UNDERTAKING J2.10

Undertaking

To provide the March quarterly management report to DRC and the Burns & McDonnell/Modus report once it has been issued to the OPG Board of Directors and subject to any confidentiality and disclosure concerns.

Response

Please see Attachment 1 for the management report to the Darlington Refurbishment Committee dated March 9, 2017 (confidential), and Attachment 2 for the Burns & McDonnell/Modus Independent Oversight Report dated March 2017 (confidential).

OPG Confidential Exclusive

ONTARIO POWER GENERATION

FOR INFORMATION to the Darlington Refurbishment Committee

March 9, 2017

DARLINGTON REFURBISHMENT PROGRAM

REASON FOR REPORT

This report provides the current status of the Darlington Refurbishment Program (DRP) including a review of strategic initiatives and program performance highlights for the quarter ending December 31st, 2016. This report augments the monthly Unit 2 Execution Status Report.

HIGHLIGHTS AND CONCLUSIONS

The execution of Unit 2 commenced on October 15th, 2016 as planned. Key program highlights for the quarter ending December 31st are listed below.

- At year-end, the combined OPG and contractor All Injury Rate (AIR) was 0.50 against a target of 0.24. There have been no lost time injuries.
- One quality incident occurred in the period associated with delays in placing SHIM mode operation in-service. SHIM mode operation is now in-service on all four Darlington Units and was utilised as planned on Unit 1 to support Unit 2 Refurbishment critical path.
- Defueling was completed on January 11th, 26 days ahead of the working schedule and 39 days ahead of the high confidence schedule. As a result, 13 days of schedule contingency valued at [redacted] has been returned to the Program General Reserve.
- Since the completion of defueling, the project has transitioned to vault preparations. As of end of February, due to unanticipated work, vendor performance, and vendor and OPG integration issues, the schedule gains achieved during Defueling have been consumed. Management anticipates that Segment 1 will be complete on March 30th, as per the original working schedule commitment.
- Some Unit 2 non-critical path activities are behind the working schedule and are impacting the Schedule Performance Index (SPI). Recovery plans have been implemented, and schedule performance of ES Fox work has greatly improved. Weekly performance monitoring is in place to ensure appropriate focus is placed on all activities to avoid impacts on critical path.
- The targeted 2016 in-service dates for the 3rd Emergency Power Generator (3rd EPG) and the Containment Filter Venting System (CFVS) projects were not achieved and this impacted the 2016 Corporate Scorecard results. Both projects are progressing through commissioning and are forecast to be placed in service mid-March.
- The DRP work completed to date has been performed for slightly more than budgeted, as reflected in the overall program Cost Performance Index (CPI) of 0.97, however, the program is holding adequate contingency for these variances. Life-to-date spending is $3.2 Billion, $79 Million below plan mainly due to lower than planned OPG resources and schedule delays.
- At the closure of 2016, 46 of 47 Integrated Implementation Plan (IIP) tasks committed to the Canadian Nuclear Safety Committee (CNSC) were completed. A late request has been approved by the CNSC to extend the CFVS in-service commitment from December 31st to April 28th, 2017. OPG continues to demonstrate to the regulator that completion of this project is a priority.

PROGRAM PERFORMANCE IN THE PERIOD

DARLINGTON REFURBISHMENT PROGRAM PERFORMANCE DASHBOARD

Safety		Status	Trend	Schedule Performance Index (SPI)		Status	Trend
All Injury Rate (#/200k hrs worked)	0.50	🔴	-	Current	0.97	🟡	-
# Level 1 Work Protection Events	2			Previous Report	0.96		
Quality		○	–	**Cost Performance Index (CPI)**		○	↓
# Event Free Day Resets	1			Current	0.97		
# Regulatory Non-Compliance	0			Previous Report	1.01		

SAFETY

The 2016 year-end combined All Injury Rate for OPG and contractor employees is 0.50. The AIR exceeded our target of 0.24 injuries per 200,000 hours worked; however, there were no lost time injuries. Safety is our number one priority and zero injuries remains our goal. For comparison purposes, DRP safety performance is seven times better than the construction industry in Ontario.

OPG and our vendor partners are actively communicating the importance of safe work practices in the field. Vendor safety performance has shown continuous improvement since November. OPG has developed a "Seven Life-Saving Rules" campaign which communicates industrial safety to all trades noting that adherence to these rules is mandatory with no tolerance for violations.

Since Unit 2 breaker-open, Radiation Safety Performance has been good with no unplanned exposures.

Additional details on conventional and radiological safety performance, including the "Seven Life-Saving Rules" campaign, are provided in Appendices 1 and 2.

QUALITY

One quality event occurred in the period when the adjuster rod SHIM mode operation could not be placed in service due to a set-point error made during design. A corrective action plan was implemented and the modification is now in-service on all 4 units.

Additional details on quality performance are provided in Appendix 3.

SCHEDULE PERFORMANCE

The DRP SPI reflects schedule performance against the aggressive working schedule, and includes execution of the Unit 2 refurbishment as well as the Facility & Infrastructure (F&IP) and Safety Improvement Opportunity (SIO) projects.

Over the period, the overall program SPI has remained relatively stable and is 0.97, indicating that the DRP is slightly behind plan. The performance is largely due to delayed completion of the F&IP and SIO projects, the construction of the Re-tube Waste Processing Building (RWPB), and execution of some of the non-critical path activities within Unit 2. Details on the delays, including the impact and mitigation activities, are discussed in the following sections of this memo.

UNIT 2 REFURBISHMENT

Defueling was completed on January 11th, 26 days ahead of the working schedule and a full 39 days ahead of the high confidence schedule. As a result, 13 days of risk based schedule contingency valued at [redacted] has been returned to the Program General Reserve.

Since that date, through the vault preparation and bulkhead installation work, the schedule gains achieved during Defueling have been consumed. Key contributors to the delays are unanticipated work (10 days), Vendor Performance (6 days), and vendor and OPG integration (3 days). Vault preparation activities are being managed in an integrated fashion between the Refurbishment project, SNC/Aecon and Darlington station to protect the overall progress on critical path.

Based on current performance and continued challenges with equipment and integration, it is anticipated that additional delays to critical path will occur while executing vault preparations with a forecast completion of the Containment Pressure Test, and Segment 1 of the refurbishment, on March 30th. This is in alignment with the working schedule commitment, and would result in 17 days of high confidence schedule contingency, allocated to the Vault Preparation phase, being unused and returned to the Program General Reserve.

Some near-critical path work, such as the pre-requisite projects, is progressing behind plan; however, OPG, together with the vendors, is actively managing near-critical path activities to recover schedule and avoid any impacts to critical path. The Schedule Performance for the month of January was good with 99% of the 88,500 hours planned for the period being earned. This is a significant improvement over December. In order to reduce the backlog, the program needs to earn more hours than planned, and have a period SPI greater than 1.00. Significant progress was made in the month of January within the Balance of Plant projects. ES Fox schedule performance was greatly improved, including recovery of the Vault Vapour Recovery System (VVRS), Conventional Dry Air, and Breathing Air system projects. This, however, was off-set by delays within the Re-tube Waste Processing Building.

In summary, on March 30th, at the completion of Segment 1, Unit 2 is forecasting to be on plan against the working schedule, and a full 30 days ahead of the high confidence schedule.

Additional details on Unit 2 critical path, including Segment 2, are included in Appendix 4 with further details provided in the monthly Unit 2 Execution Status Report.

COST PERFORMANCE

Since the November report to the DRC, the overall program CPI has declined from 1.01 to 0.97 which indicates that work is being performed for slightly more than budgeted. The decline in the period is largely due to higher costs to complete the remaining F&IP and SIO projects. Additional details on the estimate to complete for these projects, as well as the commercial performance, are included in the following sections of this memo.

FINANCIAL SUMMARY - TOTAL PROGRAM COST

Life-to-Date Cost (M$)			At Completion of Program (M$)				
Actual	Plan	Variance	Forecast	Plan	Variance	◯	↓
3,206	**3,284**	**(79)**	**12,800**	**12,800**	**0**		

Total Program Contingency (M$)					
	Budgeted		Allocated	Unallocated	◯ –
2,007	100%	[redacted]			

The life-to-date cost for the program is $3,206 Million, $79 Million below plan. Primary contributors to the under spend are lower than planned OPG resources, delays in executing some non-critical path Unit 2 work, and timing variance for Unit 3 planning and material procurement. These under spends are off-set by $11 Million of over spend within the F&IP and SIO projects. The forecast to complete the program remains within the approved budget of $12.8 Billion.

In last quarterly report to the DRC, program contingency was reported against the $2,006 Million Release Quality Estimate approved in November 2015. Since then, the program contingency has been reconciled to the Unit 2 Execution Estimate approved in August 2016, which excludes [redacted] of previously drawn contingency that was transferred to the projects prior to approval of the Unit 2 Execution Estimate. The total program contingency that has been allocated since August 2016 is [redacted]. This reflects forecast contingency draws for the F&IP and SIO projects, off-set by returns to contingency as a result of retired risks and interest re-calculations.

FACILITIES & INFRASTRUCTURE AND SAFETY IMPROVEMENT PROJECTS

In the period, work on the remaining F&IP and SIO projects has progressed, and the in-service of both the 3rd EPG and CFVS projects is forecast as mid-March. The cost estimates to complete the work exceed the established budgets, including contingency. [redacted] OPG continues to work through the contract management processes to resolve these issues, and mitigate further impact to the program cost.

Containment Filter Venting System – The equipment was successfully commissioned at the end of January; however, there were some components that were damaged during installation and required replacement prior to final acceptance by OPG. The vendor is currently replacing the deficient components, which has delayed the final in-service date until mid-March. OPG met with the CNSC prior to the end of December to seek an extension to the regulatory obligation and continues to demonstrate to the regulator that completion of this project is a priority. The IIP change control process was initiated, and a revised completion commitment for placing the system fully into service by April 28th, 2017 has been accepted by the CNSC. The target date to have the deficiencies corrected and the system fully in service is mid March, in advance of the CNSC commitment.

The forecast cost to complete the project is $101 Million, an increase of $7 Million since the last report.

3rd Emergency Power Generator – Commissioning of the 3rd EPG continues, and the forecast in-service date is mid March, in advance of the revised IIP commitment of March 31st. The generator is connected to station systems to support completion of the site acceptance testing, and has been started and synchronized. The final connection of the unit to the emergency power bus is planned for the first week of March. The building is completed structurally and final application of exterior cladding and interior painting remain.

The forecast cost to complete the project is $140 Million, an increase of $7.1 Million since the last report.

Heavy Water Storage Facility – Civil construction progressed in the period with the completion of the steel structure, second floor slab and installation of the external building precast panels. The schedule and cost estimate to complete the project is undergoing review with the vendor and OPG, and the final cost to complete the facility will exceed the current budget. Additional details, including mitigation strategies, are discussed in the Commercial and Contractor Performance section of this memo.

The SPI for the F&IP and SIO projects has increased from 0.89 to 0.91 in the period, and will continue to approach 1.00 as the projects are completed. The CPI has declined over the period, and is 0.83. The CPI will continue to decline as potential cost increases are realised.

Based on the current forecasts to complete the F&IP and SIO projects, [redacted] of contingency is required above the $17.9 Million of contingency allocated during Unit 2 Execution Estimate. This will be funded from returns to General Program Reserve.

Additional details on the remaining F&IP and SIO projects are provided in Appendix 6, and Appendix 11 provides photographs of construction activities underway.

RISK, OVERSIGHT AND ASSURANCE

RISKS

During the Defueling and early part of the vault preparation phase, active risk management has been an area of focus. Deployable risk mitigation strategies contributed to the success of Defueling; when risks occurred, plans were well established to mitigate and minimize the impact. Further, risks related to Primary Heat Transport motor failure did not occur resulting in a return of 13 days, and the associated [redacted] in contingency, back to the Program General Reserve.

As expected, while some risks have been retired without events, other events have occurred where risks and appropriate mitigation strategies were not in place. The leadership team has recognized this and has implemented a weekly risk look-ahead process to improve the identification and resolution of any risks, to the extent possible.

The Project Controls team is currently developing a risk tracking report that will show the status of all risks, including those that triggered and their impact, any new risks, and retired risks. This will be integrated with the forecasting process, and will be in place prior to the next quarterly DRC report.

Notwithstanding the fact that there have been a number of minor risk events in the period, there have been no changes to the key program risks since the last report, however, vendor performance risk is a focus area as discussed throughout this report. Details on the program risks, including the mitigation status are provided in Appendix 7.

PROJECT OVERSIGHT AND ASSURANCE

OVERSIGHT FINDINGS

There have been no significant emerging oversight findings identified by the Project and Program Oversight groups in the period. Details regarding current low level and past findings reported to the DRC are documented within the quarterly DRP Assurance Report.

AUDIT AND EXTERNAL OVERSIGHT

In the fourth quarter, there were 10 Internal and Nuclear Oversight audits conducted related to the DRP. Findings were identified in three areas relating to the implementation of Project Manager training, [redacted]'s procurement surveillance tracking, and the monitoring and recovering of costs associated with defective work. Corrective action plans are in place to address the findings and are on-track.

There were two CNSC Type II inspections conducted in the quarter in the areas of On-boarding and Oversight Training Requirements, and Quality Management and Oversight of Project Execution. These inspections noted a number of strengths, and there were no directives issued.

REFURBISHMENT CONSTRUCTION REVIEW BOARD (RCRB)

The Refurbishment Construction Review Board (RCRB) concluded its third visit on December 2nd, and provided three critical areas of focus for the Refurbishment team to improve project performance:

- Work execution needs to improve to prevent future impacts to schedule.
- Schedule stability needs to improve to facilitate schedule execution.

- Tailored Project Reporting which aligns high level program metrics with lower level project and departmental metrics is needed to drive accountability and behaviour.

A number of initiatives were completed to correct the underlying contributors to these observations. They include streamlining the existing project meeting calendar to focus on work readiness and schedule compliance; re-enforcing Project Manager accountability; supplementing both the OPG and vendor organizations with resources to drive work performance and address the backlog of work; and increasing work readiness and ownership of the plan by trades supervision.

A brief follow-up assessment was conducted in early February to status the implementation of the previous reports recommendations. The RCRB noted improvement in the refocus and accountabilities of the Project Manager, an improved scope stability, and an improved schedule performance and SPI with the exception of the RWPB project.

The following positive observations were also noted:

- Critical path performance on defueling has progressed very well, reflecting good team work.
- Good progress has been made with recruitment and on-boarding of staff.
- Steps taken for islanding of Unit 2 are very effective.
- Engineering field change process is working well with efficient issue resolution.
- There is good evidence of the shift to execution; however, continued effort is needed to further simplify processes to support schedule stability.

The RCRB reiterated that the project's most important focus area remains on improving schedule compliance which includes completing the required work that supports the project schedule. They offered a number of additional insights and suggestions to further improve work execution and schedule stability. These suggestions are currently being implemented in Refurbishment.

COMMERCIAL AND CONTRACTOR PERFORMANCE

SNC/AECON COMMERCIAL ISSUES

[redacted] OPG has initiated the following activities to mitigate the potential impact:

1. OPG is performing an independent assessment of the current project status and cost to complete to facility.
2. OPG is working with SNC/Aecon to understand their schedule basis, the reasons for the delays, and the basis for their estimate to complete the facility.

[redacted]

[redacted]

OPG continues to work through the contract management processes to resolve these issues.

ES FOX – PERFORMANCE IMPROVEMENT

[redacted] both OPG and the vendor have prepared plans for improved performance and fieldwork execution. OPG staff has been seconded to ES Fox to help drive the needed improvements. The plan developed by ES Fox focuses on five key areas: leadership and engagement, safety, quality of work, schedule completion, and accountability. Implementation of the improvement activities continues, and initial results with Unit 2 refurbishment projects are positive. Quantified improvement has been observed in the following areas:

- Project Management – Paired OPG and ES Fox Project Managers are fully engaged in driving work readiness and completion, and have produced notable improvement in safety performance.

- Near critical path projects – Completion has improved on near-critical path projects as reflected in the performance of the Breathing Air and Vault Vapour Recovery modifications.
- Backlog Reduction – Field performance has resulted in a significant reduction in the number of labour hours behind plan.

[redacted]

Additional details on vendor performance are provided in Appendix 8.

COMMUNICATION ACTIVITIES

TACTICAL COMMUNICATIONS FOR THE REFURBISHMENT TEAM

As previously reported, Corporate Relations & Communications (CRC) continues to undertake a number of initiatives to expand communication channels, build greater understanding of the project, and re-enforce behaviours expected of employees and trades. The messaging shifted in the fourth quarter of 2016 to the project pillars for execution success; turning on the 'construction switch'; as well as a strong emphasis on meeting our execution schedule commitments.

A number of programs are in place to ensure employees and contractors are aligned and informed. These include:

- An internal employee refurbishment website with weekly stories, daily communications, and access to critical production reports is in place and actively updated with over 70,000 visits per month.
- Monthly leadership messages are now sent from the SVP and senior leaders, supported with a video message. The weekly "Minute with Mike" videos continue to be produced and are receiving positive reviews.
- A metric dashboard was developed and is issued monthly to educate staff on current Key Performance indicators.
- Monthly leadership cornerstone meetings are held with the management team to align the organization around near-term objectives and recognize successes.
- Bi-monthly Standups! (face-to-face sessions) are also held with staff in multiple locations to recognize success and focus employee's attention on the key near-term outcomes.
- A successful employee and vendor event was held in January to acknowledge the successful completion of the defueling campaign.

COMMUNICATIONS TO THE PUBLIC AND STAKEHOLDERS

In the last quarter of 2016, the communications messaging shifted from planning to an execution posture. The external narrative focused on meeting our commitments by providing assurances of how the detailed planning and preparation safely got the project to the starting gate for breaker open on time and on budget.

A concerted external communications push was initiated to coincide with the start of the project on October 14th to leverage a number of highly visible events. A social media campaign supported by a print campaign in newspapers and a series of media releases was launched on November 1st; this resulted in positive media coverage across the province and increased the visits to the OPG Refurbishment website from an average of 19,000 visits to 155,000 in November. A successful public open house with 1800 visitors was held the same weekend.

To further engage the public and key stakeholders, the refurbishment website underwent a refurbishment of its own. The site is now maintained with new content including monthly performance updates as well as staff and vendor feature articles.

On the key stakeholder front, OPG communicated extensively with politicians at all levels of government and across party lines in the period and reached out to 20 different mayors across Ontario. It met with 22 members of Provincial Parliament, including the Conservative Energy critic, the PC caucus, and the NDP energy critic. Refurbishment was also discussed with 10 members of Parliament in Ottawa, including two Cabinet Ministers. This was tied to the province's consultation for their Long Term Energy Plan and resulted in strong endorsement from such groups as the Nuclear Mayor's Technology Caucus, Ontario Chamber of Commerce and Toronto Board of Trade.

In the first quarter of 2017, the social media campaign continued with a high presence on LinkedIn, Twitter and Instagram. A new Darlington TV commercial was shot in February and will be aired in April.

Additional details on internal and external communications are provided in the dashboard Appendix 9.

KEY DELIVERABLES FOR THE NEXT PERIOD

Focus has shifted to the following deliverables in the first quarter of 2017:

- Unit 2 critical path will continue through the Vault Preparations including completion of the reactor bulkhead installation.
- The Unit 2 Primary Heat Transport System vacuum dry will commence.
- External cladding will be installed on the RWPB.
- The Unit 2 Breathing Air enhancement system will be completed and placed-in-service.
- The CFVS and 3rd EPG projects will be placed in-service.
- Unit 2 Segment 1 work will end with the containment pressure test, which is planned for completion March 30th.

Following completion of Segment 1, the Removal Phase, or Segment 2a, will commence. Appendix 4 provides further details on planned activities remaining in Segment 1, and planned activities included in Segment 2a.

Submitted by:

Dietmar Reiner
SVP, Nuclear Projects

APPENDICES

1. Conventional Safety Performance
    a. Conventional Safety Performance
    b. Seven Life-Saving Rules Campaign
2. Radiological Safety Performance
3. Quality Performance
4. Schedule Performance
    a. Unit 2 Critical Path Schedule – Segment 1
    b. Unit 2 Critical Path Schedule – Segment 2
5. Cost Performance
    a. Program Financial Performance
    b. Program Contingency Management
6. Facilities and Infrastructure and Safety Improvement Projects
7. Key Program Risks
8. Vendor Performance Summary
9. Communications
10. Metrics Legend
11. Photo Catalogue

ONTARIO POWER GENERATION

Darlington Nuclear Refurbishment Program

APPENDIX 1A: CONVENTIONAL SAFETY PERFORMANCE

Bundle and Vendor Performance Year-To-Date

Period Ending: 31-Dec-16

SAFETY PERFORMANCE - YEAR TO DATE (YTD)

OPG and Vendor Refurbishment Staff	Actual		Target	Status	Trend
	Previous	Current			
Combined All Injury Rate (AIR)	0.42 [1]	0.50	0.24		-
OPG ONLY All Injury Rate (AIR)	0.00	0.00	0.24		-
# of Days Since a Lost Time Injury		2,556	Since Jan. 1, 2010		

ALL INJURY RATE - 6 MONTH TREND

ote: AIR is reset at Year-End.

BUNDLE SAFETY PERFORMANCE - YEAR TO DATE (YTD)

Line	Project Bundles Additional Project Bundles will be added as they commence work on site.	AIR *All Injury Rate*	ASR *Accident Severity Rate*	*Safety Injuries* # Lost Time Injury	 # Medical Injuries	*Safety Incidents* # High MRPH	 # Lvl 1 Work Protection Events	Hours Worked (Thousand)
1	Re-tube & Feeder Replacement							
2	Turbine Generator							
3	Fuel Handling & Defueling							
4	Shutdown Lay-up							
6	Steam Generators							
7	Islanding							
8	Balance of Plant							
9	Facilities & Infrastructure and Safety Improvement Opportunity Projects							
10	OPG Refurbishment Staff	-	-	-	-	-	-	1,369.2
9	**Nuclear Refurbishment Performance**	**0.50**	**-**	**-**	**2 9**	**3 6**	**4 2**	**3,612.1**

VENDOR SAFETY PERFORMANCE - YEAR TO DATE (YTD)

Excluding Owner-Only Metrics

Line	Vendors Additional Vendors will be added as they commence work on site.	AIR *All Injury Rate*	ASR *Accident Severity Rate*	*Safety Injuries* # Lost Time Injury	 # Medical Injuries	 # High MRPH	 # Lvl 1 Work Protection Events	Hours Worked (Thousand)
1								
2								
3								
4								
5								
6								
7	OPG	-	-	-	-	-		1,369.2
8	**Nuclear Refurbishment Performance**	**0.50**	**-**	**-**	**9**	**6**	**2**	**3,612.1**

OWNER-ONLY SAFETY PERFORMANCE - YEAR TO DATE (YTD)

1	Refurbishment Project Office	-	-	-	-	-	-	14.1
2	Re-tube Waste Processing Building	3.42	-	-	4	-	-	234.1

EXPLANATORY NOTES

[1] The 2016 Year-end AIR is 0.50 as a result of 9 medically treated injuries within 2016. There were no Lost Time Accidents. The OPG only AIR is 0.00 as a result of zero medically treated injuries involving an OPG employee. The previous period AIR, September 30th 2016, has been corrected from 0.64 to 0.42 due to understated OPG hours worked. As a result the AIR has declined over the period from 0.42 to 0.50.

[2] Four medically treated injuries occurred in the quarter, including one critical injury. An [redacted] worker on a [redacted] suffered a broken leg when he was struck by an Elevated Work Platform that he was spotting. The injured worker returned to work his next scheduled shift with modified duties. The Ministry of Labour was notified.

[3] Two High Maximum Reasonable Potential for Harm incidents occurred in the quarter. 1) The first incident is related to the previously identified medically-treated injury on the [redacted]. Work was stopped, the crew was stood down and [redacted] implemented a comprehensive improvement plan that included safety. 2) The second incident occurred on the [redacted] when an unqualified [redacted] worker modified a section of handrail while not correctly tied-off, exposing the worker to a falling risk. An inspection of all hand rail and scaffold within the mock-up was conducted to ensure a safe state and communications were rolled out to staff on potential hazards and safety expectations. Performance management of the individuals was conducted.

[4] Two Level 1 Work Protection Events occurred in the period. 1) An [redacted] worker on a [redacted] started to work on, and subsequently operated a valve without authorization. Performance management was conducted. 2) [redacted] workers removed a panel from a transformer cubicle on the [redacted] without having proper work protection in place. Workers were instructed to back out of the work area, and all [redacted] workers were stood down.

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EB-2016-0152
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Period Ending: 31-Dec-2016

APPENDIX 1B: SEVEN LIFE-SAVING RULES CAMPAIGN

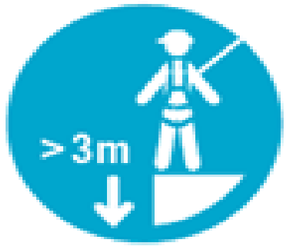
Refurbishment trades safety messaging

SEVEN **LIFE-SAVING RULES** WE MUST ALL ABIDE BY

Following these rules and procedures saves lives. Adherence to these rules is mandatory. **No tolerance for violations.** Breaking the rules may result in discipline up to and including termination.

Care enough to act. Have the courage to intervene if you see an unsafe act or condition or see someone who is unfit for work.

Verify isolation before work begins and use the required protective equipment



Ensure use of fall-arrest or restraint and always maintain 100% tie off

Obtain authorization prior to entry into confined spaces

Operate vehicles safely and stay clear of moving or hoisting equipment

Do not damage or disable safety devices or equipment

Respect work protection. Don't touch guaranteed or tagged equipment

No alcohol, drugs or behaviour that impairs your fitness for duty

Darlington Nuclear Refurbishment Program

APPENDIX 2: RADIOLOGICAL SAFETY PERFORMANCE

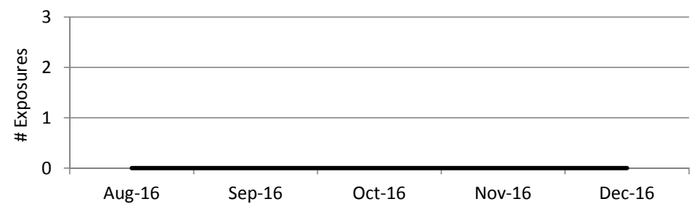
Bundle and Vendor Performance Year-To-Date

Period Ending: 31-Dec-2016

RADIATION PROTECTION PERFORMANCE - YEAR TO DATE (YTD)

OPG and Vendor Refurbishment Staff	Actual	Target	Status	Trend
Unplanned Exposures (>35µCi/l or > 100mrem)	0	0	◯	-

UNPLANNED EXPOSURES - 6 MONTH TREND



↓ is GOOD performance

Unplanned Exposures in Month

Cumulative # Unplanned Exposures - YTD

Note: Cumulative # Unplanned Exposures is reset at Year-End.

BUNDLE SAFETY PERFORMANCE - YEAR TO DATE (YTD)

Line	Project Bundles *Additional Projects will be added as they commence work on site.*	Actual	Target	# Unplanned Exposures	# Precursor EPD Whole Body Dose Alarms	# Unantici-pated EPD Dose Rate Alarms	Precursor Tritium Exposures (>10 µCi/l)	# RP License Violations (Non-PROL)	# Unposted Hazards	# RP Reg Doc. 3-1.1 Violations
		Collective Radiation Exposure (person-rem)								
1	Re-tube & Feeder Replacement									
2	Turbine Generator									
3	Fuel Handling & Defueling									
4	Shutdown Lay-up									
5	Islanding									
6	Balance of Plant									
7	Facilities & Infrastructure and Safety Improvement Projects									
8	OPG Refurbishment Staff	4.4		-	-	1	-	-	-	-
9	Collective Internal Radiation Exposure [All Bundles]	3.7		-	-	-	-	-	-	-
10	**Nuclear Refurbishment Performance**	(1) **16.6**	**18.8**	**-**	**-**	(2) **1**	**-**	**-**	**-**	**-**

VENDOR SAFETY PERFORMANCE - YEAR TO DATE (YTD)

Excluding Owner-Only Metrics

Line	Vendors Additional Vendors will be added as they commence work on site.	***Collective Radiation Exposure (person-rem)***	# Unplanned Exposures	# Precursor EPD Whole Body Dose Alarms	# Unantici-pated EPD Dose Rate Alarms	Precursor Tritium Exposures (>µCi/l)	# RP License Violations (Non-PROL)	# Unposted Hazards	# RP Reg Doc. 3-1.1 Violations
1									
2									
3									
4									
5	OPG Staff	11.5	-	-	1	-	-	-	-
6	**Nuclear Refurbishment Performance**	**16.6**	**-**	**-**	**1**	**-**	**-**	**-**	**-**

EXPLANATORY NOTES

(1) The overall Collective Radiation Exposure (CRE) is below target

(2) There has been one unanticipated Electronic Personal Dosimetry (EPD) dose rate alarm in the quarter. An OPG workers EPD alarmed while they were performing a final vault walk down of all elevations prior to the start of the defueling campaign. An immediate safe back-out from the vault was performed.

ONTARIO POWER GENERATION

Darlington Nuclear Refurbishment Program

APPENDIX 3: QUALITY PERFORMANCE

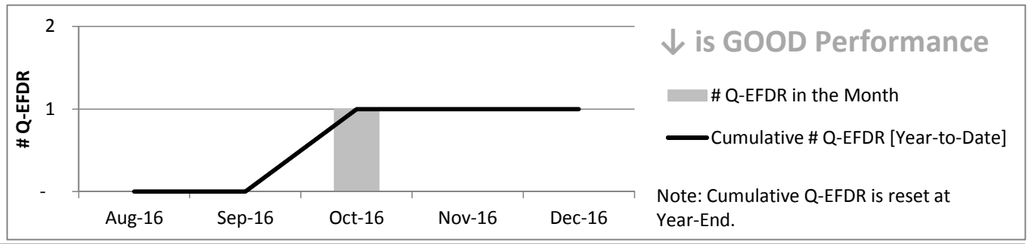
Bundle and Vendor Performance Year-To-Date

Period Ending: 31-Dec-2017

QUALITY PERFORMANCE - YEAR TO DATE (YTD)

	Status		Trend	Days Since Last Q-EFDR
	Previous	Current		
Overall Quality Performance	○	●	—	88 [1]

QUALITY EVENT FREE DAY RESET - 6 MONTH TREND



BUNDLE QUALITY PERFORMANCE - YTD

Line	Bundles	*Quality Event Free Day Resets (Q-EFDR)*	*Regulatory Non-Compliance Events*	*NCARs*	*OPG SCRs with Major Impact*	*Rework (Execution)*	*Average # of Revisions per Closed-out ECs*
1	Re-tube & Feeder Replacement	[redacted]					
2	Turbine Generator						
3	Fuel Handling & Defueling						
4	Steam Generator						
5	Balance of Plant & Refurbishment Support Facilities						
6	Shutdown, Layup and Services						
7	Unit Islanding						
8	Campus Plan - F&IP and SIO Projects						
9	Refurbishment Operations & Maintenance						
10	NR - Other						
11	**Nuclear Refurbishment Performance**	**1** [1] **1**	**2** [2] **-**	**3**	**-**	**-**	**2.1**

VENDOR QUALITY PERFORMANCE - YTD

Line	Vendors	*Quality Event Free Day Resets (Q-EFDR)*	*Regulatory Non-Compliance Events*	*NCARs*	*Vendor CARs*	*Rework (Execution)*	*Average # of Revisions per Closed-out ECs*
1	[redacted]						
2							
3							
4							
5							
6	OPG	1	-	-	-	-	-
7	**Nuclear Refurbishment Performance**	**1**	**0**	**3**	**-**	**-**	**2.1**

EXPLANATORY NOTES

1. One Q-EFDR occurred in October on a Balance of Plant project when the adjuster rod SHIM mode operation could not be placed in service due to a set-point error made during the design analysis. A corrective action plan was initiated and the modification is now in-service on all 4 units.
2. A regulatory non-compliance event previously reported to the DRC in November was related to [redacted], a non-refurbishment project. As such, the event is not included in this report; however, interim actions have been taken to prevent reoccurrence.
3. Two NCAR have been issued to the [redacted] in the quarter regarding the [redacted]. The findings involved repeat quality records issues and an observed trend of not meeting requirements of the OPG's Approved Supplier Listing. Corrective actions are in place. The NCAR related to [redacted], identified in the previous report to the board, has been removed since it occurred on the [redacted] which is not a refurbishment project. The remaining [redacted] NCAR refers to the previously identified issue related to a less than acceptable safety focus.

**NCAR = Non-conformance and Corrective Action Request; SCR = Station Condition Record; CAR = Corrective Action Request; EC = Engineering Change;*

ONTARIO POWER GENERATION

Darlington Nuclear Refurbishment Program - Unit 2

APPENDIX 4A: UNIT 2 CRITICAL PATH SCHEDULE - SEGMENT 1

Performance of Critical Path against Working Schedule

Period Ending: 14-Feb-17

DARLINGTON REFURBISHMENT Repowering Ontario

S1

Unit 2 Refurbishment: SEGMENT 1 Defuel + Containment Isolation

CURRENT: 161 days: October 15, 2016 – March 25, 2017

Critical Path Windows
Electrical Windows
Conventional Layup
Heat Transport Vacuum Dry
Other required S1 work

Unit 2 Segment 1 Status Update: February 14, 2017 @ 17:00

October 2016 | November 2016 | December 2016 | January 2017 | February 2017 | March 2017 | April 2017

10/2 10/9 10/16 10/23 10/30 11/6 11/13 11/20 11/27 12/4 12/11 12/18 12/25 1/1 1/8 1/15 1/22 1/29 2/5 2/12 2/19 2/26 3/5 3/12 3/19 3/26 4/2 4/9

2 Conventional Side LAY-UP

Drain & Protect (Lay-up) Conventional Systems from Corrosion

21-Oct-16 — OPS Apply Drain OTO's & [illegible] — COMPLETE — 01-NOV-16

Install Dehumidifiers & Establish Airflow Path — COMPLETE — 10-Jan-17 ~~29-Dec-16~~

Commission and Dry Conventional System — COMPLETE — 10-Feb-17 — 09-Jan-17 Systems Declared in Lay-up — 22-Feb-17 OTO Permit Application

Deadlegs Drained — 20-Feb-17

To inhibit corrosion damage to secondary side steel piping systems caused by moisture, temporary dehumidified air is provided. (11) Dry Air skids will be installed at various points to force warm air through the pipework in order to achieve acceptable dryness.

Layup Completion for the following systems:

DHA1:	Main Condenser
DHA2:	Boiler Feedwater
DHA3-4:	Main Condensate
DHA5:	Main Steam
DHA6-7:	Extraction Steam
DHA8-9:	Main Steam Reheat
DHA10:	D/A, Condensate Make Up & Storage Tanks
HP1:	PFW Pumps (Main & Aux)

Heat Transport Motors Disconnect and Uncouple 33120-PM1, PM2, PM3, PM4 — Remove Heat Transport Motors

Vault Access Coordination for HT Motors due to Vault Access restrictions during Critical Lifts

4 PRIMARY HEAT TRANSPORT SYSTEM VACUUM DRY

The entire HT system must be drained & dried before the retube of the reactor can begin. Once Operators have drained it through normal pipework, the Heat Transport system will be put under vacuum in order to 'boil off' the rest of the water. A Vacuum Drying Skid will be attached to the HT system to perform this. The water vapor will be condensed in receivers and sent through piping to the storage tanks outside of Unit 2. It is expected to take 40 days to completely drain & dry the HT system

Defuel Complete 11-Jan-17 @19:49 ~~06-Feb-17~~ — Declaration that Reactor Core is Defueled Before Entering State 3a

16-Jan-17 ~~11-Feb-17~~ — COMPLETE — Vac Dry Prereqs — HTS Bulk Drain

25-Feb-17 ~~04-Mar-17~~ — Heat Transport Vacuum Dry — 19-Mar-17 ~~22-Mar-17~~

30-Mar-17 — STOP — Containment Pressure Test Declared Complete

Unit 2 Shut Do[illegible] 15-[illegible]-16 — COMPLETE — West RAB Brake Repair

Shutdown Unit 2 — First things first... — 1

Unit 2 will start reducing power at 22:00 hrs on Friday Oct 14. At midnight (Oct 15th at 00:00 hrs) Operators will fire Shutdown System #2 to take the Unit deeply sub-critical. The Heat Transport System will be cooled down to 80 C to allow defueling of the reactor to take place. Years of planning has led us to this milestone to open the breaker on the first Darlington Refurbishment Unit!

308 Channels: Sin[illegible] Flow Defuel — COMPLETE — 29-Nov-16 @11:00 ~~06-Dec-16~~

36 Channe[illegible] End Flow Defuel — COMPLETE — 08-Dec-16 @08:00 ~~02-Jan-17~~

Window D17 Install APT, End Fitting Caps & Radiation Shielding — COMPLETE — E&W Carriage Removal Complete 4-Feb-17 ~~17-Feb~~

15-Jan-17 ~~8-Feb-17~~ Window D15 Vault Crane Maintenance Complete — COMPLETE — 15-Jan-17 Window 200 Shield plug swap

Middle Seal Leak Test — COMPLETE

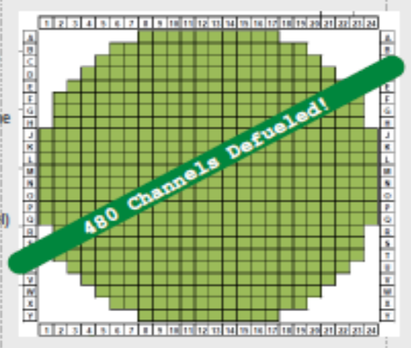
Window 23 Bulkhead Installation — COMPLETE — 24-Mar-17 Bulkhead Installation Complete

Window 24 Containment Pressure Test

To the start of Segment 2 Window 137

1 DEFUEL

The reactor will be entirely defueled prior to turnover to the Joint Venture who are going to be performing the Retube of the Unit 2 reactor and replacing feeders. The majority of the defuel campaign will be accomplished via flow defueling using the Heat Transport pumps however it is estimated that 124 dummy fuel bundles (11 per channel) will need to be installed in the low flow channels allow push defueling to empty the channel.



3 'ISLAND' Unit 2 from the DNGS Operating Units

A large steel bulkhead to bridge the gap where the fueling machines access the U2 reactor will be installed during this window. This bulkhead will form part of the temporary containment boundary which will physically separate Unit 2's containment from the operting units!.

5 VERIFY UNIT 2 is isolated from containment

The containment test is conducted to verify the integrity of the new containment boundary.

New Breathing Air System Installation

Install Mechnical Portion of Breathing Air — COMPLETE — 30-Jan-17

Install Electrical Portion of Breathing Air — COMPLETE — 13-Feb-17 OCD — 16-Feb-17 — Commission Breathing Air Outside Vault — OCD — 15-Mar-17 — Breathing Air Final Tie-in and AFS — 28-Mar-17

New Breathing Air Tie-in for Refurbishment use in Unit 2 will be performed at the start of Segment 2

Segment 1 Major Electrical Scope

21-Oct-16 — W126: T9/T[illegible] Maintenance — COMPLETE — 11-Nov-16 — To Odd Electrical Outage (Segment 2)

15-Nov-16 — W127: T10/T12 — COMPLETE — 03-Jan-17 — To TPDS and Odd Electrical Outage in S2

VVRS 3-Way Valve Replacements — COMPLETE — 30-Dec-17

VVRS ByPass Fan Installation — COMPLETE — 8-Feb-17 OCD — 15-Feb-17

To Containment Pressure Test

Window 009: VVRS Modifications

W009: VVRS Modifications — COMPLETE — 30-Jan-17

State 1: Reactor Shutdown Evolution | State 2: Guaranteed Shutdown with Irradiated Fuel Core | State 3a: Defueled State | State 3b: Defueled & Isolated from Containment State

ONTARIO POWER GENERATION

Darlington Nuclear Refurbishment Program - Unit 2

APPENDIX 4B: UNIT 2 CRITICAL PATH SCHEDULE - SEGMENT 2

Level 1 Critical Path Working Schedule for Segment 2

Period Ending: 14-Feb-17

DARLINGTON REFURBISHMENT Repowering Ontario

S2a

Unit 2 Refurbishment: SEGMENT 2a Removal Phase

213 days: March 30, 2017 – October-29, 2017

Critical Path Windows | Heat Transport Vacuum Dry | Water Systems
Electrical Windows | Other required S2 work
Moderator Windows | Near Critical windows

U2 Schedule S2a
February 28, 2017

March 2017 | April 2017 | May 2017 | June 2017 | July 2017 | August 2017 | September 2017 | October 2017 | November 2017

13-May-17 HTS Aux Vac Dry — Window 035
HTS Auxiliaries - Drain & Purge (Layup) — Window 048
40% RH Achieved
HTS Auxiliaries - Rehab — Window 048

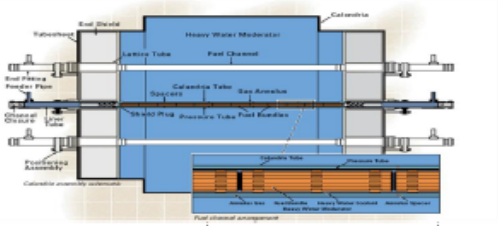
D1711 Outage

Holdout for Boiler Manway Manipulator Arms (Unit 1 Integration Logic)

PHT Vac Dry — Window 029
PHT Vac Dry stops during the Containment Pressure Test
PHT Vac Dry (Continued) — Window 029
13-May-17 Primary Side SG Layup — Window 034
17-Jun-17

6 Primary Side Steam Generator Layup

Following the vacuum dry of the Primary Heat Transport System which includes the Primary Side of the SG's, the SG Primary Side will be put into a dry air layup state. The purpose of the dry air layup is to minimize degradation of existing system assets during planned maintenance and to reduce the tritium hazard to the extent possible.



4 Vault Projects

Once the Air lock doors are open there are various projects to be executed in coordination with the work on Critical Path. The vault project work consists of Piping installation for the Emergency Heat Sink Lines, Periodic Inspection Programs, valve overhauls and install, ignitor cables and Shutdown Cooling cables

Window 104: Vault Projects
Window 105: Vault Projects
Airlock 2 Shielding Curtain Installed for Work to Progress

VERIFY UNIT 2 is isolated from containment 30-Mar-17

Segment 1 — 8d — 7-Apr-17
Window 025: Install Shielding — 19d — 26-Apr-17
Window 027: Bulk Interference Removals — 23d — 19-May-17
Window 101: Remove FM Bridges & Install RTP — 42d — 30-Jun-17
Window 111: Feeder Cabinet Removal — 16d — 16-Jul-17
RFR JV Vault Access Only
Window 042: Feeder Removal — 51d — 5-Sep-17
Window 192: Dummy FB Removal — 9d
Window 112: Pressure Tube Sever — 14d — 28-Sep-17
Window 113: Sever Bellows — 31d — 29-Oct-17
To the Start of Segment 2b Window 114 End Fitting Removal

1 Opening of Airlock Doors

Window 137: Once the Bulkheads are installed and the Pressure test is complete, the Airlocks will be opened to facilitate large numbers of workers in the vault and critical logistics. VVRS System and By-pass fans are commissioned as well as the final Breathing Air tie-in to remove reliance on use of Breathing Air from the Station Breathing Air system.

2 Vault Setup and Feeder Removal Prep

GETTING THE VAULT READY FOR REACTOR DISASSEMBLY

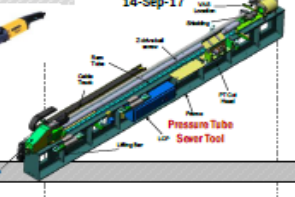
Windows 025, 027, 101, 111

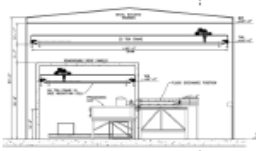
The vault needs to clear of all interferences to make room for tooling and equipment required to disassemble the reactor.

3 Reactor Disassembly

Windows 042, 192, 112, 113

A special platform (Retube Tooling Platform) will be installed to support retube tooling. Feeders will be cut into small, manageable pieces and lowered to the floor where they will be cut up even further for transport to the on-site waste processing building. Once the Feeders are removed. The Pressure tubes will be cut and End Fittings and Bellows will be cut.





14-Sep-17 RWPB Available

The Retube Waste Processing Building (RWPB) is required as part of the RFR project to support the Waste Tooling System (WTS) to optimize Radioactive waste processing and packaging operations.

Retube Waste Processing Building

5 Moderator Drain & Dry

Once the moderator has been drained & flushed, the pipe work can be disconnected to allow vac drying to occur. The calandria is isolated from the lower moderator piping. Calandria Vessel Purge Flow is required to be established for the start of the replacement of the calandria tubes and throughout the calandria tube install series.

Isolate Calandria from Main Pipe work and Hook up Drying Equipment
13-May-17 Moderator Drain & Flush — Window 038
12-Jun-17 — Window 108
10-Jul-17 Establish Upper Calandria Purge Flow and EW Valve maintenance — Window 103
1-Oct-17 — Window 098, CTI Release

Holdout to Align Resources with Horizontal Flux Detector Replacement
Window 028
20-Oct-17 Replace Vertical Flux Detector

From Window 035 HTS Aux Vac Dry
Window 067 — EP Modifications and Run Hose for Vac Dry
Window 121 — Vac Dry Lower Moderator Pipework
3-Sep-17 Moderator Valve Rehab — Window 122
28-Sep-17
Window 123 — Remove Vac Dry Equipment
Window 124 — Purge and 33410 - SDC HX 1 Installation

Holdout for Resources
10-Jul-17 Secondary Side SG Clean & Install Access Ports — Window 037
28-Aug-17 — BBD Ties to CW AWPP

Segment 2a Major Electrical Scope

Hold out for Temporary Containment Boundary Declared & Temp Vault ACU's Installed
16-Apr-17 EPS MCC Rehab — Window 005
4-Jun-17 — Class 3 Electrical Maintenance — Window 041
4-Oct-17 Class 2 Electrical Maintenance — Window 040

Hold out for Warmer Temperatures
3-Apr-17 MOT/UST/IPB/Switchyard Rehab — Window 004
15-Sep-17 — To RCHP 5

Segment 2a Water Systems Scope
8-Sep-17 PULSW Outage — Window 056
Continued in Segment 2b

State 3a: Defueled State
State 3b: Defueled & Isolated from Containment State

ONTARIO POWER GENERATION

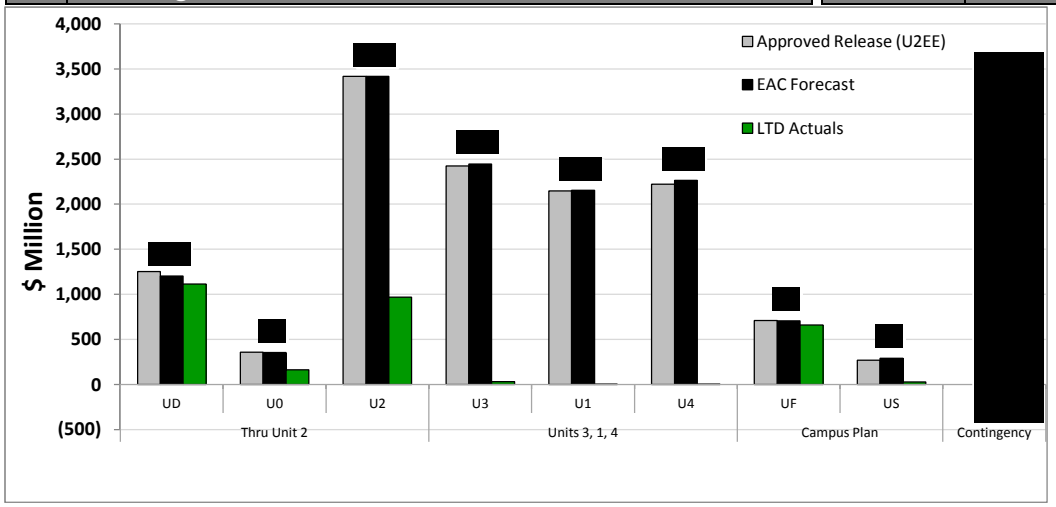
Darlington Nuclear Refurbishment Program

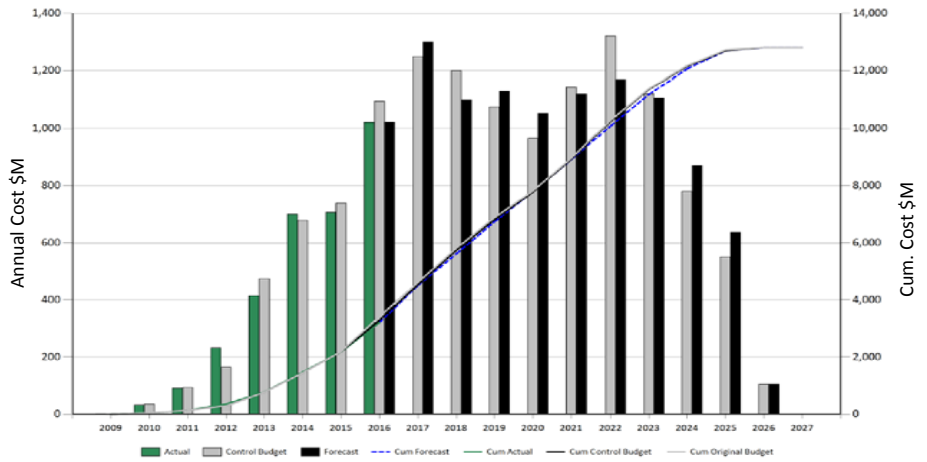
APPENDIX 5A: PROGRAM FINANCIAL PERFORMANCE BY UNIT

Financial status of the Program by Unit

Period Ending: 31-Dec-16

		Cumulative Life to Date			At Completion of Program				
		a	*b*	*c = b - a*	*d*	*e*	*f = d+ e*	*g*	*h*
Line	Description	Plan (PV)	Actual (AC)	Cost Variance From Plan	Approved Plan @ U2EE	Contingency Allocation by Unit	Approved Plan including Contingency	Current Forecast	Approved Funding Release
1	Unit D or Definition Phase	1,105	1,113	**8**	1,251	-	**1,251**	[redacted]	1,251
2	Unit 0 or Unit Common	193	163	**(30)**	359	-	**359**	[redacted]	359
3	Unit 2	1,028	968	**(60)**	2,740	677	**3,417**	[redacted]	3,417
4	**Subtotal Thru Unit 2**	**2,327**	**2,244**	**(83)**	**4,350**	**677**	**5,028**	[redacted]	**5,028**
5	Unit 3	62	31	**(31)**	1,867	557	**2,424**	[redacted]	46
6	Unit 1	9	0	**(9)**	1,739	410	**2,148**	[redacted]	51
7	Unit 4	9	0	**(9)**	1,878	345	**2,223**	[redacted]	5
8	**Subtotal Units 3,1,4**	**81**	**31**	**(50)**	**5,484**	**1,311**	**6,796**	[redacted]	**102**
9	Unit F - Facilities & Infastructure	665	661	**(4)**	690	18	**708**	[redacted]	708
10	Unit S - Safety Improvement Initiatives	254	269	**16**	269	-	**269**	[redacted]	269
11	**Subtotal Campus Plan**	**919**	**930**	**11**	**959**	**18**	**977**	[redacted]	**977**
12	Contingency	[redacted]			2,007	(2,007)	-	[redacted]	*incl. above*
13	**Total Program**	**3,284**	**3,206**	**1 (79)**	**12,800**	**(0)**	**12,800**	**12,800** **2**	**6,104**





EXPLANATORY NOTES

1. As of Dec 31, 2016, actual cost to-date was $3.2 Billion, $79 Million under spent: $83 Million through Unit 2 due to lower than planned resources and rescheduling of planned work; and $50 Million for planning and procurement for subsequent units; offset by a $11 Million over spending in Unit F and S Campus Plan projects and [redacted] of contingency allocation (from the Release Quality Estimate).
2. The cost estimate to complete the 4-Unit refurbishment remains within $12.8 Billion.
3. The total forecast for the Facilities & Infrastructure and Safety Improvement projects is [redacted]. This includes the [redacted] required for the key F&IP and SIO projects discussed in Appendix 6, plus [redacted] of minor miscellaneous projects included within the Campus Plan portfolio.
4. The forecast need for additional contingency will be funded from under-spends held in Program General Reserve. Appendix 5B provides details on contingency use and forecast to date.

ONTARIO POWER GENERATION

Darlington Nuclear Refurbishment Program

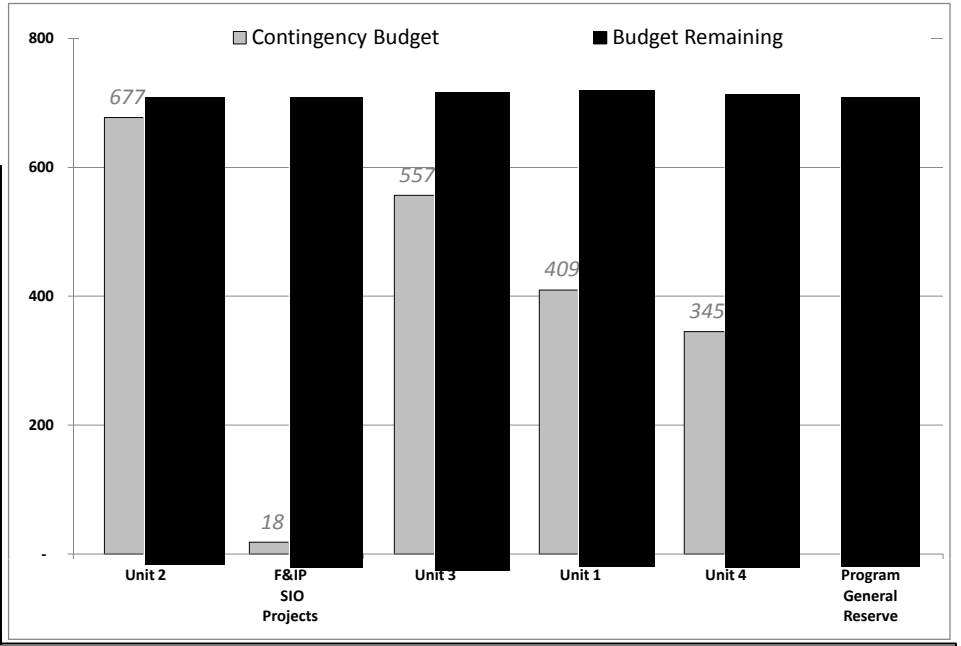
APPENDIX 5B: PROGRAM CONTINGENCY MANAGEMENT

Financial Status of the Program Contingency by Unit

Period Ending: 31-Dec-2016

UNITIZED CONTINGENCY MONITORING AND TRACKING ($ Million)

a	b	d	e	f	g	h=d:g	i
Line	Unit	Approved Release @ U2EE (1)	Drawdowns against U2EE	Transfers **to** General Reserve	Transfers **from** General Reserve	**Budget Remaining**	Current Forecasted Need
1	Unit 2	677	[redacted]				
2	F&IP & SIO Projects	18					
3	Unit 3						
4	Unit 1	409					
5	Unit 4						
6	Program General Reserve						
7	**Total Program**	**2,007**					



EXECUTIVE DISCUSSION

1. Contingency in the last Quarterly report was shown against the $2,006 Million original Release Quality Estimate (RQE) budgets. Going forward, contingency will be shown against the $2,007 Million U2EE Board Release approved in August 2016, which excludes [redacted] of contingency drawn and transferred to bundle project base cost as part of U2EE.
2. To-date, there is a net [redacted] contingency draw against U2EE approved budgets:
   - [redacted] drawn was F&IP/SIO projects due to vendor under estimation of costs and quality issues.
   - Within Unit 2, [redacted] of net drawdown is largely a result of [redacted] draw for Balance of Plant projects to address minor scope changes, field execution issues, and revised vendor estimates; [redacted] draw across multiple projects of which [redacted] of due to discrete project risk realization, and [redacted] due to estimating uncertainty; and an off-set of [redacted] of contingency return within the functional projects.
3. A Program General Reserve (PGR) has been established to set aside funding when significant risks are retired. The current [redacted] within the reserve is a result of [redacted] retired high confidence schedule contingency due to the early completion of Defuel, and a [redacted] forecasted interest cost reduction on the nearly complete definition phase. A positive PGR balance represents available contingency funding, whereas a negative balance represents the Program is temporarily consuming more than expected.
4. F&IP and SIO projects are currently forecasting an additional cost over-run of [redacted] which will be funded from surplus held in Program General Reserve.

ONTARIO POWER GENERATION

Darlington Nuclear Refurbishment Program - F&IP and SIO

APPENDIX 6: FACILITIES & INFRASTRUCTURE AND SAFETY IMPROVEMENT OPPORTUNITIES PROJECTS

Cost and Schedule Performance

Period Ending: 31-Dec-2016

COST DETAIL ($ MILLION)

		Cumulative (Life-to-Date)					At Completion of Project				In-Service Date			
		a	b	c=b-a	d	e	f	g	h	j	k	m	n	o
Line	Project Title	Plan (PV)	Actual (AC)	Variance	CPI	SPI	U2EE Budget	Estimate at Completion (EAC)	Variance from U2EE	Variance from Last Period	Need Date	Current Forecast	# Months Float	Variance from Last Period
1	Heavy Water Storage & Drum Handling Facility	346.0	340.9	(5.2)	0.86	0.87	381.2	381.1	(0.0)	0.0	-	Jun 2017	0	1
2	3rd Emergency Power Generator	128.2	135.7	7.5	0.78	0.93	120.4	140.0	19.6	7.1	Mar 2017 (IIP Commitment)	Mar 2017	0	3
3	Containment Filtered Venting System	84.0	93.9	9.9	0.82	1.02	80.6	101.0	20.4	7.0	Apr 2017 (IIP Commitment)	Mar 2017	1	4
4	Shield Tank Over Pressure Protection	21.3	20.5	(0.8)	0.78	0.99	24.1	32.7	8.6	0.0	U1-D1711 U2-DNRU2	U1-D1711 U2-DNRU2	0	N/A
5	Balance of Pre-Requisite Projects In-Service	330.8	327.2	(3.6)	*	*	337.7	328.0	(9.8)	(0.2)	IN SERVICE			
6	**Subtotal Campus Plan Before Contingency**	**910.3**	**918.2**	**7.8**	*	*	**943.9**	**982.8**	**38.8**	**13.9**				
7	**Project Contingency (included)**	*	*	*	*		[redacted]							
8	**Program Contingency**	*	*	*	*									
9	**Total Campus Plan including Contingency**	**910.3**	**918.2**	**7.8**	*	*								
Portion of the Re-tube & Feeder Replacement Bundle														
12	Re-tube Waste Processing Building	144.9	119.2	(25.7)	1.05	0.84	180.7	190.2	9.5	(3.2)	Oct 2017	July 2017	2	1

Notes: * Indicates not applicable. The CPI and SPI calculations exclude project management costs and support tasks which are considered level of effort. PHT = Primary Heat Transport

EXECUTIVE DISCUSSION

1. The Budgets have been adjusted to reflect the Unit 2 Execution Estimate budgets, including the contingency.
2. The Heavy Water Storage Facility in-service date and estimate is at risk. The vendor is preparing a cost and schedule estimate to complete the work, and OPG will fully validate this estimate as well as perform an independent review and estimate to complete. Commercial discussions at the CEO level are already occurring, and contingency measures for heavy water storage for Unit 2 are in place.
3. The estimate to complete the 3rd EPG project has increased since the last report as a result of delays in construction, and commissioning complexity; this has resulted in a delay of the in-service date to March 2017. The IIP Change Control Process was initiated and accepted by the CNSC with a revised need date of March 2017.
4. The estimate to complete for the CFVS project has increased since the last report as a result of delays in construction and additional commissioning costs. The in-service date is forecast March 2017. The IIP Change Control Process was initiated and the revised in-service commitment of April 28th has been accepted by the CNSC.
5. A total of [redacted] of additional contingency, above the contingency allocated during the Unit 2 Execution Estimate, is required to complete the projects based on the current estimates. This will be funded from the Program General Reserve. This is an increase of [redacted] in the period.

ONTARIO POWER GENERATION

Darlington Nuclear Refurbishment Program

APPENDIX 7: KEY PROGRAM RISKS

Risks Being Actively Managed by the Program

Period Ending: 31-Dec-2016

KEY PROGRAM RISKS AND MITIGATION STATUS

Line	Status	Risk Description	Mitigation Plan
1	–	**Vendor Performance** Poor vendor performance will negatively impact safety, quality, cost and/or schedule.	Vendor Performance continues to challenge the Refurbishment program and, although there has been some improvements in the quarter, this remains a high risk. OPG continues to actively manage and assist vendors by removing barriers to work and seconding OPG staff to the vendors. Focus areas in the past quarter have been on 1) supervisory training, 2) work readiness, 3) safety awareness and performance improvements, and 4) increasing project manager accountability. Vendor accountability continues to be reinforced through a number of avenues including a weekly performance meeting with focus on safety, quality, schedule and cost performance; vendor ownership levels are continuing to improve. [redacted] ES Fox performance improvement plan in in place which includes secondment of some OPG staff. Quantified improvement has been observed within the refurbishment projects.
2	–	**Availability/Retention of Project Leadership** Key project personnel with the required skill set will not be in place for the full refurbishment program resulting in impacts on performance.	Focus remains on establishing a strategic resourcing framework with the right organizational design, and ensuring the right leadership pipeline is in place for future unit refurbishments (Units 3, 1, 4). Phase 2 of the Nuclear Fleet Bench Strength Improvement Plan is in progress. The Simplified Hiring item on the Nuclear Refurbishment top 10 priority list have been completed, with the central resourcing team currently in place and single point of contacts assigned to support each organization in the expedition of staffing needs. The resource plans have been compared against RQE staffing forecasts to ensure alignment. The Executive Compensation Framework has been finalized.
3	↑	**Availability of Skilled Craft Resources/ Supervision** Key skilled craft resources may not be available when required for the Execution Phase.	Focus continues on the onboarding for trades workers and the New To Nuclear (NTN) program for Unit 2. OPG participates in labour market information studies to gain insights into labour market issues, including the identification of skilled craft resource needs using tactics that include both short and long term approaches. There is no significant risks perceived for Unit 2, however there is a risk to future units with the start of the Bruce Power Major Component Replacement program in 2019. Discussions and collaboration with Bruce Power continue and it is expected this risk will be mitigated. The current plans and tactics are being evaluated to ensure integration with the Nuclear fleet to minimize the risks in all support areas. Provisions in trades union agreements also provide for resourcing flexibility, all major unions signed Nuclear Project Agreement (NPA).
4	↓	**First of A Kind/First in A While Work and Processes** A lack of recognition of FOAK/FIAW work and processes during design and execution planning results in installations that do not meet requirements causing rework/delay or degraded production post Refurbishment.	A thorough and in-depth review was completed with Engineering, project teams and various execution and functional groups in the Nuclear Refurbishment and Projects & Modifications organizations to flag FOAK/FIAW risks. Specific mitigation actions are defined for FOAK/FIAW risks, and In-depth challenge/review of risks impact/events along with robust tracking of the mitigation actions were put in place. Through the defueling phase, active and deployable risk management contributed to a successful campaign, however, weaknesses in proactive risk identification and mitigation have been seen elsewhere, and, as a result, a weekly risk look ahead process has been put in place to reinforce active risk management. A detailed risk tracking module is currently being developed and will be in place by the end of this period (March 30, 2017).

– No change over period ↑ Improvement ↓ Decline HIGH RISK LOW RISK

Darlington Nuclear Refurbishment Program

APPENDIX 8: VENDOR PERFORMANCE SUMMARY

Core Refurbishment and Facilities & Infrastructure and Safety Improvement Projects

Period Ending: 31-Dec-2016

VENDOR PERFORMANCE INDICATORS

Line	Vendor Name & Key Scope	Safety	Quality	Cost	Schedule	Relationship	Explanatory Notes
1	[redacted]						
2							
3							
4							
5							

Note: The CPI and SPI calculations exclude project management costs and support tasks which are considered level of effort.

ONTARIO POWER GENERATION

Darlington Nuclear Refurbishment Program

APPENDIX 9A: COMMUNICATIONS - EXTERNAL INITIATIVES

Period Ending: 31-Dec-2016

External Initiatives and Outcomes

Narrative Focus: *environmental benefits, jobs and economy; project well planned – started in October as committed*

- Refurbishment website enhancements featuring staff/vendor stories and improvements to navigation
- Public newsletter issued (125K circulation)
- Launched an interactive map listing manufacturers/vendors
- Launched monthly project updates to stakeholders
- Successful public/stakeholder breaker open launch: 1,800 visitors
- Social media campaign launched November 1, supported with a print campaign

Q4 2016 (Oct, Nov, Dec)

SOCIAL MEDIA
TWITTER Q4
37 Number of posts
503 Total interactions

UNIQUE MEDIA STORIES
18 Total
10 Positive
2 Neutral
6 Negative

PRINT ADS PUBLISHED 3

MEDIA RELEASES ISSUES 5

REFURB FALL NEWSLETTER (125K CIRCULATION) 1

MOCK-UP TOURS
PRESENTATIONS Q4
Total
18

STAKEHOLDER COMMUNICATIONS AND PROJECT UPDATE REPORTS 7

OPG Refurbishment Website

OCT	NOV	DEC	Q4
18,975 TOTAL VISITS	155,517 TOTAL VISITS	8,317 TOTAL VISITS	182,809 TOTAL VISITS
17,568 TOTAL PAGE VIEWS	190,664 TOTAL PAGE VIEWS	8,132 TOTAL PAGE VIEWS	216,364 TOTAL PAGE VIEWS

VENDOR INTERACTIVE MAP | 7,755 TOTAL VISITS

Downloads

Future Objectives

- Development of an interactive online project schedule (what's involved in refurbishment)
- Enhanced frequency of project stakeholder update
- Implement enhanced search engine optimization tactics

ONTARIO POWER GENERATION

APPENDIX 9B: COMMUNICATIONS - INTERNAL INITIATIVES

Period Ending: 31-Dec-2016

DARLINGTON REFURBISHMENT COMMUNICATIONS UPDATE

Q4 2016 (Oct, Nov, Dec)

Internal Initiatives and Outcomes

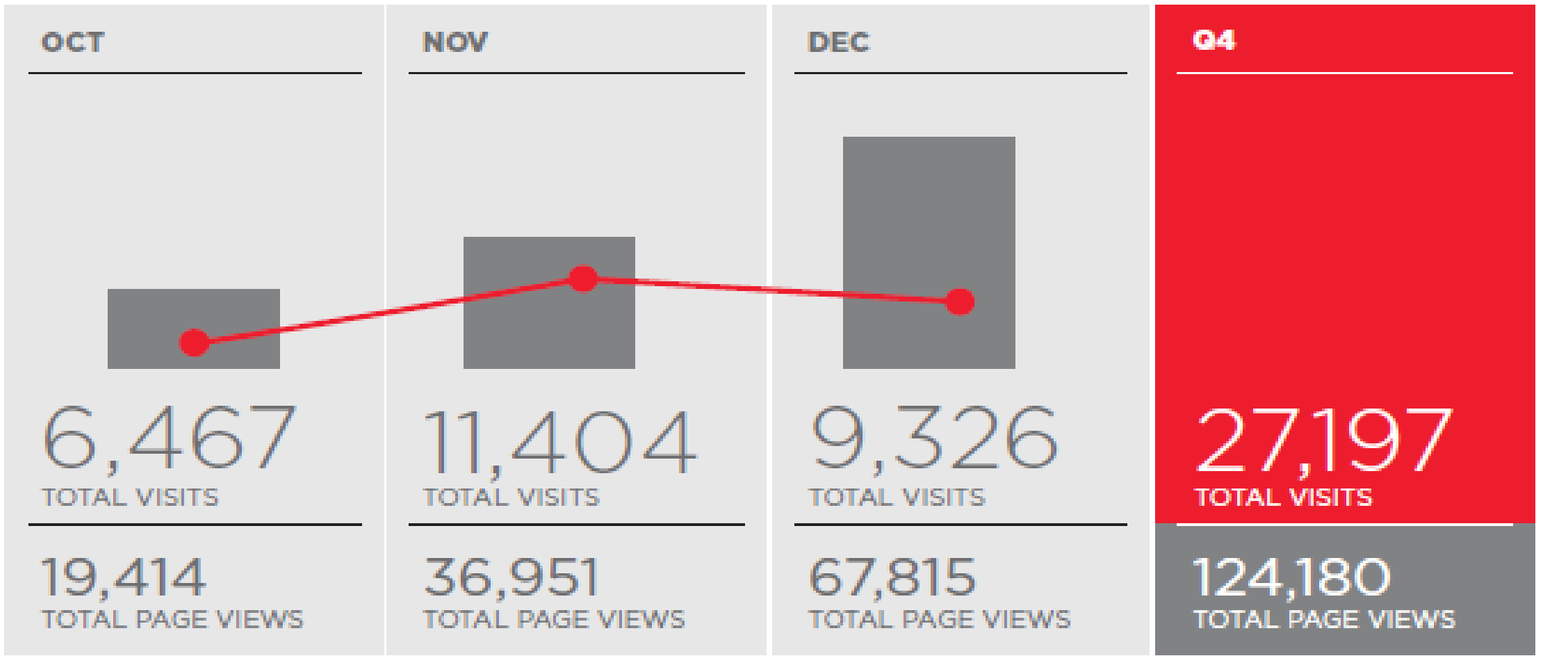
Narrative Focus: *project pillars, turning on the construction switch, OneTeam, shift from planning mindset to execution*

- Re-launched refurbishment website with value-added content and daily updates – paying strong dividends
- Successful employee/vendor breaker-open launch
- Shift to execution posture for communications – numerous daily and weekly updates
- Effective use of weekly video updates to engage staff
- Executed a successful employee/vendor recognition for defuel campaign completion (Q1 2017)

Q4 Combined Results

12 Weekly e-pulse news emails	5 Bi-monthly ***The Pulse*** (newsletter for the trades)	18 Project/leadership videos	
22 Project update stories	37 Refurbishment communications advisories issued	5 Stand-up face-to-face staff alignment meetings	11 Dir of operations/ leadership notes

Refurbishment Employee Website



Future Objectives

- Continue to build traffic to refurb website and enhance user experience and interactions
- Leadership/staff alignment rollout for segment two
- Advancement of communication vehicles targeting trades

ONTARIO POWER GENERATION

APPENDIX 10: METRICS LEGEND

DARLINGTON REFURBISHMENT PROGRAM PERFORMANCE DASHBOARD

METRIC/DESCRIPTION	TARGET	Excellent	Good	Moderate	Poor	↑ – ↓
COST PERFORMANCE INDEX (CPI) Ratio that measures the financial effectiveness. **SCHEDULE PERFORMANCE INDEX (SPI)** Ratio of schedule efficiency to date.	**1.00**	**1.01-1.05**	**1.06-1.09** **0.95-1.00**	**>1.09** **0.91-0.94**	**<0.91**	Managements assessment on the current performance trend. ↑ Performance is IMPROVING – Performance is MAINTAINED ↓ Performance is DECLINING
ALL INJURY RATE (AIR) (# Safety Events/200k hrs worked) Safety events are categorized as the number of fatalities, lost-time injuries, medical treatment injuries and other injuries/illnesses. **The safety statistics include both OPG and contractor performance year-to-date (i.e. reset in January).**	**0.24**	**AIR ≤0.19 AND WP Events = 0** AIR is significantly below target AND zero Work Protection Events in the quarter	**AIR 0.20- 0.37 AND WP Events = 0** AIR is at or below target AND zero Work Protection Events in the quarter	**AIR 0.38-0.41 OR WP Event = 1** AIR is above target within 10% OR 1 Work Protection Event occurred in the quarter	**AIR >0.41 OR WP Event ≥2** AIR is above target > 10% OR ≥2 high Work Protection Event occurred in the quarter	
# LEVEL 1 WORK PROTECTION EVENTS Count of the number of Level 1 Work Protection Events on DRP over the quarter.	**0**					
# EVENT FREE DAY RESETS (EFDR) The number of Darlington Site Event Free Day Resets that occurred within the quarter as a direct result of work being performed within the Darlington Refurbishment Program. The criteria are aligned to the nuclear industry standards and applied consistently across the sites to allow performance comparisons and benchmarking.	**0**	**BOTH at ZERO**	**BOTH at ZERO** Cumulative # of events for the quarter is 0, however previous performance was moderate or poor OR management assessment on low level trending	**EFDR + REG. = 1** Cumulative # of events for the quarter is 1. OR management assessment on low level trending	**EFDR + REG. ≥ 2** Cumulative # of events for the quarter is greater than, or equal to 2 OR management assessment on low level trending	
# REGULATORY NON- COMPLIANCE The number of regulatory non-compliance events related to quality that have occurred within the quarter.	**0**					

FINANCIAL SUMMARY

CURRENT APPROVED RELEASE refers to the total budget of the last release approved by the Board of Directors. The last release was approved by the Board in November 2015, and was to complete the Mobilization Phase.
MOBILIZATION PHASE refers to the work completed Dec 31, 2015 (end of Definition Phase) to October 15, 2016 (Unit 2 Breaker Open).
TOTAL PROGRAM refers to the refurbishment of all 4-units.

METRIC/DESCRIPTION		Excellent	Good	Moderate	Poor	↑ – ↓
LIFE-TO-DATE COST (M$)		Management's assessment based on: Current cost performance; Estimate at Completion; and Contingency allocation.				Managements assessment on the current performance trend. ↑ Performance is IMPROVING – Performance is MAINTAINED ↓ Performance is DECLINING
ACTUAL	Total Program costs incurred to date against the Approved Release.					
PLAN	Planned Program costs to date for the Approved Release.					
VARIANCE	Variance of Actual to Plan. ($) indicates underspend vs. plan.					
AT COMPLETION OF MOBILIZATION PHASE						
FORECAST	Forecast of total Program costs at the end of Mobilization phase.					
PLAN	Planned Program costs at the end of Mobilization phase as per the Approved Release.					
VARIANCE	Variance of Forecast to Plan. ($) indicates underspend vs. plan.					

PROJECT PERFORMANCE INDICATORS AND TRENDS

METRIC/DESCRIPTION	Excellent	Good	Moderate	Poor	↑ – ↓
UNIT 2 EXECUTION PROJECTS **PRE-REQUISITE PROJECTS**	Management's assessment of current performance and risk to Unit 2 Refurbishment Execution.				Managements assessment on the current performance trend.

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EB-2016-0152
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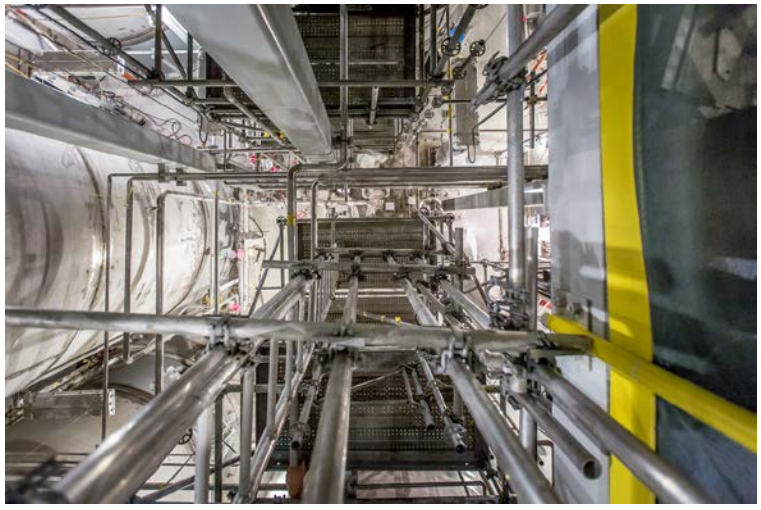
APPENDIX 11: PHOTO CATALOGUE

PROJECT

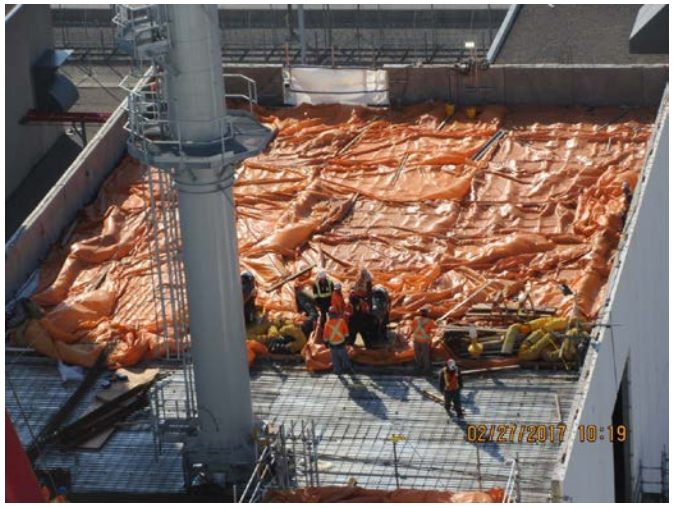
Heavy Water Storage Facility

Completion of Building Envelope

Installation of Landing Scrubber Stack



Installed Pipework



Maintenance (Heating) of Laid Concrete

APPENDIX 11: PHOTO CATALOGUE

PROJECT

3rd Emergency Power Generator

Installation of External Cladding

Roof Concrete Pour

Containment Filtered Vented System

Installation of Exhaust Stack

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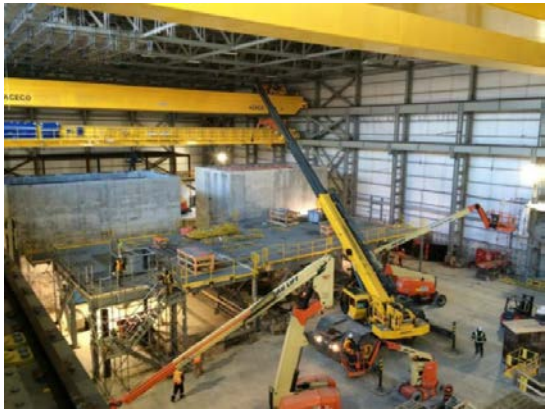
Period Ending: December 2016

APPENDIX 11: PHOTO CATALOGUE

Filter House Interior

PROJECT

Re-tube Waste Processing Building



Installation of Waste Tooling System Platform

Structural Steel Installation

Re-tube Waste Storage Building
(non-Refurbishment funded)

Electrical Room – Roof Pour

T20 Line and Load Terminations

APPENDIX 11: PHOTO CATALOGUE

PROJECT

Other On-Site Projects

Vault Prep - Installation of Bulkheads

Breathing Air Installation

Completed Work Control Centre

BURNS McDONNELL

Independent Oversight Report on the Darlington Refurbishment Project

SUBMITTED TO:

Darlington Refurbishment Committee of the Board of Directors for Ontario Power Generation

March 9, 2017

Executive Summary

OPG Management's March 9, 2017 report ("Management Report") to the DRC affirms its forecast for the Darlington Refurbishment Project ("DR Project") remains within the overall RQE control budget of C$12.8 billion and P90 schedule duration of 112 months. The Unit 2 portion of OPG's high-confidence budget is C$3.417 Billion (including C$677 million of contingency) based on an execution duration of 40 months. The DR Project's Execution Phase is currently nearing conclusion of Segment 1, during which the Unit 2 vault is being prepared for its rehabilitation. As of this writing, the DR Project is a net +5 days ahead of the working schedule's critical path since Breaker Open on October 15, 2016. After OPG's Defueling gained 26 days to critical path, 21 days have been lost [redacted] OPG's schedule metrics have significantly improved, allowing the DR Team to identify and mitigate issues, and OPG has increased field oversight in light of early performance, safety and quality trends. Assurance groups continue to be effective in identifying issues.

The Burns & McDonnell/Modus External Oversight Team ("EO Team") has identified certain issues that could have an impact on the Project if they are not addressed, including:

- SNC/Aecon's issues with vault preparation work need to be understood so that lessons learned can be incorporated in future work evolutions;
- [redacted]
- OPG's project controls focus since Breaker Open has been tracking schedule earned value; the team is refocusing on cost forecasting, including tracking the velocity of contractor costs and adverse performance trends, the effectiveness of which needs to be assessed;
- Commercial challenges in Refurbishment and F&IP projects have arisen early in the DR Project which could impact the contractors' momentum and distract OPG's and the vendors' management teams.

It should be noted that the data cut-off date for our report is February 17, 2017. While the Management Report to the DRC accurately reflects the status of the DR Project as of January 31, 2017, some data points differ from those used by the DR Team, as they reflect performance for the first 3 weeks in February.

Evaluation of DR Project Status

Key DR Project Status Indicators

Schedule Performance

	Planned	Complete	Ahead/Behind	SPI	CPI
Total Project	23.4%	19.0%	(123,876)	0.81	N/A

OPG defueled the reactor 26 days ahead of the working schedule though the post-defueling activities resulted in the DR Project losing 21 of those 26 days to date, and performance trends suggest that the bulkhead installation may further challenge the schedule. While the critical path is as of this writing, 5 days ahead, near or non-critical path work has fallen behind by 123,876 hours, with the current composite execution SPI at 0.81; RWPB, as discussed below is the largest contributor. SNC/Aecon will likely drive the critical path schedule until the reactor is fully refurbished in 1Q 2019.

Weekly schedule adherence metrics have shown a persistent problem, with causes ranging from field productivity, late construction work packages, field initiated changes and late reporting of earned value. The DR Team has instituted additional oversight of the critical path work to validate readiness with a goal of raising weekly adherence to 90% of scheduled activities.

Cost Performance	The DR Team has not exceeded the 4-unit Project control budget of $12.8 billion or the Unit 2 budget of $3.4 billion (including $677 million of contingency). Overall, the DR Project is underspent by $59 million which is split between OPG functions (-$32M) and contractor performance (-$27M). To date, contingency draws have totaled a net [redacted]. Though OPG remains resolute in doing so, the vendors' actual hours are not currently being collected for purposes of forecasting based on field productivity.
Vendor Performance	<table><tr><th>Vendor</th><th>Planned</th><th>Complete</th><th>Ahead/Behind</th><th>SPI</th><th>CPI</th></tr><tr><td>SNC/Aecon (RFR)</td><td>20.6%</td><td colspan="4" rowspan="3">[redacted]</td></tr><tr><td>ES Fox (BOP/SDLU)</td><td>29.7%</td></tr><tr><td>SNC/Aecon (TG)</td><td>40.7%</td></tr></table>
***SNC/Aecon** Critical Path or Near Critical Path Work*	[redacted] SNC/Aecon's initial critical path work has been affected by discovery work, equipment and field execution issues. The bulkhead installation began on January 27 and is currently scheduled to complete on March 22, which is a key milestone. [redacted] From August 2016 to February 2017, the RWPB has lost [redacted] and approximately [redacted] against its target price estimate. Engineering, which was planned to complete in 3Q 2016, is ongoing and has [redacted] of remaining work. In mid-November, OPG challenged SNC/Aecon to identify its recovery plan for RWPB. [redacted] SNC/Aecon's milestone for completing RWPB is July 31, 2017 is at risk, and further slippage could impact the critical path for Refurbishment. [redacted] SNC/Aecon's work on the Turbine Generator has generally tracked to its schedule and is not a concern at this time.
***ES Fox** Critical Path or Near Critical Path Work*	[redacted] ES Fox's management has implemented an improvement plan that addressed all aspects of its performance—safety, quality, schedule management and resources. While ES Fox recovered its schedule, it was not without added cost. With Segment 1 concluding, this is an opportune time to examine future work to ensure that ES Fox can sustain this improvement within budgeted cost and schedule.
Project Controls and Risk Management	The OPG Project Controls team's improved reporting has increased visibility to problem areas. [redacted] The DR Team now is increasing its cost focus to bolster its forecasting. The team is rolling-out additional cost tracking functionality and increasing its use of EcoSys as a forecasting tool. A critical

	component to accurate forecasting depends on obtaining vendors' actual hours and capturing field productivity rates. Obtaining this data will greatly increase the efficacy of OPG's cost forecasting. Risk Management activities are proceeding well with increased senior management support and visibility to successful mitigation of risk events. Contingency tracking and forecasting based upon outstanding risk needs to be validated. The EO Team has some concerns which management is addressing regarding the roll-up of contingency information from the granular to the summary level, which we will address prior to the next DRC report. The risk team is currently improving its ability to forecast potential future contingency draws in order to analyze the remaining contingency.
Construction Checkout and Testing	Vendor performance of the Construction Completion Declaration ("CCD") process and turnover for OPG commissioning/return to service is improving through consolidating turnover packages, performing early reviews of CCD documentation, and assisting vendor conformance. Attention is currently focused on near term (2 week) CCD and turnover requirements with the objective of expanding readiness to a 4+ week window.

Project and Program Assurance

The DR Team's Performance Assurance Group ("PAG"), Enterprise Risk Management and OPG Internal Audit ("IA") are executing robust plans for assurance activities. PAG and Quality Assurance are currently focused on increasing vendor focus on field supervision, safety and quality, and interacting directly with vendors to instruct them on avoiding safety and quality issues. ERM and IA continue to focus on program-level risks and vendor performance. IA is currently planning to audit barriers to field performance through direct surveillance.

OPG Project Team

The DR Team has reacted to the early challenges to critical path by increasing pre-critical path validation and preparation. OPG management has instituted more granular pre-execution reviews with the vendors and integration with key OPG personnel. OPG has also initiated a program to improve accountability which focuses on communications, teamwork, and expectations. This program's focus is on understanding responsibilities, schedule adherence, stakeholder interfaces, and increasing visibility of safety requirements and the potential consequences of non-compliance.

Project Risks and Strategic Considerations

The EO Team offers the following analysis of certain forward-looking risks and strategic considerations that could impact the P90 high-confidence schedule.

Risk Area	EO Team Observations
Performance Reporting	[redacted] The OPG team now needs to increase focus on cost reporting so that Estimates at Completion ("EAC") are accurate, impact costs are transparent and adverse trends are timely identified. Currently, cost forecasting is a *following,* rather than a *leading* indicator as it relies

	on receipt of actual invoices weeks after the work has been performed. The most critical cost trend on the DR Project requires forecasting the number of craft workers needed to accomplish the work, which is calculated based on the vendors' actual hours compared to their budgeted hours. The DR Team's forecasting needs this data to accurately track field productivity trends and to fully utilize the EcoSys cost toolset. Taking these steps will further enhance the accuracy of impacts of newly-identified risks, ongoing commercial issues or other factors that influence EAC. While the weekly progress metrics have improved such that OPG now has clear line of site into performance issues, cost impacts are not being concurrently assessed with the same rigor. Without this balance, OPG's management focus is weighted towards schedule over cost. That may be appropriate at this time, particularly since the critical path is a greater risk, but OPG needs to arrive at a balance of cost and schedule considerations to inform its decisions going-forward.
Commercial Management and Change Management	Effective commercial management involves ensuring the company's contractual position is maintained and asserted as necessary, while also protecting the project management team's focus on the work in the field. Doing so requires having sufficient talented resources in place and a high-level of efficiency in systems used to manage this effort. As anticipated, there has been a significant increase in the volume of work associated with documenting and tracking potential commercial issues. The DR Team currently lacks a formalized or standard way to initiate, respond to and track correspondence notices with vendors; track contractual milestones; monitor schedule and performance issues; or provide prompt notice of vendor deficiencies. Management should address establishing a methodology for bounding potential outcomes for commercial claims and disputes. The Change Management process is in place and seems to be working—however it is not currently automated, which is standard practice for a project of this size and complexity so that there is visibility to in-process changes. We note that the VP of Commercial Management has recognized many of these gaps and has initiated changes in processes and added resources to meet these challenges.
SNC/Aecon Performance	[redacted]
F&IP Projects	The Emergency Power Generator 3 ("EPG3"), Containment Filter Venting System ("CFVS") and D2O Storage Facility each continue to miss targeted schedule dates and cost projections. These projects continue to drain resources from Refurbishment, OPG/vendors' management attention and threaten to utilize additional program contingency for their completion. Moreover, there are trends observed in the vendors' management of those projects and other past F&IP projects that must be eradicated in Refurbishment.