Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Directorate of Regulatory Improvement and Major Projects Management

Unclassified

March 28, 2013

File No.: 2.01 / e-DOCS 4092040 (E)
e-DOCS 4111591 (F)
CCM # 2013-000211

Mr. Wayne Robbins
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Pickering, Ontario L1W 3J2

Subject: OPG Decision on the Condenser Cooling Water Option for the Darlington New Nuclear Project

Dear Mr. Robbins:

The purpose of this letter is to respond to your letter of January 7, 2013 [1] regarding OPG's decision to select a once-through cooling water system as its preferred condenser cooling water option for the Darlington New Nuclear Project (DNNP), and proposed performance targets for the intake and discharge structures to mitigate potential effects on the aquatic environment. In addition, your letter requests confirmation from CNSC staff that the *Condenser Cooling Water Option Assessment* and methodology used by OPG has satisfied Joint Review Panel recommendation #3, as accepted by the Government of Canada.

CNSC staff, Fisheries and Oceans Canada and Environment Canada have carefully reviewed your letter and supporting documentation. As outlined in your letter, OPG previously submitted its decision on the condenser cooling water option and supporting *Condenser Cooling Water Options Assessment* in August 2012 [2]. CNSC staff and the above-noted federal agencies provided comments on the assessment [3], and OPG provided responses to the comments [4]. OPG subsequently revised and resubmitted the assessment [5] to address the comments received. It is acknowledged that the revision to the assessment did not change its overall conclusion, and that a once-through cooling water system remains OPG's preferred condenser cooling water option for the DNNP.

It is CNSC staff's overall opinion that there are no fundamental barriers to licensing a once-through cooling water system for the DNNP with the performance targets proposed [1], subject to the following conditions:

- an accepted baseline by which the 90% impingement and entrainment performance targets will be measured
- design provisions to incorporate a live fish return system, should one be required in the future

- a maximum intake approach velocity of 6 cm/s for a porous veneer design (as documented in the *Condenser Cooling Water Option Assessment*) or a maximum of 12 cm/s for a wedgewire screen design as measured "within the slots"; other intake structure designs to be reviewed on a case-by-case basis
- satisfactory completion of OPG commitments [6, 7] and Joint Review Panel recommendations related to the selection of once-through cooling including, but not limited to, recommendations #30 (impingement/entrainment sampling at DNGS), #32 (location of intake and discharge structures), #34 (enhanced resolution thermal plume modelling), #35 (surface water risk assessment), #36 (adult fish monitoring) and #37 (area of aquatic effects)

It is also CNSC staff's opinion that the revised *Condenser Cooling Water Option Assessment* and the methodology used by OPG have satisfied Joint Review Panel recommendation #3, as accepted by the Government of Canada.

CNSC staff's analysis of these matters is documented in the attachment to this letter.

Please note that CNSC staff's opinion on these matters does not bind decisions made by the Commission with which the authority resides to issue a licence to construct a nuclear power plant. CNSC staff's licensing recommendation to the Commission can only be made once detailed design is complete and a construction licence application has been received. It is expected that OPG will continue to engage CNSC staff and the above-noted federal agencies during the design process to ensure the detailed design meets regulatory expectations.

These matters will be brought to the Commission's attention at an upcoming public meeting in August 2013. If you have any questions or require further clarification, please contact Mr. Ross Richardson, Senior Project Officer, at (613) 943-0241.

Yours sincerely,

D. B. Newland
Director
New Major Facilities Licensing Division

References:

1. OPG letter, A. Sweetnam to D. Newland, "Conditional Acceptance for OPG's Decision on the Condenser Cooling Water Option for the Darlington New Nuclear Project", January 7, 2013, e-Doc 4064182.
2. OPG letter, A. Sweetnam to D. Newland, "Submission of OPG's Decision on the Condenser Cooling Water Option for the Darlington New Nuclear Project", August 7, 2012, e-Doc 3987303.

3. CNSC letter, D. Newland to A. Sweetnam, “OPG Decision on the Condenser Cooling Water Option for the Darlington New Nuclear Project”, October 16, 2012, e-Doc 4004962.
4. OPG letter, A. Sweetnam to D. Newland, “OPG Response to CNSC Comments – OPG’s Decision on Condenser Cooling water Options Assessment”, December 17, 2012, e-Doc 4057742.
5. OPG letter, A. Sweetnam to D. Newland, “Submission of the Revised Condenser Cooling Water Option for the Darlington New Nuclear Project”, January 31, 2013, e-Doc 4082317.
6. OPG letter, A. Sweetnam to D. Newland, “Submission of Revised Darlington New Nuclear Project Commitments Report”, November 30, 2012, e-Doc 4049923.
7. CNSC letter, D. Newland to A. Sweetnam, “Submission of Revised Darlington New Nuclear Project Commitments Report”, February 15, 2013, e-Doc 4088333.

Attachment: CNSC Staff Analysis of OPG’s Decision on the Condenser Cooling Water Option for the Darlington New Nuclear Project

c.c.: Barclay Howden, Patsy Thompson, Mike Rinker – CNSC
Tom Hoggarth – Fisheries and Oceans Canada
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CNSC Staff Analysis of OPG'S Decision on the Condenser Cooling Water Option for the Darlington New Nuclear Project

Introduction

Ontario Power Generation (OPG) has selected a once-through cooling water system as its preferred cooling option for the Darlington New Nuclear Project (DNNP) and has committed to specific performance targets for the intake and discharge structures to mitigate effects on the aquatic environment. OPG has requested CNSC staff's conditional acceptance of its selection of once-through cooling for the DNNP [1]. Additionally OPG has requested confirmation that Darlington Joint Review Panel (JRP) recommendation #3, as accepted by the Government of Canada, has been satisfied. This summary provides CNSC staff's analysis and conclusions with respect to OPG's requests.

Background

As part of its Environmental Assessment Report [2], the JRP recommended that:

> "the Canadian Nuclear Safety Commission require that as part of the Application for a Licence to Construct a reactor, OPG must undertake a formal quantitative cost-benefit analysis for cooling tower and once-through condenser cooling water systems applying the principle of best available technology economically achievable (BATEA). This analysis must take into account the fact that lake infill should not go beyond the two-metre depth contour and should include cooling tower plume abatement technology."

This recommendation (JRP recommendation #3) was accepted by the Government of Canada, with the acknowledgement that the analysis may be required prior to the construction licence application, given the relationship between the site layout and the choice of condenser cooling technology [3].

OPG undertook this analysis during 2011–2012, comparing once-through cooling with mechanical draft cooling towers, and has selected once-through cooling for the DNNP. This analysis included a number of roundtable discussions with stakeholders, culminating in OPG formally submitting the *Condenser Cooling Water Options Assessment Report* [4] to CNSC staff in August 2012. CNSC staff and other key federal departments (Fisheries and Oceans Canada (DFO) and Environment Canada) reviewed the report and provided comments in October 2012 [5]. OPG dispositioned the comments [6] and submitted a revised report [7] on January 31, 2013, for review and acceptance by CNSC staff in order to satisfy this JRP recommendation.

Analysis

CNSC staff's analysis of OPG's selection of once-through cooling at the DNNP is based on the body of work submitted by OPG which includes:

- the *Condenser Cooling Water Options Assessment Report* [7]
- a third-party review of OPG's BATEA methodology [8]
- technical information on fish protection and improvements to condenser cooling water intake design [9, 10]
- a summary of stakeholder consultations [11]
- performance targets that OPG has committed to [1]

The analysis also considered regulatory, scientific and industry best practices, cost benefit, and risk. Finally, CNSC staff's analysis was informed by reviews and advice from DFO, Environment Canada, the Ontario Ministry of Natural Resources, as well as an independent third party, Pacific Northwest National Laboratories [12].

In doing its analysis, under the CNSC's regulatory framework, CNSC staff considered new facilities being held to higher environmental performance expectations (that is, CNSC draft regulatory document RD 337 v2, *Design of New Nuclear Power Plants* – consider the use of BATEA for the design of condenser cooling water systems) than existing facilities. This is consistent with the approach the United States takes on this matter toward new and existing facilities – an amendment under the US *Clean Water Act* section 316b added a rule in 2003 [13], that holds new facilities to higher environmental performance expectations, while a different rule has been proposed and is under consideration for existing facilities [14]).

The following subsections elaborate on these matters.

Methodology for OPG's *Condenser Cooling Water Options Assessment Report*

JRP recommendation #3 described above referred to "quantitative cost-benefit analysis". The supporting text noted the need for a more definitive comparison of alternative options that would include a quantitative basis for assessment and comparisons of cooling tower options as well as the use of weighting factors for different attributes [2]. OPG used a multi-criteria decision analysis (MCDA) instead of cost-benefit analysis (CBA) in addressing this JRP recommendation. CNSC staff's opinion is that the MCDA analysis is an appropriate methodology in this case for the reasons described below.

CNSC regulatory policy P-242, *Considering Cost-benefit Information*, notes that information on costs and benefits is only one factor that may be considered in making regulatory decisions under the *Nuclear Safety and Control Act*. The CNSC staff review of the OPG methodology took this policy consideration into account and was informed by two expert third-party review reports done independently of each other, one for OPG [8] and the other for CNSC staff [12]. The use of MCDA instead of CBA was supported by third-party reviewers due to the difficulty of attaching monetary values to the very diverse range of impacts (such as fish and bird mortality, habitat loss, visual atmospheric plume, bird habitat, noise, thermal plume) that were under discussion. Quantifying and assessing the value of these impacts is quite different from simply looking at conventional market prices [15]; many of the costs and benefits of environmental management may not be well represented or are entirely omitted by monetary measures [16, 17].

On the basis of a review of OPG's methodology, published literature (for example, [18]) and the two third-party review reports [8, 12], CNSC staff determined that the MCDA methodology was better suited to the specific matter at hand. Having OPG use a CBA methodology that included explicit weighting factors was not expected to result in information that would alter the outcome of OPG's report. OPG's use of scoring and key attributes met the basics of MCDA methodology by providing information on how well each cooling option performed for an attribute and on how well the performance of each attribute in turn contributed to the overall evaluation [18]. CNSC staff's view is that OPG has satisfied JRP recommendation #3. This conclusion is based on the review of OPG responses to federal government reviewer comments [6] and on the final *Condenser Cooling Water Options Assessment Report* received on January 31, 2013 [7].

OPG's *Condenser Cooling Water Options Assessment Report*

In accord with the JRP recommendation, the *Condenser Cooling Water Options Assessment Report* took into account the fact that lake infill should not go beyond the two-metre depth contour and also considered cooling tower plume abatement technology. The report identifies once-through cooling with its associated enhancements as BATEA at the DNNP site and identifies it as the preferred option. OPG stated in its submission cover letter [19] that the environmental impacts overall did not favour one option over the other but the cost advantage combined with the adverse local community response to towers and their associated visual plume with abatement favoured once-through cooling. Adaptability is a feature of both cooling options, which varies for different attributes with no clear advantage for one option.

Table I provides a listing by CNSC staff of the relative performance of once-through cooling versus mechanical draft cooling towers for adverse attributes. Sixteen adverse attributes are listed, based on the review of the DNNP documents and readily available literature on these technologies (for example, [20, 21]). The level of effect was ranked by CNSC staff on an increasing scale as none, negligible, low, moderate or high. Both cooling options have adverse effects at this site, with once-through cooling having lesser effects on more attributes but worse effects for most of the aquatic-related attributes when compared to mechanical draft cooling towers.

Intake Performance Target – 90 Percent Reduction in Impingement and in Entrainment

OPG has committed to a 90 percent reduction both in impingement and in entrainment (fish mortality due to the condenser cooling system.) This reduction is known as the 90/90 performance target. This means that the reduction a once-through cooling system will achieve is expected to be 90 percent or greater reduction in both impingement and entrainment mortality from that which would be achieved by a mechanical draft cooling tower system at the site [1]. It is also CNSC staff's understanding that fish mortality would be, at a minimum, similar to a 90 percent reduction in impingement and entrainment relative to the baseline (that is, unmitigated surface water intake with a standard 3/8 inch mesh travelling screen). This "baseline" definition is used in the rule for new facilities under the U.S. *Clean Water Act*, section 316b [13]. It is measurable for the DNNP based on the nearby Pickering Nuclear Generating Station surface water intake without the installed barrier net.

Based on the species of fish and projected numbers of fish impinged and/or entrained, DFO considers the 90/90 performance target to be acceptable. OPG has also agreed to offset the residual fish mortality through rehabilitation or creation of fish habitat. No net loss of productive capacity of fish habitats in Lake Ontario will result.

The 90/90 performance target is consistent with the regulatory requirements for new facilities in the United States (90 percent reduction in impingement and entrainment relative to the baseline) [13], policy requirements in New York State (90 percent performance relative to the baseline plus consideration of site-specific impacts) [22], and is similar to the United Kingdom (deep offshore velocity cap with enhancements such as a live fish return system and acoustic fish deterrents) [20].

From a technical perspective, the existing Darlington Nuclear Generating Station (DNGS) presently achieves a 90 percent reduction for impingement and likely for entrainment (with fish habitat offsets) relative to the baseline (that is, Pickering Nuclear Generating Station, without a barrier net). OPG's proposed 90/90 performance target for the DNNP will likely exceed the DNGS performance and the intake fish loss will be equivalent to that from a system using towers.

It is CNSC staff's opinion that, under the *Nuclear and Safety Control Act*, the 90/90 performance target will prevent unreasonable risk since the current DNGS operation performance is at an acceptable level. Furthermore, in the recent environmental assessment for the refurbishment and continued operation of the DNGS, the Commission and DFO concluded that there were no significant adverse effects, taking into consideration mitigation measures (that is, creating new fish habitat or improving enough existing habitat to offset losses from impingement and entrainment).

The Lake Ontario ecosystem, however, is currently undergoing changes (due to invasive species, for example) and will likely continue to change in the future. Once-through cooling is adaptable enough to accommodate future changes in amounts and types of fish intake losses. In the event that technology-based mitigation results in residual adverse effects such that the DNNP fails to meet the performance targets, DFO will accept fish habitat offsets from OPG or, if a species at risk is being adversely affected, may require OPG to provide additional mitigation. Mitigation measures, such as a live fish return system, are available and practicable and could be put in place should the need arise.

Discharge Performance Target – Thermal Effects Performance Equivalent to or Better Than the Existing DNGS Diffuser

OPG has committed to thermal effects performance equivalent to or better than the existing DNGS discharge for the DNNP.

From a regulatory perspective, the risk is low from the thermal discharge to round whitefish (one of the most thermally sensitive species) from the current DNGS, as documented in the proposed environmental assessment screening report [23] for the refurbishment and continued operation of the DNGS. It is acceptable to CNSC staff and Environment Canada and not environmentally significant. In addition, the DNGS diffuser has been meeting provincial regulatory performance requirements for thermal discharges over the past 20 years of operations.

The performance of the DNGS diffuser is consistent with the regulatory best practices for new facilities in the United States (that is, the rule under the U.S. *Clean Water Act*, section 316b) [13], as well as practices in Europe [20, 28].

It is expected that the future performance of a once-through cooling system at the DNNP will be better than the existing system at the DNGS, given the suite of enhancements expected [3, 24] such as a deeper discharge location. Additional technology and operation options are available and practicable if future changes in the Lake Ontario fish community or regulations require higher levels of risk control.

Conclusions

It is CNSC staff's opinion that the enhanced once-through cooling option is BATEA for the DNNP site since its performance is expected to be equivalent to that of towers for intake fish loss, and it is expected to prevent unreasonable risk to thermally sensitive fish species (such as round whitefish), while avoiding the other adverse effects of towers (such as aquatic and terrestrial habitat removal, visual plume effects, excavation truck traffic, cost effectiveness). As such, the DNNP once-through cooling performance is expected to be equal to or better than mechanical draft cooling towers from the perspective of integrated environmental protection, consistent with the *Nuclear Safety and Control Act*'s requirement to prevent unreasonable risk to the environment, and with CNSC regulatory policy P-223, ***Protection of*** *the Environment*. It is technologically and financially practicable, allows a level of risk control proportionate to the present understanding of the level of risk, and is adaptable to respond to potential future changes in the level of environmental risk.

In addition, *Fisheries Act* regulators (DFO, Environment Canada) find the two DNNP performance targets described in this analysis to be acceptable, and the enhanced once-through cooling system proposed for the DNNP to be consistent with regulatory international best practices.

CNSC staff expect the design to be a fully enhanced once-through cooling system that incorporates the latest in mitigation technology and techniques, consistent with CNSC draft regulatory document RD-337 v2, *Design of New Nuclear Power Plants*, and with relevant OPG commitments made during the JRP process and captured in OPG's commitments report [24, 25].

CNSC staff's opinion on these matters does not bind decisions made by the Commission with which the authority resides to issue a licence to construct a nuclear power plant. CNSC staff's licensing recommendation to the Commission can only be made once a detailed design is complete and a construction licence application has been received. It is expected that OPG will continue to engage CNSC staff and the above-noted federal agencies during the design process to ensure the detailed design meets regulatory expectations.

Table 1: Comparison of adverse attributes between once-through cooling and mechanical draft cooling towers

(**Bold** = key attributes at the DNNP site). Adapted from the UK Environment Agency [20], Viel et al [21] and the CNSC [26].

Adverse attributes	Once-through cooling	Mechanical draft cooling tower
Aquatic thermal plume area[1]	Moderate	Negligible to low
Aquatic contaminants[2]	Low	Low
Lake bottom habitat loss[3]	Low	Moderate
Aquatic habitat alteration[4]	Moderate	Negligible to low
Aquatic biota intake losses[5]	Moderate	Negligible to low
Visual impact[6]	Negligible	Moderate
Ground fog and icing	Negligible	Low
Airborne plumes/salt drift[7]	None	Low
Terrestrial habitat loss[8]	None	High
Terrestrial biota mortality[9]	None	Negligible to low
Noise[10]	None	Low
Land use/excavated soil	None to low	Moderate
Lack of adaptability[11]	Moderate (aquatic)	Moderate (terrestrial)
Water consumption[12]	Low	Moderate
Water withdrawal[13]	High	Low
Cost/energy penalty[14]	Low to moderate	Moderate to high

1. There is a potential risk of once-through cooling (OTC) thermal to round whitefish egg survival, but the hazard area for DNGS and DNNP diffusers combined is a small portion (<5 %) of the estimated available site study area habitat so no population-level risk is expected.
2. OTC has higher contaminant dilution at the end of the pipe [7] but a potentially more direct spill pathway to the lake.
3. 13 ha OTC versus 19 ha mechanical draft cooling towers (MDCT) lake bottom construction/infill.
4. Alterations include potential hazard to aquatic biota from pulsed chronic exposure to levels of temperature and chemicals above ambient, and physical transfer offshore in diffuser jet when lake currents are low (JRP recommendation #35) [2].
5. MDCT entrainment is 2.6 % of OTC since it is directly proportional to flow volume; impingement reduction would be 8 % more than enhanced OTC. OTC fish egg/larvae entrainment would be reduced by optimal location of intake structure, reduced approach intake velocity and fish habitat offsets.
6. OTC water surface ripple line from diffuser turbulence in calm lake conditions. MDCT has a visible vapour plume (46 % of the time during winter, 3–15 % of the time during the rest of year) and tower buildings 40 m in height [7].
7. Hazard but not a risk for human health effects or adverse effects on plants. No adverse effects have been observed or are expected given standard regulatory and industry protocols and DNNP site-specific location of towers.
8. MDCT requires 40 ha of land, which would result in the complete loss of the existing bank swallow nesting habitat [7].
9. Bird strikes to MDCT structures are unlikely; however, mortality increases if birds are displaced from their habitat by the footprint of MDCT and cooling water treatment pond losses [12].
10. MDCT with abatement equivalent to OTC [7].
11. OTC is less adaptable to environmental (climate change) or regulatory changes to the aquatic environment whereas MDCT is less adaptable to such changes to the terrestrial/atmospheric environment.
12. MDCT consumes more than twice as much water as is consumed by evaporation from an OTC thermal plume [27].

13. OTC withdraws 70 times more water than MDCT. The OTC water is returned to the lake after screening through 3/8 inch debris screens, heating and biocide addition. The main issue is mortality of fish, fish eggs and larvae contained in the water. This issue is covered under another adverse attribute: aquatic biota intake losses.
14. MDCT generates 1– 3.5 % less electrical output than OTC due to use of warmer condenser cooling waters which lowers turbine efficiency and requires use of electricity to run pumps and fans [28]. MDCT construction, operations and maintenance costs are 2.4 times those of OTC: a difference of ~$500M for two units [6].

References

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6. OPG letter, A. Sweetnam to D. Newland, "OPG Response to CNSC Comments – OPG's Decision on Condenser Cooling Water Options Assessment". December 17, 2012, e-Doc 4057742.

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