the timeframes for implementation. Some of the major IIP activities include:

- replacement of pressure tubes, calandria tubes, feeders and end fittings;
- installation of auxiliary shutdown cooling (SDC) pumps which are physically separate and of diverse design than the SDC pumps;
- installation of a containment filtered venting system;
- provision of shield tank overpressure protection;
- enhancements to the powerhouse steam venting system;
- installation of a 3rd seismically qualified emergency power generator;
- provision of an alternate, independent supply of water as an emergency heat sink;
- implementation of safety-related recommendations from ISR component condition assessments; and
- implementation of CEAA EA mitigation and follow-up activities.

305. CNSC staff described its review of the GAR and the IIP, and noted that it had provided comments to OPG requesting more detailed information. Following further reviews, CNSC staff stated that Revision 2 of the IIP, submitted by OPG in April 2015, met RD-360 expectations. CNSC staff accepted IIP Revision 2 in June 2015. OPG requested that the Commission approve the IIP as part of the licence renewal application.

306. Greenpeace, in its intervention, suggested that OPG would have an interest in avoiding safety upgrades in order to reduce costs, and requested that the Commission require OPG to release the cost-benefit analysis it used to justify its proposed safety improvements. Other intervenors, including individuals and Northwatch, also questioned the applicability of cost-benefit analysis to safety requirements. In response to a question from the Commission, CNSC staff explained that any gap with safety significance must be closed with an appropriate measure of control, and that cost-benefit analysis is not used as justification to avoid meeting safety standards.

307. CNSC staff further explained that, although the ISR process included a provision for cost-benefit analysis, this provision was for choosing between alternative methods of meeting an objective. CNSC staff noted that it was only used once by OPG to determine the approach it would use to address an issue. A representative from OPG explained that, as part of its ISR, OPG assessed the current state of the plant against modern codes and standards and, where gaps existed, OPG proposed means to address them to the satisfaction of CNSC staff. The OPG representative noted that, separately from the refurbishment process, OPG conducts PSA-based cost-benefit analysis to review potential enhancements to safety. The OPG representative stated that this information was protected for security purposes. The Commission is satisfied that no additional information relating to cost-benefit analysis is required.

3.16.3 Refurbishment Project Execution

308. CNSC staff stated that, according to RD-360, a licensee must prepare project plans, programs and processes to carry out the refurbishment project. The licensee is also expected to monitor the project for progress, safety and quality at all phases of the project.

Refurbishment Organization

309. OPG stated that it established a separate refurbishment management organization, distinct from the station's operating organization, in order to allow both organizations to focus on their areas of responsibility and expertise. OPG explained that the refurbishment organization is responsible for the development, implementation and assurance of the refurbishment project while the station's operating organization is responsible for safe operation of the operating units. OPG noted that the refurbishment organization is subject to OPG's nuclear management system and all governance under that system.

310. The Commission sought further information regarding the OPG organization for the planned execution of the refurbishment and the separation of the operations and refurbishment groups. OPG provided an organizational chart and explained that the standards and expectations for workers would be the same, regardless of the section of the organization they may be in.

Refurbishment Project Plans, Programs and Processes

311. OPG explained that the refurbishment project would be governed by OPG's project management program, which is implemented through standards on project management, contract management, project oversight, field engineering, and a procedure on the technical contractor management process.

312. The Commission enquired about OPG's proposed timelines for the execution of the refurbishment, noting the complexity involved in the activities and the overlapping of work on different units. An OPG representative expressed confidence that OPG could complete the refurbishment within the proposed timelines. The OPG representative responded that the timelines were planned based on the expectation that productivity and performance would be improved due to training, and noted that further performance improvements would be likely due to experience. An OPG representative further noted that the overlapping work would not be a concern because the work would be undertaken by different groups with different skillsets at different times.

313. The Commission requested that CNSC staff provide information relating to the timelines for the refurbishment of the Bruce NGS and the Point Lepreau NGS. CNSC staff provided the information to the Commission's satisfaction[35].

314. Whereas several intervenors, including individuals, businesses, North American Young Generation in Nuclear – Durham Chapter, the Canadian Nuclear Association and the Society of Energy Professionals, expressed confidence that OPG would be able to successfully complete the refurbishment in a safe and timely manner, many other intervenors, including Greenpeace and individuals, expressed the view that the refurbishment project would not be cost-effective and suggested that OPG may have difficulty meeting the proposed timelines. Some intervenors suggested that OPG may sacrifice safety in order to stay on time and on budget. In response to this issue, CNSC staff stated that, regardless of OPG's business plan and timelines for completing the refurbishment, all work must be carried out in a safe manner, in accordance with the safety case and licensing basis. CNSC staff further stated that it would ensure that safety is not compromised.

Contractor Oversight

315. OPG stated that it would use engineering, procurement and construction contractors to perform the majority of the refurbishment work. OPG explained that contractors are qualified under OPG's supply chain to ensure that they have developed and implemented a management system that meets the requirements of CSA N286. OPG noted that it would oversee the activities of the contractors in accordance with OPG's project specific oversight plans, and added that these plans would be updated during the course of the project to ensure that safety and quality requirements are met at all phases of the project.

316. CNSC staff stated that it verified OPG's contractor oversight approach for the refurbishment project and confirmed that it would provide the interfaces required for meeting CSA N286 requirements. CNSC staff noted that it would continue to conduct regulatory oversight to ensure that OPG is providing the necessary measures for contractor oversight for the refurbishment project.

317. The Commission asked OPG to provide more information concerning its contractor oversight. A representative from OPG noted that OPG has programs to manage contractors at its facilities and stated that contractors would be expected to meet OPG standards. CNSC staff stated that it would include oversight of contractors as part of its compliance verification activities, and reiterated that contractors would be expected to perform their work safely and within regulatory requirements.

318. Some intervenors, including Black & McDonald and BWXT Canada Ltd., expressed

[35] CNSC staff provided the information to the Commission Secretariat during Part 2 of the hearing. The supplementary information was filed as CMD 15-H8.D, was distributed to the Commission, and was available to the public.

support for OPG's supply chain management and ensuring that components meet requirements. The Commission further enquired about OPG's supply chain management. A representative from OPG responded that OPG has an extensive quality assurance program in place to ensure the quality and integrity of its components. CNSC staff stated that it was satisfied with OPG's program in this regard.

319. Dr. Greening, in his intervention, highlighted points from a 2014 report critiquing OPG's capacity for contractor oversight and expressed concerns in this regard. The Commission asked for more information on this subject. A representative from OPG responded that OPG had addressed the findings of the 2014 report and incorporated them into its oversight plans. The OPG representative stated that OPG had sufficient resources to monitor and provide the necessary oversight. The OPG representative explained that OPG would provide direct oversight of contractors to ensure that the work is being done in accordance with the standards established by OPG. The OPG representative noted that contractors would be expected to comply with OPG's programs and that, while the ultimate accountability for executing the work would be with the contractor, OPG would verify that the work satisfies OPG requirements. CNSC staff stated that it had reviewed the 2014 report, and noted that it resulted in a change in OPG's approach to contractor oversight, as well as in additional oversight from the CNSC. CNSC staff stated that it was satisfied with OPG's approach.

Benchmarking from other Refurbishment Projects

320. OPG stated that, as part of the initial planning for the refurbishment project, it had benchmarked its program with other refurbishment projects, including the refurbishments of Bruce Power NGS Units 1 and 2, Point Lepreau NGS, and the Wolsong NGS in South Korea. OPG stated that it also seconded staff to the Bruce Power NGS Units 1 and 2 and the Point Lepreau NGS refurbishment programs to gain experience and capture lessons learned. OPG noted that key lessons learned included establishing a separate refurbishment organization independent from the station, performing detailed front-end planning, and the construction of a full-scale reactor mock-up for training and tool development.

Training and Mock-up Building

321. OPG stated that the refurbishment project would require a significant workforce of temporary supplemental workers that would have to complete initial training to ensure that they are familiar with OPG safety standards and expectations. The initial training would be followed by training to ensure that workers have the required knowledge, skills and behaviours to perform the technical tasks safely and competently.

322. In preparation for refurbishment, OPG constructed a full scale replica of a Darlington reactor to be used to train staff prior to performing work in the field, and to test and commission specialized tooling required for refurbishment work. OPG explained that

the full-scale reactor mock-up would assist in the training of personnel, the testing of tools, and the development of work plans, as well as to ensure worker familiarity with tasks and tooling compatibility when the refurbishment begins.

Monitoring and Reporting

323. OPG submitted that timely and effective internal reporting would support the refurbishment program. OPG explained that reporting would support management decision processes, measure progress against established business objectives, and flag any performance gaps that may require management attention, including taking corrective actions. OPG stated that it would establish and maintain a comprehensive, tiered metrics infrastructure at program, project and functional levels to measure progress in the areas of:

- environment, health and safety;
- scope;
- schedule;
- cost; and
- quality.

324. In addition, OPG stated that it would produce reports for communicating performance to various stakeholders. OPG noted that these reports would be differentiated by the intended audience, level of detail required, and the metrics reported. OPG indicated that it was working with CNSC staff to determine the information to be reported to the CNSC on a routine basis, and committed to providing updates to the Commission at public meetings following the refurbishment outage on each unit.

325. CNSC staff explained that its oversight for the refurbishment would be in line with the compliance verification criteria for the refurbishment activities. CNSC staff noted that, once the IIP has been approved by the Commission, it will form the basis for the compliance verification criteria. CNSC staff further stated that the CNSC has experienced inspectors and specialists who have overseen other reactor refurbishment projects at the Point Lepreau NGS and the Bruce Power NGS.

326. The Commission asked for more information concerning how the OPG organizational structure would respond to, as an example, a small procedural non-compliance. A representative from OPG responded that OPG has many layers of internal oversight, such as self-reporting and supervisor oversight, and noted that OPG has a corrective action program to ensure that such issues are addressed. The OPG representative stated that such events would be reported to direct supervisors, and, if necessary, through the organization to management. Noting that there is no such thing as a “small non-compliance,” CNSC staff responded that the CNSC inspectors would follow their compliance follow-up process and, if necessary, enforcement process, to ensure that such events are reported and addressed.

327. The Commission asked how OPG proposed to give updates to the Commission

following each refurbishment. A representative from OPG responded that the proposed update would include information relating to the execution of the refurbishment, whether there were any significant issues or concerns that arose during the refurbishment, and on key lessons learned that could be incorporated in the refurbishment of the subsequent unit. The OPG representative noted that OPG proposed to provide these updates in public meetings of the Commission. CNSC staff noted that it would also provide updates to the Commission in its annual report. Many intervenors suggested that the public should be invited to participate in the updates to the Commission.

3.16.4 Applicability of SCAs Related to Refurbishment

328. OPG provided information concerning the applicability of safety and control areas related to refurbishment. The safety and control areas were described in more detail earlier in this *Record of Proceedings*.

Management System for Refurbishment

329. OPG stated that it prepared program management plans to describe how the refurbishment would meet its Nuclear Management System and to identify any supplemental guidance or direction specific to undertaking refurbishment activities. OPG noted that contractors would be qualified under a process that would ensure that they meet the requirements outlined in CSA N286. OPG explained that principal contractors would be allowed to use their own quality program and manage quality to all applicable standards, and that they would report to OPG on agreed project metrics and implement improvements as required.

330. CNSC staff stated that it would continue to conduct regulatory oversight to ensure that OPG is providing the necessary measures for contractor oversight for the refurbishment project.

331. The Commission enquired about the application of the LCH and CNSC oversight in scenarios where some reactor units are operating and others are being refurbished. CNSC staff responded that physical boundaries would be in place between the units being refurbished and the rest of the units that are operating. CNSC staff noted that the OP&P include distinctions between the different operating states of the reactor units, such as for normal operation and refurbishment. CNSC staff further noted that once the Commission approves the IIP, the LCH and CNSC compliance verification criteria oversight would be focused on the IIP and the refurbishment progress would be measured against the IIP.

Human Performance Management for Refurbishment

332. OPG indicated that, in order to manage human performance, its personnel involved in the refurbishment would be subject to extensive field supervision, cultural and task specific training, job planning, rehearsal using the reactor mock-up, sound work procedures, oversight, and the implementation of a continuous improvement program. OPG noted that contractors would be required to have human performance programs that are equivalent to those established by OPG. In addition to the established OPG training requirements, OPG stated that refurbishment-specific training would be undertaken.

333. CNSC staff stated that it would verify OPG's oversight of contractor organizations during the refurbishment project as part of the compliance program. CNSC staff further stated that it was satisfied that OPG adequately detailed the activities and tasks necessary to fulfill the training requirements for the refurbishment project. CNSC staff noted that OPG would also be required to continue to maintain personnel certification, meet minimum shift complement requirements, and ensure worker fitness for duty, with CNSC staff verifying regulatory compliance.

334. Several intervenors, including individuals and the Canadian Coalition for Nuclear Responsibility, noted the importance of training to protect worker health and safety, particularly for contractors who may not have experience with radioactive work environments. Other intervenors, including the Power Workers' Union and the Society of Professional Engineers and Associates, expressed support for OPG's training programs. The Commission enquired about OPG's training for refurbishment activities. OPG described the measures it had in place, including the mock-up facility and training workers using full personal protective equipment. The OPG representative noted that all workers at the Darlington site would have training in the site's safety protocols, and that workers would also receive work-specific training. Regarding experience, an OPG representative noted that some OPG staff were directly involved with CANDU refurbishments, such as at the Point Lepreau and Bruce NGSs, and added that its contractors included experts who were also directly experienced in CANDU refurbishment projects. CNSC staff stated that it was satisfied with OPG's training programs, and noted that it would evaluate OPG's training of workers to ensure that OPG will meet requirements.

335. Mr. Bertrand, in his intervention, questioned whether OPG had sufficient workforce succession planning, given the long-term nature of the refurbishment project. The Commission asked OPG to describe its plans in this regard. A representative from OPG acknowledged that succession planning was important for the nuclear industry, and stated that OPG has a robust succession planning process in place, including knowledge management.

Operating Performance for Refurbishment

336. OPG stated that the Safe Operating Envelope of each reactor unit would be maintained at all times. OPG explained that the OP&P would be revised, as required, to reflect the unit and station unique configurations, and noted that, in all cases, the changes would be supported by the appropriate safety assessments and analysis and subject to CNSC notification or acceptance in accordance with the Darlington LCH. CNSC staff confirmed that any changes to the OP&P must be supported by assessment and analysis, and subject to CNSC notification or approval as required.

Safety Analysis for Refurbishment

337. OPG stated that all modifications to the Darlington NGS would be carried out in accordance with the OPG engineering change control process in order to ensure that there is no unintentional reduction in safety. OPG explained that this process would include steps requiring assessment against reactor safety criteria, including explicit consideration of impact on safety analysis. In addition, OPG stated that it would update its Operational Safety Requirements documentation and the OP&P to incorporate new or modified systems or components.

338. OPG noted that the 2015 DARA update included a sensitivity assessment for the risk improvements obtained from the Safety Improvement Opportunities. OPG further noted that the DARA would be updated to reflect the changes that have been implemented once all of the refurbished units are back on-line. CNSC staff confirmed that the PSA would be updated once all units were refurbished.

Physical Design for Refurbishment

339. OPG described the modification and design process for the refurbishment work and stated that it would ensure that contractors prepare the detailed design in accordance with OPG's Engineering Change Control Program and design management procedures. OPG noted that it would monitor and assess design activities to ensure that appropriate interfaces and oversight are maintained throughout the modification process, and stated that all design modifications would have to be accepted by OPG prior to being released for construction.

340. CNSC staff stated that it would be monitoring OPG's oversight and implementation of contractor's design processes during refurbishment as part of the compliance program. CNSC staff noted that a number of design-related codes and standards, associated effective dates and conditions have been established to ensure consistent and stable design requirements are applied throughout the refurbishment project.

Fitness for Service for Refurbishment

341. OPG submitted that it would perform surveillance and testing on equipment and systems that are put into a shutdown or lay-up state, in accordance with applicable equipment and system lay-up specifications. OPG noted that some components may be removed and subjected to special testing or inspections. OPG stated that the requirements for testing of removed components would be driven through OPG's Aging Management Program. CNSC staff stated that it would continue to provide regulatory oversight in this area as part of the CNSC compliance program.

Radiation Protection for Refurbishment

342. OPG expressed its commitment to execute the refurbishment in a manner consistent with OPG's safety values and objectives, as well as best industry practices. As such, contractors would follow OPG radiation protection procedures, including compliance with OPG's radiation protection action levels and administrative dose limits for the Darlington NGS. OPG stated that radiation protection field staff would oversee contractors and ensure that OPG Radiation Protection Program requirements are met.

343. OPG explained that, in addition to the normal OPG radiation protection practice, it would develop and implement strategies such as:
- routinely analyzing and reviewing radiological source terms associated with major system and components likely to interface with the refurbishment operations, in order to minimize the possibility of unforeseen radiation hazards;
- ensuring lessons learned from the first outage experience are documented and applied to subsequent outages to further reduce collective doses; and
- monitoring refurbishment work scope that may provide dose reduction benefits for continued operations, such as closure plug redesign, reactor component crud removal, radiation hot spot removal/remediation, and breathing air upgrades.

344. CNSC staff stated that, based on its assessment, it was satisfied that the implementation of OPG's radiation protection program during refurbishment activities will meet regulatory requirements and ensure adequate provision for the protection of persons from radiation at the Darlington NGS.

345. The Commission enquired about OPG's workforce requirements in relation to radiation protection. A representative from OPG responded that OPG would have a flexible workforce to allow its radiation protection department to expand as needed to support refurbishment while remaining within the overall framework of OPG's organization. CNSC staff stated that OPG is expected to continue to perform within the regulatory requirements of its existing framework.

346. The Commission enquired about the sharing of radiation protection information within the organization. A representative from OPG described the process under which OPG would assess radiation hazards and share information with specialists and workers prior

to beginning a specific task. The OPG representative noted that the information would be available so that workers can plan their activities with an understanding of the hazards, and that monitoring would continue during the work. CNSC staff stated that it would provide regulatory oversight and verify that OPG is following approved procedures.

347. Ms. Tilman, in her intervention, noted that there was a difference between the administrative annual doses to nuclear energy workers for OPG employees and contractors in the draft LCH. The Commission asked for more information concerning the administrative dose limits for workers. A representative from OPG responded that although there was a difference in the LCH, OPG planned to use the same administrative dose limits for both OPG workers and contractors during refurbishment, with a maximum dose of 18 mSv/y for all workers.

348. The Society of Energy Professionals, in its intervention, stated that a radiation protection committee was included in the planning for the refurbishment work. The Society of Energy Professionals explained that the committee was involved in setting the dose targets for the refurbishment activities in order to ensure that doses remain ALARA.

349. Several intervenors, including Dr. Greening and the Canadian Coalition for Nuclear Responsibility, referred to a 2009 event during the refurbishment of the Bruce A NGS where workers were exposed to alpha radiation, and expressed concerns that workers could be exposed to radiation hazards during refurbishment. A representative from OPG affirmed that OPG would take into account lessons learned from the nuclear industry, including the Bruce A NGS alpha event, and noted OPG's preparation, planning and training in this regard. An OPG representative stated that OPG's radiation protection program for refurbishment was extensive and included specific measures, including real-time monitoring, for alpha radiation and other hazards. CNSC staff stated that it was satisfied with OPG's radiation hazard control. Based on the information presented, the Commission is satisfied that OPG has appropriate measures in place to control radiation hazards during refurbishment.

Conventional Health and Safety for Refurbishment

350. OPG stated that the refurbishment activities would be undertaken in a manner consistent with the requirements set out in the OHSA. OPG noted that it would engage contractors that have proven health and safety programs. CNSC staff confirmed that refurbishment activities would be performed in accordance with the OHSA.

351. Dr. Greening, in his intervention, questioned whether there had been any injuries or "near-miss" incidents at the reactor mock-up facility. The Commission asked OPG to address this question. A representative from OPG responded that there had been one near-miss event relating to a safety harness not being properly fastened. The OPG representative noted that OPG and its contractors were meeting their safety targets.

352. The Society of Energy Professionals, in its intervention, highlighted OPG's health and safety programs, and noted the importance of the Joint Health and Safety Committee in ensuring a safe workplace. The Commission asked if there was a separate committee for the refurbishment project. A representative for the Society of Energy Professionals responded that the committee had not yet determined the best way to address the refurbishment, given the number of different workforces.

Environmental Protection for Refurbishment

353. OPG stated that it would oversee the environmental performance of its contractors, who would monitor their own compliance with all relevant environmental protection governance and procedures. OPG noted that it defined environmental requirements for refurbishment, including oversight criteria, and established an environmental review team as a key oversight mechanism.

354. OPG stated that it would establish spill prevention and contingency plans for contractor use, and noted that the station's Emergency Response Team would respond to any hazardous materials spills in accordance with current procedures. OPG further stated that it would require that contractors have a hazardous materials management plan that is in accordance with documented expectations and that complies with the OPG Health and Safety Framework for control and assessment of nonradioactive hazardous materials.

355. Lake Ontario Waterkeeper, in its intervention, expressed concerns regarding the potential environmental effects that refurbishment activities and the continued operation of the Darlington NGS could have on Lake Ontario. Lake Ontario Waterkeeper also noted that the lake ecosystem could change over time. The Commission asked for more information concerning the expected effects of refurbishment activities on fish and fish habitat. A representative from OPG responded that changes were not anticipated, and noted that the EA follow-up monitoring program would confirm this prediction. The OPG representative noted that the monitoring would allow OPG to respond should conditions in Lake Ontario change over time.

Emergency Management and Fire Protection for Refurbishment

356. OPG stated that it would ensure that personnel, programs and processes for emergency preparedness are integrated into refurbishment activities. OPG noted that contractors would follow the same procedures as OPG staff, and that additional assembly and accounting areas would be set up to accommodate refurbishment staff and contractors. CNSC staff stated that it would continue to monitor the application and management of the emergency preparedness program as part of the compliance program.

357. One intervenor suggested that the likelihood of an accident was greater during

refurbishment. In response to a question from the Commission, a representative from OPG stated that the risk of an accident during refurbishment was significantly reduced because the fuel would be removed from the reactor before any work would begin. CNSC staff concurred with OPG.

Waste Management for Refurbishment

358. OPG described the measures to manage the radioactive waste that would be generated during refurbishment activities. OPG noted that re-tube waste, including removed fuel channel components, would be packaged and transferred to a Re-tube Waste Storage Building, and stored for approximately 25 years. OPG further stated that this waste would then be transported to its Western Waste Management Facility, and eventually to OPG's proposed Low- & Intermediate-Level Waste (L&ILW) Deep Geological Repository (DGR).

359. OPG stated that, consistent with OPG's existing program for managing L&ILW, other L&ILW generated during the refurbishment outages would be collected and transported to the Western Waste Management Facility. OPG noted that it would continue to apply its waste reduction programs.

360. OPG stated that non-radioactive waste would be reused or recycled, and collected regularly by licensed contractors and transferred to appropriate off-site disposal facilities. OPG noted that any hazardous waste would be handled in accordance with applicable provincial regulations. OPG further noted that it would monitor all waste generated from within the station's radiological zones for radiation, in accordance with existing plant and regulatory requirements.

361. Several intervenors, including individuals, Beyond Nuclear and Northwatch, expressed concerns related to the amount of waste that would be generated during the refurbishment, and suggested that OPG did not have a plan for managing this waste. In response to a question from the Commission, a representative from OPG stated that OPG had a good understanding of the volume of waste expected to be produced during refurbishment, and that OPG has planned for this volume. The OPG representative noted that OPG would continue to review and update its plans to ensure that it retains sufficient capacity to manage it.

362. Northwatch also expressed concerns relating to the capacity of the IFBs to receive fuel waste during operation and refurbishment, including contingencies. The Commission asked for more information on this subject. A representative from OPG responded that OPG had sufficient capacity available for over 10 full reactor cores, and noted that OPG manages its fuel in a continuous and forward-looking way in order to maintain sufficient capacity. The OPG representative added that OPG had upgraded the IFB heat exchangers to manage the additional heat load from the fuel. CNSC staff stated that it was satisfied that OPG had sufficient capacity available for refurbishment.

363. Beyond Nuclear, in its intervention, suggested that there was a conflict of interest for the CNSC to be reviewing the operation and proposed life extension of the Darlington NGS while participating in a federal EA for a long-term waste facility because there would be interdependency between the two facilities. CNSC staff stated that interdependency did not represent a conflict of interest. The Commission is satisfied that this allegation is groundless. The Commission notes that neither the Commission Members nor any of the CNSC staff operate any of the facilities that they regulate, and that the role of the CNSC under the NSCA means that it regulates every stage of every nuclear facility. It is, in the Commission's view, somewhat nonsensical to allege that the CNSC would have an interest in a nuclear power plant licensee operating more in order to generate more waste, because the CNSC regulates waste management facilities.

364. CNSC staff expressed satisfaction with OPG's plans for waste management, and noted that the Re-tube Waste Storage Building, located on OPG property adjacent to the Darlington Waste Management Facility, is licensed separately from the Darlington NGS under the Darlington Waste Management Facility Operating Licence.

Security for Refurbishment

365. OPG stated that its Nuclear Security Program would continue to be in effect for all refurbishment activities, which would ensure the consistent application of security measures to all areas of the Darlington NGS site. OPG explained that its nuclear security team is engaged with all projects being executed at the Darlington NGS site ensuring that existing security systems remain unimpeded and operational, and that required changes to security systems or new security requirements are applied to maintain full compliance with the *Nuclear Security Regulations*.

366. OPG described security measures, including updated personnel screening equipment, vehicle searches, and the Refurbishment Project Office. OPG noted that the existing Physical Barrier System would be extended to the north side of the Refurbishment Project Office building, extending the facility's overall protected area.

367. OPG stated that security staffing requirements would increase to meet the needs of the station and refurbishment work that will be conducted at Darlington NGS, and noted that it would review and update its threat assessment to include changes being made in support of the refurbishment. OPG further noted that an access authorization process would be followed to ensure that personnel and contractors do not pose a risk to the facility, its employees or company assets. CNSC staff expressed satisfaction with OPG's security program and its applicability to refurbishment.

Safeguards and Non-Proliferation for Refurbishment

368. OPG stated that it would provide required routine and advance notifications and

declarations to the IAEA of re-tube outage dates and details related to defueling, initial core loading, and maintenance work which may interfere with the functionality of safeguarded equipment.

369. CNSC staff stated that OPG would be required to continue to implement its program that ensures the effective implementation of both safeguards measures and nuclear non-proliferation commitments with respect to Canada's international obligations, including submitting all necessary accountancy and operational reports. CNSC staff noted that the IAEA would continue to undertake inspections at the Darlington NGS, including those relating to the verification of changes to the reactors and/or site during refurbishment.

Packaging and Transport for Refurbishment

370. OPG stated that it would continue to implement its packaging and transport program during refurbishment. OPG explained that re-tube waste will be packaged in purpose-built containers and transferred via truck to the Re-tube Waste Storage Building. CNSC staff expressed satisfaction regarding the applicability of OPG's packaging and transport program to refurbishment.

3.16.5 Return to Service

371. CNSC staff stated that RD-360 requires that the licensee establish a return to service plan for the refurbishment project. CNSC staff explained that return to service involves returning the reactor to commercial operation – post-refurbishment – and includes demonstration that the associated work meets specified requirements and management arrangements have been updated appropriately. As outlined in RD-360, return to service is accomplished through four commissioning phases:

1. Phase A: Focuses on ensuring that those systems required to ensure safety with fuel loaded in the reactor have been adequately commissioned. This phase must be successfully completed prior to loading the fuel in the reactor;
2. Phase B: Focuses on ensuring the fuel is loaded in the reactor safely, and confirming that the reactor is in a suitable condition to be started up and that all prerequisites for permitting the reactor to go critical have been met. This phase must be successfully completed prior to removal of the guaranteed shutdown state;
3. Phase C: Focuses on confirming reactor behavior at the state of initial criticality and subsequent low power tests, and includes activities that cannot be done during GSS; and
4. Phase D: Focuses on demonstrating reactor and systems behavior at higher power levels, including activities that could not be carried out at the power levels in Phase C.

372. CNSC staff noted that return to service and commissioning would be achieved through the accomplishment of a number of milestones, including regulatory hold points, which

are typically aligned with the four phases of commissioning. CNSC staff identified the following four regulatory hold points for the return to service of each unit undergoing refurbishment:

1. prior to fuel load;
2. prior to guaranteed shutdown state removal;
3. prior to exceeding 1 percent full power; and
4. prior to exceeding 35 percent full power.

373. CNSC staff explained that these hold points would serve as regulatory verification to ensure operational readiness of the plant safety systems to support full power operation, and satisfy regulatory requirements for staged increases in reactor power. CNSC staff noted that similar hold points had been selected for the Point Lepreau NGS and Bruce Power Units 1 and 2 refurbishment projects.

374. OPG stated that it had a return to service program management plan that described the processes, procedures and organization to be used by OPG to manage the commissioning and restart activities of the refurbished Darlington units. CNSC staff stated that this plan, which described the return to service phases and hold points that would be used to ensure that pre-requisite activities have been completed and that the required approvals have been obtained prior to transitioning from one state to another, was in accordance with RD-360 requirements.

375. CNSC staff recommended that approval to remove regulatory hold points be delegated to the Executive Vice President and Chief Regulatory Operations Officer, Regulatory Operations Branch. CNSC staff noted that the Commission had previously granted similar delegation of authority for the Bruce Power NGS Units 1 and 2 and the Point Lepreau NGS refurbishment projects. CNSC staff explained that approval to remove a hold point would be contingent on OPG's submission of completion assurance documentation, which provides evidence that all prerequisite commitments have been met. CNSC staff further noted that pre-requisite commitments for each regulatory hold point were included in the draft LCH.

376. CNSC staff stated that it would use the process for releasing a regulatory hold point that was successfully used for the Bruce Power NGS Units 1 and 2 and the Point Lepreau NGS refurbishment projects. CNSC staff explained that, prior to the release of the hold point, it would verify compliance and provide a report to the Executive Vice President and Chief Regulatory Operations Officer, Regulatory Operations Branch. Based on the review of this report, the Executive Vice President and Chief Regulatory Operations Officer, Regulatory Operations Branch would issue a record of decision.

377. CNSC staff committed to updating the Commission on the status of the refurbishment project as part of the annual Regulatory Oversight Report. CNSC staff noted that the Commission could provide the public with the opportunity to participate in the proceedings when this report is presented to the Commission each year. CNSC staff stated that it would continue to update the Commission on the performance of the Darlington NGS, including refurbishment, as part of the routine status reports on power

reactors and through event initial reports as necessary. OPG also committed to appear before the Commission following the completion of each unit's refurbishment outage.

378. The Commission, noting that OPG had different hold points in its submission, asked for clarification in this regard. A representative from OPG responded that OPG had established nine Restart Control Hold Points, of which four were regulatory hold points from the CNSC.

3.16.6 Conclusion on Refurbishment and Life Extension

379. The Commission is satisfied that the EA requirements have been met for the purpose of the proposed refurbishment and continued operation of the Darlington NGS. The Commission is satisfied that OPG has adequate programs in place to safely carry out the proposed refurbishment. The Commission accepts the IIP proposed by OPG and accepted by CNSC staff. The Commission notes that this includes the implementation of the follow-up monitoring program for the EA for the proposed refurbishment. As such, the Commission expects CNSC staff to report to the Commission if the predictions of the EA are not being confirmed.

380. Based on the above information, the Commission concludes that OPG is qualified to carry on the proposed refurbishment project. The Commission is of the opinion that OPG, in carrying on that activity, will make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

381. The Commission delegates to the Executive Vice President and Chief Regulatory Operations Officer, Regulatory Operations Branch, the authority for the removal of regulatory hold points for the return to service of the refurbished reactor units.

3.17 Improvement Plans and Significant Future Activities

382. OPG provided information concerning planned improvements at the station, including an update on the status of the Fukushima Action Items. CNSC staff stated that it was satisfied with OPG's proposed station improvement initiatives for the Darlington NGS. CNSC staff reported that OPG's proposed improvements to the plant and the site infrastructure were comprehensive, and noted that it would continue to monitor the implementation of OPG's improvement initiatives as part of the compliance program.

3.17.1 Integrated Implementation Plan and Safety Improvement Opportunities

383. As discussed in the Refurbishment and Life Extension section of this *Record of Proceedings,* OPG has completed an ISR, GAR, and IIP, as set out in CNSC regulatory

document RD-360. CNSC staff proposed that completion of the IIP actions be included as a licence condition.

384. The IIP includes the implementation of the safety improvement opportunities that OPG committed to install as part of the EA for the Darlington refurbishment and continued operations. OPG selected the safety improvement opportunities for implementation using risk insights gained from PSA to improve overall safety margins and increase plant robustness to cope with severe beyond design basis accidents. The safety improvement opportunities include the following:
    - Containment Filtered Venting System;
    - Shield Tank Overpressure Protection;
    - a third Emergency Power Generator;
    - Powerhouse Steam Venting System enhancements; and
    - an independent source of emergency water supply to the heat transport system.

3.17.2 Other Station and Site Infrastructure Improvements

385. OPG stated that it was making further improvements to the plant and to the site infrastructure to improve station reliability and to support the refurbishment project, including:
    - inspections and repairs of the four turbine generator sets and the replacement of analog control systems with new digital control systems;
    - mechanical cleaning, water lancing, inspection and maintenance work of the steam generators;
    - construction of a new heavy water storage facility;
    - replacement of the existing auxiliary building heating system;
    - construction of a re-tube waste processing and storage building;
    - replacement of the existing water treatment plant;
    - construction of new shop and office facilities to support refurbishment activities; and
    - improvements in site infrastructure such as sewer, water, electrical power distribution and site roads to support the new facilities.

386. CNSC staff stated that OPG's improvement plans to the station and to the site infrastructure were comprehensive, and noted that CNSC staff would continue to monitor the station and site infrastructure improvement initiatives as part of the compliance program.

3.17.3 Fukushima Action Items

387. OPG stated that all of the Fukushima Action Items in response to lessons learned from the Fukushima nuclear accident had been closed at the Darlington NGS, the first NPP licensee in Canada to have done so. OPG noted that this included strengthening reactor defence-in-depth and enhancing its emergency response capabilities at the Darlington

NGS.

388. The Commission noted that some of the Fukushima Action Items would be completed during the refurbishment and questioned why OPG stated that they had all been closed. A representative from OPG responded that OPG had met the closure criteria for all of the Fukushima Action Items but acknowledged that work remained to implement them. CNSC staff noted that it would continue to monitor the implementation through compliance verification.

3.17.4 Conclusion on Improvement Plans and Significant Future Activities

389. The Commission is satisfied that the proposed improvements will lead to enhanced safety at the Darlington NGS.

3.18 Aboriginal Engagement and Public Information

3.18.1 Aboriginal Engagement

390. The common law duty to consult with Aboriginal groups applies when the Crown contemplates actions that may adversely affect potential or established Aboriginal and/or treaty rights. The CNSC, as an agent of the Crown and as Canada's nuclear regulator recognizes and understands the importance of building relationships and consulting with Canada's Aboriginal peoples. The CNSC ensures that all of its licensing decisions under the NSCA uphold the honour of the Crown and considers Aboriginal peoples' potential or established Aboriginal and/or treaty rights pursuant to section 35 of the *Constitution Act, 1982*[36].

391. CNSC staff noted that the proposed licence renewal involved activities occurring on an existing fenced-in site with restricted access. Based on previous requests to be kept informed of activities at the Darlington NGS and through CNSC staff research, CNSC staff identified the following First Nation and Métis groups as having an interest in the licence renewal application:

- Williams Treaties First Nations (Alderville First Nation, Chippewa Indians of Christian Island (Beausoleil First Nation), Chippewa Indians of Georgina Island, Curve Lake First Nation, Chippewa Indians of Rama First Nation, Hiawatha First Nation (Mississauga Indians of Rice Lake), Mississauga Indians of Scugog Island First Nation);
- Mississaugas of the New Credit First Nation;
- Mohawks of the Bay of Quinte;
- Saugeen Ojibway Nation (SON) (Saugeen First Nation and the Chippewas of Nawash Unceded First Nation);
- Association of Iroquois and Allied Indians;

[36] *Constitution Act, 1982*, Schedule B to the *Canada Act 1982*, 1982, c. 11 (U.K.).

- Six Nations of the Grand River;
- Chiefs of Ontario;
- Union of Ontario Indians; and
- Métis Nation of Ontario (MNO).

392. CNSC staff stated that Aboriginal groups who may have an interest in the licence renewal application were identified early in the review process, provided with information about the project, encouraged to participate in the Commission's public hearing, and to apply for funding through CNSC's Participant Funding Program. CNSC staff stated that since the Commission public hearing in December 2012 regarding the EA for the proposal to refurbish and continue to operate the Darlington NGS, no related issues or concerns related to impacts on Aboriginal and/or treaty rights had been raised by the identified First Nation and Métis groups during CNSC staff consultation activities. CNSC staff further stated that, based on the information received and reviewed to date, CNSC staff were of the opinion that this licence renewal application will not cause adverse impacts to any potential or established Aboriginal and/or treaty rights. The identified First Nation and Métis groups were encouraged to participate in the licence renewal application review process and in the Commission public hearing to advise the Commission directly of any concerns they may have in relation to this licence application.

393. CNSC staff described the ways by which it informed these groups of the EA follow-up monitoring program for the refurbishment and continued operation of the Darlington NGS, as well as of the licence renewal application. CNSC staff stated that it sent notices and requests for comments on the draft EA follow-up monitoring program in July 2013, but noted that no comments were received from any of the groups. CNSC staff stated that it also sent letters of information in March 2014 that included information on the licence renewal application, availability of funding through CNSC's Participant Funding Program, and encouraged groups to advise the CNSC of views they may have in relation to this licence renewal application. CNSC staff noted that it also conducted follow-up phone calls with the groups.

394. CNSC staff reported that it had not been made aware of any concerns from the identified Aboriginal groups in relation to the subsection 35(2) *Fisheries Act* authorization issued by DFO. CNSC staff stated that it would continue to share information with DFO on issues or concerns raised by Aboriginal groups through its Aboriginal consultation activities with respect to this authorization.

395. CNSC staff also provided information regarding its meetings with Aboriginal groups. CNSC staff explained that it met with the Williams Treaties First Nations on June 17, 2014, and with the Mississaugas of the New Credit First Nation on July 18, 2014 in order to discuss the Darlington NGS licence renewal application. In addition, CNSC staff stated that it participated in a day-long session hosted by OPG in April 2015, with representatives of the Williams Treaties First Nations, the Mississaugas of the New Credit First Nation, the Mohawks of the Bay of Quinte and the Métis Nation of Ontario at the Darlington NGS to provide an update on the Darlington NGS licence renewal

process and discuss any concerns that the groups may have in relation to the licence renewal application.

396. CNSC staff stated that the identified Aboriginal groups raised concerns including the licence period requested by OPG (i.e. the longer licence period could reduce the number of meaningful opportunities to participate for Aboriginal communities), the period of time provided to the public to review CMDs and the desire to be more involved in OPG and/or CNSC environmental monitoring programs. CNSC staff noted that no concerns were raised directly related to impacts on potential or established Aboriginal and/or treaty rights. CNSC staff affirmed its commitment to continue to engage with the identified First Nation and Métis groups.

397. The Mohawks of the Bay of Quinte, in their intervention, presented findings from an environmental review of OPG's application. The Mohawks of the Bay of Quinte also discussed findings from an Aboriginal information session they attended that was held by OPG at the Darlington Information Centre in April 2015. The Mohawks of the Bay of Quinte requested that OPG enhance its environmental monitoring program to reflect Aboriginal interests. The Commission enquired about this matter. A representative from OPG responded that OPG was planning to expand its program to include traditional plants and harvest goods, and noted that OPG would work with Aboriginal communities to ensure that the program includes goods important to them. CNSC staff stated that they were reaching out to Aboriginal groups to introduce them to the IEMP and encourage their participation, and noted that CNSC staff is available to meet with Aboriginal groups to discuss the program and its results.

398. The Mohawks of the Bay of Quinte also commented on the period of time to review CMDs for the public hearing, stating that 30 days was not sufficient. The Commission asked for further information concerning this position. The Mohawks of the Bay of Quinte expressed the view that a 90-day period would be reasonable. The Commission notes that intervenors had more than 60 days to review OPG's submission and CNSC staff's recommendations, from July 20, 2015 to September 28, 2015, the deadline for submissions from intervenors.

399. In their intervention, the Mississaugas of the New Credit First Nation reported that they were engaged in positive and substantive discussions with OPG regarding their concerns relating to the impacts of the Darlington NGS on their rights and interests. The Mississaugas of the New Credit First Nation noted that they also had a positive relationship with CNSC staff. The Mississaugas of the New Credit First Nation expressed that they expect meaningful engagement with DFO and CNSC specific to consultation and accommodation processes for impacts of the Darlington NGS on fish. The Mississaugas of the New Credit First Nation also expressed that they expect to have the opportunity to review and comment on environmental monitoring and compliance reports. The Mississaugas of the New Credit First Nation also expressed an interest in ongoing discussions relating to waste management.

400. The Commission asked if the Mississaugas of the New Credit First Nation were

satisfied with OPG's performance regarding emissions. A representative of the Mississaugas of the New Credit First Nation responded that they were comfortable that OPG was doing everything possible to mitigate impacts on their aboriginal and treaty rights, specifically with emissions but also generally with the overall operation of the Darlington NGS.

401. The Commission enquired about OPG and CNSC staff's engagement with the Mississaugas of the New Credit First Nation. A representative from OPG responded that OPG has a sustained, positive relationship with the Mississaugas of the New Credit First Nation that works with an open dialogue on issues of common interest. CNSC staff stated that they have a meaningful, two-way dialogue with the Mississaugas of the New Credit First Nation, including sharing information and learning about their territory and cultural practices. CNSC staff noted that their discussions have also included opportunities to participate in the CNSC's independent environmental monitoring program.

3.18.2 Public Information

402. A public information and disclosure program (PIDP) is a regulatory requirement for licence applicants and licensed operators of Class I nuclear facilities. Paragraph 3(*j*) of the *Class I Nuclear Facilities Regulations*[37] requires that licence applications include "the proposed program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environment and the health and safety of persons that may result from the activity to be licensed."

403. OPG described its public information and community relations program and stated that it shares information regarding its operations and plans, as well as anticipated effects on the environment and the health and safety and persons that may result from licensed activities. CNSC staff reported that OPG has a well-established PIDP that meets the specifications of RD/GD 99.3, *Public Information and Disclosure*, and that ensures that information is effectively communicated to the public.

404. CNSC staff explained that it reviewed OPG's annual report on the implementation of its PIDP and identified a number of best practices, including the dissemination of information pertaining to the licence renewal process and refurbishment activities through various means, including tours of the Darlington Energy Complex, a training facility built for the refurbishment of Darlington, and the distribution of a Nuclear Safety Guide to provide information about what to do in the unlikely event of a nuclear emergency. CNSC staff noted that it would continue to assess and monitor OPG's program.

405. Several intervenors, including individuals, Greenpeace, Durham Nuclear Awareness and Northwatch, stressed the importance of publically available information. The

[37] SOR/2000-204.

Commission enquired about the availability of information for intervenors. A representative from OPG responded that relevant documents for the hearing process were posted on the OPG website, as well as those for the previous EA. In addition, the OPG representative stated that OPG provides opportunities for the public to visit its visitor centre and the Darlington Energy Complex, and that OPG participates in public meetings, such as for the Darlington Community Advisory Council, the Durham Nuclear Health Committee, and municipal council. The OPG representative added that OPG was open to providing specific information to the public if requested, but cautioned that certain information was not available for security reasons. CNSC staff stated that it was also open to providing information to the public, and noted that comprehensive information is available on the CNSC website.

406. The Commission enquired about ways to provide clear technical information to the public without compromising sensitive information. CNSC staff stated that summary documents were a useful way to provide this information.

407. Several intervenors, including the Darlington Community Advisory Council, Clarington Board of Trade and Office of Economic Development, and other community organizations expressed support for OPG's public information program. One intervenor expressed the view that both OPG and the CNSC need to do a better job of engaging youth. The Commission asked for more information concerning OPG's programs for engaging with the community. A representative from OPG responded that the Darlington Community Advisory Council is a key forum through which OPG relates to the community, in addition to the tours of the Darlington Energy Complex, open houses and local newsletters. An OPG representative noted that OPG also holds events in communities, and uses different platforms, such as social media, in order to reach a wider audience.

408. Durham Nuclear Awareness, in its intervention, presented information relating to a community poll that included a question on preferred ways to engage residents in the community. Durham Nuclear Awareness stated that while mail was the most cited response, respondents also preferred a face to face approach, including public meetings, facility tours, and school visits. Regarding emergency preparedness, Durham Nuclear Awareness stated that the majority of respondents were not prepared for a nuclear emergency. The Commission asked OPG to comment on this matter. An OPG representative acknowledged that emergency preparedness on the whole was a challenge for the general population, and particularly for nuclear emergencies because the perception of risk is low. The OPG representative stated that OPG was working with the Region of Durham and the City of Toronto on effective emergency preparedness communications, and expressed optimism that the recent KI pills distribution led to improved awareness. A representative from OPG added that OPG would review the survey to identify areas for improvement.

409. The Commission asked OPG how it planned to communicate the status of the refurbishment project to the public. An OPG representative responded that OPG would establish a process to do so via the internet, while continuing its public outreach

activities, including a viewing gallery for the reactor mock-up.

3.18.3 Conclusion on Aboriginal Engagement and Public Information

410. Based on this information, the Commission is satisfied that OPG's public information program meets regulatory requirements and is effective in keeping Aboriginal communities and the public informed of facility plans and operations. The Commission encourages OPG to continue to maintain and improve its dialogue with the neighbouring communities.

411. The Commission recognizes the public's interest in up-to-date information, as well as more technical information. The Commission expects OPG to make clear summaries of technical information available to assist the public, including all references in licence applications. The Commission also expects OPG to make new information more accessible, and to be proactive in providing it to the public.

412. While the Commission appreciates the effort required on the part of intervenors to review the information submitted at the hearing, the Commission is of the view that the length of time between the availability of CMDs from OPG and CNSC staff and the interventions deadline (more than two months) is acceptable.

413. The Commission acknowledges the efforts made by CNSC staff in relation to the CNSC's obligations regarding Aboriginal consultation and the legal duty to consult. The Commission is satisfied that the proposed licence renewal will not cause any adverse impacts to any potential or established Aboriginal or treaty rights and that the engagement activities undertaken for this licence renewal were adequate.

3.19 Decommissioning Plans and Financial Guarantee

414. The Commission requires that licensees have operational plans for decommissioning and long-term management of waste produced during the life-span of the facility. In order to ensure that adequate resources are available for safe and secure future decommissioning of the Darlington NGS, the Commission requires that an adequate financial guarantee for realization of the planned activities is put in place and maintained in a form acceptable to the Commission throughout the licence period.

415. The Darlington NGS PROL requires OPG to maintain a financial guarantee for the future decommissioning of the Darlington NGS that is acceptable to the Commission. CNSC regulatory guides G-219, *Decommissioning Planning for Licensed Activities*, and G-206, *Financial Guarantees for Decommissioning of Licensed Activities*, provide guidance on calculating the financial guarantees.

416. OPG maintains a consolidated financial guarantee for decommissioning its Ontario assets, including the Darlington NGS, the Bruce A and B NGS, the Pickering NGS, as

well as the Darlington, Pickering and Western Waste Management facilities. Based on OPG's most recent annual report for the 2013-2017 CNSC Financial Guarantee, the total value of the available financial guarantee stands at $17,004 million. The financial guarantee for these facilities, which was accepted by the Commission in 2012, includes:

- segregated funds established pursuant to the Ontario Nuclear Funds Agreement (ONFA) between OPG and the Province of Ontario (the "ONFA Funds");
- the trust fund for the management of spent fuel established pursuant to the Nuclear Fuel Waste Act (the "NFWA Trust"); and
- the Provincial Guarantee pursuant to the Provincial Guarantee Agreement between the CNSC and the Province of Ontario.

417. CNSC staff reported that the financial guarantee was in effect and sufficient to fund the future decommissioning of OPG's Class I facilities as anticipated by its Decommissioning Plans. OPG is required to review and revise the Decommissioning Plans, the associated cost estimates and the proposed financial guarantee by June 30, 2017, for the next five-year cycle. CNSC staff stated that it was satisfied that OPG's financial guarantee meets the guidance as set out in CNSC Regulatory Guide G-206.

418. Some intervenors, including the National Farmers Union – Waterloo Wellington Local and the Ontario Sustainable Energy Association, expressed concerns regarding decommissioning and waste management costs being a burden for future generations. In response to a question from the Commission, a representative from OPG stated that the costs did not represent a burden for future generations, explaining that the OPG decommissioning fund was fully funded, including costs for future fuel waste disposal, and noting that it would continue to be maintained through detailed reviews in accordance with CNSC requirements. CNSC staff concurred with OPG and noted that, in addition to the five-year review cycle, any major changes to OPG's operations would also necessitate a review of the decommissioning plan and financial guarantee.

419. Based on this information, the Commission considers that the preliminary decommissioning plans and related financial guarantee are acceptable for the purpose of the current application for licence renewal. The Commission is satisfied that these plans, and the financial means in place to pay for them, will avoid burdening future generations.

3.20 Cost Recovery

420. It is a requirement of the NSCA under paragraph 24(2)(*c*), that the licence application is accompanied by the prescribed fee. The *Canadian Nuclear Safety Commission Cost Recovery Fees Regulations*[38] set out the specific requirements based on the activities to be licensed. CNSC staff reported that OPG was in good standing with respect to Cost Recovery Fees Regulations requirements for the Darlington NGS, and that, based on

[38] SOR/2003-212.

OPG's performance, there were no concerns over payment of future cost recovery fees.

421. The Commission is satisfied that OPG has met the requirements of the *Cost Recovery Fees Regulations* for the purpose of its licence application.

3.21 Nuclear Liability Insurance

422. As required under subsection 15(1) of the *Nuclear Liability Act*[39], the "operator shall, with respect to each nuclear installation of which he is the operator, maintain with an approved insurer insurance against the liability imposed on him by this Act, consisting of:
(a) basic insurance for such term and for such amount not exceeding seventy-five million dollars as may be prescribed with respect to that nuclear installation by the Canadian Nuclear Safety Commission, with the approval of the Treasury Board, and
(b) supplementary insurance for the same term and for an amount equal to the difference, if any, between the amount prescribed under paragraph (a) and seventy-five million dollars, and containing such terms and conditions as are approved by the Minister."

423. CNSC staff stated that it was satisfied with OPG's provision to fulfill its obligation under the *Nuclear Liability Act*. CNSC staff explained that, under policy OF021, the Nuclear Insurance Association of Canada had provided a limit of liability of $50 million and under policy EL031CA14, the European Liability Insurance for Nuclear Industry had provided a limit of liability of $25 million. CNSC staff further stated that this policy is valid from January 1, 2015 to January 1, 2016, unless amended or cancelled, and it is expected to continue to be renewed each year, consistent with past practice, so long as the *Nuclear Liability Act* remains in force.

424. Several intervenors, including individuals, and Citizens for a Safe Environment and The Committee for Safe Sewage, expressed concerns relating to the potential cost of a nuclear accident, and expressed the view that the $75 million under the *Nuclear Liability Act* was not sufficient. A representative from OPG responded that the Government of Canada had recently reviewed the amount covered under the *Nuclear Liability Act*, and stated that the new *Nuclear Liability and Compensation Act*[40] was expected to come into force in 2016. The new Act received Royal Assent in 2015 and will come into force when regulations are made, likely in 2016. CNSC staff explained that the new Act would require insurance starting at $650 million, moving up to $1 billion over a three-year period.

425. The Commission is satisfied that OPG has fulfilled its obligation under the *Nuclear Liability Act*.

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[39] R.S.C. , 1985, c. N-28.
[40] S.C. 2015, c. 4, s. 120.

3.22 Licence Term and Conditions

3.22.1 Licence Term

426. OPG requested a 13-year licence term, to December 1, 2028, in order to cover the refurbishment of the four units and the completion of the IIP commitments. OPG acknowledged that this would be a longer licence term than has been traditionally granted to a Canadian licensee. OPG's rationale for requesting a longer licence was based on the completion of the ISR and allowance of sufficient time to complete the proposed refurbishment outages and other IIP commitments on all units within a single licence term. OPG explained that its plan would result in the completion of IIP commitments for Unit 4 in 2028. In support of its request for a longer licence term, OPG committed to appearing before the Commission at the end of each refurbishment outage, in addition to its annual appearance before the Commission for the annual Regulatory Oversight Report.

427. CNSC staff recommended a licence period of 10 years, to December 31, 2025. CNSC staff explained that this was consistent with its recommendation outlined in CMD 15-M12[41], which introduced PSRs to the CNSC regulatory framework. CNSC staff noted that it had recommended transitioning to operating licences for NPPs that are valid for 10 years, as compared to the current five-year licence period, and a PSR done every 10 years to coincide with licence renewals. CNSC staff noted that this recommendation was more in line with the international practice of longer licence terms.

428. CNSC staff noted that the length of a licence term does not impact the effectiveness of CNSC staff's compliance program or the authority of the Commission to amend, suspend, revoke or replace the licence including the establishment of new licence conditions at any time. CNSC staff stated that it would continue to update the Commission on the performance of the Darlington NGS, including updates on the refurbishment project and completion of IIP commitments, as part of the annual Regulatory Oversight Report. CNSC staff further stated that it would also continue to update the Commission on the performance of the Darlington NGS as part of the routine status reports on power reactors and through event initial reports as necessary.

429. Many intervenors, including individuals, Greenpeace and the Green Party of Ontario, expressed concerns regarding the 13-year licence period requested by OPG. These intervenors expressed the view that this timeframe was unprecedented for NGSs in Canada, and that it would result in fewer opportunities for the public to scrutinize OPG's operations and the refurbishment project. Intervenors were also concerned that this could result in relaxed regulatory oversight. Many intervenors requested that the Commission grant a licence term of no more than five years.

430. Some intervenors, including individuals, businesses, Canadian Nuclear Workers Council, Women in Nuclear Canada, the Canadian Nuclear Association, the Clarington Board of Trade and Office of Economic Development, the Regional Municipality of

[41] Refer to the Minutes of the Canadian Nuclear Safety Commission Meeting held on March 25 and 26, 2015.

Durham, supported OPG's request for a 13-year licence. Some intervenors, including the Society of Energy Professionals and the Power Workers' Union, supported the 10-year licence term proposed by CNSC staff.

431. The Commission sought further information from OPG and CNSC staff regarding the licence term. A representative from OPG stated that it was OPG's preference to execute its refurbishment plans within the scope of one licence in order to ensure consistency in the refurbishment process. The OPG representative expressed that it would be safer to proceed under "regulatory certainty." CNSC staff acknowledged that a shorter licence period would require OPG to undergo an additional licence renewal application, however, CNSC staff was of the opinion that this would not affect safety. CNSC staff affirmed that safety and regulatory oversight would be continuous but noted that a longer licence period would allow CNSC staff to focus on regulatory oversight and inspections rather than licensing.

432. A number of intervenors questioned OPG's request for "regulatory certainty", noting that regulatory requirements could change at any time, regardless of the licence term. The Commission asked OPG to clarify its position in this regard. An OPG representative acknowledged that regulatory requirements can evolve with time, and stated that OPG would manage any changes as necessary. CNSC staff confirmed that the licensing term is not a regulatory tool, and stated that licensing actions can be taken at any time, if necessary. CNSC staff noted that regulatory codes, standards and practices may change and that these would be reviewed and implemented accordingly.

433. The Commission sought insight concerning shorter licence periods. A representative from OPG responded that shorter licence periods would require additional licence renewal processes, which could result in a shift in regulatory expectations that could influence the project planning for refurbishment. The OPG representative stressed the importance of planning to ensure that the project is executed safely. Another OPG representative noted that OPG's licence application included the ISR and IIP, which detailed OPG's planning for the next 13 years, and as a result, there would not be a need for OPG to make a new application within that timeframe. The OPG representative explained that, following the PSR framework from the CNSC, OPG would prefer to complete the current plan before undertaking the next PSR.

434. CNSC staff explained that the intention of the PSR framework is to have a single site-wide IIP under implementation. CNSC staff stated that it selected the 10-year licence term in order to fit into the PSR framework, and explained that once the IIP has been approved by the Commission, it would form the basis of a safety case that would be valid for 10 years. CNSC staff noted that regardless of licence term, OPG would be expected to begin its next PSR within the 10-year timeframe, and, at a minimum, present a basis document for its next PSR. CNSC staff further stated that it would expect that the next PSR and IIP be considered in a public proceeding of the Commission.

3.22.2 Licence Conditions

435. CNSC staff recommended that the following conditions, specific to refurbishment and life extension, be included in the proposed licence:
- a condition requiring OPG to implement the IIP resulting from the ISR and the CEAA EA;
- a condition requiring OPG to implement a return to service plan for refurbishment activities;
- a condition requiring OPG to perform a PSR in accordance with REGDOC-2.3.3, *Periodic Safety Reviews*, in support of OPG's next licence application;
- a condition requiring OPG to obtain the approval of the Commission, or consent of a person authorized by the Commission, prior to the removal of established regulatory hold points during return to service.

436. CNSC staff noted that these proposed conditions were included in the proposed licence and additional details were contained in the draft LCH.

437. Regarding the licence condition relating to REGDOC-2.3.3, CNSC staff explained that REGDOC-2.3.3 superseded regulatory document RD-360, built upon the ISR process outlined in RD-360 and included a requirement for a safety review to be completed every 10 years throughout the lifetime of a nuclear power plant. CNSC staff noted that the ISR performed by OPG in accordance with RD-360 was considered to be equivalent to the first PSR.

438. During its presentation at Part 2 of the hearing, CNSC staff proposed that OPG be required by licence condition to commence implementation of a site-wide PSR process in accordance with REGDOC-2.3.3 during the proposed licence period. CNSC staff further explained that the PSR process would require OPG submission and CNSC staff acceptance of a PSR basis document, safety factor reports, a GAR and an IIP. CNSC staff stated that the intent is to provide a seamless transition from the refurbishment IIP to the PSR IIP, and noted that the future PSR IIP, which would likely be reviewed in a subsequent licence renewal application, would require Commission approval in a public proceeding.

439. The Commission sought more details on reporting and the introduction of PSRs. CNSC staff responded that, following international trends where some countries issue 10-year, 40-year, or indefinite licences, CNSC staff recommended an evolutionary approach with the transition to 10-year licences that include PSRs and annual reporting. CNSC staff noted that this recommendation would provide an opportunity for the public to actively participate during annual regulatory oversight reporting, PSR or through the licence renewal process. CNSC staff explained that the PSR process would have four steps that would be performed during these 10-year cycles. The first step is to document the codes, standards and practices against which OPG would do the assessment. This step would be followed by a technical assessment called the safety factor review. The third step would be the generation of a GAR that would summarize

all necessary actions that would be included in an IIP. As the final step of the process, with an opportunity for the public to participate, the IIP would be submitted to the Commission for its approval.

440. One intervenor questioned the proposed wording of licence condition 15.2, "The licensee shall implement a return to service plan for refurbishment," and suggested that this meant that OPG would not be in compliance with its licence if it does not refurbish the Darlington NGS. CNSC staff explained that the licence condition requires that OPG implement a return to service plan in order to restart a reactor unit following refurbishment. The Commission is satisfied that the licence condition pertains to the return to service of a refurbished reactor unit, and that the licence condition does not require that OPG refurbish the Darlington NGS.

3.22.3 Conclusion on Licence Term and Conditions

441. Based on the above information received during the course of the hearing, the Commission has determined that a licence with an expiry date of November 30, 2025 is appropriate. The Commission accepts the licence conditions as recommended by CNSC staff, with the following modification.

442. Licence condition 3.4 is modified from

The licensee shall prepare and conduct a periodic safety review in support of its subsequent power reactor operating licence application.

to

The licensee shall ***implement*** *a periodic safety review in support of its subsequent power reactor operating licence application.*

443. With respect to licence condition 3.2, the Commission delegates the authority for consent to restart a reactor after a serious process failure to the following CNSC staff:
- Director, Darlington Regulatory Program Division;
- Director General, Directorate of Power Reactor Regulation; and
- Executive Vice-President and Chief Regulatory Operations Officer.

444. With respect to licence condition 15.4, the Commission delegates the authority to remove regulatory hold points for the return to service of each unit undergoing refurbishment to:
- Executive Vice President and Chief Regulatory Operations Officer, Regulatory Operations Branch.

445. The Commission expects updates from OPG on the status of the refurbishment project following the return to service of each reactor unit. Furthermore, the Commission directs OPG and CNSC staff to provide a formal update to the Commission on the

status of the refurbishment project following the return to service of the first reactor unit or by no later than the mid-term of the licence period. This update will take place in a public proceeding of the Commission, with public participation.

446. The Commission acknowledges the concerns from intervenors who expressed the desire to scrutinize OPG's operations and participate in public proceedings of the Commission. The Commission notes that public hearings are not the only venues for the public to participate in its proceedings. The Commission encourages intervenors to utilize these other venues, notably the public meetings that consider the annual regulatory oversight reports, as well as the public proceeding following the return to service of the first refurbished reactor unit.

4.0 CONCLUSION

447. The Commission has considered the information and submissions of the applicant, all participants and CNSC staff, as set out in the material available for reference on the record, as well as the oral presentations made and written submissions provided by the participants at the hearing.

448. The Commission is satisfied that the applicant meets the requirements of subsection 24(4) of the *Nuclear Safety and Control Act*. That is, the Commission is of the opinion that the applicant is qualified to carry on the activity that the proposed licence will authorize and that the applicant will make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

449. The Commission, pursuant to section 24 of the *Nuclear Safety and Control Act*, renews the Nuclear Power Reactor Operating Licence issued to Ontario Power Generation Inc. for its Darlington Nuclear Generating Station located in the Municipality of Clarington, Ontario. The renewed licence, PROL 13.00/2025, is valid from January 1, 2016 until November 30, 2025.

450. The Commission authorizes OPG to operate the Darlington NGS Units 1-4 beyond 210,000 equivalent full power hours up to the proposed refurbishment outages, to a maximum of 235,000 equivalent full power hours.

451. The Commission accepts the licence conditions as recommended by CNSC staff, with the following modification:

Licence condition 3.4 is modified from

The licensee shall prepare and conduct a periodic safety review in support of its subsequent power reactor operating licence application.

to

The licensee shall implement a periodic safety review in support of its subsequent power reactor operating licence application.

452. With respect to licence condition 3.2, the Commission delegates the authority for consent to restart a reactor after a serious process failure to the following CNSC staff:
- Director, Darlington Regulatory Program Division;
- Director General, Directorate of Power Reactor Regulation; and
- Executive Vice-President and Chief Regulatory Operations Officer.

453. With respect to licence condition 15.4, the Commission delegates the authority to remove regulatory hold points for the return to service of each unit undergoing refurbishment to the Executive Vice President and Chief Regulatory Operations Officer.

454. The Commission notes that CNSC staff can bring any matter to the Commission as necessary. The Commission directs CNSC staff to inform the Commission on an annual basis of any changes made to the Licence Conditions Handbook.

455. With this decision, the Commission directs CNSC staff to provide annual regulatory oversight reports on the performance of the Darlington NGS and on the status of the refurbishment project and emergency planning, as part of the CNSC's annual *Regulatory Oversight Report for Canadian Nuclear Power Plants*. CNSC staff shall present these reports at public proceedings of the Commission. The Commission requests that CNSC staff provide updates on the setting of emission limits and effluent discharge limits as part of CNSC staff's regular reporting to the Commission. The Commission also requests that CNSC staff provide an update to the Commission on the report from CANDU Owners Group on issues raised by Dr. Nijhawan, once the report is finalized.

456. The Commission expects updates from OPG on the status of the refurbishment project following the return to service of each reactor unit. Furthermore, the Commission directs OPG and CNSC staff to provide a more comprehensive update to the Commission on the status of the refurbishment project following the return to service of the first reactor unit or by no later than the mid-term of the licence period. This update will be considered in a public proceeding of the Commission, with public participation. The Commission looks forward to public participation and is of the view that both the annual *Regulatory Oversight Report for Canadian Nuclear Power Plants* and the more comprehensive update to the Commission after the return to service of the first reactor unit or at the mid-term of the licence period will provide opportunities

for interested persons to participate in Commission public proceedings.

MAR 0 2 2016

Michael Binder
President,
Canadian Nuclear Safety Commission

Date

Appendix A – Intervenors

Intervenors	Document Number
Canadian Environmental Law Association, represented by C. Yick, E. Stahl and T. McClenaghan	CMD 15-H8.2 CMD 15-H8.5 CMD 15-H8.5A CMD 15-H8.5B
Lake Ontario Waterkeeper, represented by P. Feinstein and T. Willis	CMD 15-H8.3 CMD 15-H8.3A
Mississaugas of the New Credit First Nation, represented by Chief B. LaForme and M. LaForme	CMD 15-H8.4
Mohawks of the Bay of Quinte represented by K. Shipley, G. Mallette and N. Storms	CMD 15-H8.6 CMD 15-H8.6A
Northwatch, represented by B. Lloyd	CMD 15-H8.7 CMD 15-H8.7A
Frank Greening	CMD 15-H8.8 CMD 15-H8.8A CMD 15-H8.8B
Women in Nuclear Canada, represented by H. Kleb, L. Marshall and J. Shikaze	CMD 15-H8.9
Greenpeace, represented by S. Stensil	CMD 15-H8.10 CMD 15-H8.10A CMD 15-H8.10B
Power Workers' Union, represented by A. Clunis and D. Trumble	CMD 15-H8.11 CMD 15-H8.11A
Provincial Council of Women of Ontario, represented by G. Janes	CMD 15-H8.12
Regional Municipality of Durham, represented by G. Cubitt, W. Leonard and K. Gorman	CMD 15-H8.13
Canadian Nuclear Workers Council, represented by D. Shier, J. Usher and C. Leavitt	CMD 15-H8.14 CMD 15-H8.14A
Canadian Nuclear Association, represented by J. Barrett and P. Poruks	CMD 15-H8.15
Society of Energy Professionals, represented by S. Travers, J. Fierro, P. Choiniere and D. Romanowicz	CMD 15-H8.16 CMD 15-H8.16A

Intervenors	Document Number
Dan Rudka	CMD 15-H8.17
Organization of Canadian Nuclear Industries, represented by R. Oberth	CMD 15-H8.18
Municipality of Kincardine, represented by Mayor A. Eadie	CMD 15-H8.19 CMD 15-H8.19A
Canadian Nuclear Society, represented by J. Roberts and C. Hunt	CMD 15-H8.20
Alexander Belyakok	CMD 15-H8.21 CMD 15-H8.21A
Anna Tilman	CMD 15-H8.22 CMD 15-H8.22A
Port Hope Community Health Concerns Committee represented by F. More and D. Rudka	CMD 15-H8.23
Allan and Barbel Canning	CMD 15-H8.24
Louisette Lanteigne	CMD 15-H8.25
Stephanie Woodward	CMD 15-H8.26
Canadian Association of Physicians for the Environment, represented by C. Vakil	CMD 15-H8.27 CMD 15-H8.27A
Citizens for a Safe Environment and the Committee for Sage Sewage, represented by K. Buck and D. Done	CMD 15-H8.28
Durham Nuclear Awareness, represented by M. McNeill, P. Seccaspina and B. Pulst	CMD 15-H8.29 CMD 15-H8.29A
Green Party of Ontario, represented by M. Schreiner	CMD 15-H8.30
Suhail Barot	CMD 15-H8.31
Ontario Sustainable Energy Association, represented by C. Young	CMD 15-H8.32 CMD 15-H8.32A
S. Nijhawan	CMD 15-H8.33 CMD 15-H8.33A CMD 15-H8.33B

Linda Gasser	CMD 15-H8.34 CMD 15-H8.34A
Ole Hendrickson	CMD 15-H8.35
Borden Rhodes	CMD 15-H8.36
Louis Bertrand	CMD 15-H8.37 CMD 15-H8.37A
Beyond Nuclear, represented by K. Kamps	CMD 15-H8.38
Friends of the Farewell, represented by L. Racansky	CMD 15-H8.39
Robert Azzopardi	CMD 15-H8.40
Kirsten Dahl	CMD 15-H8.41
Canadian Coalition for Nuclear Responsibility, represented by G. Edwards	CMD 15-H8.42
New Clear Free Solutions, represented by C. Rouse	CMD 15-H8.43
Michel Duguay	CMD 15-H8.44
Severin Hoch	CMD 15-H8.45
Gail Cockburn	CMD 15-H8.46
	CMD 15-H8.47
Stephanie Beausoleil	CMD 15-H8.48
Monica Whalley	CMD 15-H8.49 CMD 15-H8.49A
Jeff Brackett	CMD 15-H8.50
Kathleen Chung	CMD 15-H8.51
Canadian Association of Nuclear Host Communities and the Municipality of Clarington, represented by A. Foster, F. Wu and G. Weir	CMD 15-H8.52

Intervenors	Document Number
SNC-Lavalin represented by R. Whalen	CMD 15-H8.53
Ontario Clean Air Alliance	CMD 15-H8.54
Society of Professional Engineers and Associates, represented by M. Ivanco and P. White	CMD 15-H8.55 CMD 15-H8.55A
Brigitte Vitali	CMD 15-H8.56
Renee Cotton	CMD 15-H8.57
Peter Tabuns, MPP for Toronto-Danforth	CMD 15-H8.58
GE Hitachi Nuclear Energy Canada	CMD 15-H8.59
Larraine Roulston	CMD 15-H8.60
Ioana Antohe	CMD 15-H8.61
Granville Anderson, MPP for Durham	CMD 15-H8.62
Thomas Lawson	CMD 15-H8.63
Environmental Earth Angels	CMD 15-H8.64
Don Ross	CMD 15-H8.65
Orono Crown Lands Trust Board	CMD 15-H8.66
Port Hope & District Chamber of Commerce	CMD 15-H8.67
Voices for Earth Justice	CMD 15-H8.68
BettyAnne and Al Bod	CMD 15-H8.69
Sarah Hutchinson	CMD 15-H8.70
H. Douglas Lightfoot	CMD 15-H8.71
Larry Wiwchar	CMD 15-H8.72
Lois Banks	CMD 15-H8.73
Margaret Forsythe	CMD 15-H8.74

Intervenors	Document Number
Lorraine Mazzocato	CMD 15-H8.75
Clarington Museums and Archives	CMD 15-H8.76
Big Brothers Big Sisters of Clarington	CMD 15-H8.77
Cameco Corporation	CMD 15-H8.78
Brian Blomme	CMD 15-H8.79
Bruce Balsdon	CMD 15-H8.80
Mary Everrett	CMD 15-H8.81
University of Ontario Institute of Technology represented by Edward Waller	CMD 15-H8.82
University of Ontario Institute of Technology represented by G. Bereznai	CMD 15-H8.83
Geneva Speakman	CMD 15-H8.84
Darlington Community Advisory Council represented by J. Boate	CMD 15-H8.85 CMD 15-H8.85A
Andrea Peloso	CMD 15-H8.86
A.J. Kehoe	CMD 15-H8.87 CMD 15-H8.87.A
National Farmers Union, Waterloo-Wellington Local, represented by L. Laepple	CMD 15-H8.88
James Ranscombe	CMD 15-H8.89
Elaine M. Walters	CMD 15-H8.90
T. Seitz	CMD 15-H8.91 CMD 15-H8.91A
Darlene Buckingham	CMD 15-H8.92
Clarington Board of Trade and Office of Economic Development, represented by S. Hall and D. Rickard	CMD 15-H8.93
Parkcrest Tenants' Association	CMD 15-H8.94

Intervenors	Document Number
Aecon Group Inc.	CMD 15-H8.95
Durham College	CMD 15-H8.96
Michelle Simeunovich	CMD 15-H8.97
Brad Blaney	CMD 15-H8.98
Pat Rogerson	CMD 15-H8.99
Deborah A. Beatty	CMD 15-H8.100
Greg Allen	CMD 15-H8.101
Wendy Hunter	CMD 15-H8.102
Joe Dickson, MPP for Ajax-Pickering	CMD 15-H8.103
George Milne	CMD 15-H8.104
Barbara J. Moore	CMD 15-H8.105
Janey Edwards	CMD 15-H8.106
John LaForge from Nukewatch	CMD 15-H8.107
Susan Hoch	CMD 15-H8.108
Bruce Campbell	CMD 15-H8.109
Graham Lodge	CMD 15-H8.110
Melanie Duhamel	CMD 15-H8.111
Carolina Rodriguez	CMD 15-H8.112
Sandra Halls	CMD 15-H8.113
Stacey Snow	CMD 15-H8.114
Natasha MacKenzie	CMD 15-H8.115
Marilyn McKim	CMD 15-H8.116
Women's Healthy Environments Network (WHEN)	CMD 15-H8.117

Jacqueline Wakefield	CMD 15-H8.118
Lorraine D'Antonio	CMD 15-H8.119
Julia Levin	CMD 15-H8.120
Michelle Boigon	CMD 15-H8.121
CANDU Owners Group	CMD 15-H8.122
Travis Turner	CMD 15-H8.123
Uniform Durham Regional Environment Council	CMD 15-H8.124
Matthew Rushton	CMD 15-H8.125
Whitby Chamber of Commerce	CMD 15-H8.126
Ajax-Pickering Board of Trade	CMD 15-H8.127
Susan Larsh	CMD 15-H8.128
Judith Cockman	CMD 15-H8.129
Aidan McTeague	CMD 15-H8.130
Bruce Peninsula Environment Group	CMD 15-H8.131
John Herda	CMD 15-H8.132
Belinda Cole	CMD 15-H8.133
William Shore	CMD 15-H8.134
Dwayne E. King	CMD 15-H8.135
Jutta Splettstoesser	CMD 15-H8.136
Eleanor Ward	CMD 15-H8.137
Douglas Saunders, Clear Path Solutions	CMD 15-H8.138
Dennis Wharton	CMD 15-H8.139
Swith Bell	CMD 15-H8.140

Intervenors	Document Number
Alec Adams	CMD 15-H8.141
Monica Vida	CMD 15-H8.142
Kelly Clune	CMD 15-H8.143
Greater Oshawa Chamber of Commerce	CMD 15-H8.144
Janine Carter	CMD 15-H8.145
Pickering Nuclear Community Advisory Council, represented by J. Vincett, T. Kellar, D. Fabbro and C. Morrison	CMD 15-H8.146
Coalition for Nuclear Free Great Lakes	CMD 15-H8.147
Evelyn Butler	CMD 15-H8.148
Black & McDonald, represented by M. Healy	CMD 15-H8.149 CMD 15-H9.149A
North American Young Generation in Nuclear – Durham Chapter, represented by R. Mutiger, M. Mairinger, R. Naqvi, A. Baytekin and M. Chauhan	CMD 15-H8.150 CMD 15-H8.150A
Brenda Stevenson	CMD 15-H8.151
BWXT Canada Ltd., represented by J. MacQuarrie	CMD 15-H8.152 CMD 15-H8.152A
Trixie Deveau	CMD 15-H8.153
Several Individuals (letter writing campaigns)	CMD 15-H8.154
David Archer	CMD 15-H8.155
Sharen Skelly	CMD 15-H8.156
County of Bruce, represented by M. Twolan	CMD 15-H8.157
Nancy Doucet	CMD 15-H8.158
Christine Koenig	CMD 15-H8.159
Jo Hayward-Haines	CMD 15-H8.160

Intervenors	Document Number
Curtis Bennett	CMD 15-H8.161
Australian Radiation Protection and Nuclear Safety Agency	CMD 15-H8.162