ONTARIO POWER GENERATION

Internal Audit

Nuclear Engineering Capital Spending

December 5, 2017

Report Rating: **Requires Improvement**

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1.0 EXECUTIVE SUMMARY

1.1 Report Rating and Summary of Findings

Report Rating: **Requires Improvement**

No.	Finding	Risk Type	Risk Rating[1]		
			High	Moderate	Low
1	Project governance does not require Nuclear Engineering review of Type 3 Business Case Summaries.	Operational	X		
2	Nuclear Engineering is not well-integrated in the project management process.	Operational		X	
3	Some Post-Implementation Reviews and lessons learned were not completed properly.	Operational		X	
4	Project status reports are inconsistent among projects.	Operational		X	
5	Dedicated, qualified Project Managers were not always assigned to projects.	Operational		X	
6	Work Breakdown Structures are not used for Nuclear Engineering-led projects.	Operational			X
Total		**6**	**1**	**4**	**1**

1.2 Background

The Nuclear Engineering organization ("Nuclear Engineering") provides engineering services to the Darlington and Pickering nuclear power generating stations and the nuclear waste facility. The organization is comprised of over 900 personnel and is under the oversight of the Chief Nuclear Engineer. The annual budget managed by Nuclear Engineering includes approximately $170M base OM&A and $10M outage OM&A. For 2017, Nuclear Engineering is expected to lead capital portfolio projects of approximately $50M and to provide approximately $11M in engineering services to support capital projects managed by Projects and Modifications ("P&M") and Inspection and Reactor Innovation ("IRI"). Involvement from the Nuclear Engineering organization from a design, change control and oversight perspective is important to successfully completing the projects on time, on budget and in accordance with requisite quality standards.
With respect to capital projects, the Nuclear Engineering organization's key strategic objectives include:

a) Operational excellence, including optimizing asset management;
b) Project excellence, including delivery of projects safely, to the required quality level, on time, and on budget;
c) Financial strength including regulatory effectiveness, risk management, commercial focus, value for money; and
d) Social license including relationship, outreach and safety.

Recognizing the unique challenges of planning and performing nuclear projects, a Corporate Project Excellence initiative was put in place and the company has recently implemented a number of initiatives that are intended to closely align with industry best practices. To the extent possible, audit findings and observations acknowledge current or planned activities to address noted risks.

[1] Please refer to Appendix A for risk rating definitions

1.3 Objective and Scope

The objective of the audit was to assess whether the processes and controls related to Nuclear Engineering's involvement in the planning and delivery of capital projects support on-time completion and adherence to the approved budget.

In order to achieve the audit objective, the audit tested processes and controls related to Nuclear Engineering's involvement with the capital program including both projects directly managed by Nuclear Engineering and projects managed by P&M and IRI for which Nuclear Engineering provides support. The audit excluded controls related to Darlington Refurbishment. The following processes were tested on a sample basis to determine whether:

A. Integrated Planning and Oversight (Nuclear Engineering-supported projects)
• Nuclear Engineering input to integrated project plans and design plans related to scope, design, cost estimates and scheduling reflected the requirements related to project management and engineering change control; • Throughout the project life cycle, input from Nuclear Engineering was provided in the identification, management and mitigation of risks related to quality, cost or project scheduling for individual projects and reflected as appropriate in documents submitted to oversight committees; • Post-Implementation Reviews ("PIR"s) confirmed that the sponsor was satisfied that the project had met the PIR measures identified in the Business Case Summary ("BCS"); and • Nuclear Engineering executed its engineering oversight responsibilities, using a graded approach, throughout the project lifecycle, including input to the change management process.
B. Planning (Nuclear Engineering-led projects)
• Nuclear Engineering's input to budgets and BCS documents reflected input from key stakeholders and was validated to ensure reasonability of estimated costs and project schedule; • Risk requirements were addressed throughout the gating process and were reflected in the contingency fund estimate; • Contractor agreements reflected performance expectations and timelines, and were vetted with appropriate internal/external stakeholders and approved; • Processes were in place to ensure that appropriate Work Breakdown Structures ("WBS") were developed which identified in-scope deliverables and aligned to cost estimates; and • Cost estimates were reviewed and approved by management, including classification of costs as OM&A or capital.
C. Execution
• Capital costs were allocated to the appropriate projects and cost classification (e.g. capital vs. operating), consistent with the intended accounting treatment reflected in the approved project plan, unless otherwise justified; • Contractor billings and performance complied with contract terms; • Scope changes and purchase order increases were properly approved prior to the work being performed; • Significant performance issues were actioned on a timely basis; and • Consideration was given to the effect of scope changes on interdependent areas.
D. Monitoring and Reporting
• Significant schedule and cost performance issues were identified and addressed on a timely basis, including the update of project forecasts and initiation of fallback plans; • Nuclear Engineering capital costs were monitored against forecast and budget and reviewed with the CNE and senior leaders on a periodic basis; and • PIRs confirmed that the sponsor was satisfied that the project had met objectives identified in the BCS.

The scope period for the audit covered primarily open projects as at August 31, 2017 and projects that were closed during 2015 and 2016.

1.4 Conclusion

Overall, controls relating to Nuclear Engineering's involvement in capital projects require improvement to support effective integrated planning and oversight, especially in relation to Nuclear Engineering-led projects. Our audit found that engineering involvement in aspects of project management including reviews of BCSs and communication of results of engineering oversight activities could be standardized and strengthened.

Positive Observations

At the time of the audit, a number of key initiatives were being implemented, which may mitigate risks related to the audit findings. These include:

- Within the Corporate Project Excellence initiative, the establishment of a Nuclear Projects Management Office ("NPMO")/Centre of Excellence ("CoE") to support the initiation, monitoring, control, and reporting of projects. Key deliverables of the NPMO/CoE include providing project management expertise, best practices, tools, processes and lessons learned. A dedicated function has been put in place to specifically focus on project controls for the Engineering phases of project delivery;
- The NPMO/CoE has established a common, scalable project delivery model for projects with a focus on delivering projects safely, on budget, and with quality and schedule project goals met. These tools include a PIR and BCS toolkit; and
- Efforts are underway to integrate and streamline Nuclear Engineering's existing processes in order to achieve a more consistent and timely approach to the development of cost estimates for preliminary and detailed design-related activities.

Key Findings & Recommendations

The following findings and recommendations reflect the need for better integration of Nuclear Engineering in the project management process:

- Although the policy for developing and documenting BCSs requires Project Managers to engage stakeholders, Nuclear Engineering is not always engaged, resulting in inconsistent review of draft BCS by Nuclear Engineering. We recommend that the higher risk Type 3 BCSs should be reviewed by Nuclear Engineering for completeness and accuracy of engineering information and risks;
- Throughout the project management lifecycle, Nuclear Engineering's involvement in overseeing aspects of the project, such as vendor performance, is not formalized and consistent. Nuclear Engineering should be better integrated into the project management process to improve engineering planning and oversight; and
- Reporting on project status and completion of PIRs and lessons learned required improvement in standardization and quality of information. We recommend that reporting be standardized and the importance of quality documentation for PIRs and lessons learned be reinforced.

The findings noted in this report have been reviewed with management and they have committed to specific action plans. Please refer to Section 2.0 for specific details of the above findings, along with the associated risk impact, audit recommendations and management action plans.

2.0 DETAILED AUDIT FINDINGS

Internal Audit identified the following detailed findings that have been risk-rated based on the definitions outlined in Appendix A.

1. Project governance does not require Nuclear Engineering review of Type 3 Business Case Summaries.	**High**

Business Cases Summaries ("BCS"s) are used to document the rationale for projects and to obtain approval for different phases of project funding. BCSs that are classified as Type 3 are complex undertakings with long timelines and a significant degree of risk, and often require a phased approach to project development and approvals. Project risks are documented in the BCS, including engineering risks. Governance on Developing and Documenting Business Cases (OPG STD-0076) requires Project Managers to engage stakeholders.

In our review of 10 P&M / IRI-led capital projects, drafts of BCSs were not consistently shared with Nuclear Engineering to ensure completeness and accuracy of submissions. We interviewed Project Managers who stated that they request input from stakeholders, but do not routinely circulate drafts of the BCS to stakeholders including Nuclear Engineering for review and feedback prior to finalization.

Under the Project Excellence initiative, input from key stakeholders in Nuclear Engineering and Operations and Maintenance will be required earlier in the planning phase (e.g. through the Engineering Resource/Work Requirement and Early Stakeholder Engagement processes). BCSs may also include references to stakeholder involvement.

Potential Causes & Impact

Potential Causes:

- Existing governance is not specific on how and when to engage key stakeholders to ensure completeness and accuracy of BCS submissions; and
- Project Managers may limit circulating draft documents due to timing considerations.

Impact:
BCSs for complex projects may not fully reflect relevant information and risks that may impede effective decision-making.

Recommendations

Management should:

- Provide additional guidance on stakeholder engagement including references to business units, timing and input required; and,
- Consider including stakeholder engagement plans as part of Project Management Plans.

Management Action Plan

NPMO/CoE management will, working with other groups as required, review and update governance, where necessary, to ensure stakeholder plans are in place and key stakeholders are participating in key meetings, such as risk workshops and/or review key documents such as business cases. Management will phase this in, as part of the Gated Process.

Owner: Gary Rose, Vice President, Project Planning and Controls
Target Completion Date: June 30, 2018

2. Nuclear Engineering is not well-integrated in the project management process.	Moderate

To effectively manage risks for Engineer, Procure and Construct ("EPC") contracts, Nuclear Engineering should be effectively integrated into project management activities including key oversight committee submissions, project status updates, vendor performance management and capturing lessons learned.

Inconsistencies exist in the degree to which Nuclear Engineering is integrated into project management processes. Areas in which inconsistencies and gaps were observed included:

- Key project documents, such as BCSs, contain inconsistent and a generally low level of detail on engineering-related risks. For example, in the Full Release request for Project #83039 Rapid Delivery Machine ("RDM"), the technical risks were not specific and defined as "*a risk that not all the requirements mandated by OPG by the RDM will be met*";
- BCSs currently do not include estimates of financial exposure for engineering risks, some of which are readily available in Design Modification forms (N-FORM-10958);
- Project Managers do not consistently monitor engineering oversight activities or include these activities in the Risk Management Oversight ("RMO") tool activity tracker;
- Nuclear Engineering's vendor performance monitoring process is not integrated or aligned with the scorecard process used by P&M and Nuclear Supply Chain; and
- Several comments in PIRs and lessons learned documents prepared by Project Managers identified opportunities to mitigate vendor performance issues by increasing vendor oversight. However, the nature of engineering oversight is not specified, and there is a risk that some Project Managers may interpret engineering oversight as being design verification.

As part of the Project Excellence initiative, the following actions are underway which may help to mitigate some risks related to the above findings:

- Enhanced risk and cost estimate challenge processes under Project Controls;
- Increased upfront involvement by Nuclear Engineering through a new Engineering Resource/Work Request process; and
- Expanded use of NPMO tools for Nuclear projects, including Engineering-led and Engineering phases of projects, including the Risk Management tool to document and monitor risks, mitigation activities and issue tracking.

Potential Causes & Impact

Potential Causes:

- Engineering oversight has traditionally been executed in parallel with Project Management, with limited integration; and
- Existing tools and processes used by Project Managers do not facilitate sharing and tracking of information related to engineering oversight activities.

Impacts:

- Oversight committees may not be fully informed of potential engineering cost or scheduling risks;
- Lack of timely feedback on risks may delay necessary changes to engineering engagement activities thus increasing quality, cost and scheduling risks; and
- Business planning, resourcing and cash flow processes may be negatively impacted if significant engineering design changes are required.

Recommendations

NPMO/CoE management working with the appropriate group(s) should consider:
• Modifying BCS guidance to include additional qualitative details on high risk items and estimated financial impacts for individual risks;
• Expanding Project Management planning and monitoring activities to include more specific engineering oversight elements that align with the Engineering Change Control process;
• Integrating and aligning vendor performance scorecarding processes with other business units to include the four key pillars of quality, safety, cost and schedule; and
• Enhancing the understanding of engineering oversight and interdependences, including:
  o Clarifying the scope and intent of engineering oversight versus design verification; and
  o Reinforcing collaboration and communication as key success factors for effective engineering oversight and project technical risk mitigation, including importance of challenge discussions and Issue Tracking Files.

Management Action Plan
NPMO/CoE management will, working with other groups as required: 1. Review and update governance, where necessary, to ensure stakeholder plans are in place and key stakeholders are participating in key meetings, such as risk workshops and/or review key documents such as a business cases; 2. As part of the project planning process, ensure that engineering activities are identified, planned, and incorporated with project plans, including funding and resource loading; 3. Management will phase this in, as part of the Gated Process; and 4. Align and integrate Engineering Vendor Scorecard metrics and process with the standard Project Dashboards to reflect the four pillars. **Owner (Items 1 – 3):** Gary Rose, Vice President, Project Planning and Controls **Target Completion Date:** June 30th, 2018 **Owner (Item 4):** Carla Carmichael, Vice President, Project Assurance & Contract Management **Target Completion Date:** November 2nd, 2018.

3. Some Post-Implementation Reviews and lessons learned were not completed properly.	Moderate

PIRs are used to evaluate actual performance of the installed modification against success metrics defined in the BCS. The PIR also includes a section on lessons learned that should be used to improve performance in the future.

In our review of five PIRs (two P&M and three Nuclear-Engineering-led), we noted that the quality of documentation varied both in terms of reporting against success metrics and lessons learned:

- Two PIRs did not assess actual performance against approved success performance metrics of the availability of the Service Area Bridge or the availability of spares;
- Two PIRs were not timely with completion more than a year after the end of the project; and
- Engineering lessons learned are not centralized, but captured in Station Condition Records, the Available For Service process, the RMO tool and lists maintained by Nuclear Engineering and P&M.

The CoE is strengthening risk management under Project Controls to collaborate with project teams to ensure a consistent approach to project risk identification and inclusion in cost estimates. Access to lessons learned will be an important resource to inform this improved risk quantification.

Potential Causes & Impact

Potential Causes:

- Completion of PIRs may be viewed by Project Managers as a formality with limited value add, since lessons learned may be captured through other means (AFS, RMO, SCRs, P&M listings, and Nuclear Engineering listings); and
- Governance does not specify the manner of involvement of key stakeholders in PIR process.

Impacts:

- Project objectives may not be achieved without critical and timely assessment of deliverables through the PIR process; and
- Benefits of lessons learned may not be realized if lessons are not captured in a central repository.

Recommendations

NPMO/CoE management should consider:

- Reinforcing and communicating the importance of completing PIRs appropriately and clarifying the involvement of key stakeholders in the PIR process in OPG-PROC-0056; and
- Establishing processes and tools to facilitate consolidation of lessons learned for future reference.

Management Action Plan

NPMO/CoE management will, working with other groups as required:

1. Update the Gated process to ensure review of and documentation of lessons learned occurs (currently required in close out phase for Gate 5) prior to the progression to the next gate; and
2. Implement a tracking and review process, with project stakeholders, of the PIR.

Owner: Gary Rose, Vice President, Project Planning and Controls
Target Completion Date: October 26th, 2018

4. Project status reports are inconsistent among projects.	**Moderate**

Project status should be reported consistently across projects to ensure key risks are monitored and managed in accordance with the scope of risks referenced in the BCS.

Project Managers often rely on project status reporting provided by vendors or produce their own reports for purposes of tracking project progress. However, the status reporting varies among vendors and OPG Project Managers in content and format and generally excludes details on areas related to safety, quality and technical considerations. These risk areas are referenced in the BCS and should be monitored and reviewed as part of project status updates.

Current Project Management Standards are generic in terms of guidance on project reporting, and exclude details on the types of metrics or information to be tracked and reported.

New Project Management guidance will require Project Managers to monitor and analyze key cost and schedule metrics as well as performance trends to better manage and correct project variances. New reports and dashboards are also being developed for the project, portfolio and plant level. These standardized reports will be used by Projects and are expected to include a more complete set of metrics aligned with the scope of the BCS such as safety, quality, cost and schedule. Vendors will also be required to adhere to new reporting requirements.

Potential Cause & Impact

Potential Cause:

Previous Project Management standards provided only general guidance in relation to the scope and types of metrics and information to be tracked and reported.

Impact:

Periodic status discussions that focus on cost and schedule may not address the complete scope of areas for which the Project Team is responsible, including quality, technical, health, safety, and environment.

Recommendation

Management should consider aligning future project status reporting standards and templates for both OPG and external vendors with key risks in the BCS (e.g. health, safety, quality and technical).

Management Action Plan

NPMO/CoE management will, working with other groups as required, develop and initiate standardized reporting requirements and dashboards for all projects that are executed in Nuclear that identify key metrics including schedule, cost, risk and safety.

Owner: Gary Rose, Vice President, Project Planning and Controls
Target Completion Date: June 30th, 2018

5. Dedicated, qualified Project Managers were not always assigned to projects.	Moderate

In line with industry practices, OPG governance requires that Project Executing Organizations should assign a dedicated, qualified Project Manager to oversee each capital project. The role of the Project Manager is important to ensuring delivery of the approved scope of work within the approved schedule and budget.

In reviewing four Nuclear Engineering and six Minor Modifications-led projects, we noted that one Nuclear Engineering-led project (#82816 - DN Vault Cooling Coil Replacement) had not been assigned a qualified Project Manager.

Potential Cause & Impact

Potential Cause:

Qualified, dedicated resources may not have been assigned due to staff resourcing challenges and/or staff turnover.

Impact:

Project milestones may be missed and project objectives may not be met.

Recommendation

Nuclear Engineering management should ensure that dedicated Project Managers with appropriate qualifications and experience are assigned to capital projects.

Management Action Plan

1. Nuclear Engineering management will ensure that a sufficient number of project managers are available within their organization are linked to the qualifications/training in the Project Excellence PMPro (PM Proficiency) training program and qualified for the role. This number will based on the Capability requirements action #2 noted below; and

2. NPMO/CoE management will, working with other groups as required, update the gated process and scalability model to guide the PMPro Capability level that a project manager should be at when assigning a PM for a level A, B, C, or D project. Incorporate this into the Charter/assignment of PM's to projects process.

Owner (Item 1): W.S. Woods, Senior Vice President, Nuclear Engineering and Chief Nuclear Engineer
Target Completion Date: December 31st, 2018

Owner (Item 2): Gary Rose, Vice President, Project Planning and Controls
Target Completion Date: March 31 st, 2018

6. Work Breakdown Structures are not used for Nuclear Engineering-led projects.	Low

Project Management governance (OPG-STD-0148) requires that a project be sub-divided into smaller more manageable components by establishing a work breakdown structure ("WBS") that defines 'work packages'.

We noted that in seven of the 10 sampled Nuclear Engineering-led projects, the WBS was not used to manage projects. As Nuclear Engineering-led projects were smaller and less complex (average cost of sample projects was $12.4M), it was an accepted practice not to use WBSs. As an alternative, MS Project was used by Project Managers to document the progress / milestones without using the appropriate WBS.

The Project Excellence initiative will include a review of appropriate reporting tools and processes for less complex projects in 2018. Application of a graded approach to Project Controls along with cost/benefit considerations will be addressed as part of this upcoming exercise.

Potential Cause & Impact

Potential Cause:
Nuclear Engineering exercised discretion in applying the existing governance given the smaller size of the projects based on past practices and the available NPMO resources.

Impact:
The lack of WBS may cause challenges in co-ordinating work and increase the risk of execution errors.

Recommendation

CoE management should provide additional guidance and thresholds on applying Project Control tools for less complex and lower dollar value projects.

Management Action Plan

The current Gated process has deployed a scalable model, which is being rolled out to the organization in November 2017 via the Conduct of Project Management training program. The NPMO assesses the requirements for each project against this model. The model will be re-assessed periodically and updated as required.

Target Completion Date: COMPLETE

APPENDIX A - RISK RATING DEFINITIONS FOR AUDIT FINDINGS

Ratings are derived through professional judgment by the audit team and discussion with management. The ratings for individual control findings are outlined below.

Rating	Definition
High Risk	The finding results in levels of risk exposure for the organization that, if not mitigated, could have a potentially severe/major impact on safety, project excellence, operational excellence and reliability, regulatory compliance, social license, environment, or financial results. The finding requires immediate attention.
Moderate Risk	The finding presents a risk that could potentially have a moderate impact on safety, project excellence, operational excellence and reliability, regulatory compliance, social license, environment, or financial results. If not remediated, the risk could escalate.
Low Risk	The finding could potentially have a minor impact on safety, project excellence, operational excellence and reliability, regulatory compliance, social license, environment, or financial results. Implementation of the recommendation may lead to improvement in the quality and/or efficiency of the area or process being audited.

OVERALL REPORT RATING SCALE

An overall report rating has been assigned as an indication of the overall design, existence and effectiveness of the components of the internal control structure that was subject to the internal audit. The internal audit rating should be considered in conjunction with the definitions noted above.

- *Effective:* control and risk management practices provide reasonable assurance that business process objectives will be achieved and may include minor improvements and/or opportunities for improvement.
- *Generally Effective*: control and risk management practices require more than minor but less than significant improvements to provide reasonable assurance that business process objectives will be achieved.
- *Requires Improvement*: control and risk management practices require significant improvements in high risk and/or core areas to provide reasonable assurance that business process objectives will be achieved.
- *Not Effective:* control and risk management practices are not designed and/or are not operating effectively.

APPENDIX B – PROCESS OWNER & DISTRIBUTION LIST

To:

Glenn Jager
Nuclear President and Chief Nuclear Officer

W.S. Woods
Senior Vice President, Nuclear Engineering and Chief Nuclear Engineer

Gary Rose
Vice President, Project Planning and Controls

Carla Carmichael
Vice President, Project Assurance & Contract Management

Cc: Jeff Lyash – President and Chief Executive Officer
Ken Hartwick – Senior Vice President, Finance, Strategy, Risk and Chief Financial Officer
John Blazanin – Vice President, Nuclear Finance
Paul Murray – Vice President, Projects and Modifications
Stephanie Powers – Vice President, Projects and Modifications
Gregg McCabe – Director, Design Engineering
Stuart Harris – Manager, Projects Design
Adam Chiarandini – Director, Enterprise Risk Management
Janice Ding – Director, Internal Audit
Mark Knutson – Director, Nuclear Oversight