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February 27, 2015

**OPG PROPRIETARY**

CD# P-CORR-00531-04405

**MR. M. SANTINI**

Director

Pickering Regulatory Program Division

Canadian Nuclear Safety Commission  
280 Slater Street  
Ottawa, Ontario  
K1P 5S9

Dear Mr. Santini:

**Pickering NGS: Risk Improvement Plan Update**


Pursuant to Licence condition 5.1 of PROL 48.01/2018 and as described in the Licence Conditions Handbook, the purpose of this letter is to submit the annual routine report on the status of implementation of the risk improvement plan provided in Commission Member Document CMD 14-M42.1 (Reference 1). This action plan also provides the update committed in Reference 2.

The required update is in Attachment 1. This attachment:

- summarizes the current status of Pickering risk estimates.
- updates plans and timelines for improvements to be implemented.
- summarizes the status of potential improvements that are being considered.
- status updates for the timeline to address whole-site based safety goals and probabilistic safety assessment (PSA) methodology.
- summarizes plans and timelines for risk re-calculation and possible additional upgrades.

OPG has taken appropriate follow-up actions for all of the committed and potential risk improvements in our action plan.

If you have any questions, please contact Jack Vecchiarelli, Manager, Nuclear Safety and Technology at 905-839-6746 extension 5444.



26 Feb 2015

Brian McGee  
Senior Vice President  
Pickering



Mr. M. Santini  
CD# P-CORR-00531- 04405

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cc: CNSC Site Office – Pickering

References:

1. OPG Letter, B. McGee to M.A. Leblanc, "OPG Material (CMD 14-M42.1) for the August 20, 2014 CNSC Public Meeting", August 6, 2014, e-Doc # 4482740, CD# P-CORR-00531-04275.
2. OPG Letter, W.M. Elliott to M. Santini, "Submission of Action Plan Outline for Enhancements to Pickering NGS Probabilistic Safety Assessment (PSA)", May 5, 2014, e-Doc # 4431045, CD# P-CORR-00531-04090.

Attachments:

1. Pickering Risk Improvement Plan

**ATTACHMENT 1**

**Pickering Risk Improvement Plan**

### **Attachment 1: Pickering Risk Improvement Plan**

This attachment updates the Pickering NGS risk improvement plan that was provided to the CNSC (References 1 to 4). This attachment:

- summarizes the current status of Pickering risk estimates.
- updates plans and timelines for improvements to be implemented.
- summarizes the status of potential improvements that are being considered.
- status updates for the timeline to address whole-site based safety goals and probabilistic safety assessment (PSA) methodology.
- summarizes plans and timelines for risk re-calculation and possible additional upgrades.

#### **Pickering Risk Estimates**

Estimates for Severe Core Damage Frequency (SCDF) and Large Release Frequency (LRF) are important outputs of the PSA for Pickering. The latest estimates for Pickering (References 5 and 6) are less than applicable limits for all assessed hazards; however, for some hazards, the estimated SCDF or LRF exceeds the OPG target (Reference 7). The Pickering Licence Conditions Handbook (Reference 8) requires that improvements should be made, where practicable, to meet these targets.

It is important to note that the Pickering PSAs were produced to achieve S294 compliance. The primary focus was to demonstrate compliance with limits, not to produce a lowest defensible estimate. Many conservative assumptions were deliberately made to simplify and expedite the analysis.

It is equally important to note that the Pickering PSAs were prepared at the same time that many and significant plant safety upgrades were being made as part of follow-up into the accident at the Fukushima Da-ichi plant. These upgrades were specifically intended to reduce risk; however, the timing of their implementation did not allow their complete inclusion in the Pickering PSAs. As a result, the full benefits of the Fukushima upgrades are not fully reflected in the PSAs, which are summarized in References 5 and 6.

As a result, OPG recognized that References 5 and 6 over-estimate SCDF/LRF. Reference 9 was prepared to provide more accurate estimates as follows:

- It revisited some of the simplifying assumptions made in References 5 and 6.
- More importantly, it re-estimated SCDF/LRF with full credit for the Fukushima enhancements in place at that time.

The results of Reference 9 can be summarized as follows:

- For all (10 of 10) assessed hazards, Pickering B meets OPG target for SCDF and LRF.
- Pickering A meets the OPG target for SCDF for 9 of 10 of the assessed hazards. The sole exception is internal at-power fires.
- Pickering A meets the OPG target for LRF for 8 of 10 of the assessed hazards. The exceptions are internal at-power fires and internal at-power process failures.

These are useful and important conclusions; they allow the Pickering Risk Improvement Plan to be simplified and better focused. Specifically:

- Risk improvements specific to Pickering B are not an immediate priority.
- Risk improvements specific to external hazards (including seismic, high wind and flooding) are not an immediate priority.
- The immediate priorities are to reduce Pickering A SCDF/LRF for internal fires and reduce Pickering A LRF for at-power process failures.

### **Improvements To Be Implemented**

Reference 4 provides a table that summarizes improvements to be implemented. That table is updated below. Items in italics are changed/added since the previous update.

<b>Table 1: Committed Risk Improvements</b>	
<b>Improvement</b>	<b>Timeline</b>
Phase I Emergency Mitigating Equipment (EME) modifications	Complete
Passive Autocatalytic Recombiners	Complete
Tie-down of EME equipment for high wind	Complete
Procedural changes for deployment of Phase I EME	Complete
Analysis of environmental impact of large feedwater line break in PNGS A powerhouse	Complete
Other analytical enhancements for FAP updated PSAs	Complete
Emergency makeup water to refill ECI storage tank	Complete
Flood barriers at PNGS buildings	Complete
Accounting for percentage of time in Guaranteed Shutdown State	Complete
EME modifications (Phase I enhancement e.g., quick connect, and Phase II)	<i>Implementation per the plan and schedule provided for FAI 1.7.1 closure (References 10, 11 and Note #1 below)</i>
<i>Extension of Auxiliary Power Supply (APS) mission time to 72 hours</i>	<i>Complete (see Note #2 below)</i>

<b>Table 1 (continued): Committed Risk Improvements</b>	
<b>Improvement</b>	<b>Timeline</b>
<i>Analysis to remove conservatism from level 2 outage assumptions</i>	<i>Complete (see Note #3 below)</i>
<i>Trace cables for select systems which are currently not credited in the Fire PSA</i>	<i>December 31, 2015 (see Note #4 below)</i>
<i>Crediting of some SAMG operator actions where possible, e.g., FADS activation</i>	<i>December 31, 2015 (see Note #5 below)</i>
<i>Facilitate EME hook-up south of H-line to improve EME benefit for accident scenarios that impose environmental restrictions on turbine building accessibility (e.g., large secondary side line breaks and large turbine hall fires).</i>	<i>December 31, 2015 (see Note #1 and Note #6 below)</i>
<i>Manual containment box-up after major turbine-generator fires</i>	<i>December 31, 2015 (see Note #7 below)</i>

Notes to Table 1:

1. Reference 4 included OPG plans to facilitate firewater and/or EME makeup to the Pickering A boilers by adding a new EME connection to the Emergency Boiler Water Supply (EBWS) at Unit 2. This connection is now in place and available for service.
2. Extended APS generator operation has been reviewed. On-site fuel capacity allows adequate time (~30 hours) for on-site fuel stocks to be replenished. In addition, it has been concluded that the generators can continue to operate during re-fuelling. Procedures have been revised to support extended operation of APS, including any necessary re-fuelling.
3. New analysis in Reference 12 concludes that the likelihood of early calandria vessel failure (ECVF) is negligible for accidents that initiate more than 10 days after the start of an outage. This will provide a small reduction in the predicted LRF for all Level 2 outage PSAs. Since outage risk is not an immediate priority, no further action is needed at this time. The new ECVF estimate will be factored into the next outage PSA update for Pickering A.
4. Significant progress has been made on this item. OPG has completed two important studies related to cables and the Pickering A Fire PSA. The Fire PSA credited only a very limited number of mitigating systems for which detailed cable information was available. One of the conclusions of the recently completed cable reviews is that a significant risk improvement (potentially >50% reduction in SCDF) may be achievable by tracing cables in un-credited mitigating systems, thereby allowing these systems to be credited in the Fire PSA. The results of cable tracing (including an estimate of impact on risk), will be reported in the 2016 risk improvement plan update.
5. SAMG enabling instruction NK30-SAM-09013-10000-ENI32 has been issued to support powered operation of the Filtered Air Discharge System (FADS) under beyond design basis accident (BDBA) conditions. Work is in progress to prepare

similar procedures for un-powered FADS operation under BDBA conditions. The target date for these procedures is December 31, 2015. These two new procedures will allow FADS operation to be credited for many BDBA sequences. The resulting risk improvement will be reflected in the 2017/2018 REGDOC 2.4.2 updates for Pickering. An estimate of this improvement will be included in the 2016 risk improvement plan update.

6. This is an improvement in the plan that has arisen from work on an initiative previously identified as "being considered". As discussed below, OPG considered analysis of turbine building response to catastrophic fires involving generator hydrogen and/or turbine oil. This led to the conclusion that risk could be reduced by EME deployment south of H-line. It was then further realized that this could also reduce risk for any accident that might threaten turbine building accessibility. Given the potential benefit, it was decided to include this as an "improvement to be implemented". Necessary changes to the physical plant are already being made as part of planned EME upgrades (Note 1 above). EME guidelines and supporting procedures will be revised to highlight and support available deployment options. Status (including estimated risk improvement) will be provided in the 2016 improvement plan update.
7. This is a new committed improvement. Review of Reference 13 highlighted that a major LRF contribution in the Fire PSA is inability to close the containment isolation dampers due to fire-induced "hot shorts". The intent of this new action is to assess manual damper closure to avert this containment bypass and resulting large release. Again, an estimate of the resulting risk improvement will be provided in the 2016 improvement plan update.

### **Improvements Being Considered**

Section 2.1.3 of CMD 14-M42.1 (Reference 4) identified a number of additional improvements that were being considered at that time. The status of these is as follows:

#### *Additional Cable Tray Fire Barriers*

As discussed in Note 4 above, significant progress has been made reviewing fire impact on cables. This work included assessment of the benefit of additional fire protection barriers in credited cable trays. The analysis concluded that only a small risk improvement (~10% risk reduction) can be realized by doing this. Given the high cost of barrier installation, this potential improvement will not be pursued further as part of this Risk Improvement Plan.

#### *Maintenance Optimization*

As discussed above, OPG now has a better understanding of the Pickering A PSA results. Predicted LRF is elevated due to common-mode failures attributable to harsh plant environment conditions (e.g., steam or fire). For such consequential failures, better maintenance is unlikely to afford significant risk improvement. Therefore, maintenance optimization will not be pursued further as part of this Risk Improvement Plan.

### *Re-assessment of Large Fire Scenarios*

As discussed in References 4 and 13, large fires involving generator hydrogen and/or turbine oil can cause collapse of the turbine hall. The Fire PSA assumes that this collapse leads to loss of all mitigating systems in the powerhouse. This assumption negates any EME benefit for these scenarios, resulting in a major contribution to SCDF/LRF in the Fire PSA

As discussed above, existing EBWS piping has been used to provide a new and alternate EME connection at Unit 2. This now allows all EME deployment to be made south of H-line and the turbine hall. This improves immunity of EME deployment to catastrophic turbine building fires.

Equally important, this also improves EME deployment for secondary side accidents that create steam environment problems north of H-line. Such scenarios are a major contributor to LRF for at-power process failures.

Given the preceding, it was decided to create a new improvement initiative (see Table 1 and Note 6 above). Specifically, to reduce SCDF/LRF for at-power fire and at power process failures (particularly, large secondary side breaks), OPG will improve EME capability and coverage by facilitating multiple deployment and hook-up options (including hook-up locations remote from the turbine building). The scope of committed EME enhancements includes hook-up redundancy/diversity. After committed EME enhancements are completed, deployment procedures will be revised to facilitate alternate hook-up options. The target completion date for this is December 31, 2015. As a result, the need to re-assess large fire scenarios is obviated.

### *Off-site EME*

As discussed in Reference 4, OPG has considered the possibility of reducing risk by using off-site EME, including EME from Darlington.

Significant progress has been made on this initiative. In addition to the Mutual Aid Agreement (Reference 14) that was put in place in 2012, OPG has initiated work to facilitate sharing of EME between Pickering and Darlington (Reference 15).

Although OPG is pursuing this initiative, it is concluded that it is not likely to significantly affect this risk improvement plan. As discussed above, a major contributor to Pickering A estimated risk is inability to deploy EME (e.g., due to plant environment after postulated accidents). If post-accident plant environmental conditions preclude deployment of on-site EME, they will also preclude deployment of off-site EME.

Therefore, while OPG intends to pursue sharing of EME per Reference 15, this activity will not be included as part of this risk improvement plan.



### **Whole-site Based Safety Goals and PSA Methodology**

OPG actively participated in the international workshop organized by the CNSC on multi-unit PSA in November 2014.

Although not strictly part of the Pickering risk improvement plan, whole-site PSA is a related issue for which OPG committed to provide an update.

COG Joint Project JP-4499 has been initiated to address whole-site site based safety goals and PSA methodologies (see References 16 and 17).

Per section 2.3 of Reference 4, the work is being done in 3 phases. These phases can be summarized as follows:

- Phase A - Safety goals framework (TCD - 2015),
- Phase B - Risk aggregation studies (TCD - 2016),
- Phase C - Pilot whole-site PSA for PNGS (TCD - 2017).

Phase A results/status will be provided to the CNSC in the February 2016 update of this plan.

### **Plans and Timelines for Risk Re-calculation and Possible Additional Upgrades**

Based on the discussion above, the scope of planned improvements is now finalized. Potential improvements that were previously under consideration have either been added to the list of committed improvements, or they have been dispositioned as unnecessary.

During 2015, work will continue on EME enhancements (References 10 and 11) and on the other improvements noted above. Based on the target dates in Table 1, by the end of 2015, it will be possible to estimate the resulting risk improvement. This estimate will be provided in the next annual update of this plan. Detailed risk re-quantification will be provided in the 2017 Pickering B and 2018 Pickering A PSA updates (per the update cycle in REGDOC 2.4.2).

If the committed improvements in Table 1 are found to not be sufficient to reduce risk below target, this risk improvement plan will be revised (in the next annual update) to consider additional risk reduction measures (including re-consideration of some of the lower priority upgrades discussed above). Any further upgrade proposals will consider cost-benefit consistent with assessment methodologies such as References 18, 19 and 20.

### **Summary**

OPG has taken appropriate follow-up action for all of the committed and potential risk improvements identified in Reference 4. This has resulted in the plan becoming simpler,

more focused and firmer. The desired risk improvements can now be succinctly and specifically defined as follows:

- All Pickering A and Pickering B hazards now meet the OPG target with the exception of the Pickering A SDCF on internal at-power fires and the Pickering A LRF on internal at-power fires and internal at-power process failures.
- Pickering A SDCF and LRF exceed target for internal fire scenarios because of uncertainty about cable routing, the potential for isolation damper failure, and the possibility of a serious fire preventing EME deployment. Specific and credible actions have been committed to determine cable routing, to provide manual containment isolation and to enable backup EME connection capability.
- Similarly, Pickering A LRF exceeds target for at-power process failures (e.g., large secondary side pipe breaks) that produce plant environments that can impede EME deployment. If those same plant environmental conditions lead to a severe accident initiating on a second unit, the energy absorbing capacity of containment can be exceeded leading to a large release. Again, alternate EME connection capability is the committed improvement.

Two high level areas dominate the risk improvement plan:

- For both fires and process failures, risk increases if the postulated hazard produces plant environment conditions that prevent EME deployment. When the current Pickering PSA was produced, EME implementation was just starting and limited EME hook-up options were available. When EME implementation is complete, the final modifications will include redundant and diverse EME deployment options. This will significantly narrow any gap related to adverse accident environmental conditions.
- Similarly, when the Phase 2 EME modifications are complete, additional capability (building coolers and the Filtered Air Discharge System) will be available to increase the energy capacity of containment; this will reduce LRF.

EME was installed to prevent and mitigate severe accidents. As such, completion of the committed EME upgrades is the cornerstone of the risk improvement plan.

- OPG is confident that risk will be reduced. However, if the committed improvements in Table 1 are found to not be sufficient to reduce risk below target, this risk improvement plan will be revised (in the next annual update) to consider additional risk reduction measures (including re-consideration of some of the lower priority upgrades discussed above).

## References:

1. OPG Letter, W.M. Elliott to M. Santini, "Submission of Action Plan Outline for Enhancements to Pickering NGS Probabilistic Safety Assessment (PSA)", May 5, 2014, e-Doc # 4431045, CD# P-CORR-00531-04090.

2. CNSC Letter, M. Santini to B. Phillips, "OPG Action Plan Outline for Enhancements to Pickering NGS Probabilistic Safety Assessment (PSA)", May 9, 2014, e-Doc # 4433096, CD# P-CORR-00531-04246.
3. CNSC Letter, L. Levert to B. Phillips, "Summary Record of Proceedings and Decision", June 3, 2014, e-Doc # 4445761, CD# P-CORR-00531-04263.
4. OPG Letter, B. McGee to M.A. Leblanc, "OPG Material (CMD 14-M42.1) for the August 20, 2014 CNSC Public Meeting", August 6, 2014, e-Doc # 4482740, CD# P-CORR-00531-04275.
5. OPG Report, NA44-REP-03611-00036-R000, "Pickering A Risk Assessment Summary Report", April 25, 2014.
6. OPG Report, NK30-REP-03611-00021-R000, "Pickering B Risk Assessment Summary Report", February 14, 2013.
7. OPG Nuclear Program, N-PROG-RA-0016, "Risk and Reliability Program".
8. CNSC Letter, M. Santini to B. McGee, "Pickering NGS: Licence Conditions Handbook", December 29, 2014, e-Doc # 4604664, CD# P-CORR-00531-04362.  
[Note: Refer to last paragraph on page 46 of Attachment 1 to this letter (LCH-PNGS-R003).]
9. OPG Report, P-REP-03611-00006, "Pickering NGS PSA Update to Include Enhancements from the Fukushima Integrated Action Plan", April 30, 2014.
10. OPG Letter, W.M. Elliott to M. Santini and F. Rinfret, "OPG Progress Report No. 4 on CNSC Action Plan – Fukushima Action Items", January 31, 2014, CD# N-CORR-00531-06316.
11. OPG Letter, W.M. Elliott to M. Santini and F. Rinfret, "Pickering NGS and Darlington NGS - OPG Specific Action Items Related to Closed Fukushima Action Items - Progress Update No. 3", September 30, 2014, CD# N-CORR-00531-06659.
12. OPG Report, NA44-REP-03611-0519754, "MAAP Analysis and Phenomenological Assessment in Support of PNGS A Level 2 Outage PRA for LRF Refinement", October 27, 2014.
13. OPG Report, NA44-REP-03611-00038-R000, "Pickering Nuclear Generating Station A Fire Probabilistic Risk Assessment (PRA) - Summary Report", March 28, 2014.
14. Mutual Aid Agreement, OPG CD# N-LEGL-03490-0413370, November 30, 2012.
15. OPG Memorandum, N-CORR-09013-0490805, "Emergency Preparedness – Path Forward for Emergency Mitigating Equipment Storage", June 17, 2014.

16. CANDU Owners Group Report, COG 13-9034, "Development of a Whole-Site PSA Methodology", February 2014.
17. CNSC Letter, L. Levert to B. McGee, "Record of Proceedings, Including Reasons for Decision", August 1, 2014, e-Doc # 4456871, CD# P-CORR-00531-04299.
18. CANDU Owners Group Report, COG 01-002, "Benefit Cost Analysis: Principles and Process", July 2003.
19. CANDU Owners Group Report, COG 01-003, "Benefit-Cost Analysis Implementation Guidelines", January 2004.
20. CANDU Owners Group Report, COG 02-902, "Benefit Cost Analysis Workbook Programmers and Users Manual", January 2004.