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Written submission from the Society of United Professionals

Exposé oral

Mémoire de la Society of United Professionals

In the Matter of the

À l'égard d'

Ontario Power Generation Inc.

Ontario Power Generation Inc.

Applicability of the Darlington New Nuclear Project environmental assessment and plant parameter envelope to selected reactor technology

Applicabilité de l'évaluation environnementale et de l'enveloppe des paramètres de la centrale à la technologie de réacteur sélectionnée pour le projet de nouvelle centrale nucléaire de Darlington

Commission Public Hearing

Audience publique de la Commission

January 2024

Janvier 2024

November 15, 2023

Re: Darlington New Nuclear Project (DNNP) Public Hearing 2024-H-2

The Society of United Professionals represents over 9,000 engineers, scientists, supervisors, and other professionals in Canada's energy and legal sectors. As an organization, we have represented professionals for over 70 years.

The Society represents employees working for a dozen different employers in the electricity sector, including Ontario Power Generation, Bruce Power, Nuclear Waste Management Organization, Hydro One, the Independent Electricity System Operator, the Ontario Energy Board, Toronto Hydro, Kinectrics, and the Electrical Safety Authority.

Our members work in every aspect of the electricity industry. They are involved in generation, transmission and distribution of electricity, management of the electricity system, regulation and enforcement of standards, and management of the electricity market. They are employed as first-line managers and supervisors, professional engineers, scientists, information systems professionals, economists, auditors and accountants, as well as many other professional, administrative, and associated occupations.

The Society's members are knowledge workers who take great pride in exercising their civic, social, and professional responsibilities. As a union, we stand behind our members' professionalism, integrity, and commitment to excellence in all areas, particularly workplace safety, public health, and environmental sustainability.

Advocating for safe and healthy operation of our nuclear workplaces is one of the Society's highest priorities as a union. Our members work inside of, and in close proximity to, nuclear facilities, and they are among the first in harm's way if the highest standards of safe operation, and occupational health and safety are not adhered to. They and their families are residents of Clarington and Durham and Port Elgin and they are very conscious of the importance of ensuring a safe and healthy environment in the areas where they live.

The Society recognizes that this consultation is only to determine whether the existing environmental assessment for the Darlington new nuclear site is applicable to the reactor technology chosen for the project, the BWRX-300 small modular reactor.

The Society engaged a third-party expert consultant – Dr. Kirk Atkinson, PhD, Associate Professor in the Faculty of Energy Systems and Nuclear Science and Director of the Centre for Small Modular Reactors at Ontario Tech University – to provide an opinion on the applicability of the existing environmental assessment to the BWRX-300 reactor. Dr. Atkinson's full report has been included with this submission.

Dr. Atkinson concluded that "Given the reduced size and thermal power of the BWRX-300 SMR compared to the DNNP candidate reactor technologies for which the [Plant Parameter Envelope] was originally developed and on which the [Environmental Impact Statement] EIS was based…the 2009 EIS conclusions remain valid" and "there are no obvious findings that challenge the approved [Environmental Assessment]."

The Society, having reviewed Dr. Atkinson's assessment, submits that the existing environmental assessment is applicable to the BWRX-300 reactor technology chosen for the Darlington New Nuclear Project, and as such no new environmental assessment need be conducted.

Additionally, the CNSC Staff Report concluded that "CNSC staff expect no significant residual adverse environmental effects from the deployment of up to four BWRX-300 reactors, provided the mitigation measures identified in the EA are implemented, as required by OPG's EA follow-up program"[1] and that "based on a review of information presented in this CMD, OPG's selection of the BWRX-300 reactor technology is bounded by the EA, and the EA remains applicable for this reactor technology."[2]

The Society supports the conclusions of the CNSC Staff Report, and Dr. Atkinson's assessment, that the BWRX-300 technology selected for the new nuclear project at Darlington by OPG is within the bounds of the existing environmental assessment.

Sincerely,

MJohnston

Michelle Johnston
President
The Society of United Professionals

[1] https://nuclearsafety.gc.ca/eng/the-commission/hearings/cmd/pdf/CMD24/CMD24-H2.pdf
[2] ibid

TECHNICAL CRITIQUE

Darlington New Nuclear Project Plant Parameter Envelope (PPE) Revision 5 and BWRX-300 Environmental Impact Statement Review

Background

In September 2006, Ontario Power Generation (OPG) made a preliminary application to the Canadian Nuclear Safety Commission (CNSC) for a license to prepare the Darlington site for new nuclear build. In accordance with the Canadian Environmental Assessment Act (CEAA), it was determined that an Environmental Assessment (EA) of the Darlington New Nuclear Project (DNNP) was necessary. This EA was undertaken over a three-year period and, in the absence of a selected reactor technology, used a Plant Parameter Envelope (PPE) based on limiting parameters for three reactor types under consideration for analysis. The resulting Environmental Impact Statement (EIS) submitted in September 2009 was subsequently revised on request from the Joint Review Panel (JRP) to include consideration of additional reactor types. Ultimately, after revision of the EIS, the EA was accepted by the JRP in 2011, and in May 2012 the Government of Canada accepted the JRP recommendations and a Power Reactor Site Preparation Licence (PRSL) issued.

In 2013 the Ontario Government deferred new nuclear build at Darlington, a circumstance that persisted until OPG began exploring Small Modular Reactor (SMR) technologies in 2018. In December 2021, OPG selected the GE-Hitachi BWRX-300 SMR for the DNNP and in accordance with commitment D-P-12.1(a) in the Comprehensive Environmental Impact Statement Review:

"Once the specific technology is selected and design information is available, OPG will comprehensively review the EIS to ensure that the results of the EIS remain valid. If this review indicates either a gap or a condition not bounded by the EIS, OPG will initiate corrective actions as necessary. This may include mitigation options."

In late 2022, the PPE was revised (revision 5) to include the BWRX-300 and the EIS was reviewed to ensure its conclusions were unchanged (or found to be insignificant) thereby meaning the original approved EA remained valid.

Scope of critique

To ensure due diligence on behalf of its members, the Society requested that the following documents be reviewed, and strengths, weaknesses, or shortfalls identified with respect to consideration of the BWRX-300:

Use of Plant Parameters Envelope to Encompass the Reactor Designs being considered for the Darlington Site (Document reference: N-REP-01200-10000-R005).

Darlington New Nuclear Project Report for the Review of the Environmental Impact Statement for Small Modular Reactor BWRX-300 (Document reference: NK054-REP-07730-00055-R000).

Critique of Plant Parameter Envelope (PPE) Revision 5

To facilitate quantitative analysis in the EA, the PPE was developed to provide a bounding envelope of (worst case) values for plant design and site characteristics, along with any interactions between the two. The approach followed precedent in the U.S. The PPE considers both individual, vendor-specific limiting values, and assembles them into a composite form that takes the worst value of a given parameter across all technologies under consideration. Clearly any reactor technology that is bounded by the PPE could be deployed at the DNNP. The original PPE considered the possibility of four AP-1000, ACR-1000, or EC6 units, or three EPR units, being built on site, with a maximum output of 4800 MWe. The BWRX-300 was not considered until this revision of the PPE (revision 5).

Whilst the PPE format is solid and most of the limiting values presented therein approved in earlier revisions of the document, a minor observation was made pertaining to revision 5 as read in March 2023:

- In section B.1.3 Table 3. “Site Parameters and Darlington Characteristic Values, Composite Table,” parameter 2.3.1, the condenser/heat exchanger maximum inlet temperature, is set as 25.5°C against a characteristic site value of 24°C, the latter value being based on historic precedent and future projections published in 2008. Given the intended sixty-year operating lifetime of new build units and increasingly frequent extreme temperature events seen globally; whilst the volume of Lake Ontario is very large (compared to the rivers in France for which high temperatures led to the shutdown of reactor units in 2022) and hence should suppress extreme conditions, what would the implications and/or mitigations be for operating units if a temperature of 25.5°C was exceeded at some point in the future? Whilst this is unlikely to be of a significant concern, given the lack of certainty around predicting the consequences of climate change, some additional consideration would not be unwarranted to de-risk potential future concerns.

As the BWRX-300 has an electrical output of 300 MWe and a thermal power of 870 MW, a maximum four-unit deployment (i.e., 1200 MWe / 3480 MWth) will have essentially the same power output as a single unit of a bigger plant (e.g., an AP-1000 produces 1110 MWe / 3415 MWth). Simple scaling therefore shows that site power-related outcomes will in many cases be approximately one quarter those predicted for the reactor deployments described in previous versions of the PPE. The PPE therefore already bounds almost all parameters being considered, the only divergence being through design differences, e.g., as per section B.1.4 Table 4: “Consolidated PPE Parameters, Values, Where Used and How Used” the only parameters where the BWRX-300 provides a limiting value are:

- Parameter 1.1.2, Foundation Embedment, as the BWRX-300 extends to a depth of 38 m below grade due to the reactor containment being sunken into the ground.
- Parameter 7.1.1, Maximum Use of raw water by the Fire Protection System.
- Parameter 7.1.3, Stored Water Volume for the Fire Protection System.

- Parameter 9.4.2, (minimum) Elevation of the Airborne Effluent release point during normal operation, i.e., only 35 m for the BWRX-300.
- Parameter 17.1.2, the Spent Fuel Cask Weight being a mighty 133 tonnes due to the differences in used fuel characteristics, and thereby causing challenges for site access and road infrastructure.

Additionally, whilst to first approximation fission events in low enriched uranium fuel (i.e., the type of fuel used in all candidate reactor technologies for DNNP) will yield similar fission product distributions; variations in enrichment, fuel irradiation times (longer times typically result in higher activities per unit volume of fuel), neutron fluxes and spectra, even between similar reactor types (i.e., light water reactors) will yield differences in the resulting radiological inventories. These differences are captured in the data provided for the following source terms:

- Parameter 9.5.1, Airborne Source Term.
- Parameter 10.3.1, Liquid Effluent Source Term.
- Parameter 11.2.1, Solid Radwaste Activity Levels.

Whilst revision 5 of the PPE lists source term information for each of the DNNP candidate reactor technologies, information provided for the BWRX-300 seemingly being the most complete, the method by which these data were deduced is not made immediately clear. The presumption is that values were calculated, e.g., using a code such as ORIGEN, but the tables do not explicitly state this. It is a minor point given the presented values will not have a significant impact on the bounding assumptions (since the power per BWRX-300 is roughly a quarter that of the larger reactors considered, the total inventory activity per unit will be smaller even at higher fuel burn ups), yet clarification would be warranted.

With recent acknowledgements that along with First-Of-A-Kind (FOAK) SMR deployment at Darlington, new build ‘large’ nuclear is once again under serious consideration in the Province of Ontario, it follows that as Darlington remains the only site currently licensed for new build, there is a small possibility that mixed deployment of reactor types on-site could be proposed (whilst the BWRX-300 is the test case for grid-scale SMRs in Canada, even in a four-unit configuration, the deployment is not maximising power per hectare despite future electricity demands in Ontario and beyond being well recognised).

- The PPE only considers multi-unit deployments of similar reactor technologies. Either consideration should be given in the PPE as to the implications of dissimilar reactor technologies being deployed adjacent to one another, or the possibility should be explicitly excluded.

Critique of BWRX-300 Environmental Impact Statement Review

Led by Calian Nuclear, a consulting team comprising Calian, SLR Consulting, Ecometrix, Independent Environmental Consultants, Golder Associates and Beacon Environmental was assembled in 2022 to review the accepted 2009 Environmental Impact Statement

(EIS) for new nuclear build at Darlington considering OPG's selection of the BWRX-300 SMR for the DNNP. For the approved EA to remain valid, the BWRX-300 technology must remain bounded by the EIS or any deviance from it must not materially change its scope or conclusions. As such, being that the EIS was based on the PPE, analysis having been undertaken previously to ensure the environmental impacts of each bounding parameter were at least tolerable or could be mitigated; the Calian-led team reviewed PPE revision 5 to identify which parameters had changed with respect to the BWRX-300. They found that of the 198 parameters in the PPE, 60 were not applicable due to the design of the BWRX-300 (principally related to the fact that a BWR does not require heat exchangers, and because the condenser employs once-through cooling using lake water rather than employing cooling tower infrastructure), 129 were within bounding limits, and 9 were out of bounds. These nine include the eight described above, along with PPE parameter 1.7.2 pertaining to Importance Factors employed for wind speed analysis during plant design.

- No indication was given in the PPE that suggested parameter 1.7.2, Importance Factors, employed for wind speed analysis during plant design was not bounded adequately in revision 5. Amendment of the PPE may be warranted.

Calian subsequently analysed these nine PPE parameters to prove they did not cause significant residual environmental effects. They concluded that:

- The deeper foundation depth (parameter 1.1.2) would cause negligible impacts on groundwater flow in the longer term (post-construction), whilst construction related activities remained consistent with the 2009 EIS.
- The Importance Factors employed for wind speed analysis (parameter 1.7.2) were based on a newer methodology that gave results (strength targets) consistent with the 2009 EIS.
- The additional water requirements for fire protection (parameters 7.1.1 and 7.1.3) were offset by lower water usage elsewhere within the plant, i.e., net water use is lower than that found by integration over all water-using PPE parameters.
- The 35 m elevation of the Airborne Effluent release point during normal operation (parameter 9.4.2), whilst being beneath the 48.8 m height specified in the 2009 EIS did not result in doses to the public greater than those specified previously.
- The Airborne Source Term (parameter 9.5.1) did not result in doses to the public greater than those specified in the EIS.
- The Liquid Effluent Source Term (parameter 10.3.1) did not result in doses to the public greater than those specified in the EIS.
- Solid Radwaste Activity Levels (parameter 11.2.1), whilst above those specified previously, could be mitigated by improved tooling and hence the EIS conclusions were unchanged.
- The Spent Fuel Cask Weight (parameter 17.1.2), whilst 13 tonnes heavier than specified previously, could be mitigated by roadway reinforcement and hence the EIS conclusions were unchanged.

In short, it was found that accounting for all 138 PPE parameters applicable to its design, selection of the BWRX-300 had no impact on the conclusions found within the 2009 EIS. Moreover, by virtue of its design the BWRX-300 was found to have less environmental impact compared to the other reactor types considered in the EIS. In particular:

- Due to its smaller size and footprint compared to larger plants, construction of the BWRX-300 will provide increased opportunities for habitat retention and lower greenhouse gas (GHG) emissions due to reduced excavation needs.
- The non-requirement for cooling towers will prevent significant negative visual and practical consequences, allowing the deployment to fit better with its surroundings.
- Infilling of on-site ponds may be unnecessary, hence preserving non-human biota.
- The Bank Swallow population, a threatened species in the Province of Ontario, will likely be unaffected by construction of the first BWRX-300 unit.

Whilst almost all residual adverse effects were found to be not significant by inspection, just as they were within the 2009 EIS; five (including new dust pathways and a new bat population), whilst also expected to be not significant were deemed worthy of additional studies to ascertain if there will be a need for additional mitigations to make this so.

Whilst the EIS Review is quite thorough, some inconsistencies or omissions were found:

- Table 4 (Project Works and Activities) alludes to a post-construction workforce of approximately 300 persons for four operating units yet section 5.2.12 suggests this figure is 1,400 persons. This inconsistency should be resolved or clarified.
- Recognising that REGDOC-2.5. 2 has superseded Regulatory Document RD-337; the evaluation of the BWRX-300 PSA described in Section 5.7.3 of the EIS Review indicates that the design satisfies required safety goals, but also makes the pointed acknowledgement that this pertains to the design “as it has progressed to date”. It would have been valuable for the EIS Review to have identified where the BWRX-300 design has not progressed, or where it might yet change significantly enough to impact the conclusions of EIS. If the remaining aspects of design are unlikely to change these conclusions, the review should say so to reduce uncertainty.
- Section 5.7.4 states that as BWRX-300 fuel will be within the range of enrichment (<5%) assessed in the 2009 EIS, an out-of-core criticality accident will not lead to any significant residual adverse effects. Whilst this may well be true, it was rather dismissive of the criticality safety risks generally. Over 60 criticality accidents have occurred worldwide since the advent of the nuclear age (see, for example, the Tokaimura Criticality Accident in 1999 which led to the evacuation of residents and more than a hundred people receiving a >1 mSv dose), each of which was different due to the fuels, facilities, and/or processes involved. Whilst globally there is much experience of how to mitigate criticality safety risks along with well-documented guidelines; due to its widespread use of natural uranium fuel, Canadian industry experience of handling low enriched uranium fuels is lacking. Moreover, given it is a new design, it is plausible that some of the details pertaining to BWRX-300 fuel

management are unavailable at the present time. Whilst potential consequences can likely be comfortably bounded by prior precedent, knowledge, and analogy, more detailed consideration may be warranted if there are known unknowns.

More generally, whilst their potential environmental impacts were likely captured during analysis using parameters 9.5.1 (Airborne Source Term) and 10.3.1 (Liquid Effluent Source Term), it was surprising that there was no explicit mention of the potential for irradiated steam release or the reduced barriers to fission product release due to once-through cooling. It is assumed that the probabilities of such outcomes, and the mitigations in place to prevent them, are captured in documents elsewhere.

Conclusions

Given the reduced size and thermal power of the BWRX-300 SMR compared to the DNNP candidate reactor technologies for which the PPE was originally developed and on which the EIS was based; it is unsurprising to find that aside from the nine exceptions described above, earlier versions of the PPE adequately bound the BWRX-300, and hence the 2009 EIS conclusions remain valid. Furthermore, for the few instances where PPE revision 5 deviated from earlier versions, the EIS Review adequately demonstrated that residual adverse effects were not significant and hence, again, the 2009 EIS conclusions remain valid. Consequently, there are no obvious findings that challenge the approved EA.

This Technical Critique has reviewed both documents in good faith, checking references where necessary to interpret findings therein. Independent validation of findings was not within the scope of work, nor possible with the information provided. Opting for terseness over verbosity, it has not restated the tables and findings verbatim, but has highlighted possible inconsistencies or omissions in both, along with potential points to consider. All in all, the PPE, and EIS (and by extension the EIS Review) are fit-for-purpose but judging from some subtleties in choice of words (within the EIS Review), perhaps the collective understanding of Boiling Water Reactors is less strong than it could be.