SEC Interrogatory #085

Interrogatory

Reference:
D2-3-8, p. 9

Question(s):

OPG is seeking approval for concurrent cost recovery ("CCR") interest amounts over the rate term regarding Units 6-8. If the OEB ultimately determines in a future proceeding, that in whole or in part, the costs of Unit 6-8 are imprudent, what happens regarding the CCR interest paid on those expenditures?

Response

The CCR mechanism for the Pickering Refurbishment Program outlined in this Application is established by Ontario Regulation 53/05, with requirements set out in section 6(2)12.1 and section 5.8. A summary of the requirements can be found in Ex. I1-1-3, Section 3.0.

Under the operation of the CCR mechanism as prescribed by the regulation, there are no adjustments to CCR interest amounts that have already been recovered.

SEC Interrogatory #086

Interrogatory

Reference:
D2-3-8, p. 11-16

Question(s):

For Charts 6-11, please provide a summary breakdown of each work bundle in the RQE budget. For each, please provide a significantly more detailed budget.

Response

Refer to Attachment 1.

Pickering Refurbishment Major Work Bundles - Budget Annualized ($M)

Bundle	#	Category	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Retube, Feeder and Boiler Replacement	1	Project Management	2,028	3	35	97	203	333	413	390	345	174	37	-	-
	2	Inspections	0	0	0	0	-	-	-	-	-	-	-	-	-
	3	Engineering	307	2	40	54	52	37	30	35	31	24	1	-	-
	4	Procurement	2,940	7	123	520	766	437	383	311	217	157	18	-	-
	5	Construction	1,542	-	1	56	107	204	283	334	249	241	67	-	-
	6	Commissioning & Close-out	493	-	0	1	11	99	100	102	56	112	12	-	-
	7	**Sub-Total**	**7,309**	**12**	**198**	**728**	**1,139**	**1,111**	**1,208**	**1,172**	**899**	**708**	**135**	**-**	**-**
	8	Escalation	543	-	-	-	29	52	88	120	112	117	26	-	-
	9	**Total**	**7,853**	**12**	**198**	**728**	**1,167**	**1,163**	**1,296**	**1,291**	**1,010**	**826**	**161**	**-**	**-**
Turbine Generator	1	Project Management	608	0	7	18	78	87	110	132	104	54	12	5	-
	2	Inspections	1	-	-	-	0	0	0	0	0	0	-	-	-
	3	Engineering	166	-	7	16	36	32	25	30	10	7	4	0	-
	4	Procurement	1,358	-	29	283	269	245	255	185	73	15	4	0	-
	5	Construction	677	-	-	1	14	68	153	177	158	90	15	2	0
	6	Commissioning & Close-out	89	-	0	-	-	-	3	23	33	20	9	0	-
	7	**Sub-Total**	**2,900**	**0**	**42**	**318**	**397**	**432**	**546**	**547**	**378**	**187**	**45**	**7**	**0**
	8	Escalation	373	-	-	-	17	41	68	83	81	50	22	10	0
	9	**Total**	**3,272**	**0**	**42**	**318**	**414**	**473**	**614**	**630**	**459**	**238**	**67**	**17**	**0**
Balance of Plant	1	Project Management	478	0	7	26	56	82	65	60	46	33	53	29	21
	2	Inspections	22	-	-	3	7	5	3	2	2	0	0	-	-
	3	Engineering	272	-	1	36	89	56	36	25	11	6	6	4	3
	4	Procurement	447	-	11	38	153	82	74	63	14	3	3	7	-
	5	Construction	315	-	-	5	32	70	83	80	42	4	-	-	-
	6	Commissioning & Close-out	46	-	0	0	1	3	13	11	8	6	3	0	0
	7	**Sub-Total**	**1,580**	**0**	**18**	**108**	**338**	**298**	**273**	**241**	**122**	**52**	**65**	**40**	**24**
	8	Escalation	167	-	-	-	11	28	37	31	21	15	12	8	4
	9	**Total**	**1,747**	**0**	**18**	**108**	**349**	**326**	**310**	**272**	**142**	**68**	**77**	**48**	**28**
Operations and Maintenance	1	Project Management	191	-	2	7	16	22	30	31	28	18	23	13	-
	2	Functional Labour	1,263	-	5	20	88	214	240	248	180	127	93	49	-
	3	Inspections	1	-	0	0	0	0	-	-	-	-	-	-	-
	4	Engineering	61	-	1	11	26	9	4	3	3	2	1	0	-
	5	Procurement	178	-	1	5	48	52	41	16	11	3	1	0	-
	6	Construction	209	-	0	4	74	70	41	7	7	4	1	0	-
	7	Commissioning & Close-out	56	-	0	0	1	1	0	7	12	7	13	13	-
	8	**Sub-Total**	**1,958**	**-**	**9**	**48**	**253**	**367**	**356**	**313**	**241**	**161**	**133**	**76**	**-**
	9	Escalation	298	-	-	-	10	26	37	45	48	39	58	34	-
	10	**Total**	**2,256**	**-**	**9**	**48**	**263**	**393**	**393**	**358**	**290**	**200**	**191**	**110**	**-**
Facilities & Infrastructure	1	Project Management	78	-	2	17	52	7	0	0	0	0	0	-	-
	2	Inspections	6	-	2	3	1	-	-	-	-	-	-	-	-
	3	Engineering	37	-	1	23	12	1	-	-	-	-	-	-	-
	4	Procurement	119	-	0	28	31	12	8	8	8	8	8	8	-
	5	Construction	139	-	0	42	92	5	-	-	-	-	-	0	-
	6	Commissioning & Close-out	17	-	0	9	5	1	-	-	-	-	-	2	-
	7	**Sub-Total**	**396**	**-**	**5**	**123**	**193**	**25**	**8**	**8**	**8**	**8**	**8**	**10**	**-**
	8	Escalation	15	-	-	0	9	5	0	0	0	0	0	0	-
	9	**Total**	**411**	**-**	**5**	**123**	**202**	**30**	**8**	**8**	**8**	**8**	**8**	**10**	**-**
Deep Water Intake	1	Project Management	230	-	2	26	68	44	39	32	19	-	-	-	-
	2	Inspections	12	-	-	1	1	3	4	3	1	-	-	-	-
	3	Engineering	77	0	2	16	40	11	5	3	-	-	-	-	-
	4	Procurement	335	-	0	1	26	179	115	13	-	-	-	-	-
	5	Construction	173	-	12	11	28	31	55	34	2	-	-	-	-
	6	Commissioning & Close-out	6	-	0	0	1	-	-	0	5	-	-	-	-
	7	**Sub-Total**	**832**	**0**	**16**	**56**	**164**	**268**	**217**	**85**	**26**	**-**	**-**	**-**	**-**
	8	Escalation	93	-	-	-	5	25	31	19	14	-	-	-	-
	9	**Total**	**926**	**0**	**16**	**56**	**169**	**293**	**248**	**104**	**40**	**-**	**-**	**-**	**-**

SEC Interrogatory #087

Interrogatory

Reference:
D2-3-8, p. 18-20

Question(s):

Please provide individual business cases for each of the early in-service facilities and infrastructure projects.

Response

All scopes of work for the Pickering Refurbishment Program ("PRP"), including the early in-service facilities and infrastructure projects, follow the Project Controls plans established for strategic projects as part of OPG's governance.

Facilities and infrastructure projects are within the PRP Charter as referenced in Ex. D2-3-2, Attachment 1. As referenced in Ex. D2-3-9, Attachment 1, specific business case summaries for project scope executed within the PRP Charter are not required.

SEC Interrogatory #088

Interrogatory

Reference:
D2-3-8
EB-2016-0152, JT 1.17C

Question(s):

Please provide the expected quarterly cumulative capital costs based on the RQE budget for each quarter through the end of the PRP, similar to what was provided in Undertaking JT 1.17C (EB-2016-0152).

Response

Attachment 1 shows the expected quarterly cumulative capital costs based on the Release Quality Estimate ("RQE") through the end of the PRP, consistent with EB-2016-0152 Undertaking JT 1.17C. The chart includes capitalized interest that was calculated at the time of the RQE.

Quarterly Cumulative Capital Expenditures - Pickering Refurb

	2023	2024				2025			
$M	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Capital	15.4	41.1	82.2	89.3	154.7	405.6	276.7	351.5	432.0
Interest	0.0	0.1	0.5	1.4	2.2	3.7	6.4	9.1	15.0
Total capital cost [1]	15.4	41.3	82.7	90.7	156.9	409.3	283.1	360.6	447.0
Cumulative cost	**15.4**	**56.6**	**139.4**	**230.1**	**387.0**	**796.3**	**1,079.4**	**1,440.0**	**1,887.0**

	2026				2027			
$M	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Capital	826.9	798.8	736.1	683.7	779.2	804.5	796.6	1,092.8
Interest	23.5	30.8	38.6	46.2	58.3	70.6	81.5	90.0
Total capital cost [1]	850.4	829.6	774.7	729.9	837.5	875.1	878.1	1,182.9
Cumulative cost	**2,737.4**	**3,567.0**	**4,341.7**	**5,071.6**	**5,909.1**	**6,784.2**	**7,662.3**	**8,845.2**

	2028				2029			
$M	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Capital	880.5	832.8	820.2	1,074.1	781.4	791.3	939.7	1,065.9
Interest	103.1	114.7	125.8	137.2	152.0	163.5	175.1	187.1
Total capital cost [1]	983.6	947.6	945.9	1,211.3	933.4	954.8	1,114.8	1,253.0
Cumulative cost	9,828.8	10,776.4	11,722.3	12,933.6	13,867.0	14,821.8	15,936.6	17,189.6

	2030				2031			
$M	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Capital	893.2	645.6	505.7	637.0	622.6	482.1	346.4	409.4
Interest	201.4	213.7	223.0	224.5	225.2	163.4	136.0	141.9
Total capital cost [1]	1,094.6	859.3	728.7	861.4	847.8	645.5	482.4	551.3
Cumulative cost	18,284.2	19,143.5	19,872.2	20,733.6	21,581.4	22,226.9	22,709.3	23,260.6

	2032				2033			
$M	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Capital	539.1	293.4	186.7	185.5	192.5	197.6	178.7	199.6
Interest	149.4	155.1	98.4	100.9	101.5	50.3	52.0	50.9
Total capital cost [1]	688.4	448.5	285.1	286.4	294.1	247.9	230.7	250.4
Cumulative cost	23,949.0	24,397.5	24,682.6	24,969.0	25,263.1	25,511.0	25,741.7	25,992.2

	2034			
$M	**Q1**	**Q2**	**Q3**	**Q4**
Capital	76.7	70.3	72.7	77.7
Interest	51.9	53.4	18.4	-
Total capital cost [1]	128.6	123.7	91.1	77.7
Cumulative cost	26,120.8	26,244.4	26,335.5	26,413.3

[1] Annual values for 2023-2031 per Ex.D2-3-8, Table 1

SEC Interrogatory #089

Interrogatory

Reference:
D2-3-8

Question(s):

With respect to the business cases and budgets:

a) Please provide a table that shows every cost estimate (e.g. internal, class, release, and phase) developed for the project, broken down by bundles/category. For each estimate, please provide the date, phase, and reason for the change.

b) Please provide a copy of each business case (for each class and release) developed for the PRP.

Response

a) and b)
This interrogatory seeks materials and cost estimates that have been superseded by the Release Quality Estimate provided at Ex. D2-3-8, Attachment 1. OPG declines to provide the requested information on the basis of relevance. The Release Quality Estimate is the basis on which OPG is undertaking the work and is the basis of the application before the OEB. Any previous materials and costs estimates, or evolution of cost estimates, are not relevant to evaluating the issues in this proceeding.

SEC Interrogatory #090

Interrogatory

Reference:
D2-3-8, Attachment 1

Question(s):

With respect to the PRP RQE Memorandum to the OPG Board of Directors:

a) [p.2] The memo states that as part of the definition phase, it included "[r]ecommendations to optimise scope and lower first-of-a-kind ["FOAK"] project risks for Unit 5 have been approved and included in the estimate." Please provide details regarding the recommendations and the impact on optimizing scope and lowering FOAK project risk.

b) [p.4,14] OPG states "[t]he Levelized Cost of Energy (LCOE) is $169/MWh ($2024)". Please provide all underlying calculations and assumptions used in the calculation.

c) [p.5] Please provide a similar memorandum for the Board of Directors for Release 1A-1 and 1A-2.

d) [p.5] The memo states that "checkpoints will be used to confirm that the program cost and schedule estimates remain within the bounding cost and schedule durations requested during the RQE or identify significant changes that may require additional actions to be taken." Please provide details regarding each of the checkpoints.

Response

a) As discussed in Ex. D2-3-5, Unit 5 scope assessment was undertaken to identify and manage key execution and schedule risks. The assessment considered material procurement lead times, vendor capability to meet approved design submission milestones, and execution challenges arising from schedule and configuration changes. Additionally, results from updated condition assessments identified opportunities to safely defer scope from the refurbishment outage executed through established Integrated Operations Plans and/or a future planned outage.

The following scope items associated with the Unit 5 scope assessment, including applicable common systems, were recommended and approved to be descoped to lower first-of-a-kind ("FOAK") projects risk for Unit 5:

- Unit 5 digital control computer replacements
- Unit 056 standby generator replacement
- Selected valve replacements in the moderator and instrument air systems to address leakages
- Ultrasonic flow measurement upgrades
- EPG fuel tank inspections
- Replacement of screenhouse bar screens
- Selected non-vacuum building Pickering A/B station separation scope.
- Fire protection hydrants, pumps, and pipe header isolation valves
- Construction of a new D20 upgrader
- Selected reactor building air conditioning units.

These scope deferrals were reviewed through a risk-based evaluation conducted by a cross-functional team with expertise in engineering, operations, maintenance, asset management, and outage planning. The review considered risk exposure, component condition, equipment reliability, FOAK implementation considerations, and alignment with future outage schedules.

b) For informational purposes, a detailed breakdown of the LCOE and assumptions can be found at Ex. D2-3-8, Attachment 1, pp. 14 and 16.

OPG declines to provide the underlying LCOE calculations on the basis that this information is not relevant to evaluating the issues that are within the scope of this proceeding. As stated in Ex. D2-3-1, the Province of Ontario ("Province") announced support for OPG to proceed with the next steps toward refurbishing Pickering Units 5-8 following completion of the 2023 feasibility assessment, and has further approved OPG's plan to refurbish Units 5-8 following completion of the release quality estimate, noting that refurbishing Ontario's nuclear fleet is a key pillar of the Province's Integrated Energy Plan.[1] LCOE is a factor used to consider the appropriate generation options to meet electricity demand in Ontario, a consideration that is within the purview of the Ministry of Energy and Mines, with support from the IESO. In accordance with this framework, OPG's position is that the LCOE is not relevant to the consideration of the prudence of the overall PRP cost and the effectiveness of the project's execution, in accordance with OEB approved Issues List for this proceeding.

[1]Energy for Generations Ontario's Integrated Plan to Power the Strongest Economy in the G7: https://www.ontario.ca/files/2025-07/mem-energy-for-generations-en-2025-07-18.pdf

c) OPG declines to provide the requested information for the same reasons as outlined in Ex. L-D2-SEC-089.

d) There are multiple oversight checkpoints used to confirm that the program cost and schedule remain within the bounding Release Quality Estimate ("RQE") cost and schedule for the Pickering Refurbishment Program throughout the various phases, which include the following:

- A program check estimate is being prepared prior to the start of execution to further validate the RQE (refer to Ex. D2-3-8, Attachment 1, p. 15)
- Ex. D2-3-9, pp.11-15 describes the comprehensive internal and external assurance oversight structure that is in place to monitor and track performance as described in Ex. D2-3-9, pp. 11-15. This includes monthly project oversight forums, Major Projects Committee Board of Directors updates, and Refurbishment Review Board independent assessments.

SEC Interrogatory #090

Interrogatory

Reference:
D2-3-8, Attachment 1

Question(s):

With respect to the PRP RQE Memorandum to the OPG Board of Directors:

a) [p.2] The memo states that as part of the definition phase, it included "[r]ecommendations to optimise scope and lower first-of-a-kind ["FOAK"] project risks for Unit 5 have been approved and included in the estimate." Please provide details regarding the recommendations and the impact on optimizing scope and lowering FOAK project risk.

b) [p.4,14] OPG states "[t]he Levelized Cost of Energy (LCOE) is $169/MWh ($2024)". Please provide all underlying calculations and assumptions used in the calculation.

c) [p.5] Please provide a similar memorandum for the Board of Directors for Release 1A-1 and 1A-2.

d) [p.5] The memo states that "checkpoints will be used to confirm that the program cost and schedule estimates remain within the bounding cost and schedule durations requested during the RQE or identify significant changes that may require additional actions to be taken." Please provide details regarding each of the checkpoints.

Response

In accordance with the Motions Resolutions letter filed on May 4, 2026, OPG has revised this interrogatory response.

a) As discussed in Ex. D2-3-5, Unit 5 scope assessment was undertaken to identify and manage key execution and schedule risks. The assessment considered material procurement lead times, vendor capability to meet approved design submission milestones, and execution challenges arising from schedule and configuration changes. Additionally, results from updated condition assessments identified opportunities to safely defer scope from the refurbishment outage executed through established Integrated Operations Plans and/or a future planned outage.

The following scope items associated with the Unit 5 scope assessment, including applicable common systems, were recommended and approved to be descoped to lower first-of-a-kind ("FOAK") projects risk for Unit 5:

- Unit 5 digital control computer replacements
- Unit 056 standby generator replacement
- Selected valve replacements in the moderator and instrument air systems to address leakages
- Ultrasonic flow measurement upgrades
- EPG fuel tank inspections
- Replacement of screenhouse bar screens
- Selected non-vacuum building Pickering A/B station separation scope.
- Fire protection hydrants, pumps, and pipe header isolation valves
- Construction of a new D20 upgrader
- Selected reactor building air conditioning units.

These scope deferrals were reviewed through a risk-based evaluation conducted by a cross-functional team with expertise in engineering, operations, maintenance, asset management, and outage planning. The review considered risk exposure, component condition, equipment reliability, FOAK implementation considerations, and alignment with future outage schedules.

b) For the Pickering Refurbishment Program ("PRP"), LCOE can be calculated based on the assumptions detailed at Ex. D2-3-8, Attachment 1, p. 16, using the following main steps:
   i. Obtain actual PRP expenditures for each of the historical years and forecast remaining PRP expenditures for the future years, excluding any capitalized interest.
   ii. Forecast annual operations, maintenance and administration ("OM&A") costs, nuclear fuel costs and non-PRP capital expenditures for Pickering Units 5-8 during refurbishment and throughout the expected operating life of the station, including by escalating near-term cost levels at 2% annually for purposes of deriving longer term cost levels. Nuclear fuel costs are forecast using a dollar per MWh rate.
   iii. Apply a preliminary estimate of the forecast federal Clean Electricity Investment Tax Credits ("CEITC") in respect of the PRP expenditures, which serves to reduce the LCOE.
   iv. Forecast annual post-refurbishment production values throughout the expected operating life of the station, using an average capacity factor.
   v. For purposes of step vii), apply a CPI-based escalation rate and a tax effect at (1 - tax rate of 25%) to the stream of the production values resulting from step iv).

vi. For purposes of step vii), apply a tax effect at (1 - tax rate of 25%) to the stream of tax deductible costs from steps i) and ii) and, for capital costs, apply a tax deduction for the corresponding capital cost allowance amounts.

vii. Obtain LCOE by dividing the present value, as of 2024, of the stream of annual costs from steps i) and ii), net of the CEITCs from step iii) and as tax affected in step vi), by the present value of the tax affected stream of escalated annual production values from step v), calculated using a discount rate.

Having provided this information in accordance with the Motions Resolutions letter filed on May 4, 2026, OPG maintains that the underlying LCOE calculations are not relevant to evaluating the issues that are within the scope of this proceeding. As stated in Ex. D2-3-1, the Province of Ontario ("Province") announced support for OPG to proceed with the next steps toward refurbishing Pickering Units 5-8 following completion of the 2023 feasibility assessment, and has further approved OPG's plan to refurbish Units 5-8 following completion of the release quality estimate, noting that refurbishing Ontario's nuclear fleet is a key pillar of the Province's Integrated Energy Plan.[1] The LCOE is a factor that was used to consider the appropriate generation options to meet electricity demand in Ontario, a consideration that is within the purview of the Ministry of Energy and Mines, with support from the IESO. In accordance with this framework, OPG's position is that the LCOE is not relevant to the consideration of the prudence of the overall PRP cost and the effectiveness of the project's execution, in accordance with OEB approved Issues List for this proceeding.

c) Refer to Ex. L-D2-SEC-080, Attachment 1, Attachment 2, and Attachment 3, which have been provided in accordance with the Motions Resolutions letter filed on May 4, 2026.

d) There are multiple oversight checkpoints used to confirm that the program cost and schedule remain within the bounding Release Quality Estimate ("RQE") cost and schedule for the Pickering Refurbishment Program throughout the various phases, which include the following:

- A program check estimate is being prepared prior to the start of execution to further validate the RQE (refer to Ex. D2-3-8, Attachment 1, p. 15)
- Ex. D2-3-9, pp.11-15 describes the comprehensive internal and external assurance oversight structure that is in place to monitor and track performance as described in Ex. D2-3-9, pp. 11-15. This includes monthly project oversight forums, Major Projects Committee Board of Directors updates, and Refurbishment Review Board independent assessments.

[1]Energy for Generations Ontario's Integrated Plan to Power the Strongest Economy in the G7: https://www.ontario.ca/files/2025-07/mem-energy-for-generations-en-2025-07-18.pdf

SEC Interrogatory #091

Interrogatory

Reference:
D2-3-8, Attachment 2

Question(s):

With respect to the KPMG, *Pickering Refurbishment Project Release Quality Estimate Independent Review*:

a) Which KPMG employees authored the review, and what are their qualifications?

b) [p.6] Please provide the RQE roadmap.

c) Did OPG implement the recommendations as part of the RQE? If so, please provide details regarding each recommendation.

Response

a) Refer to Attachment 1.

b) Refer to Attachment 2.

c) Yes, OPG implemented all the KPMG recommendations, as described in Chart 1.

Chart 1: KPMG Recommendations and OPG Actions.

KPMG Recommendations	OPG Actions
The draft BOE and BOS documents should be finalized and integrated into the final RQE Estimate Package.	Basis of Estimate and Basis of Schedule were finalized and integrated into the RQE package in November, 2025. Refer to Ex. L-D2-Staff-106, Attachment 1 and 2.
In alignment with AACE guidance and industry leading practices, it is recommended that OPG clearly document how benchmarking cost data (particularly relating to the	Refer to Ex. L-D2-Staff-102 for documentation of how benchmarking cost data has been applied.

DNRP) has been applied. Accordingly, in addition to the high-level summary provided in the draft Program-level BOE, it is recommended that CWP and other estimate working papers more clearly cite how benchmarking data and inputs from other project have been integrated and adapted to the specific considerations of the PRP and specific bundle.	The finalized Basis of Estimate reflects how benchmarking data and other applicable inputs have been integrated into the PRP. Refer to Ex. L-D2-Staff-106, Attachment 1 for additional information.
It is recommended that OPG consider the use of more construction industry-specific indices that better reflect the higher rates of escalation in construction labour, equipment, and materials compared to CPI. The use of more applicable indices will help improve the accuracy of estimates that leverage cost data from DNRP and other comparator projects.	For major equipment procurement included in the RQE, vendor quotes were obtained which reflect current pricing and are inclusive of construction industry-specific inflation considerations.
Given the complexity of the PRP and the differences in the nature of the various bundles, it is recommended that OPG continue to closely monitor the assessment of design completion and conduct regular reviews to ensure the reported metrics are an accurate reflection of completion and remaining effort.	OPG is continuing to closely monitor the assessment of design completion and conduct regular reviews, as discussed in Ex. L-D2-Staff-109.
Implementing a more standardized approach would help to improve alignment between the various project bundles and enable more detailed review and comparison of inputs and assumption, thus improving estimate quality. OPG noted that standard forms and instructions on the estimating approach were provided as part of the Vendor Agreements and SOWs provided to vendors. This	OPG has issued a new revision of its standardized template for all nuclear vendor estimates. OPG reviewed the permissibility of deviating from the standard template and format deviations are reviewed and approved on a case-by-case basis.

included the N-FORM template reviewed by KPMG, which are required by OPG for smaller project estimates (e.g., the Balance of Plant bundles). While it is recognized that the estimating structure and approach for larger and more complex packages may evolve over the course of the project, it is recommended that OPG review the permissibility of deviations from the requested estimate format in order to improve consistency across the estimates for the respective bundles.	
As OPG approaches the completion of the RQE Package, it is recommended that OPG carry out an audit of the vendor estimate packages for Target Price contracts to ensure all associated documents, including any data and analysis supporting inputs and assumptions have been provided to OPG in accordance with the respective Vendor Agreements in order to confirm that OPG has the required documentation to effectively challenge the vendor's proposed target price.	Refer to Ex. L-D2-Staff-108.

1

KPMG Team

An overview of the team, including summarized experience and detailed CVs are provided below.

Andrew McHardy | Engagement Partner

Andrew has over 25 years' experience leading multi-disciplinary engineering, consulting and project teams to successfully design, plan and deliver capital projects, operational excellence programs and business transformation. He has held leadership roles from field to executive level, working with asset-intensive organizations in Canada and internationally, across the power and utilities, energy, mining, industrial and public sectors. As Vice President Energy & Process for WSP Canada, Andrew had oversight for the development of capital and operational cost estimates for large-scale energy and industrial projects. In a previous consulting role, Andrew supported OPG with the development of major project governance, decision-making framework, and reporting processes, tools, and templates for the DNRP. For this engagement, Andrew will be responsible for overall quality assurance, ensuring that all project deliverables meet OPG's expectations and are aligned with industry best practices.

Jordan Thomson | Engagement Director

Jordan is a Director within KPMG's Global Infrastructure Advisory group. With over 15 years' experience as a strategic advisor and Professional Engineer (P.Eng.), Jordan combines deep industry expertise and technical understanding, with commercial, financial, and operational business knowledge. Jordan's technical background includes experience with construction contractors and design engineers spanning construction management and design and engineering across infrastructure, energy, mining, and utilities sectors. As an advisor to owners, contractors, and engineering firms, Jordan specializes in project and program management, contract audits, claims and disputes, commercial strategy, and project due diligence. Jordan has a long-standing relationship with OPG having supported the DNRP, Darlington New Nuclear Program, and the Renewable Generation Refurbishment Program.

Doug Ewing | Quality Review Partner

Doug is an astute commercial and technical leader, specializing in the structuring and implementation of large-scale infrastructure projects. Doug's experience includes advising on cost estimating and management reviews for projects such as for Keeyask Generating Station and Trans Mountain Expansion project. Doug joined KPMG from a role as VP of Projects at Partnerships BC. In this role he provided project oversight and guidance on a portfolio of projects exceeding $2B annually. This included sitting on 8 project boards with senior provincial decision makers, including Deputy and Assistant Deputy Ministers. As Quality Review Partner, he will conduct a detailed review of all deliverables prior to submission and provide strategic support and guidance to the KPMG team.

Janet Rieksts Alderman | Major Projects & Nuclear Sector Advisor

Janet is a Partner with firm's Global Infrastructure Advisory practice with close to 20 years of experience in project management, schedule management, cost control, project risk assessments, and claims and disputes. Her experience spans projects ranging from hundreds of thousands to multi-billions across sectors such as infrastructure, real estate, health care, education, transit, energy, mining and renewables. Janet is highly experienced in the Canadian nuclear industry, having served as a director on the board of the Nuclear Waste Management Organization (NWMO) and provided advisory services for various power utilities on its nuclear programs such as OPG's DNRP, New Brunswick Power's Point Lepreau Nuclear Refurbishment, and Candu Nuclear Project.

Jamie Cameron | Cost Estimating Process & Governance Advisor

Jamie Cameron is a Director in the Global Infrastructure Advisory practice. Jamie is both a professional engineer (P.Eng.) and project manager (PMP) with over 18 years in industry and consulting. He specializes in capital program and project management, assurance, audits, oversight, governance, risk and controls for major infrastructure projects, serving both public and private sector organizations. Jamie also provides strategic planning services for clients around capital program management. Jamie brings hands-on experience with OPG, having supported the RQE assessment for the DNRP, and has extensive experience in operational project management of major capital projects.

Nipun Dhawan | Schedule Analyst

Nipun is a Manager in KPMG's Global Infrastructure Advisory practice. As a civil engineer, Nipun has worked across various public and private sectors clients, including large industrial projects, infrastructure, real estate, power and renewables. With an over 11 years of experience, Nipun has spent over 8 years working as a planning manager for both owner and contractor firms. His expertise extends to the development, maintenance, and reporting of integrated master schedules at both project and program levels, and the development of work breakdown structures. He also focuses on helping clients with performing reviews of schedule submitted by vendors and identifying areas for improvement.

Camille McJunkin | Cost Analyst

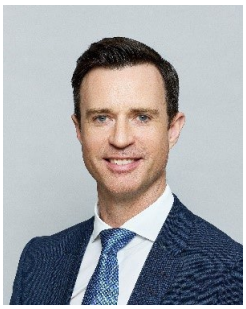
Camille is a Senior Consultant within KPMG's Global Infrastructure Advisory Practice in Toronto. Camille has over 4 years of experience in supporting clients in capital project delivery, focusing on planning, execution, and claims resolution. Camille has a technical background working in design and construction of projects in the built environment that equips her to understand intricate relationships within infrastructure projects and communicate findings effectively. Camille brings hands-on experience in the development and analysis of project budgets and the assessment of project management processes and governance for major projects.

Gautham A | Cost Analyst

Gautham is a Consultant in KPMG's Global Infrastructure Advisory practice, bringing over a decade of hands-on experience in infrastructure projects. He has worked closely with clients in Canada, India, and Middle East, supporting them in planning and delivery of capital projects. As an experienced civil engineer, he specializes in cost reviews, contract administration, project health checks, and governance reviews. Gautham's meticulous attention to detail and experience across various stages of the project lifecycle enables him to conduct effective estimate reviews to assess the basis of estimate and underlying processes to identify risks and issues that require resolution.

Alvin Lok | Data Quality Specialist

Alvin, a Consultant in KPMG's Global Infrastructure Advisory practice in Toronto, brings a unique blend of expertise in Civil Engineering and data analytics to client engagements. His skill set encompasses project management, process optimization, machine learning, and data science. Alvin excels by harnessing his diverse skillset in engineering, business, and analytics to innovate and enhance efficiency, unveil valuable insights, and drive business growth. His professional background includes hands-on experience in project management, cost estimating, contract audits, business development, and analytics, gained through involvement in diverse projects across Canada, including reviews of OPG's Darlington New Nuclear and Renewable Generation Refurbishment Programs.



Andrew McHardy
Partner, Decarbonization Hub Leader

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Function and Specialization

- Major project delivery
- Cost, schedule and risk management
- Decarbonization strategy
- Energy management
- Low-carbon fuels
- Renewable power
- Electrification
- Energy storage
- Carbon capture and sequestration

Professional Associations

- Project Management Professional Project Management Institute

Representative Clients

- OPG
- Hydro One
- BC Hydro
- OEB
- IESO
- Canada Growth Fund
- Enbridge
- TC Energy
- ATCO
- Suncor

Education, Licenses and Certifications

- MSc, Industrial and Systems Engineering (Maintenance and Reliability), Rutgers, The State University of New Jersey
- MSc, Statistics (Quality and Productivity Management), Rutgers, The State University of New Jersey
- BEng, Chemical and Materials, Royal Military College of Canada
- Master of Defence Studies, Royal Military College of Canada
- Joint Command and Staff Program, Canadian Forces College

Background

As a partner in KPMG's Global Infrastructure Advisory practice and National Decarbonization Hub Leader, Andrew is focused on helping organizations increase sustainability and resilience, reduce emissions, and transition to low-carbon energy. This work includes advising on strategies, technologies and tools to decarbonize at the asset-level and supporting the development of large-scale energy transition projects.

Andrew has over 25 years' experience leading multi-disciplinary engineering, consulting and project teams. He has held leadership roles from field to executive level, working with asset-intensive organizations in Canada and internationally, across the power and utilities, energy, mining and metals, industrial, and public sectors.

Prior to joining KPMG, Andrew was Vice President, Energy for a global engineering consultancy, providing strategic leadership and direction for the planning, design, engineering and development of low-carbon energy, including the production, transport, and storage of renewable fuels (hydrogen, biofuels, renewable natural gas), carbon capture, utilization and sequestration (CCUS), and electrification of industrial processes and energy systems.

Professional and Industry Experience

Power & Utilities

- **Project Governance and Reporting Process, Nuclear refurbishment project**

  Development of major project governance and reporting processes, tools and templates for the refurbishment of a nuclear generating station, including definition of key performance indicators, decision-making framework, and interactive reporting to monitor project performance.

- **Contract review for Sir Adam Beck 2 Turbine Overhaul Program, Ontario Power Generation**

  Led a review of the collaborative contract between OPG and GE Vernova regarding the overhaul of 5 turbines at OPG's Sir Adam Beck 2 Hydroelectric Generating Station. The review focused on the assessment of appropriate rates for professional staff and contractor overhead costs.

- **Coal-Fired Power Plant Conversion, Public utility**

  Technical and financial analysis to support investment decision-making for a proposed major refurbishment project to convert a coal-fired power plant to utilize agricultural biomass pellets for low-carbon electricity generation.

- **Climate Adaptation and Transmission Planning, Independent Electricity System Operator (IESO)**

  Development of strategic actions to understand and integrate sustainability, climate change adaptation and transition risk considerations into long-term transmission system planning.

- **Review of Distribution System Plans, Ontario Energy Board (OEB)**

  Review (on behalf of OEB) of various Distribution System Plans (DSP) and cost estimates submitted by a local distribution companies to support their 5-year rate application.

- **Bioenergy Facility Performance Improvement, Public utility**

  Current state technical, operations and maintenance, and commercial assessment of an operating bioenergy facility to identify opportunities to improve financial performance.

- **Digital Strategy and Roadmap, Electricity generation, transmission, and distribution company**

Developed a digital strategy and technology roadmap for the project delivery function of a major electrical utility to improve performance of a capital program valued over $2B annually.

- **Contracting Strategy and Contract Management Operating Model, Electricity transmission and distribution company**

  Development of a business process and analytical tool to support capital allocation decisions and prioritization of projects for contracting as part of a 5-year capital program; designing contract management framework to procure engineering and construction services.

Energy Transition & Decarbonization

- **Green Hydrogen Production, Storage and Export, Green energy company**

  Multiple scoping and pre-feasibility studies for GW-scale production of green hydrogen in Canada for domestic and export markets. Services included market analysis, financial and economic modeling, funding applications, technology and site selection, preliminary design, CAPEX and OPEX estimates, environmental applications, and project schedules for the production, renewable power generation and transmission, storage infrastructure, and rail and port facilities.

- **Steel Plant Decarbonization, Canadian Infrastructure Bank**

  Lender's Technical Advisor for the construction of two electric-arc-furnaces to replace the Algoma Steel's existing gas-fired blast furnaces. Services included a comprehensive risk review of the project, including technology selection and procurement, project approach and governance, and capital cost estimate.

- **Renewable Fuels Production Plant, Canadian biofuel company**

  Technical study, including design basis, process simulation, plant layout and capital cost estimates to compare the feasibility of producing of hydrogen or renewable natural gas from wood biomass (approximately 1000 ton/day) at various sites in Ontario.

- **Blue Ammonia Production Plant, Canadian energy company**

  Technical study, including design basis, technology review, process simulation and capital cost estimate to support project development for a blue ammonia production facility in Alberta.

- **Analysis of Clean Fuels Adoption in Newfoundland & Labrador, econext**

  Assessment of potential demand, environmental and economic impacts, and challenges and opportunities for clean fuel adoption across eight end-use sectors in Newfoundland and Labrador. The eight end-use sectors included public transportation, heavy-duty transportation, marine, ports, aviation, remote communities, heavy industry and electricity grid integration.

- **Decarbonization Due Diligence, Confidential Investor**

  Due diligence services to support a potential transaction related to a greenfield mine and processing plant development. Services include a red-flag review of environmental and social conditions, feasibility assessment of the decarbonization plan (construction, fleet and operations), and estimation of avoided and enabled emission reductions associated with the project.

- **Avoided Emissions Due Diligence, Confidential Investor**

  Due diligence services to support a transaction related to a carbon capture and sequestration (CCS) project. Services included reviewing the forecast emissions calculation (Scope 1 and 2) and estimating Scope 3 emissions for both the base and project cases to understand the potential avoided emissions associated with the project.

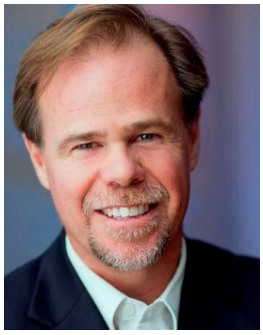
- **Gas Plant Electrification, Integrated energy company**

  Design and engineering services for the replacement of natural gas driven compressors with electric motor drive (EMD) compressors to reduce gas plant GHG emissions.

- **Carbon Capture and Sequestration Hub, Canadian energy company**
  Engineering and advisory services to enable development of a large-scale CO2 transportation and sequestration solution, supporting various customers across Alberta to reduce their carbon emissions.
- **Green Hydrogen Production and Refueling Facilities, ATCO Ltd.**
  Detailed design of two green hydrogen production and refueling facilities in Alberta (Calgary and Edmonton) to support Canada Pacific's (CP) Hydrogen Locomotion Program. Each facility includes a 1MW electrolyzer, compression, storage and dispensing for locomotive refueling, utilizing renewable power from CP's solar power facility.
- **Waste to Biofuel Production Facility, Joint venture company**
  Detailed design for $875M gasification facility to transform mixed municipal, industrial and forestry waste into low-carbon biofuels using a proprietary process development by Enerkem, a Canadian clean technology company.

Energy, Resources & Industrial

- **Industrial Operations Improvement, Global mining company**
  As the global analytics service provider for a leading mining company, developed analytics solutions including a predictive maintenance program, base-metal refining process optimization, and process contamination reduction.
- **Project Readiness and Performance Assessments, Canadian mining company**
  Independent review of the governance, organization, processes and controls for the development of a greenfield mine and processing plant; subsequently, conducted a performance assessment of the project during construction to identify cost, schedule and quality risks and opportunities.
- **IT/OT Sustainment Program, Canadian mining company**
  Developed baseline technical requirements and processes for an information and operations technology (IT/OT) sustainment program, including service level agreements, alert and incident management, and data quality monitoring for improved asset performance.
- **Digital Capital Project Strategy, Integrated energy company**
  Development of a digital strategy, initiative definition and prioritization, technology assessment and implementation roadmap to achieve top quartile capital efficiency in the delivery of capital projects.
- **Operations and Financial Reporting Application, Integrated energy company**
  Design and development of a custom financial application built on SAP HANA to support operational decision making and reporting of yield, daily gross margin, earnings, purchases and sales, and inventory transactions for the downstream oil and gas business.
- **Digital Transformation Strategy, Canadian oil producer**
  Developed digital transformation strategy, including evaluation of the current-state Information and Operational Technology (IT and OT) landscape and definition of foundational data, analytics and technology requirements.
- **Data Governance Business Case, Midstream oil and gas company**
  Assessment of data gaps and opportunities, and development of a business case including strategic goals, future-state operating model and investment roadmap to establish a data governance function for the organization.



Doug Ewing
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Function and Specialization

- Business case and project strategy
- Procurement strategy and execution
- Contract development & negotiation
- Risk analysis
- Program and project management
- Project governance and oversight
- Organizational design and change management
- Project recovery and claims

Education, Licenses & Certifications

- Registered Professional Engineer, Association of Professional Engineers and Geoscientists of BC
- Master of Business Administration, Queen's University
- Master of Environmental Science (Architecture), University of Calgary
- Bachelor of Applied Science (Civil Eng.), Queen's University

Background

Doug is a Partner in KPMG's GIA practice based in Vancouver. He is an astute commercial and technical manager, specializing in the structuring and implementation of large-scale infrastructure projects. Doug has led business case, procurement, and construction implementation stages for a number of public infrastructure programs across a variety of sectors. This has included all forms of contracting from conventional delivery through to complex P3 transactions and alliancing. In addition, Doug has a deep understanding of developing program strategy: putting together complex contracts, interfacing with technical teams, working with First Nations and implementing project governance and management.

Doug joined KPMG from a role as VP of Projects at Partnerships BC, a government agency with centralized expertise in procurement. In this role, he oversaw the procurement options analysis and business case development for numerous public infrastructure projects. In doing so, Doug oversaw multiple cross-functional project teams in the research, review and preparation of a quantitative and qualitative project procurement analysis. This included the creation of detailed triple bottom line analyses, risk assessments, and financial models as well as the execution of market sounding assessments. In this role, Doug became very familiar with the provincial and federal government grant processes, guidelines and funding applications as well as the inner workings of both Partnerships BC and P3 Canada.

Professional and industry experience

Trans Mountain Expansion Project

- KPMG was engaged by the Board of Directors of Trans Mountain Corporation (TMC) and Canada Development Investment Corporation (CDEV) to providing ongoing Project Advisory Assurance Services. This scope included an initial set of reviews to assess integrity of the project cost and schedule, as well as the ability of the existing management systems to monitor and control the project. The scope also included the establishment and execution of a Steady State Monitoring framework to monitor ongoing project performance and support in early identification of risks and emerging issues.
- Doug was the lead Partner for KPMG and oversaw KPMG's role as the Project Assurance Advisor. Doug worked closely with project leadership and CDEV. Doug reported directly to the Assurance Advisory Team (AAT) and the Board.

Broadway Subway Project

- As the engagement partner, Doug was selected as the Commercial Advisor to sit on the Risk Review Committee for the project. As part of the committee, Doug serves as a senior review function and provides feedback on the material commercial issues and risks identified by the project. Doug is the trusted commercial advisor of the senior project leadership team.
- Procurement and Commercial Advisor: He is involved in advising on the procurement strategy, the allocation of key commercial risks and the governance of the project. Doug is leading the KPMG team in the set up phase of the project. This includes providing advice and guidance on the structure of the team, the key interfaces and interdependencies on the project and key project documentation, such as the Project Management Plan.
- Project Setup: The KPMG team are working closely with the project to develop a Project Management plan that is tailored to the project.

City Of Calgary – Green Line LRT Project

- Doug is the lead Partner for KPMG's role on the Green Line LRT project where KPMG is both the commercial and financial advisor on this $4.9B DBF light rail project. Doug is working closely with senior leadership on the project to structure the project in advance of it being released to market. Doug is developing and defining procurement strategies, as well as providing input into the Project Agreement, and the risk transfer of the project, particularly around the 4km tunnel that is part of the alignment.

CDPQ - Réseau Express Metropolitain

- Doug's role as a subject matter expert for the design build and engineering procurement construction (EPC) included working closely with the CDPQ procurement team. Doug defined and developed procurement strategies including responsibility for the quality review of the development of procurement documents and project agreements. KPMG acted as procurement, commercial and financial advisor to CDPQ on the procurement of this major electric light rail project (around $ 6.3B).

TransLink - Capital Project Review

- Doug has been leading the engagement in advising C-Level executives at TransLink on the delivery of its capital projects. The engagement revolves around reviewing the capacity and capability and organization of TransLink's infrastructure group to deliver the forward program of works, highlight gaps and potential areas of improvement.

TransLink, Metro Vancouver Regional Transportation Authority

- As the engagement partner, Doug provided strategic review of the project management, procurement and governance practices adopted by TransLink on some of their high-risk, high-traffic, high-visibility SkyTrain station $200M+ expansion projects in the metropolitan Vancouver area. Doug's expertise provided in-depth industry expertise in procurement approach, market engagement and contracting models. High profile stations included the high-profile and high-traffic Commercial/Broadway, Main Street, Metrotown and New Westminster stations.

Manitoba Hydro, Keeyask Project

- Doug is the engagement partner leading a multi-disciplinary and multi-national team in a range of engagements supporting a major $8.7B North American hydroelectric project. Contract Structures - Alliancing, DBB, DB.
- Alliancing: Doug supported the renegotiation of an alliance target price cost reimbursable contract with pain share/gain share mechanism. This renegotiation was completed after the 1st year of construction in order to reset the contract and ensure performance from the main civil contractor. Doug then continued to support the MH in implementing this contract in terms of resetting the relationship between the owner and Contractor.
- Healthcheck, Cost and Schedule Assessment: Doug led a healthcheck, cost and schedule assessment of Keeyask Project. The healthcheck was conducted in accordance with KPMG's well established propriety methodology which has been tried and tested on hundreds of similar engagements with peer clients across Canada and the world. In addition to an overall Project Healthcheck, KPMG also conducted an independent review of the Project cost estimate to ensure its overall quality; identified potential schedule risks by conducting a

schedule analysis; and leading practice estimating and scheduling practices were incorporated.

- Recovery Plan Strategy: Doug led the KPMG engagement team in the development and implementation of a Project Recovery Strategy. The Project experienced significant performance issues during 2016 construction leading to a $2.2B overrun. The Recovery Plan Strategy included an in depth review of the root causes of poor performance and identified the steps to recovery including resetting the general civil contractor's contract.
- Recovery Plan Implementation: Doug led Recovery Plan implementation efforts with the senior Keeyask leadership team. This included implementing an integrated program with the general civil contractor designed to improve overall project performance, align the interests of the Owner and the Contractor, address the specific challenges relating to cost and schedule within the Project and revising the contractor and owner reporting to improve the transparency of Project's performance.
- Commercial Lead: Doug is acting as the Commercial Lead for the Project, providing contractual advice to senior management and project leaders on contract management and various modifications and changes to complex, high value construction and service contracts for the Project. This includes providing strategic insight into major claims including with the Turbine and Generator Supplier.
- Claims Settlement and Contract Negotiations: Doug was the lead advisor in the analysis and settlement of all claims with the general civil contactor. Claims were estimated to be over $500M. This settlement included renegotiating the contract and establishing new cost and schedule baseline, target price incentives and contract language.
- Change Management: Doug is overseeing the people change management services provided to the Project team. This includes developing executive leadership skills, coaching, contractor relationship, employee engagement and internal communications.
- Regulatory Support: Doug advised the team through the 2017 rate application and responded to intervenor questions and panel requests as required.
- Data Analytics: Doug is overseeing the development and implementation of a digital cost compliance audit program. This would enable the automation of 100% review of all invoices prior to payment.

Manitoba Hydro, Bipole III Transmission Reliability Project

- Doug is the engagement partner currently leading a team conducting a healthcheck on the current state of the $4.6B Bipole 3 project. The project is a new high voltage direct current (HVDC) transmission project to improve overall system reliability and enhancing the dependability of Manitoba Hydro's transmission system.
- Healthcheck: It involves the construction of a 500 kV HVDC transmission line, 2 new conversion stations, 2 ground electrodes, and an additional 230 kV transmission line, all within a new corridor in western Manitoba. The project is anticipated to be completed and operational by 2018

BC Hydro Site C Clean Energy Project

- Doug is currently leading a team on a multi-year, wide range of engagements with the Provincial Crown as part of the procurement of the $10.5B Site C Clean Energy Project on the Peace River in northeastern BC. The Site C Project is the largest public sector project in BC, and when completed will produce an additional 5,100 GWh of electricity each year.
- Procurement and Commercial Advisor: Doug was involved in advising on the governance model, on the procurement strategy, on the allocation of key commercial risks, on First Nations contracting strategy and liaising with the project's technical advisors. The key challenges for this project are the size of the project, complex regulatory process and First Nation discussions, the challenging geotechnical conditions, the need to set up a separate project delivery team for a project of this size.
- Contract Agreement & Independent Review: Doug provided oversight and leadership to the development of the Worker's Accommodation contract agreements and an independent review of the project costs.
- Project Readiness Assessment: Doug provided executive leadership and advisory services to BC Hydro through an in-depth project readiness assessment of the Project Owners including a critical gap assessment and reorganization of the project team across task functions and contract streams.

BC Hydro John Hart Generating Station Replacement Project

- Doug led the business case analysis and procurement phase at Partnerships BC. This is BC Hydro's largest capital project second to Site C. In addition, Doug provided strategic advice with how to provide contract opportunities with the impacted First nations and project governance advice for the project both to the project board and BC Hydro Board.
- Procurement: The key challenges for BC Hydro on this project include this being the first major construction project undertaken in many years, the use of alternative approach to procurement (design build finance and rehabilitate) that has not been previously used by BC Hydro, the complex technical issues associated with the rehabilitation of an existing powerhouse and dam, First Nation discussions and the change management required within BC Hydro required to implement the project.
- Risk Assessment and VfM: The business case phase included a detailed risk assessment, value-for-money analysis and rate payer assessment and this information was a key component to BC Hydro's decision to proceed with an alternative procurement method as well as forming a key part of the BCUC regulatory submission. The procurement phase included developing a new PPP contract document for the hydro sector, determining key commercial strategies that the private sector could finance, putting together a comprehensive technical document for design build specifications and responding to complicated procurement issues as they arose during procurement.

Alberta Electric System Operator

- Doug provided key commercial advisory services into infrastructure procurement and interpretation of contract behavior in support of the KPMG team acting as the Financial advisor to assist in the completion of the $1.4B Fort McMurray west 500 kV Transmission Project. The project entails a 500-kilometre transmission line with associated facilities between the Edmonton and Fort

McMurray regions and is the first transmission line project to be procured by way of the Competitive Process in Alberta.

SaskPower - Tasi Twe Procurement Strategy and Project Readiness Assessment

- Conducted an overall health assessment of the proposed Taze Twe Hydro Electric Project, including an in-depth assessment of the contracting strategy for SaskPower and the Board of Directors. Doug was involved in the commercial, procurement and implementation planning and review phases.

Keyano College Clearwater Campus Student Residency Project

- Doug led the engagement team in the development of a bespoken construction management risk contract, in close coordination with the College Lawyer Project Team.
- Construction Management Risk Contract: This project was part of the College's Comprehensive Institutional Plan, establishing the needs and priorities for campus infrastructure/facilities redevelopment with the notable prioritizing of student housing. The projected capital cost of construction is approximately $120M and currently pending construction, will include new facilities for student housing, faculty family residences, retail and an underground parking garage.

Encana Cutbank Ridge Natural Gas Development Program

- As Engagement Partner, Doug and his team assisted with the development of a series of gas processing projects in western Canada (approx. $3B total expenditure, under a joint venture arrangement). The first phase of work involved developing an EPCM/C contract negotiation strategy; conducting a program framework review focusing on governance and organization, project controls and reporting, and supply chain management; and an assessment of the organization's change management challenges. The second phase of work involved facilitation of the EPCM and construction contract negotiations; development of stakeholder and communication management plans; helping the owner to create and define an organizational structure with clear definition of all interfaces and development of roles and responsibilities for key positions; development of the program execution strategy; and implementation of the framework review recommendations to create a suite of standardized major project controls plans and procedures. The third phase of work involved ongoing personnel amendments supporting project controls and project management and helping to steward the projects to successful outcomes. Throughout the engagement, Doug provided active support in contract strategy development and implementation, critical project performance assessments and decision analyses, and executive and board-level communications.

VANOC - Whistler Olympic Park

- The Vancouver 2010 Winter Olympic Games was deemed a major success by both the International Olympic Committee and International Paralympic Committee and highly regarded for its achievement in delivering the vital games infrastructure and venues ahead of schedule and within budget.
- As Project Manager, Doug was responsible for leading the design, procurement and construction of Whistler Olympic Park: Biathlon, Cross Country and Ski Jump Venues as well as the supporting infrastructure necessary to operate the Park as a successful Legacy.

- The Whistler Olympic Park was a fast-tracked construction program involving construction management, design-bid-build, design-build, design-build-operate contracts with over 50% of the facility being completed in partnership with the local First Nations.
- After the completion of this Facility and for the last year of construction, Doug was the Program Director for all Whistler Olympic Venues: Whistler Olympic Park, Whistler Sliding Centre, Creekside Downhill and the Whistler Athlete's Centre.

Janet Rieksts Alderman
Partner, Global Infrastructure Advisory

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Function and Specialization

- Nuclear Sector
- Mining Sector
- Hydrogen Sector
- Skills and capabilities assessments
- Regulatory experience
- Government sector
- Educational institution
- Project Governance and Risk Management
- Independent project advisor/ assurance
- Expert Reports
- Governance

Function and Specialization

- Nuclear Waste Management Organization
- Ontario Power Generation
- NB Power
- Irving Oil
- WDBA
- Vale
- Potash Corp
- Infrastructure Ontario
- Hydro One

Education, Licenses & Certifications

- Masters of Business Administration
- CPA, CMA, Institute of Chartered Accountants of Ontario

Background

Janet is a widely respected Canadian business and thought leader 20 years' active in the Nuclear sector across the value chain from refurbishment to generation to waste.

She has performed reviews, risk assessments and strategic planning engagements in over 50 organizations spanning Nuclear, Mining, Government, Energy, Transportation, Asset Management, educational institutions, Real estate, Infrastructure, Shipbuilding Government, and engineering sector. Her work has taken place across Canada, US, UK, Australia, South and Central America and the Middle East.

To this engagement, she brings a perspective of not only the nuclear sector but also adjacent industries such as mining and engineering as well as working with regulators. She has deep relevant industry experience, facilitating workshops and developing methodology to meet the goals of the engagement – to produce sound, impactful results.

Janet has acted as an expert in project performance, claims and disputes, including for a nuclear organization as part of the regulatory submission. She has also advised the Federal government on infrastructure investment strategy.

Prior to coming to KPMG, she has been a director on several boards including the Nuclear Waste Management Organization, Childhood Cancer Canada, and Waterfront Toronto where she served as Acting Chair and led the Audit Committee, overseeing the historic $1.25-billion flood-protection project in the city's Port Lands district.

Janet is a CPA, CMA and holds a Master of Business Administration.

Professional and industry experience

- Nuclear Waste Management Organization – past Board of Directors, Chair of Governance and HR Committee, Member Technical Committee
- Darlington Nuclear Refurbishment – Project Governance and Oversight
- New Brunswick Power – Point Lepreau Nuclear Refurbishment Project, Project Risk Assessment including Monte Carlo Simulation
- Led Capital Project scope of Outsource Internal Audit engagement for large Canadian Utility
- Candu Nuclear Project Risk and Project Performance Oversight
- Operational Risk Assessments in Candu Nuclear Business in Atlantic Canada
- Led Internal Audit Outsourcing engagement for Regional Canadian Utility
- Was seconded to International Oil and Gas Company to assess Capital Project Risk following a high-profile disaster.

Jordan Thomson
Director, Global Infrastructure Advisory

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Professional Associations

- Professional Engineers of Ontario

Languages

- English, French (Intermediate)

Education, Licenses & Certifications

- Master of Business Administration, University of Cambridge Judge Business School
- Bachelor of Engineering, McMaster University
- Professional Engineer (P.Eng)

Publications and Speaking Engagements

- Digitizing the Canadian Construction Industry – Canadian Construction Association Annual National Conference [March 2023]
- Construction 4.0: The transformation of the construction industry – Canadian Construction Association Insight Report [June 2022]
- Canadian Construction in the Digital Age – Benchmarking the sector's digital maturity - Canadian Construction Association Presentation [March 2021]
- COVID-19 Project Continuity Planning – Understanding impacts to date & risks going forward - Canadian Construction Association Presentation [May 2020]
- Force Majeure: COVID-19 – Impacts of the COVID-19 Pandemic on the Construction Industry [April 2020]

Background

Jordan leads KMPG's Engineering & Construction team within the firm's Global Infrastructure Advisory practice. With over 15 years' experience as a strategic advisor and Professional Engineer, Jordan is able to combine deep industry expertise and technical understanding, with commercial, financial, and operational business knowledge. Jordan's technical background includes experience with Aecon construction and Golder Associates spanning construction management and design engineering across the mining, oil & gas, utilities, and infrastructure sectors.

Professional and industry experience

As an advisor to owners, contractors, and engineering firms, Jordan has focused on applying his industry experience to help clients across the Canadian and UK markets maximize value from their largest and most complex projects. In particular, Jordan specializes in commercial management, project and portfolio management, commercial strategy, cost and schedule management , claims and dispute resolution, and project economics.

Ontario Power Generation

Ontario Power Generation – Darlington New Nuclear SMR Review

– Led the review of the contractor costs to date for the Darlington New Nuclear Small Modular Reactor project under its integrated project delivery model. This focused on a review of engineering and planning hours and associated expenses against the provisions of the project agreement and leading industry practices.

Ontario Power Generation – Darlington Refurbishment Cost Review

– Led the review of the cost performance of the Heavy Water Storage Building construction project as part of the overarching Darlington Refurbishment program. This included the development of an integrated data model to audit the direct field labour, management team, and contractor costs against contractual obligations, resulting in a recovery opportunity of over $1M.

Ontario Power Generation – Sir Adam Beck 2 Turbine Overhaul Program

– Led a review of the collaborative contract between OPG and GE Vernova regarding the overhaul of 5 turbines at OPG's Sir Adam Beck 2 Hydroelectric Generating Station. The review focused on the assessment of appropriate rates for professional staff and contractor overhead costs.

Nuclear

Federal Nuclear Operator – Delivery Model Options Analysis & Alliance Development

– Conducted an options analysis of potential delivery models for the construction and operation of a multi-billion-dollar nuclear facility, including assessment of traditional, P3, and collaborative models against strategic priorities and organizational capabilities and maturity.

– Following the findings of the options analysis, KPMG conducted further analysis of the alliance delivery model and its suitability for the project. This includes assessment of potential alliance structures, commercial arrangements, governance, organizational structures, and procurement processes.

Cost and Estimate Reviews

University of Toronto – University Planning, Design & Construction Group Support

– Provided strategic level support and advice to the University's Planning, Design & Construction Group across their multi-billion-dollar portfolio of projects. This included guidance on procurement approaches, commercial strategies, project controls, and change management, as well as providing expert advice on market conditions, and claims and disputes. This included conducting reviews of the estimates for two major projects to validate the process followed and the basis of the inputs and assumptions used.

Seaspan – Joint Support Ship Program Management Baseline Review

– Conducted a detailed review of the processes for the development, management, and control of the project management baseline and basis of estimate for the $4.1B Joint Support Ships Program. The engagement including conducting interviews with numerous project stakeholders across the organization to identify pain points and potential areas for improvement in order to provide Seaspan improved control of cost and schedule and increased certainty in performance against the contract target cost.

Nalcor – Muskrat Falls Balance of Plant Contract Review

– Led a review of the costs billed by the contractor as part of the balance of plant contract for the Muskrat Falls powerhouse. This included a review of the contractor's invoices and project records against the contract in order to identify potential recoveries by the owner. The engagement also included a review of evolution of the project schedule and the impacts of delays in other contracts on this scope of work.

Nalcor – Muskrat Falls Earthworks Contract Performance Review

– Undertook a review of the earthworks contractor's performance in the construction of Muskrat Falls dam in relation to its contractual obligations. This included a review of the contractor's project controls function against contractual requirements and industry leading practices in order to quantify an estimate for recovery by the owner and identify areas for improvement for the remainder of the project.

Technical Due Diligence

LNG Terminal & Pipeline Project Review – KOGAS

– Led an independent review of the health of a multi-billion-dollar greenfield natural gas export terminal and interprovincial pipeline. The review focused on assessment of the project construction progress, cost and schedule risk, and commercial considerations under the changing market conditions in order to assess the risk-adjusted return on KOGAS' investment.

Canadian Pension Fund – Renewable Natural Gas Production Facility Review

– Conducted a technical due diligence review of two in-flight projects for the construction of renewable natural gas production facilities that will convert alcohol distillery waste to natural gas. This review focused on the assessment of cost and schedule risk, including significant delays in procurement and mobilization, and potential impacts to the operations of the target company.

Private Equity – Global EPC Firm Technical Due Diligence

– Led the technical due diligence of a global construction firm, encompassing over $25B of EPC and P3 projects in sectors spanning from infrastructure, oil and gas, transportation, and renewable power generation. This involved assessment of project performance to date and cost and schedule trends going forward, as well as review contractual risks, and the quantification of potential financial risk exposure and impact on project and overall company profitability. This also included provided general guidance to the client on industry trends, competitors, and opportunities.

Global EPC Firm - Multinational Construction Company Due Diligence

– Provided technical specialist advisory support as part of KPMG's global due diligence of a multinational construction company, focusing on the cost and schedule performance and the quantification of potential financial risk exposure of several >$100M commercial and large-scale residential projects. Jordan also provided guidance on market trends, competitor performance, opportunities for growth, and potential risks moving forward.

Canadian Pension Fund – Champlain Hudson Power Express Project Review

– Led the technical due diligence review of the $6B Champlain Hudson Power Express transmission line between Quebec and New York City. This included a review of the engineering, construction, and operations contracts for execution risks and potential cost and schedule growth, as well as review of offtake agreements and revenue risk for the investor.

Claims & Dispute Advisory

New Champlain Bridge – Commercial Dispute Strategy and Quantification

– Oversaw multiple work streams and worked with senior client stakeholders and legal counsel in the development of a strategy to understand and quantify the impacts of a change in law on a $4B major bridge and highway infrastructure project. This involved the development of detailed analytical models to track the lifecycle of thousands of individual components and undertaking a time impact analysis in order to build a case for an extension of time for the contract.

– Led a second engagement to assess and quantify the impacts of an unforeseen work action by one of the key unions on the project. This involved detailed schedule analysis and presentation of the client's case for an extension of time before the project dispute resolution board.

– Led a final retrospective analysis of project performance at substantial completion, working with legal counsel and the project executive committee in the development of a strategy for negotiation and litigation. This included detailed schedule analysis to assess strengths and weaknesses of the client's position and selection of an independent expert for court proceedings.

Renewable Power Generator – Commercial Dispute Advisory

– Led an independent forensic review of the construction of a $140M wind farm, focusing on the contractor's performance during the preparation of the municipal and turbine access roads. The intent of the study was to assess and quantify the delay attributable to the contractor under the project agreement in order estimate the net liquidated damages and any additional opportunities for cost recovery by the owner.

Windsor Detroit Bridge Authority – Gordie Howe International Bridge

– Led the claim review of cost and schedule impacts on the $5.7B international bridge and adjoining point of entry facilities due the discovery of geotechnical obstructions. This included conducting a detailed time impact analysis of impacts due to removal of unforeseen obstructions and forensic analysis of changes to the project schedule over time in order to assess the net impact to the critical path.

Library & Archives Canada – Gatineau II Preservation Facility Claims Support

– Led a long-term engagement to support Library and Archives Canada (LAC) in the assessment, quantification, and negotiation of claims stemming from impacts of the COVID-19 Pandemic and associated changes in law. This included schedule and cost analysis of over 20 claim packages and the development of counteroffers, resulting in ~50% in overall claim value.

Retail Developer – Construction Damages Review & Litigation Support

– Worked with legal counsel and other experts in the development of an independent assessment of the required costs to construction a multi-storey retail facility in support of active litigation proceedings. KPMG was subsequently engaged to provide expert testimony on its analysis.

Toronto Area Hospital – Capital Project Procurement and Management Review

– Supported hospital board of directors and legal counsel in a review of the procurement and project management practices employed by hospital staff regarding a major expansion of the facility to ensure Broader Public Sector procurement policies and processes were followed. This included assessment of potential process gaps and opportunities for improvement.

Toronto Area P3 Hospital – Bond Payment Review

– Undertook a detailed review of costs claimed against the project insurer and the assessed performance bond funds available to the project. This included detailed review of performance bond contract documents, lenders terms, contractor and subcontractors' invoices and claims, financial reports, and third party engineering reports to develop a comprehensive understanding of the costs incurred and available funds.

Retail Developer – Expert Opinion on Construction Management Fees

– Served as an independent Expert to provide an opinion on the construction management fee percentage applied for the development and construction of commercial properties.

Alliance & Collaborative Contracting

Metrolinx – Union Station Expansion Project Alliance Review

– Jordan is currently leading a review of the $0.6B Union Station Expansion Project with a focus on ensuring proper governance and commercial controls are in place. As the first alliance on a major civil project in North America, the project provides important insights on the challenges and opportunities presented by alliancing in the Canadian construction industry.

New Brunswick Power – Early Contractor Involvement Strategy

– Led the development of an early contractor involvement (ECI) strategy in support of NB Power's life achievement program for the Mactaquac Dam, which incorporated principles of collaborative contracting. This included providing guidance and training to senior team members on commercial strategies and development of a commercial strategy for the target price structure.

Flatiron Construction – Alliance Contracting Training

– Provided training on collaborative contracting practices and the alliance contracting strategy in support of Flatiron's pursuit of a major alliance contract. This included workshops to prepare for the various stages of the alliance procurement process and guidance on collaborative behaviours.

Project & Portfolio Management

ONxpress Transportation Partners – Organizational Development Strategy & Support

– Led a strategic diagnostic review to identify issues affecting the collaborative environment between the members of ONxpress and their client Metrolinx in the delivery of their expected $12B track electrification and operation program. This included conducting workshops and interviews with executive leadership and the development action plans to address key pain points.

– Led a subsequent engagement to support the development and implementation of document and data management processes across the organization. This involved close consultation with teams across ONxpress to assess their unique ways of working, develop processes and tools, and define KPIs to monitor benefits.

Metrolinx Transit Authority – Commercial Support Team Development & Commercial Training

– Led a multi-year engagement with Metrolinx's Capital Projects Group to help develop and implement the new claims management team, working with senior stakeholders to define processes and roll-out training on commercial management, claims, and disputes. This engagement also included providing direct support to construction teams for claims and commercial issues, including providing cost and schedule impact assessments for several rail corridor and station projects across Metrolinx's $40B capital plan.

Toronto Transit Commission – New Streetcar Program Management Support

– Directly supported the Program Director and senior staff for the TTC's $1.1B procurement of Toronto's new streetcar fleet to develop and implement key project and commercial management and project controls tools and processes to bring the program in line with leading industry practices. This included the development of an integrated schedule, budget, and risk management tools, as well as the overarching Project Management Plan and Quality Assurance Plan.

Toronto Transit Commission – Electric Bus Pilot Program

– Directly supported the TTC project team with the planning and procurement of the pilot program to purchase a fleet of battery electric busses. This included support of the procurement of the busses from three proponents as well as planning of the upgrades to three of TTC's garages to accommodate the required charging infrastructure.

Seaspan – Risk Management Process Review

– Led a review of Seaspan's risk management processes and tools across the Joint Support Ship (JSS) and Offshore Oceanographic Science Vessel Programs. This included engaging with project mangers and key staff to identify and assess program risks and developing a framework to provide a portfolio level view of key risk areas.

Vancouver Fraser Port Authority - Roberts Bank Terminal 2

– Provided strategic commercial advice to project leadership regarding claims avoidance and schedule management requirements in the development of the Project Agreement for the upcoming ~$3B Roberts Bank Terminal 2 project.

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- **Canadian Construction in the Digital Age** – Benchmarking the sector's digital maturity - Canadian Construction Association Presentation [March 2021]
- **COVID-19 Project Continuity Planning** – Understanding impacts to date & risks going forward - Canadian Construction Association Presentation [May 2020]
- **Force Majeure: COVID-19** – Impacts of the COVID-19 Pandemic on the Construction Industry [April 2020]

Jamie Cameron
Director (SME)

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Function and Specialization

- Capital Delivery
- Municipal Transformation
- Strategy, governance, and project management of large-scale infrastructure projects, with a focus on transportation projects

Education, Licenses & Certifications

- MBA - Master of Business Administration, Schulich School of Business, York University, Ontario
- BASc - Bachelor of Applied Science in Engineering (Mechanical), Queen's University, Ontario
- Professional Engineer (P.Eng.) - Mechanical, Professional Engineers Ontario
- Project Management Professional (PMP), Project Management Institute

Background

Jamie Cameron is a Director in the Infrastructure practice of KPMG's Toronto office. Jamie specializes in capital program and project management, oversight, governance, risk and controls. Jamie also provides strategic planning services for clients around capital program management. He has a solid experience in project controls and time/schedule management, in the business of operational project management of major capital projects and has a breadth of experience across the infrastructure asset lifecycle. James is both a professional engineer (P.Eng.) and project manager (PMP) with over 19 years in industry and consulting. Jamie also plays a lead role within KPMG Infrastructure's Decarbonization Hub, leading our work on decarbonization of transport as KPMG Infrastructure's National Lead for Transit and Future Mobility.

Professional and Industry Experience

As a lead member of the Major Projects team in Toronto within KPMG's Infrastructure Advisory practice, Jamie focuses on supporting clients in successfully delivering on the elements of KPMG's Five Pillars which include Governance & Oversight, Organization & Performance, Commercial & Financial, Approvals & Social License and Delivery & Risk Management.

Specific areas of focus include:

- Assessments of organizational project management maturity.
- Development of project management frameworks (topics include risk management, project change control, and project delivery options analysis)
- Design of organizational project governance structures and systems.
- Board-level (and below) training on project governance and stewardship responsibilities.
- Portfolio and Project Management Office development and support.
- Past experience in engineering and design management.
- Project reviews of project management, governance and controls.
- Independent project oversight, including ongoing cost, scope (change orders), schedule and risk register review and analysis.
- Construction claims analysis and negotiation support, including assessments related to scope creep from initial estimates and contract compliance.
- Risk register development.
- Financial modeling, with an emphasis on translating technical inputs into model assumptions.

A summary of Jamie's relevant experience is provided below.

- **Capital Delivery Review - City of Toronto:** Jamie is currently leading a review of capital project delivery within the City's Infrastructure Services Unit, including the Divisions of Engineering & Construction Services (ECS), Toronto Water, Transportation Services and Solid Waste Management Services (SWMS). The review has examined over 24 projects and has 31 recommendations focussing on the areas of project management, procurement, communications/consultation and

the introduction of stage gates and project categorization. The report will be presented to the City's Infrastructure Committee and

- **Capital Program Delivery Review "CPDR" - City of Toronto / TTC:** Jamie worked for the City Manager's Office of the City of Toronto to assess the Toronto Transit Commission's (TTC) capital program project management, controls and governance maturity, and to investigate alternative delivery models. This assessment was facilitated by a review of 13 recent or active capital projects and programs spanning multiple delivery departments (ITS, ECE, Operations) and structured interviews with individuals representing project management, finance, procurement and executive leadership. Jamie managed 60+ interviews with senior internal and external stakeholders at the TTC, City of Toronto, Metrolinx, Infrastructure Ontario and multiple contractors. The project also involved multiple working sessions and briefings with high level City and TTC staff, as well as politicians. The review included 41 recommendations, as well as a Project Risk & Complexity Classification framework and a Project Delivery Options Analysis framework. The TTC accepted all 41 recommendations for implementation at their September 2016 TTC Board meeting.
- **City of Toronto – Ferry Replacement Program Support:** In 2021, the City engaged KPMG to support the development of a business case that assessed the commercial considerations associated with the delivery of ferry services, which included an analysis of the replacement of 4 existing vessels with a new fleet of electric vessels – 3 passenger-only vessels and 1 vehicle/passenger vessel – and associated operations, electrical infrastructure requirements and potential upgrades to the Jack Layton Ferry Terminal. This work involved performing a current state assessment of existing ferry services, performing a comparative analysis of national/international ferry services, conducting interviews with potential private and public sector partners, performing a high-level analysis of potential delivery options associated with delivering ferry services, and identifying key findings and considerations for City decision-makers.
  As a follow-on to this work, KPMG will be acting in an independent and advisory role, helping the project team ensure good governance and support oversight of the technical consultants.
- **Project Management Process Improvement – Halifax Regional Municipality:** Jamie recently completed an initiative to validate the project management maturity of HRM's Transportation and Public Works department and develop a project management framework and associated guidelines and processes for rollout across their portfolio.
  Operations Capital Program Planning & Delivery Optimization – Cadillac Fairview
  Jamie led a nationwide review of a large commercial/retail developer's Operations practices at the corporate, portfolio and property levels relating to capital project planning and execution. The practices were compared to those of the Development group, as well as benchmarks of other leading businesses. The resulting report and recommendations for a more formalized Operations Project Management Function and greater emphasis on asset management have since been adopted by the organization.
- **Capital Project Risk, Governance & Control Review – City of Regina:** Jamie led an engagement with the City of Regina to assess

their capital construction project controls and governance procedures. This assessment was facilitated by a review of 5 recent or current construction projects, and structured interviews with individuals representing project management, finance, procurement and executive leadership. The aim of the project was to identify risks and improvement opportunities for capital project management functions at the City.

- **Project Management Review - City of Vancouver:** Jamie conducted a review of the City's Engineering Services Department aimed at evaluating the maturity of project management practices. The work resulted in a series of opportunities for project management improvement. KPMG is continuing to help the City through the implementation of these improvements.
- **Operations Capital Program Planning & Delivery Optimization – Cadillac Fairview:** Jamie led a nationwide review of a large commercial/retail developer's Operations practices at the corporate, portfolio and property levels relating to capital project planning and execution. The practices were compared to those of the Development group, as well as benchmarks of other leading businesses. The resulting report and recommendations for a more formalized Operations Project Management Function and greater emphasis on asset management have since been adopted by the organization.
- **Capital Project Lifecycle Review – Greater Toronto Airports Authority:** KPMG provides a wide array of risk-based internal audit assistance to the GTAA across their operations and capital programs. Jamie has been supporting their reviews on capital project delivery since 2019.
  Jamie led a review of their Airport Development PMO's new project lifecycle framework, including a review of the design of their processes, procedures and standard documentation, as well as the effectiveness of their Project Management Information System (PMIS).
  Jamie led work reviewing the organizational readiness (governance, process, people, etc.) of the Airport Development PMO to support the rapidly expanding capital program that is seeing significant and accelerating growth coming out of the pandemic. KPMG's recommendations focused on governance, capacity and capability and continued maturation of the organization's project management maturity.
  Jamie led work providing program management support to the early planning stage of the GTAA's Transformative Capital Program. KPMG supported the multi-disciplinary team involving Airport Development & Construction and Airport Planning in supporting the early-stage development of a program charter and the scoping of a stakeholder management plan.
- **Capital Project Delivery Process and Project Reviews – Metrolinx:** Jamie is currently the senior team member supporting Metrolinx's Internal Audit function on a variety of capital projects related initiatives. Jamie has been supporting Metrolinx IA since 2019, with reviews covering topics such as third-party utilities management, cost estimating and reporting, as well as a number of projects related to GO Expansion early works, stations and the Union Station Expansion Project (USEP).

As a part of the KPMG's broader internal audit support, Jamie led two reviews of capital project delivery processes for both cost estimating and reporting, and the management of third-party utilities.

- **Capital Project Management Prudency Services – Enbridge Gas Distribution:** Jamie was as a lead team member on a multi-year engagement acting as a third-party project management, governance and control oversight on a $700M+ pipeline expansion project. Jamie was involved in an initial governance & controls maturity assessment, and completed monthly reviews of the project (contract, schedule, cost, risk), aiding in identifying potential project management issues. The work concluded with a close-out report related to project management prudency in support of a regulatory rate application.
- **Capital Program Delivery Support – TTC:** Since the delivery of the CPDR, Jamie has led **9+ years of continuous, ongoing strategic support** of the TTC's capital delivery program spanning project management maturity, portfolio strategy and program and project management support. Individual tasks delivered over multiple contracts include the following:
  - **Implementation Scoping -** As a follow-on to the Capital Program Delivery Review, Jamie assisting the TTC develop the detailed scoping of the TTC's implementation of the review's 41 recommendations, working through multiple stakeholder workshops to develop what ultimately became a 4-year Project Management Maturity implementation plan ("PMM Plan").
  - **Project Management Framework Development** - Jamie assisted the TTC develop a corporate Project Management Framework ("PMF"), fulfilling a number of the key recommendations in KPMG's CPDR. Approved by the TTC Board at its June 2017 meeting, the PMF addresses project governance based project categorization by risk and complexity and overlaid on a stage gate process. It also addresses corporate standards in the areas of risk management, business case development, cost estimating, and project monitoring, among others.
  - **Organizational Project Management Services, Portfolio Management Office ("PfMO") -** Jamie led a variety of tasks to assist the TTC's PfMO deliver on their Project Management Maturity Plan. Work assisting with the development of project management standards, providing advice on process improvements for budgeting and project prioritization, providing support to staff in the development of business cases, and an annual maturity assessment to assess how the TTC has progressed against their PMM Plan. The PMM Annual Assessment was received by the TTC Board at their December 2017 meeting.
  - **Project and Program Management Support Services -** Jamie continues to lead the team in providing project management services in the form of specific project deliverable support (i.e. the development of business cases, risk registers, schedules, project charters, project management plans, etc.) in the following areas:
    - Supporting the TTC 2018 Capital Budget process, through the PfMO, by providing as-needed support in the development and improvement of Statement of Intents (SOI), Business Cases and Project Change Requests (PCRs). Projects supported spanned the TTC's portfolio and included the Culverts Program,

Data Centre Expansion, Consolidated Warehouse, Hillcrest Storage Expansion, Enterprise Data SOGR and Greenwood HVAC program, among others.

- Supporting the TTC 2019 Capital Budget process, through the Service Delivery PMO, by providing as-needed support in the development and improvement of all business cases and changes on a variety of projects and programs such as LFLRV, eBus, Bus and Wheel-Trans Procurement.
- Providing Project Management support to the Farecard team over a 9-month period, and Program Management for 20 months, supporting both the Open Payments and Mobile Wallet workstreams, and the settlement delivery plans.
- Project Managers, Business Analysts, Commercial Analysts and scheduler supporting the development of PMF deliverables for all major Service Delivery sponsored or managed projects and programs, including the review/comment on Project/Program Charters for Stations Transformation and VISION and Program Charter, Business Case and Board Report for Wheel-Trans Transformation.
- Development of major deliverables for the New Streetcar Program (charter, Project Management Plan ("PMP"), risk register, schedule, consolidated budget), eBus Program (charter, PMP, risk register, schedule, 15+ year program budget, cost management file/tracker) and bus program (charter, risk register)
- Development of integrated master portfolio milestone schedule for all projects/programs sponsored and managed by the Service Delivery group.
- Supporting the Vehicle Programs team, including ongoing support of the Green Bus program. KPMG is also leading the development of the TTC's first Sustainability Report since 2012 and supporting the development of the Innovation & Sustainability Program's strategy and roadmap.
- Supporting the Renewable Energy Programs team in the commercial delivery and oversight of the PowerON contract for the delivery of charging infrastructure.
- A 2025 refresh of the TTC's Project Management Framework and Standards, with work to be completed in Q2 of 2025.

- **End-to-End Development Review Process Review – City of Toronto:** Jamie was the project manager on work with the City's Transformation office and the Chief Planner to complete an end-to-end review of the processes, governance, roles and responsibilities and technology used in the cross-divisional process that intakes, comments on, and ultimately approves development applications. Those applications include things like re-zoning applications, site plan approvals and committee of adjustment applications for minor variances. The work is heavily focused on stakeholder engagement and participative operating model and process re-design.
- **Procurement & Asset Management Audit – Multiple BC Municipalities:** KPMG worked on behalf of the BC Auditor General of

Local Governments to audit capital project procurement and asset management at six small municipalities in British Columbia. Jamie led the audits for one municipality, including a wastewater treatment plant and a small road project.

- **Transportation & Public Works Reviews – Multiple Municipalities:** Jamie has completed a number of public works and transportation services reviews for municipal client, focusing on service levels, equipment and fleet requirements and facility needs. Clients have included Oxford County (and its 9 constituent municipalities), Wellington County, Town of Pelham, Town of South Glengarry, Huron County, Town of Thorold, Town of Ajax and Town of Whitby.
- **City of Toronto – Infrastructure and Development Services PMO:** KPMG was engaged by the Deputy City Manager, Infrastructure and Development Services (IDS) to support the City in establishing a strategic program management office for IDS to facilitate coordination, provide strategic support and create visibility for major growth-related capital projects, including development, transit and infrastructure. Our work involved extensive stakeholder engagement (both internal to the City and external partners and agencies who work regularly with the City), in-depth leading practice research, including interviews with globally recognized project management teams, and establishing a future state governance model and roles and responsibilities for the IDS PMO.
- **Toronto Transit Commission – Business Transformation Office Support:** KPMG was engaged by the TTC to provide support to its Business Transformation Office (BTO) with the development of business cases and other deliverables as required for up to 20-25 projects within the BTO's remit. The support has included information gathering to confirm the understanding of particular projects and developing a one-pager to clearly articulate the scope, preparing project documentation, including stakeholder analysis and readiness assessments, qualitative research and benchmarking and financial analysis, and supporting the implementation of particular initiatives. This work built off of KPMG's prior work on the TTC Capital Program Delivery Review, including making use of the Project Management Framework KPMG developed for the TTC. The TTC CPDR was commissioned jointly by the City Manager's Office and TTC. Completed in 2017, KPMG has been supporting implementation of the report's recommendations continuously in the ensuing 6+ years, including this work for the Business Transformation Office.

Nipun Dhawan
Manager

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Function and Specialization

Manager in the Major Projects Advisory group within KPMG's Global Infrastructure Advisory practice, specializing in project management, capital project review, governance and risk assessment.

Languages

English

Education, Licenses & Certifications

- Bachelor of Technology in Civil Engineering
- Postgraduate in Advance Construction Management

Background

Nipun is a Manager in KPMG's Global Infrastructure Advisory Practice in Toronto, Ontario. With over 11 years' experience, Nipun has worked across various sectors, including large industrial projects (such as refinery and steel), infrastructure, real estate, power, and renewables. He has extensive experience working in Project management, Portfolio management, Governance and Risk management aspects of mega projects and operations.

Prior to joining KPMG, Nipun spent several years working as a project manager in the Industrial and Real estate projects across the project lifecycle. He has experience working in a client firm as well as a contractor. Through his experience, he has developed a strong understanding of the needs of project owners, how to mitigate risks and challenges and ensuring successful delivery of projects.

Since joining KPMG, Nipun has worked closely with both private and public sector clients in providing project management advisory services, conducted governance reviews, and carried out internal audits.

Professional and Industry Experience

- **City of Brampton, Capital program management review:** Supported in reviewing established PMO policies, procedures, and templates to support governance and oversight, scope management, and contract management. The process entailed evaluating the degree of implementation of the EPMO's new policies, procedures, and templates by the teams from different divisions through document review and interviews. Additionally, it included identifying key risk areas and improvement opportunities, followed by summarizing the findings.
- **Sherritt International, Capital projects, asset management and asset reliability review:** Supported in reviewing the current state of management processes that oversee capital projects, asset integrity, and equipment maintenance in alignment with internal policies, procedures, and industry best practices. A comprehensive assessment was performed to determine any potential gaps, risks, issues, or improvement opportunities associated with these processes. The audit focused on the following areas: Governance, Risk Assessment, Monitoring and performance review, Incident Management, and reporting. Findings were presented to the management, and a detailed report of findings and recommendations was submitted to the client.
- **Ontario Power Generation (OPG) –Pre-Commissioning Review:** Supported in conducting a thorough review of employee rates and foreign exchange rates to ensure accuracy, reviewing overtime charges, evaluating employee roles and grades, and examining contractor project cost system records. Additionally, the responsibilities involved assessing unbilled project-borne costs, scrutinizing a sample of expenses for permissibility and

substantiation, and verifying overhead and profit amounts against the contractual terms.

- **Toronto Transit Commission, Development of Project Management Plans:** Supported in setting up the project charter for the eBus charging infrastructure program. This involved defining the project's goals, identifying stakeholders, outlining the project's scope, and establishing the project's deliverables. Additionally, responsible for the development of comprehensive project management plans. These plans encompassed various aspects such as project schedule, cost management, quality management, risk management strategies, benefits realization, and communication management plans. The project management plans were designed to ensure the successful execution of the eBus charging infrastructure program.
- **Metrolinx, OOl Transition readiness review:** Supported in the review of 6 major workstreams which includes Network Operations Control (NOC), Train Crew (TC), Fixed Asset Maintenance (FAM), Revenue Vehicle Maintenance (RVM), Technology (Tech) which were planned for effective OOI transition by January 1st, 2025 while Train Service Planning (TSP) was planned to be transitioned by October, 2024.The review focused on identifying and analyzing gaps between the current operational state and the requirements for integration by the assumption date of January 1st, 2025, evaluate potential risks associated with the transition and develop mitigation strategies for smooth transition, ensuring alignment.
- **Metrolinx, Ontario Line Interface Management review:** Supported the team in reviewing the existing governance structures and communication protocols, evaluating the interface management in place, assessing the contractual obligations outlined in the Project Agreement, analyzing reporting requirements for transparency, and examining knowledge transfer processes to foster continuous improvement. The goal was to identify areas for enhancement and ensure the optimal functioning of governance and project management to achieve the desired outcomes.
- **CAE, Project Management review:** Supported in evaluating roles and responsibilities, reviewing policies and procedures, assessing decision-making processes, examining risk and issue management, monitoring communication and reporting, analyzing stage gates, projects control in place, reviewing lessons learned, and monitoring effectiveness of program performance being reported. This comprehensive assessment aimed to ensure effective governance, operational efficiency, and alignment with organizational strategic objectives.
- **Leading shoe Manufacturer, Independent Oversight:** Supported in setting up project governance; monitoring and reviewing developers’ schedules, integrating developer schedules with clients’ schedules to understand the dependencies involved and track the critical path, reviewing project budgets and invoices, suggesting

procurement strategies, identifying key challenges and risks, and providing recommendations for improvement.

Projects executed outside of KPMG

- **ONxpress** *Operations Inc. (OOI):* Supported as a Fleet Planner for the Revenue Vehicle and Maintenance team within the OOI group. Nipun was responsible for the development and maintenance of comprehensive project schedule for Revenue Vehicle maintenance group. He coordinated with various groups within OOI to understand the interdependencies and regularly monitored interdependencies along with activities falling under critical path.
- **ITC Limited,** *Mixed Used Development project:* Led the team as a project manager in overseeing the construction of three commercial towers, two residential buildings and one hotel. Responsibilities included design review, procurement, vendor enrollment and negotiations, performance evaluation; Involved in preparation of integrated project schedules, closely monitoring budgets, and tracked resources.
- **ITC Limited, Perfume Manufacturing Plant:** Led the team as a project manager to deliver the 200,000 Square foot pre engineered building in a span of 7 months. Responsibilities included design review, procurement, vendor enrollment and negotiations, performance evaluation, preparation of integrated project schedules, resource allocation, cost estimation, budget monitoring and control and invoice reviews.
- **ITC Limited, Integrated Food Manufacturing Facility & Warehouse:** Supported as a planning manager to deliver four food-manufacturing plants along with an automated warehouse. Responsibilities included preparing, tracking, and monitoring the integrated schedule, estimating project costs and resources, identifying, and implementing procurement strategies, evaluating project performance, conducting variance analysis, updating the project dashboard, tracking procurement timelines, evaluating change orders, and updating the budget, including contingencies.
- **Larsen & Toubro Construction, 400, 220, 132 kV Power Substation:** Supported as a Planning Engineer for a general contractor firm, with a focus on project planning, schedule & resource monitoring, and budget management. Additional key responsibilities included performing quantity take-offs, cost estimation based on bill of quantities and drawings, and performing risk assessments.

Publications and Speaking Engagements

- Thought Leadership – Embodied Carbon Management for Global Infrastructure: KPMG India, March 2023

Camille McJunkin
Senior Consultant,
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Education, licences & certifications

- Engineer-in-Training (EIT) with Engineers & Geoscientists British Columbia
- LEED Green Associate
- Bachelor of Applied Science in Mechanical Engineering, University of British Columbia

Languages

- English
- French (Intermediate)

Background

Camille is a Senior Consultant within KPMG's Global Infrastructure Advisory Practice in Toronto. She supports public and private clients in the construction and energy sectors with strategy development, procurement, stakeholder engagement, capital project management and execution, and project reviews and claims. Camille has a Bachelor of Applied Science in Mechanical Engineering and worked as an Engineer-in-Training at AME Consulting Group prior to joining KPMG, where she designed energy efficient mechanical building systems for projects in the educational, commercial, and residential sectors. She previously held a Maintenance Engineering Internship position at Metro Vancouver, where she supported several maintenance programs at the region's Water and Wastewater Treatment Plants. Her technical background and experience throughout the project life cycle has prepared her to understand the complex relationships between various aspects of infrastructure project delivery and present findings in a clear and concise manner.

Professional and Industry Experience

- **Ontario Transit Group – Escalation Mechanism Review**

  Ontario Transit Group (OTG), the contractor delivering the downtown portion of the Ontario Line in Toronto, engaged KPMG to review the cost escalation mechanism included in their construction contract. Camille led the analysis of the construction budget and schedule, which included an assessment of the planned work and expenditures throughout the project lifetime. This output of this analysis was an updated construction price index weighting profile that was used to develop proposed revisions to the escalation mechanism aimed at reducing the client's overall project cost burden.

- **New Brunswick Power – Mactaquac Lifetime Achievement Project (MLAP) Commercial and Strategic Advisory**

  New Brunswick Power has engaged KPMG as the commercial and strategic advisor for the planning stage of the MLAP, a multi-billion-dollar rehabilitation project which will enable the Mactacquac Generating Station to achieve its intended 100-year lifespan. This engagement is comprised of multiple workstreams including procurement options analysis, current state review and readiness assessment, project governance options review, and general MLAP project management support. Camille is supporting the engagement team with multiple aspects of this project, including creating functional management strategies and owner management plans, as well as developing budget estimates to support the business case and procurement decision making.

- **Canadian Power Utility – Small Modular Reactor Project Alliance Strategy**

  Camille is currently working with a Canadian power utility to support the development, planning, and procurement of an alliance to design and construct a Small Modular Reactor (SMR). This includes the development of the commercial strategy and alliance agreements as well as the development of the alliance governance, organizational structures, and project management processes.

- **Wawanesa Insurance – Head Office Contract Review**

  KPMG was engaged by Wawanesa to review the development, design, and construction costs for the company's new office tower in Winnipeg and confirm adherence of partner billing to the contract terms. Camille conducted a thorough review of construction costs incurred through the cost-reimbursable contract to verify that all billings were substantiated and constituted allowable costs per the development agreement. This included an analysis of Wawanesa's contracts as well as supporting invoice and change order documentation.

- **Purolator – Fleet Electrification Program Audit**

  KPMG has been engaged by Purolator to conduct an audit of their fleet electrification program. The work consists of assessing the effectiveness of the program's implementation to date and identifying areas for improvement as the organization transitions from the pilot program to nationwide electrification. Camille's responsibilities on this engagement include reviewing program documentation, supporting interviews with key program stakeholders, identifying strengths and pain points, and developing recommendations based on best practices for management of fleet electrification programs.

- **Infrastructure Ontario – International Contractor Market Engagement Study**

  Infrastructure Ontario has engaged KPMG to conduct a study aimed at understanding the barriers to participation in the Ontario construction market faced by international general contractors and identifying potential solutions to foster increased competition on upcoming procurements. Camille has played a key role through all phases of this engagement, supporting the team in conducting research and client workshops to select target firms, developing outreach materials including a briefing package on the Ontario construction market, carrying out market sounding interviews, and developing a comprehensive report detailing findings and recommendations for Infrastructure Ontario's consideration.

- **Confidential Client – Claims Support**

  KPMG was engaged by a confidential contractor client to provide expert support services in a construction claims case. Camille supported the engagement team by compiling and reviewing evidence,

conducting industry research, and drafting an expert report for use in mediation proceedings, ensuring careful attention to detail and clear articulation of the expert position.

- **Ontario Energy Board – Utility Distribution Plan Review**

  The Ontario Energy Board (OEB) engaged KPMG to support in the review of a Local Distribution Company's Distribution System Plan (DSP), which would assist the OEB in its funding allocation decision-making. Camille supported the team in analyzing the DSP and developing insights related to the proposed capital plan, including return on investment, impacts on system reliability and asset management, accommodation of system growth, and engagement with third parties.

- **Ontario Ministry of Transportation – Delivery Model Cost Analysis**

  The Ontario Ministry of Transportation engaged KPMG to conduct an analysis of the cost and risk implications of various delivery models and considerations for application to an upcoming highway project. Camille's responsibilities on this project included conducting research into the outcomes Canadian and international highway projects by delivery model employed, assisting in the analysis of cost overruns and variations in the Ministry's portfolio of past highway projects, and developing considerations related to risk contingency and escalation allowances for the target project.

- **Sobeys Canada – Project Management Capability Assessment and Portfolio Review**

  Sobeys Canada engaged KPMG to perform an assessment of the organization's project management and delivery capabilities as well as a review of the successes and challenges seen throughout recently completed capital projects. Camille supported the team in conducting interviews with project management and construction personnel, assessing drivers for cost and schedule overruns, and identifying changes to processes and procedures throughout the project lifecycle that will support improved project outcomes.

- **Confidential Client – Claims Support**

  A confidential contractor client engaged KPMG to provide expert support services in a construction claims case. Camille led the analysis of supporting evidence provided by both parties to develop a report quantifying the substantiated portion of the claim for use in mediation proceedings.

Alvin Lok
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Skills & Expertise

- Advanced analytics
- Artificial intelligence
- Machine learning
- Project management
- Digital transformation
- Data governance

Representative Clients

- City of Toronto
- Toronto Transit Commission
- Region of Peel
- Infrastructure Ontario
- New Brunswick Power
- Environment and Climate Change Canada
- Ontario Power Generation

Education, licenses & certifications

- Master of Management Analytics, Rotman School of Business at University of Toronto
- Bachelor of Applied Science in Civil Engineering, University of British Columbia

Background

With degrees in civil engineering and management analytics, Alvin helps asset-intensive organizations enhance business performance through the application of advanced analytics, machine learning and artificial intelligence. His consulting capabilities and experience include:

- Developing, implementing, and deploying cutting-edge machine learning and deep learning techniques to build statistical models, make accurate predictions, and uncover hidden patterns;
- Building dynamic data visualizations and advanced dashboards to help clients understand complex relationships, identify trends and drive better decision-making;
- Assembling big data pipelines within enterprise data warehouses and data lakes to process and clean massive, heterogenous datasets into user-friendly tables;
- Engaging complex statistical and machine learning techniques to clean, standardize, and preprocess unstructured data, increasing the quality and integrity of information to enable insight extraction;
- Engineering robust data pipelines to streamline data collection and creating cloud-based agents to automate repetitive processes, lowering process costs while also enhancing information accuracy;
- Presenting sophisticated technical analysis in easy-to-understand, plain language for different audiences, from senior executives to frontline staff.

Professional and industry experience

- **Ontario Power Generation, Sir Adam Beck Contract Review** — Ontario Power Generation (OPG) employed KPMG to perform an exhaustive review of the project agreement between OPG and its contractors to ensure adherence to the contract. Alvin led the analysis of client cost data, using a combination of Python and Excel to comb through vast amounts of enterprise data pulled from the SAP platform, verifying claimed expenses, overhead, and profit calculations. This analysis was instrumental in validating project related charges to the client, ensuring a transparent client-contractor relationship in which actions from both parties fully aligned with the project agreement.
- **Ontario Power Generation, Darlington SMR Cost Review —**Ontario Power Generation enlisted KPMG's support for a cost review and analysis of the Darlington New Nuclear Project, during the initial development phase of their small modular reactors (SMR). Alvin assumed a critical role in scrutinizing cost data related to labor and expenses billed to the client by contractors. The objective was to identify non-contract compliant charges and highlight outliers, ultimately resulting in cost savings for the client.
- **Region of Peel, Construction Cost Escalation Analysis and Risk Mechanism** - The Region of Peel engaged KPMG to conduct an analysis focusing on escalation within critical construction domains. The primary objective was to assess the impact of COVID-19 and the subsequent supply chain disruption on material and labor costs and to design a mechanism to limit the risk exposed to contractors and suppliers. Alvin processed and visualized data, employing a blend of Python and Excel to reveal valuable insights and detect patterns and correlations. The insights gathered were then used to design a cost escalation mechanism to protect companies bidding for contracts for the Region of Peel from extreme market

fluctuations, offloading significant risk from contractors and incentivizing a reduction in bid prices.

- **International Construction Material Provider Client – Claims Support** A confidential contractor client engaged KPMG to provide expert support services in a construction claims case. In this capacity, Alvin contributed significantly to the engagement team by compiling and reviewing evidence, conducting comprehensive industry research, and crafting an expert report specifically tailored for use in mediation proceedings. This report was vital in ascertaining the validity of different items on the claim, resulting in substantial cost reductions.
- **City of Toronto, Comprehensive Development Application Fee Review -** The City of Toronto engaged KPMG to facilitate a comprehensive review of development application fees. The first comprehensive review in more than 10 years, the work includes the design, deployment and analysis of an online survey to gather information about the effort required to process different development applications from more than 500 staff across 10 City Divisions. Alvin led the analysis of survey outputs. Using advanced data modelling and statistical techniques, he cleaned and structured millions of disorganized records into an easy-to-use data model, allowing the team to identify trends, insights and accurate observations about staff effort. Alvin used Python, SQL, VBA, and Excel to design the data models.
- C**ity of Toronto, Solid Waste Management Strategy** — KPMG supported the development of the City of Toronto's Long Term Waste Strategy to efficiently allocate and deploy their waste management assets following the passing of significant changes to recycling legislation in Ontario. Alvin contributed significantly to aggregating client data in creating a summary report of operating and capital expenses. He also assisted in developing a sophisticated cost model capable of comparing different scenarios against one another to assist the client in optimizing decision making.
- **City of Calgary, Machine Learning and Monte Carlo Analysis of Energy Prices for Virtual Power Purchase Agreements** — City of Calgary engaged KPMG to conduct a study on the feasibility of entering into a virtual power purchase agreement to meet their renewable energy usage targets. Alvin utilized Excel to aggregate historical energy cost, usage, and production data, subsequently employing Python to conduct advanced analytics, leveraging machine learning techniques to model trends. To enhance the analysis, Monte Carlo simulations were executed to determine the expected value of each target variable, allowing the establishment of risk thresholds on which to base key decisions on renewable energy distribution. The comprehensive findings were then presented in a detailed report to the client.
- **NB Power, Mactaquac Dam Commercial Advisory —** NB Power enlisted KPMG to conduct cost analyses and optioneering for various strategies concerning the Mactaquac Dam in New Brunswick. Alvin contributed to this project by employing stochastic modeling, utilizing Monte Carlo simulations to evaluate the financial risks associated with each option. Leveraging advanced analytics, Alvin generated data-driven recommendations, enabling the client to make informed decisions for the dam's refurbishment and life extension.

Gautham A
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Education, licenses & certifications

- Postgraduate in Advanced Construction Management, National Institute of Construction Management and Research (India)
- Bachelor of Technology in Civil Engineering, University of Calicut (India)
- Chartered Engineer (India)
- Six-Sigma Green Belt
- Certificate Program in Contract Management (The World Bank)
- Certificate Program in Public Procurements (The World Bank)

Background

Gautham is a versatile project management professional with more than 10 years of experience and a demonstrated history of working in advisory and management consulting. He has worked closely with clients in India, Sri Lanka, Middle East and Canada, supporting them in establishing and running Program & Project Management Offices, developing project management frameworks, contract administration and management (including projects under PPP mode), procurement and bid process advisory, project health checks, techno-commercial studies, & maturity assessment. Prior to joining KPMG, he was associated with the Capital Projects and Infrastructure practice of PwC India.

Professional and industry experience

- **Ontario Power Generation – Darlington New Nuclear SMR Review** – Supported in review of the contractor costs for the Darlington New Nuclear Small Modular Reactor project under its integrated project delivery model which included review of engineering and planning hours and associated expenses against the provisions of the project agreement.
- **International Contractor JV – Escalation Mechanism Analysis and Economic Forecasting –** Supported in the analysis of a contractual escalation mechanism regarding a multi-billion-dollar subway project to assess the potential impact on the contract value. This involved analysis of the project budget and schedule to determine the project cost profile by commodity.
- **Confidential US Healthcare client, Cost audit –** Supported in cost audit engagement to perform cost audit including labour rates, burdens and overhead assessment for multiple contractors under the client's multi billion-dollar project.
- **Program implementation support for $340 million ADB funded highway works under Hybrid Annuity PPP mode (India)** – Advised the state government in its implementation of road highway projects including monitoring the project progress and contractual obligations of concessionaires. This involved cost management, review of invoices, payments; preparation of disbursement and budgetary projections, review of claims and change requests submitted by Concessionaire including Force Majeure events and prompt coordination with funding agencies to develop project implementation plans
- **BC Ferries Governance Review (Canada) -** Review the BC Ferries' Fleet Renewal Program in terms of organizational structure and governance mechanisms. Assess existing processes and identify gaps in governance structures including governance protocols including risk management, support in stakeholder workshops, and provide recommendations that align with industry best practices.
- **University of Victoria: Capital Projects Audit (Canada) -** Supported in the review of capital projects' governance which involved reviewing existing processes and implementation across the projects including risk management processes, identifying process deviations, benchmarking with best practices and recommending improvement actions.
- **Program Management Office (PMO) for a Smart City Projects (India) -** Supported in monitoring of multiple **water supply and waste treatment initiatives/ projects** under the Smart City Program which included monitoring project status, financial

progress, developing look ahead plans, targets, key risks along with providing bid process management support for appointing the vendors.

- **Metrolinx: Project Management Review (Canada)-** Supported the Metrolinx internal audit by assessing the performance of high-risk projects which included assessment of project health in terms of risks, cost and schedule.
- **City of Mississauga – Development of Field Services Manual -** Supporting City to develop a comprehensive Field Services Manual to standardize project management processes and construction protocols, ensuring compliance with existing policies and best practices for the City of Mississauga.
- **City of Toronto – Capital Project Delivery Review –** Supported in conducting jurisdiction scans and review of existing project progress to understand current state of capital project delivery of various departments in City of Toronto.
- **Due diligence of road sector SPVs in India for acquisition by Private Equity firms/EPC conglomerates based in UK/Japan-** Supported in performing commercial/technical due diligence, identifying red flags and defining governance and support in preparation of scope of work for transition service agreements.
- **TMEP Pipeline expansion project – Project Controls (Canada)-** Supported in productivity analysis and critical success factors assessment using cost reports for pipeline project along with determining cost performance indices and cost overruns for multiple packages.
- **Program implementation and procurement support for $110 million World Bank funded projects in Water Transport Sector (India)-** Supported project implementation planning and scheduling, monitored contractor/consultant progress, and prepared MIS dashboards. Developed risk registers, conducted risk meetings, assisted in tender document preparation, facilitated pre-bid meetings, and evaluated bids. Created Operation Manuals and Procurement Strategy Documents, and reviewed project feasibility and strategic studies.
- **Procurement Support - Intercity passenger rail project (Canada)-** Supporting one of three bidders during the development of certain commercial and procurement portions of their bid. Also supported in benchmarking procurement programs to support minority-owned businesses, research on management performance incentives and research on community and indigenous participation programs on High-Speed Rail projects.

Pickering Refurbishment RQE Roadmap

Updated: 30Sep25 Rev: 02

2024 | 2025 | 2026

Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar

RQE Major Milestones

All Estimate Submissions Complete (July 11) — RQE Package Drafted — Bundle Challenge reviews — Internal Executive Challenge Deep Dive Review — CPO Review — Board Level Deep Dive — RQE Pkg Finalized Sep 26 — ELT Update 29Oct25 — Final RQE Submission to Board Secretary Oct 30 — RQE Complete & Board Approved

Third Party

Third Party RFP — Third Party Review Kick-Off — External Third Party Review of RQE — External Preliminary Report on RQE Process — External Review of RQE Complete — External Review Consolidated Report — Business Plan Submission — OEB Application Finalized — OEB Load Review — OEB Application Submission 14Nov25

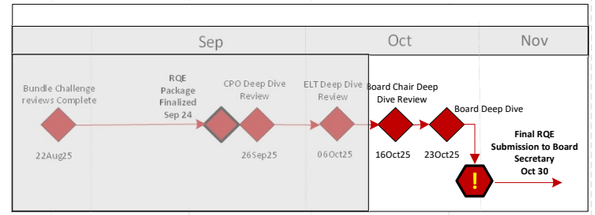
Program Integration

Lifecycle Class 4 Estimate Forecast Loaded into EcoSys — Issue Rev A-1 Schedule — Schedule Advancement Decision — DNNP RQE LL — MDP — Draft Rev B Schedule — Initial QRA — Final QRA — ALL SYSTEM UPDATES COMPLETE — Economic Impact Assessment Prepared — Rev A Schedule (P6-8) — Rev B Schedule Issued (P5)

Program Dates represent Target Dates

RQE Report Preparation — *All estimate costs in EcoSys and RQE Project Summary Sheet* — RQE Report — Challenge review meetings

All PMPs finalized — Discrete risk and opportunities updated in EBX — Life Cycle L2 (4 units) — Estimate Validation — Report Preparation Support — Life Cycle L3 (4 units) — Cost Uncertainty Updated in EBX — Class 3 LC Estimate Submitted — Escalation Interest and Contingency Calculated



RFBR Bundle

L2 Schedule (All Units) Developed — Lifecycle Class 4 Estimate Forecast Loaded into EcoSys — Discrete risk and opportunities updated in EBX — Cost Uncertainty Updated in EBX — Class 3 LC Estimate Submitted — L2 LC Schedule (All Units) — Life Cycle L3 (4 units) — LLM POs Issued — 40% Detailed Design

TG Bundle

Lifecycle Class 4 Estimate Forecast Loaded into EcoSys — L2 Schedule LC (All Units) Developed — Definition Class 3 Estimate Submitted and Validated — Definition L3 Schedule (All Units) Developed — Discrete risk and opportunities updated in EBX — Cost Uncertainty Updated in EBX — Class 3 LC Estimate Submitted — L2 LC Schedule (All Units) — LLM POs Issued — Life Cycle L3 (4 units) — 40% Detailed Design

DWI Bundle

Lifecycle Class 5 Estimate Forecast Loaded into EcoSys — L2 Schedule LC — Discrete risk and opportunities updated in EBX — PMP Finalized — Cost Uncertainty Updated in EBX — LC Class 4 Estimate Submitted and Validated — Life Cycle L2 — Life Cycle L3

F&I Bundle

LLM POs Issued — Lifecycle Class 4 Estimate Forecast Loaded into EcoSys — Lifecycle L3 Schedule Developed — Discrete risk and opportunities updated in EBX — Life Cycle L2 (4 units) — Life Cycle L3 (4 units) — Cost Uncertainty Updated in EBX — Class 3 LC Estimate Submitted — 40% Detailed Design — 100% Detailed Design

O&M Bundle

L2 Schedule LC (All Units) Developed — LC Class 4 Estimate Forecast Loaded into EcoSys — Material & Equipment Quotations Received (CL3) — Initial Assessing Complete (CL3 Estimate) — Discrete risk and opportunities updated in EBX — Initial Assessing Complete — Cost Uncertainty Updated in EBX — Life Cycle L2 (4 units) — Life Cycle L3 (4 units)

BOP Bundle

L2 Schedule LC (All Units) Developed — Lifecycle Class 5 Estimate Forecast Loaded into EcoSys — Class 4 Estimate Submitted (23) — Discrete risk and opportunities updated in EBX — Cost Uncertainty Updated in EBX — LLM POs Issued — Class 4 Estimate Submitted (6) — Life Cycle L2 (4 units) — Life Cycle L3 (4 units)

Legend

- Engineering
- Procurement
- Schedule
- Documentation
- Risk
- Program Level
- Class 3 Estimate
- Class 5/4 Estimate

Approved for Issue By:

Vijay Santhanam
Director, Project Controls

Luca Ceccato
SVP, Refurb Execution

Ontario Power Generation — Road to RQE

SEC Interrogatory #092

Interrogatory

Reference:
D2-3-9

Question(s):

For each year of the rate term, how many OPG FTEs will work on the PRP? Please provide a breakdown by each work bundle, and project management/support function.

Response

Refer to Ex. F2-1-1, Table 2a (as corrected in Ex. L-F2-Staff-199) that provides OPG FTEs attributed to the PRP. Chart 1 below provides a more detailed split of such FTEs forecast for the 2026-2031 period by each major work bundle and support function.

Chart 1 – FTE Forecast by Bundle / Support Function

#	Bundles / Category	2026	2027	2028	2029	2030	2031
1	Retube, Feeder, & Boiler Replacement	69.0	86.0	87.0	94.0	94.0	84.0
2	Turbine Generators	31.1	36.0	36.0	35.0	35.0	34.0
3	Balance of Plant	84.0	93.8	84.3	71.3	65.5	54.5
4	Operations & Maintenance	606.5	1,514.0	1,643.7	1,619.2	1,514.6	877.6
5	Facilities & Infrastructure	21.8	11.0	9.0	9.0	9.0	9.0
6	Deep Water Intake	14.5	23.0	22.0	21.0	21.0	-
7	**Sub-Total Major Work Bundles**	**826.8**	**1,763.7**	**1,882.0**	**1,849.4**	**1,739.1**	**1,059.1**
8	Project Services	116.3	138.8	139.8	136.8	134.8	134.8
9	Enterprise Operations (Engineering, Fleet, CNO)	493.4	742.6	752.6	758.7	746.2	702.7
10	Support Services (IT, Supply Chain, CM, Finance, HR, Shared Services, Real Estate)	154.7	260.4	248.9	248.9	243.1	179.2
11	**Total OPG FTEs – PRP**	**1,591.2**	**2,905.5**	**3,023.3**	**2,993.8**	**2,863.2**	**2,075.8**

SEC Interrogatory #093

Interrogatory

Reference:
D2-3-9, p. 7

Question(s):

With respect to cost and schedule performance, please provide the most recent PRP, a) Schedule Performance Index (SPI), b) Cost Performance Index (CPI), c) Cost Variance (CV) and Schedule Variance (SV), d) Estimate at Completion (EAC), and e) Variance at Completion (VAC) scores/values, as well as the inputs (e.g. for CPI, the Earned Value and Actual Cost).

Response

Chart 1 provides the requested cost and schedule performance metrics and input data.

Chart 1: Cost and Schedule Performance Metrics and Inputs

Performance Metrics	**Value[1]**
Schedule Performance Index (“SPI”)	0.99
Cost Performance Index (“CPI”)	1.01
Cost Variance (“CV”)	$27M
Schedule Variance (“SV”)	0.01 (~-40K hrs.)
Estimate at Completion (“EAC”)	$26,840M
Variance at Completion (“VAC”)	No variance
Inputs	**Value[1]**
Earned Value (Hrs.)	3,619,637
Planned Value (Hrs.)	3,660,290
Earned Value ($M)	1,931
Planned Value ($M)	2,124
Actual Cost (“AC”) ($M)	1,904
Estimate to Complete ($M)	24,936
Budget at Completion ($M)	26,840

[1] As of January 31, 2026

SEC Interrogatory #094

Interrogatory

Reference:
D2-3-9, p. 13

Question(s):

With respect to the Refurbishment Review Board (RRB):

a) Please provide all reports (either formal or informal) produced by the RRB to-date.

b) Please provide the RRB terms of reference, and all other governing documents, including any contracts, retainer agreements or other agreements.

c) Please provide a list of RRB members and their biographies.

Response

a) Refer to Ex. L-D2-Staff-116.

b) In accordance with the Motions Resolutions letter filed on May 4, 2026, OPG has revised this interrogatory response.

Refer to Attachment 1 for the RRB terms of reference, which is the governing document. The contract is OPG's standard form contract for general services.

OPG understands that SEC also seeks disclosure of the Burns & McDonnell/Modus Strategic Solutions governing documents with respect to the Darlington Refurbishment Program. Refer to Attachment 3 (confidential) for the Burns & McDonnell/Modus Strategic Solutions governing document.

c) Refer to Attachment 2 (confidential).

Darlington Refurbishment
Repowering Ontario

ONTARIO POWER GENERATION

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OVERSIGHT SERVICES BY THE REFURBISHMENT REVIEW BOARD

SCOPE OF WORK

ABOUT ONTARIO POWER GENERATION (OPG)

OPG is an Ontario-based electricity generation company whose principal business is the generation and sale of electricity in Ontario. Our focus is on the efficient production and sale of electricity from our generation assets, while operating in a safe, open and environmentally responsible manner. OPG was established under the *Business Corporations Act* (Ontario) and is wholly owned by the Province of Ontario.

OPG's generating portfolio has a total capacity of over 21,000 megawatts (MW) from sources of Nuclear, Hydro, and Thermal stations, making us one of the largest power generators in North America.

OPG owns and operates the Pickering and Darlington Nuclear Power Stations. The two stations have a combined in service generating capacity of about 6,600 MW.

OPG's Canadian Deuterium Uranium (CANDU®) reactors are designed to provide decades of safe and reliable electricity generation. Mid-way through the reactor's life, replacement of some of the key reactor and station components is required to allow for continued operation for approximately 30 additional years. OPG has moved forward with plans for the mid-life refurbishment of the Darlington Nuclear Generating Station (the "Refurbishment Program" or "DRP"). For more information on the Refurbishment Program please visit www.opg.com.

In early 2023, OPG's shareholder requested that OPG conduct a feasibility study for the refurbishment of Pickering B. This was completed and authorized by the OPG Board to be submitted to the shareholder in August 2023. The Board also authorized spending for continuing with certain limited preliminary planning and preparation activities for the potential Pickering Refurbishment Project (PRP).

The purpose of this scope of services document is to provide an outline of OPG's requirements for conducting periodic independent assessments of aspects of the DRP and the PRP if the latter proceed for the Major Projects Committee ("MPC" or "Committee") of the OPG Board of Directors (the "Oversight Services"). The Oversight Services will be performed by consulting individuals (each, a "Consultant" or an "RRB member"), collaborating with each other and collectively known as the Refurbishment Review Board (RRB).

The RRB will deliver Oversight Services reporting directly to the Committee. While acting as independent advisors to the Committee of the OPG Board of Directors, no member of the RRB will perform oversight or assessments of any aspect of the DRP or PRP on behalf of any group other than the Committee of the OPG Board of Directors.

1.0 PURPOSE OF THE REFURBISHMENT REVIEW BOARD

The purpose of the RRB is to advise the MPC on the DRP and PRP as set out in Section 3.0 further below. The RRB is part of a multi-layer oversight and reporting structure for the DRP and PRP.

For the RRB to effectively perform the Oversight Services, OPG will provide the RRB access to information related to the DRP and PRP and access to any logistical or other support that the RRB may request from time to time. The expectation is that the RRB will not duplicate work that is already being carried out by OPG, whether by OPG's internal resources or by OPG's other contractors.

2.0 MEMBERSHIP ROLES AND RESPONSIBILITIES

2.1 RRB Member General Requirements

RRB members will have experience in senior oversight and/or advisory capacities, with project management related to a "mega-project" (i.e., over one billion dollars). Additionally, the RRB members will have experience with nuclear plant operations (reporting to a Vice President or higher), other extensive nuclear power, regulatory, construction management, major contract management, and project controls experience. It is expected that at least one member will have a strong background in major construction projects, with it being possible that it not be nuclear mega-project experience, while another should have held senior management roles in a nuclear power plant.

2.2 Roles and Responsibilities

2.2.1 RRB Chair

One of the RRB members defined in section 2.1 may be asked to perform the role of Chair of the RRB, either on a permanent or semi-permanent basis. The RRB Chair will interface with the Committee and, as the Committee may request on its behalf for information as needed, also with OPG Executives in the establishment of the scope of assessments, and ensure that the activities of the RRB are aligned with the expectations of the Committee. The RRB Chair will be responsible for advising the Committee of RRB activities and concerns, the overall conduct and performance of the RRB, defining and coordinating their tasks in conjunction with the OPG Executives, and preparing and delivering verbal and/or written reports as requested.

2.2.2 RRB Members

All RRB members are responsible for their attendance at meetings, the review of the material provided to them, and the active contribution of their experience and judgment to RRB deliberations. Attendance at OPG by individual RRB members is dependent upon the scope of each review and attendance will be determined in consultation with the RRB Chair.

2.2.3 OPG Internal Member

The RRB team will be supported by a designated OPG executive, but who will not be an RRB member, to provide additional support including organizational knowledge and insights.

2.2.4 OPG Coordinator

A designated Internal OPG Coordinator will work together with the RRB Chair to facilitate appropriate membership for each visit based on scope and availability of individual members. The OPG Coordinator will be responsible for coordinating and managing all RRB activities including meetings and teleconferences; development of the visit schedule in consultation with the RRB Chair; distribution of review materials; and logistical support to external members as required.

3.0 AUTHORITY, SCOPE AND DELIVERABLES

The RRB is authorized to observe and review any aspect of the DRP and PRP related to:

- Safety
- Cost
- Schedule
- Quality

Periodically, the RRB will conduct independent assessments of project performance, risks and opportunities, identifying "blind spots" that management may not be aware of, and provide recommendations to the MPC that will help to mitigate the project risks and improve overall project performance. The focus of the RRB is to be forward looking; advising the Committee of any future risks. Specific areas of emphasis for review may be provided to the RRB for different assessments.

The RRB may also comment on the quality and completeness of information provided by the Refurbishment Teams to the Committee regarding whether management is effectively identifying and resolving issues. Reports may provide high-level guidance about what areas the Committee may further inquire.

The RRB will determine how best to achieve the foregoing; however, it may include the following activities:

- Identify emerging trends and/or potential risks with respect to safety, quality, cost, schedules, resourcing, contractor oversight, etc.
- Review DRP and PRP and Project metrics to ensure they are appropriate and to determine accuracy and fidelity.
- Identify whether there are any significant unresolved challenges.
- Test the effectiveness of the Refurbishment Projects' programs.

The RRB members are authorized to communicate directly with all DRP and PRP staff on matters of RRB interest. At any time the RRB sees a major issue that is impacting or will impact the performance of the DRP and PRP, the RRB will communicate it immediately to the Refurbishment Team as appropriate, or OPG management.

The RRB is an oversight body to the MPC and cannot authorize any expenditure or issue any orders that are binding on OPG. For clarity, this does not limit the right of the RRB members to incur travel expenses to support their activities (which expenses are the direct obligation of the member and will be reimbursed by OPG in accordance with OPG's Business Travel and Expense Policy).

4.0 SITE VISITS, SCHEDULE AND REVIEW MATERIAL

The RRB will be asked to review the DRP and PRP approximately three to four times per year for PRP and twice a year for DRP, or at revised frequencies as directed by the Committee. Ad hoc meetings may also be called by the Committee, if required. Dates for the review meetings will be established by OPG.

It is expected that RRB reviews will consist of up to 4-day site visits per each of DRP and PRP.

Records and a draft visit schedule will be provided to RRB members by the OPG Coordinator in advance for pre-reading and preparation for each on-site assessment.

5.0 REPORTS

After completing the visits and reviewing the materials and information, the RRB will prepare a draft written report to be reviewed by Projects' management for accuracy approximately 2 weeks prior to the MPC meeting. The RRB will use its judgement to determine which comments from DRP and PRP management should be included. The report will summarize all findings and will include recommendations if requested by MPC. The written report's information will be prepared at an appropriate level for MPC members.

The final written report will be provided to MPC members approximately 10 days in advance of the MPC Meetings. The MPC meetings are usually held in March, June, August and November.

6.0 COMPENSATION

RRB members will be compensated on a Time and Materials basis using fixed hourly rates for time spent completing any OPG or site-specific training courses, preparing for and participating in each site review, and any other work that is requested by the MPC. Estimated hours are shown below:

Nature of Work	Estimated Hours
Preparation	Approx. 30 hours per site review
On-site Visit and Report Preparation	Approx. 40-50 hours per site review
Training	6 to 8 hours per year

7.0 SECURITY CLEARANCES AND TRAINING QUALIFICATIONS

RRB members will be required to complete paperwork and provide documentation to satisfy criteria to hold Site Access CNSC security clearance to access the nuclear facility.

Completion of various computer-based training courses will also be required to maintain OPG facility access qualifications. Completion and maintenance of Radiation Protection training may be required. Most training can be completed remotely through the OPG e-Learning portal.

8.0 TERM OF RRB MEMBERSHIP

It is expected that one of the RRB members will perform the role of RRB Chair, either on a permanent or semi-permanent basis. Each RRB member will commit to a three-year term plus up to two additional (subsequent) one-year extensions at OPG's sole discretion. Members may serve on the RRB for additional periods upon mutual agreement with OPG.

Darlington Refurbishment
Repowering Ontario | ONTARIO POWER GENERATION

Refurbishment Review Board (RRB)
External Membership

Paul Pasquet (Chair)

[redacted]

Michael Burke

Michael Burke is a professional engineer [redacted]

Darlington Refurbishment
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Refurbishment Review Board (RRB)
External Membership

Chris Grier

[redacted]

John Neal

[redacted]

Darlington Refurbishment
Repowering Ontario | ONTARIO POWER GENERATION

Refurbishment Review Board (RRB)
External Membership

Reg Niganobe

[redacted]

Craig Sellers

[redacted]

Darlington Refurbishment
Repowering Ontario | ONTARIO POWER GENERATION

Refurbishment Review Board (RRB)
External Membership

INTERNAL OPG SUPPORT TO THE RRB

Ebraheem Waraich

[redacted] Ebraheem is currently in role as Director of Balance of Plant for the Darlington New Nuclear Project. [redacted]

Ebraheem is a Professional Engineer [redacted].

OPG CONFIDENTIAL

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INDEPENDENT OVERSIGHT SERVICES AGREEMENT

FOR

the DARLINGTON REFURBISHMENT PROGRAM

April 11, 2016

Between

ONTARIO POWER GENERATION INC.

and

BURNS & MCDONNELL CANADA, LTD

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INDEPENDENT OVERSIGHT SERVICES AGREEMENT

This Agreement is made as of **April 11, 2016** between:

ONTARIO POWER GENERATION INC., a corporation existing under the laws of Ontario ("**OPG**"),

and

BURNS & MCDONNELL CANADA, LTD, a corporation existing under the laws of Ontario (the "**Contractor**")

RECITALS

A. OPG is the owner and operator of the Darlington nuclear generating station in Clarington, Ontario (the "**DNGS**").

B. The DNGS is approaching its mid-life refurbishment. The refurbishment involves outages for the replacement of life limiting components as well as the refurbishment or replacement of other components.

C. The goal of the refurbishment is to extend the service life of all four units of the DNGS (the "**Darlington Refurbishment Program**").

D. The Darlington Refurbishment Program comprises a number of individual projects (each a "**Project**").

E. OPG is retaining the Contractor to provide the Services (hereinafter defined) to advise the OPG Board of Directors (hereinafter defined) on the project management aspects of the Darlington Refurbishment Program as a whole or any of the Projects, as may be requested by OPG.

F. This Agreement is a "conformed contract" and all the terms between the Parties respecting the Services are set out in this Agreement.

For value received, the Parties agree as follows.

SECTION 1 – INTERPRETATION

1.1 Definitions

In this Agreement, the following terms have the respective meanings set out below.

(a) **Affiliate** means, when used with reference to a specified Person, any other Person that directly, or indirectly through one or more intermediaries, controls, is controlled by or is under common control with the specified Person or any partner of the specified Person. For the purposes of this definition, a Person "controls" another Person if the former directly or indirectly possesses the power to direct or cause the direction of the management and policies of the latter, whether through the ownership of securities, by contract or by any other means, and "controlled by" and "under common control with" have corresponding meanings.

(b) **Agreement** means this independent oversight services agreement, including any recitals and schedules or attachments thereto, as amended or restated from time to time by an Amendment.

(c) **Amendment** means a written amendment agreement for the Darlington Refurbishment Program signed by the Parties, in the form of document attached as Schedule A which makes any change to this Agreement or an amended and restated agreement.

(d) **Applicable Laws**, in respect of any Person, property, transaction or event, means all applicable laws, statutes, by-laws, regulations, treaties, judgements and decrees of any Governmental Authority applicable to that Person, property, transaction or event at the applicable time and, whether or not having the force of law, all applicable Approvals, requirements, requests, directives, rules, guidelines, standards, specifications, codes, instructions, circulars, manuals, and policies of any relevant technical organisation or any Governmental Authority having or purporting to have authority over that Person, property, transaction or event at the applicable time.

(e) **Approvals** means any approvals, permits, licences, consents, grants, privileges, rights, clearances, orders, ordinances, registrations, filings or other authorisations as may be required from any applicable Governmental Authorities or by this Agreement.

(f) **Assessment** means an assessment, typically provided in the form of a report, conducted by the Contractor at the request of the OPG Board of Directors to determine if there are significant unresolved challenges respecting any of the project management aspects of the Darlington Refurbishment Program as a whole or any of the Projects, and, if required, providing the OPG Board of Directors with recommendations as to resolving such challenges.

(g) **Billing Rates** means rates charged for each individual anticipated to be employed by the Contractor or a Subcontractor in the provision of the Services, as particularly set out in Schedule 4.1, as amended from time to time in accordance with this Agreement.

(h) **Business Day** means any day other than a Saturday, Sunday, New Year's Day, Family Day, Good Friday, Easter Monday, Victoria Day, Canada Day, Civic Holiday, Labour Day, Thanksgiving Day, Christmas Day and Boxing Day. Each Business Day will end at 5:00 p.m. on that day.

(i) **Business Expense Schedule** means the Standard Business Expense set out in Schedule B.

(j) **Contractor Group** means the Contractor and the Contractor's shareholders, directors, officers, partners, members, employees, representatives, agents, advisors, and any other Person for whom the Contractor is responsible at law.

(k) **Contractor's Personnel** means all personnel, including the Contractor's Representative, and members of the Key Personnel, used by the Contractor or assisting the Contractor in the provision of the Services, including any personnel, staff, labour and other employees of the Contractor or a Subcontractor and any Subcontractor who is an individual.

(l) **Contractor's Representative** is defined in section 2.2(a).

(m) **Darlington Refurbishment Program is defined** in Recital C.

(n) **Dispute** is defined in section 10.1.

(o) **DNGS** is defined in Recital A.

(p) **Governmental Authority** means any domestic or foreign government, including, any federal, provincial, state, territorial, municipal or local government, and any government established court, agency, tribunal, commission, self-regulatory organization or other authority exercising or purporting to exercise executive, legislative, judicial, regulatory or administrative functions on behalf of the government.

(q) **Indemnitor** means Burns & McDonnell Canada, Ltd, a corporation existing under the laws of Ontario and providing an indemnity in accordance with section 3.4.

(r) **Key Personnel** means a team, established by the Contractor, of approximately two to four individuals with the appropriate experience and necessary expertise, including the Contractor's Representative and any other Contractor's Personnel identified as key personnel in accordance with section 2.2(c), that will conduct Assessments and provide reports to the OPG Board of Directors.

(s) **Losses** means all costs, penalties, expenses, incurred liabilities, injuries, losses and damages (including all fees and charges of engineers, architects,

accountants, lawyers and other professionals and experts and all court, arbitration and other dispute, mediation or resolution costs), whether incurred through settlement or otherwise, together with interest at the rate of the Bank of Canada Prime Lending Rate plus 2% annually, compounded monthly, and calculated from the date that the Losses were suffered or incurred, in each case whether arising before or after the termination of this Agreement.

(t) **Notice** means any notice, approval, demand, direction, instruction, consent, designation, request, document, instrument, certificate or other communication required or permitted to be given under this Agreement.

(u) **OPG Board of Directors** means a body of appointed members jointly overseeing OPG's activities.

(v) **OPG Group** means OPG, each of OPG's Affiliates and each of OPG's and each such Affiliates' shareholders, directors, officers, employees, representatives, agents, independent contractors and advisors, including OPG's Representative, but, for greater certainty, excluding all members of the Contractor Group.

(w) **OPG's Representative** means the individual designated in writing by OPG, from time to time, to act as OPG's representative in dealings with the Contractor under this Agreement.

(x) **Parties** means OPG and the Contractor and each of their successors or permitted assigns, and **Party** means either one of them.

(y) **Person** means any individual, sole proprietorship, partnership, limited partnership, limited liability partnership, corporation or company, with or without share capital, trust, foundation, joint venture, Governmental Authority or any other incorporated or unincorporated entity or association of any nature (including any heir, executor, administrator, personal or legal representative, successor or assign).

(z) **Project** is as defined in Recital D.

(aa) **Reimbursable Expenses** are expenses permitted under the Business Expense Schedule.

(bb) **Scope of Services** means the information set out in Schedule C as amended or restated from time to time in accordance with an Amendment.

(cc) **Services** means the independent oversight services provided or required to be provided by the Contractor to the OPG Board of Directors in accordance with this Agreement, including the Scope of Services and the Services Plan.

(dd) **Services Plan** means a detailed and comprehensive plan prepared by the Contractor for the Services in accordance with section 2.6.

(ee) **Site** means the facilities or any other location in Ontario designated by OPG for the purposes of this Agreement.

(ff) **Standard of Care** is defined in section 2.1(c).

(gg) **Subcontractor** means a Person who supplies services to the Contractor in relation to the Services under an agreement with the Contractor, another Subcontractor or a combination of the Contractor and another Subcontractor and includes, for greater certainty, individuals who are "independent contractors" to the Contractor or a Subcontractor.

(hh) **Tax** means all present and future taxes, surtaxes, duties, levies, imposts, rates, fees, premiums, assessments, withholdings, dues and other charges of any nature imposed by any Governmental Authority (including income, capital, gross receipts, consumption, sales, use, transfer, goods and services or other value-added, excise, customs or other import, anti-dumping, countervail, net worth, alternative or add-on minimum, windfall profits, stamp, registration, franchise, payroll, employment insurance, Canada Pension Plan, workers' compensation, health, education, school, business, property, local improvement, environmental, development and occupation taxes) together with all fines, interest, penalties in respect thereof, or in lieu of or for non-collection thereof.

(ii) **Term** is defined in section 9.1.

1.2 Headings and Table of Contents

The division of this Agreement into sections, the insertion of headings and the provision of a table of contents are for convenience of reference only and are not to affect the construction or interpretation of this Agreement.

1.3 Expanded Definitions

Unless otherwise specified in this Agreement, words importing the singular include the plural and vice versa and words importing gender include all genders. The term "**including**" means "including without limitation", and the terms "**include**", "**includes**" and "**included**" have similar meanings. The term "**will**" means "**shall**". Any reference in this Agreement to any other agreement, is deemed to include a reference to that other agreement, as amended or restated from time to time. When words that have a well-known technical, construction industry or trade meaning are used in this Agreement to describe any Services, such words will be interpreted in accordance with that meaning.

1.4 Time of Day

Unless otherwise specified in this Agreement, references to time of day or date mean the local time or date in Ontario. When any period of time is referred to in this Agreement by days, it will be computed to exclude the first and include the last day of such period. A day is 24 hours measured from midnight to the next midnight.

1.5 Business Days

If under this Agreement any payment or calculation is to be made on or as of a day which is not a Business Day, that payment or calculation is to be made on or as of the next day that is a Business Day. For certainty, any calculation that is to be made as of a "day" will be made on calendar days and will not be made based on Business Days.

1.6 Governing Law

This Agreement, each of the documents contemplated by this Agreement and the conduct of the Parties with respect to the formation and performance of this Agreement are governed by, and are to be construed and interpreted in accordance with, the laws of Ontario and the laws of Canada applicable in Ontario. Each of the Parties irrevocably submits to the non-exclusive jurisdiction of the courts of Ontario. No Party will oppose the enforcement against it in any other jurisdiction of any judgement or order duly obtained from an Ontario court respecting this Agreement. A Party may affect service of summons or any other legal process that may be served in any action, suit or other proceeding by delivering any such process to another Party in accordance with section 10.4. Nothing in this section 1.6 will affect the rights of a Party to serve legal process in any other manner permitted by law.

1.7 Conflict

If there is a conflict between any term in one part of this Agreement and any term in another part of this Agreement, the relevant term in the part of this Agreement or other document listed first in this section 1.7 is to prevail:

(a) Amendments, excluding any part of an Amendment that applies to a Schedule;

(b) this Agreement, excluding the Schedules;

(c) Amendments to a Schedule; and

(d) Schedules to this Agreement.

1.8 Severability

If any term of this Agreement is or becomes illegal, invalid or unenforceable, the illegality, invalidity or unenforceability of that term will not affect the legality, validity or enforceability of the remaining terms of this Agreement and the Parties will, if necessary, amend this

Agreement to accomplish the intent of the Parties as originally set out in this Agreement to the maximum extent allowed by Applicable Laws.

1.9 Time

All references in this Agreement to time are intended by the Parties to be the actual time designated without the application of any principles of equity.

1.10 Statutory and Technical References

Each reference to a statute in this Agreement is deemed to be a reference to that statute, and to the regulations made under that statute, all as amended or re-enacted from time to time. Each reference, whether express or implied, to a standard, specification, manual or code of any technical organisation or Governmental Authority is deemed to be a reference to that standard, specification, manual or code as amended or re-published from time to time.

1.11 Entire Agreement

This Agreement constitutes the entire agreement between the Parties regarding the subject matter and, except for any Amendment, supersedes all other agreements, negotiations, discussions, undertakings, representations, warranties and understandings whether written or verbal, including any OPG request for proposals, any Contractor proposal and any amendments or restatements of any such request or proposal. Specifically, except as expressly provided in this Agreement, OPG has not made any representations, warranties or guarantees whatsoever respecting the Services or the Project or this Agreement, including any minimum or maximum hours of employment or respecting any statements or other information previously provided to the Contractor or respecting any physical conditions, labour conditions or scheduling. If the Contractor did not seek a clarification during the request for proposals process regarding any term in this Agreement and there is a subsequent controversy respecting the interpretation of that term, OPG's interpretation will govern.

SECTION 2 - THE CONTRACTOR'S OBLIGATIONS

2.1 Intent and Initial Actions

(a) **General.** The scope of the Services to be made available by the Contractor under this Agreement is included in the Scope of Services. At any time and from time to time during the Term of this Agreement OPG may request and the Contractor will supply such Services to OPG in accordance with the terms of this Agreement. The Contractor will, safely and diligently, provide the Services in an organised and timely manner and in accordance with this Agreement. The Contractor will use such tools, techniques and procedures, quality of personnel, level of co-ordination and other elements reasonably required to provide the Services to meet the intent of this Agreement.

(b) **Intent.** The Contractor will provide all services (which are deemed to be part of the Services), whether or not specifically required under this Agreement, which are evidently necessary, usually provided by prevailing custom or trade usage, or can be reasonably implied for the proper provision of the Services. The Contractor acknowledges and agrees that OPG may acquire services similar to the Services from one or more persons other than the Contractor and that Contractor agrees to work collaboratively with any such Person in order to best meet OPG's needs and interests.

(c) **Standard of Care.** In the provision of the Services, the Contractor will exercise that degree of skill, care, diligence, prudence and foresight and that degree of professional thoroughness and competence that is the customary and usual standard exercised by contractors providing services of a similar nature for a similar project in terms of scope, character and magnitude (the "**Standard of Care**").

(d) **Financial Information.** The Contractor authorises OPG to make credit enquiries about the Contractor or any of its Affiliates from time to time and to receive and exchange credit information from credit reporting agencies or other Persons with which the Contractor or any of its Affiliates has or may expect to have financial dealings. The Contractor has provided OPG with the Contractor's consolidated audited financial statements for the last three financial years. Such financial statements have been prepared in accordance with **U.S.** generally accepted accounting practices, consistently applied. Such financial statements fairly reflect the consolidated financial position of the Contractor as at the dates and for the periods set out in such statements. The Contractor will provide OPG with such audited consolidated financial statements within 120 days of each year end.

(e) **No Guarantee of Work.** The Contractor acknowledges and agrees that no number of hours of Services have been guaranteed by OPG. For greater certainty, notwithstanding the fact that a Project may be identified in Schedule C or may otherwise be identified by OPG, there is no guarantee that OPG will engage the Contractor with respect to such Project and OPG may elect to utilize alternative contractors with respect to any Project.

(f) **The Contractor's Representations.** The Contractor represents and warrants to OPG that the Contractor:

(1) is sufficiently experienced and properly qualified, licensed, equipped, organised and financed to provide, or cause the Services to be completely provided as set out herein;

(2) has thoroughly familiarized itself with this Agreement, including the schedules;

(3) has thoroughly reviewed OPG's policies and procedures as they relate to the Services (as amended from time to time);

(4) has thoroughly reviewed the current copies of OPG's code of business conduct and supplier code of conduct located at www.opg.com and in particular such codes have been reviewed by the Contractor's Personnel;

(5) has disclosed in writing to OPG the names of each of the Contractor's Personnel who will be providing Services at the Site continuously, who is a former OPG employee and who received a severance package from OPG, is receiving pension payments from OPG or is receiving a non-working pension bridge from OPG;

(6) is satisfied that it can provide the Services in accordance with this Agreement;

(7) is not using any Subcontractors other than Subcontractors identified in Schedule 2.7(a) and if Subcontractors are being used, has engaged and will engage only Subcontractors that are qualified and pre-approved by OPG;

(8) has verified that the Contractor's Personnel set out in Schedule 2.2(c) comply with the requirements and qualifications set out in this Agreement, including the Scope of Services;

(9) has examined and has satisfied itself in respect of all matters respecting the Services, including:

A) all necessary information respecting the risks, contingencies and other circumstances which may affect the Billing Rates or the Services;

B) all Applicable Laws, including any restrictions on hours of work, and any required Approvals;

(10) is not aware of any legal action instituted, threatened or pending against the Contractor that could have a material adverse effect on its ability to perform its obligations under this Agreement; and

(11) the Contractor and the Contractor's Personnel will not provide any services, which are related to the Darlington Refurbishment Program, to a third party without OPG's knowledge and written consent.

2.2 Organisation and Personnel

(a) **Provision of Personnel.** The Contractor will provide, schedule and co-ordinate all Contractor's Personnel required for the provision of the Services including a

dedicated representative of the Contractor who is trained, qualified and experienced in project management who will have overall responsibility for the Services (the "**Contractor's Representative**").

(b) **Non-Canadian Personnel.** The Contractor will obtain the written approval of OPG prior to engaging any Contractor's Personnel who are non-Canadian in connection with the Services. Prior to granting any approval, OPG will require submission by the Contractor of the name, title and Billing Rates for such individuals. Billing Rates for foreign nationals will be inclusive of all costs, mark-ups and profits including tax equalization costs or any other associated costs. For greater certainty, OPG is only responsible for paying the applicable Billing Rate for approved hours worked and no other additional indirect or direct costs associated with non-Canadian personnel. The Contractor will obtain and maintain at its cost all Approvals from applicable Governmental Authorities respective all non-Canadian personnel and ensure that such non-Canadian personnel at all times have the required Approvals to perform the specified Services for OPG in Canada. The Contractor will indemnify and save harmless all members of the OPG Group from and against all Losses suffered or incurred by any member of the OPG Group on account of claims made or grievances filed by any third party, personnel or by a union, where the claim or grievance is based on an allegation that such personnel did not have the required Approvals.

(c) **Contractor Organisation and Key Personnel.** Schedule 2.2(c) sets out an organisational chart identifying the Contractor's Personnel by name, title and contact information, and, if applicable, anticipated availability who will be involved in any material way in providing the Services. The Contractor's Representative and the names on the chart that are followed by an asterisk are considered members of the Key Personnel. The Contractor will provide any information reasonably required by OPG about any of the Contractor's Personnel included in Schedule 2.2(c).

(d) **Competent Contractor's Personnel.** The Contractor will ensure that the Contractor's Personnel assigned to the provision of the Services:

(1) are qualified and experienced to perform the Services because of certification, knowledge, training and experience; and

(2) understand, and have the necessary skills to perform the Services, are familiar with and capable of complying with OPG's requirements, including OPG's policies and procedures relating to health and safety, and such other policies and procedures as may be communicated by OPG.

(e) **Changes to the Contractor's Personnel.** The Contractor will not make any changes to or reduce the responsibilities of any member of the Contractor's Personnel, and specifically of any member of the Key Personnel, identified in Schedule 2.2(c) without the prior written consent of OPG. If any Contractor's Personnel are terminated by the Contractor or a Subcontractor or any one of them resigns, the Contractor will notify OPG in writing within three days, in respect of the Contractor's Personnel who are not members of the Key Personnel, and within 24 hours, in respect of the members of the Key Personnel, of receiving Notice from such personnel that they are resigning or that the Contractor or a Subcontractor intends to terminate the employment of such personnel. At the same time, but in any event no later than within five Business Days, the Contractor will also advise OPG of the name of the individual proposed to replace any individual listed in Schedule 2.2(c) and provide OPG with such individual's resume. Any such changes to the Contractor's Personnel will be subject to OPG's prior written approval. Once any such changes to the Contractor's Personnel are agreed to by OPG, OPG's Representative will issue a written Notice to evidence changes to Schedule 2.2(c).

(f) **Reasonable Objections by OPG.** The Contractor will not provide to OPG any individuals to whom OPG may from time to time reasonably object. The Contractor will promptly remove any Person whom OPG's Representative does not consider competent or otherwise considers unsuitable for performing the applicable Services.

(g) **Skill and Co-ordination of Personnel.** The Contractor will ensure that all Contractor's Personnel have all the necessary skills certification, knowledge, training and experience to perform their roles and obligations under this Agreement. Where applicable, the Contractor will ensure that Services provided by professionals, including engineers and architects, will be provided by professionals duly licensed in Ontario and, without limiting the Standard of Care required of the Contractor under this Agreement, such professionals will satisfy all standards expected of such professionals.

(h) **Personnel Not Employees.** For all purposes under this Agreement and Applicable Laws, the Contractor's Personnel are full time employees of, or independent contractors to the Contractor or its Subcontractors, and not OPG. Accordingly, none of the Contractor's Personnel are entitled to any benefits respecting any pension or other benefit plan, program or policy of OPG. The Contractor will indemnify and save harmless all members of the OPG Group from and against all Losses suffered or incurred by any member of the OPG Group resulting from a claim by any member of the Contractor's Personnel against OPG for any such benefits, including resulting from claims made or grievances filed by any member of the Contractor's Personnel or by a union,

where the claim or grievance is based on an allegation that such member of the Contractor's Personnel was an employee of OPG.

(i) **Remittal of Benefits.** The Contractor will withhold and remit all Taxes (e.g., income tax, employer health tax), all benefit coverage and related remittances (e.g. CPP, EI, WSIB, health plan coverage), and fulfill any obligations under the *Employment Standards Act* (Ontario) with respect to Contractor's Personnel and OPG will have no responsibility for any such taxes, benefits remittances and obligations with respect to the Contractor's Personnel.

(j) **WSIB.** The Contractor's Workplace Safety and Insurance Board ("**WSIB**") account number is [redacted]. The Contractor is and will remain at all times in good standing with the WSIB. The Contractor will immediately give Notice to OPG of any change in the Contractor's standing with the WSIB. Upon request of OPG, the Contractor will submit a certificate of compliance from the WSIB as to the Contractor's status and that of all Subcontractors.

(k) **Former OPG Employees.** The Contractor acknowledges that OPG has a policy restricting the involvement in OPG contracts of former OPG employees who received a severance package or who are receiving pension payments from OPG, or an affiliated company or are on a non-working pension bridge form working at OPG. The Contractor will disclose in writing to OPG the names of each individual who will be providing or performing the Services, who was a former OPG employee and, if the individual is such a former employee, whether such individual received a severance package from OPG, is receiving pension payments from OPG or is receiving a non-working pension bridge from OPG.

(l) **Non-Solicitation of OPG's Employees.** During the Term of this Agreement and until the date that is 12 months from the date of termination or expiry of this Agreement, the Contractor will not, directly or indirectly, whether through an Affiliate, a Subcontractor or otherwise, without the prior written consent of OPG, solicit the employment of, hire or otherwise retain in any capacity, any employee of OPG. Neither the Contractor nor any of its Affiliates will be prohibited from employing any such individual who contacts the Contractor or any of its Affiliates on that individual's own initiative and without any direct or indirect solicitation by the Contractor or any of its Affiliates. A general advertisement not specifically directed at OPG or its employees will not be considered a solicitation under this section 2.2(l).

2.3 Conflicts of Interest and Disputes

(a) **Conflicts of Interest.** During the Term of this Agreement, the Contractor will not undertake, directly or indirectly, either alone or in conjunction with any Person any commissions or contracts or provide any goods or services:

(1) to, or together with, any Person in relation to the Darlington Refurbishment Program;

(2) to any other Person who would adversely affect the Contractor's provision of the Services, or who could constitute a conflict of interest in the provision of the Services;

(3) assist Person with claims against OPG; or

(4) for construction claims consulting services or any related services which conflicts with the interests of OPG,

unless, in each case, OPG's Representative expressly consents in writing, in OPG's sole discretion, to the Contractor engaging in such activity.

(b) **Continuing the Services.** Provided that OPG continues to pay compensation for the Services that are not the subject of any Dispute, the Contractor will not stop, delay or suspend the provision of the Services, in whole or in part, due to any Dispute. In the event of any Dispute, the Contractor will ensure that the provision of the Services is not stopped, delayed or suspended pending resolution of any such Dispute and will continue to provide the Services and ensure the provision of the Services in a timely manner.

2.4 Reliance on Information

The Contractor will verify the accuracy and completeness of all information, provided by any member of the OPG Group that is necessary for the Contractor to provide the Services. The Contractor expressly waives all claims for Losses attributable to errors and/or omissions in such information.

2.5 Applicable Laws, Approvals and Procedures

(a) **Applicable Laws.** The Contractor will comply with all Applicable Laws, including those relating to health, safety, environment and use, storage, processing or any other handling of information that is subject to the *Nuclear Safety Control Act* (Canada), the *Export and Import Permits Act* (Canada) or *Nuclear Non-Proliferation Import and Export Control Regulations* SOR/2000-210, as amended from time to time, and that may be provided by OPG to the Contractor under this Agreement (collectively, **"Restricted Information"**). The Contractor will ensure that all use, storage, processing or any other handling of Restricted Information will be performed by the Contractor's Personnel or any employees or representatives of the Contractor or its Subcontractors within Canada, and no such Contractor's Personnel, employees or representatives of the Contractor or its Subcontractors will store, process, communicate, transfer, access or permit or enable direct or remote access to any Restricted

Information outside of Canada. Except as expressly set out in this Agreement, the Contractor will submit, and provide a copy to OPG of, all notices, requests, documents, instruments and certificates to all applicable Governmental Authorities as may be required in respect of the Services.

(b) **Policies and Procedures.** The Contractor will follow all written instructions of OPG's Representative in the provision of the Services. The Contractor acknowledges that the Contractor's Personnel must comply with OPG's policies and procedures applicable to the provision of the Services that may be communicated to the Contractor's Personnel, from time to time, in writing by OPG's Representative.

(c) **Failure to Comply with Applicable Laws.** OPG will not be responsible for monitoring the Contractor's compliance with, or for any failure of the Contractor to comply with, any Applicable Laws, OPG's applicable policies and procedures or this Agreement.

(d) **Codes of Conduct.** The Contractor will not take any action that would: (i) cause any member of the OPG Group to breach an obligation set out in OPG's code of business conduct, as amended from time to time ("**Code**"); or (ii) breach any of the Contractor's obligations set out in OPG's supplier code of business conduct ("**Supplier Code**"). Current copies of the Code and the Supplier Code are located at www.opg.com. The Contractor confirms that it has reviewed the current copies of the Code and the Supplier Code.

2.6 Provision of Services

Promptly following execution of this Agreement, the Contractor will prepare the Services Plan. The Services Plan and any changes thereto will be reviewed with the OPG Board of Directors. The Services Plan will include a list of Assessments to be conducted by the Contractor. The Contractor will summarize and provide results of the Assessments in its reports. The frequency and extent of the reports will vary depending on OPG's requirements and the needs of the Darlington Refurbishment Program. The Contractor will conduct the Assessments and provide the reports in accordance with the Scope of Services.

2.7 Subcontractors

(a) **Retention of Subcontractors.** Set out in Schedule 2.7(a) is a list of each Subcontractor who will or may be providing any of the Services, together with a summary of the Services to be provided by each such Subcontractor. The Contractor will not change any Subcontractor or materially change the Services provided by any such Subcontractor without OPG's prior written consent. Once any such changes are agreed to by OPG, OPG's Representative will issue a written Notice to the Contractor to evidence such consent and reflect changes to Schedule 2.7(a). The Contractor will not

subcontract the Services or any portion thereof without the prior written consent of OPG's Representative. For purposes of obtaining such consent, the Contractor will submit to OPG a listing of Subcontractors' staff (including independent contractors) with names, titles and rates for Subcontractor personnel. OPG may accept or reject any Subcontractor or any change to any Subcontractor in OPG's sole and absolute discretion.

(b) **Responsibility.** The Contractor will ensure that all Contractor's Personnel comply with this Agreement to the same extent as if each of the Contractor's Personnel were a party to this Agreement and had all of the same obligations as the Contractor under this Agreement. Notwithstanding any term in this Agreement, the Contractor will be responsible for all acts and omissions of the Contractor's Personnel as if such acts or omissions were done by the Contractor.

(c) **Terms in Subcontracts**. The Contractor will ensure that each subcontract with a Subcontractor respecting the Services will give OPG the right to direct the Contractor to assign the subcontract with the Subcontractor to OPG if OPG decides to finish entirely the Services in accordance with section 8.3. In such a case, the Contractor will comply in a timely manner with any such direction from OPG, if OPG elects to deliver any such direction. In the case of such an assignment of a subcontract to OPG, all invoices submitted by the Subcontractor must be addressed directly to OPG. The Contractor will ensure that each subcontract with a Subcontractor providing any of the Services contains a term stating:

"Notwithstanding any term in this Agreement, the Parties commit to each other and to Ontario Power Generation Inc., as a third party beneficiary of this contract, that each Party will comply in all respects with section 2.7(c) of the Independent Oversight Services Agreement for the Darlington Refurbishment Program dated as of April 11, 2016 between Ontario Power Generation Inc. and Burns & McDonnell Canada Ltd.

2.8 Security Practices and Checks

(a) **Security Practices.** The Contractor's security practices in relation to the management of OPG's information, documents and data will conform with those security requirements that may be set out in the Scope of Services, as amended by OPG from time to time, and to generally accepted standards in the nuclear power generation industry. If deficiencies are identified by OPG as a result of inspections, audits or otherwise, the Contractor will implement additional security practices consistent with the required standards and procedures. At OPG's request, the Contractor will provide reasonable assistance in identifying, tracking and closing any deficiency in security.

OPG may request that any of the Contractor's Personnel who perform Services sign a computer access and confidentiality agreement reflecting the requirements of this section 2.8(a).

(b) **Security Checks.** OPG will perform an employment suitability check for each of the Contractor's Personnel from time to time. Upon request by OPG, the Contractor will, at its own cost, submit to OPG's Representative the information required by OPG for each of the OPG identified Contractor's Personnel. The information that OPG requires, such as photographic identification, birth certificate and citizenship card, may vary from individual to individual, depending on the individual's background and circumstances. OPG may require, from time to time, that any of the Contractor's Personnel complete OPG forms for security clearance. These forms may include a five year, or more, residence and work history. If any of the Contractor's Personnel have not resided in Canada for more than five years, OPG will require that such Contractor's Personnel provide further information, including references, education credentials and criminal record checks. OPG may require any supporting documentation to be verified in a manner established by OPG, including by notarising. If OPG determines that any of the Contractor's Personnel is unsuitable for any reason, or if OPG is not satisfied with the timeliness, accuracy, validity, adequacy or completeness of any of the information received by OPG, then the Contractor will ensure that the applicable Contractor's Personnel is replaced immediately, at its own cost. OPG will maintain all the information submitted to OPG under this section 2.8(b) in accordance with Applicable Laws.

2.9 Intellectual Property

(a) **OPG Rights.** Except as otherwise specified in this section 2.9, all intellectual property (including, all trade secrets, patents, patent applications, rights to file patents, copyright, inventions, ideas, processes, discoveries, designs, techniques, drawings, specifications, data, software (hard copies and machine readable formats) and know-how (collectively, the "**Intellectual Property**") conceived, reduced to practice, designed, provided or developed by or for the Contractor under this Agreement will vest in and be owned exclusively by OPG. For greater certainty, and without limiting any term in this section 2.9(a), the Intellectual Property which is owned by OPG includes all Intellectual Property that is contained or embedded in, was used in the production of, or is required or desirable for the provision, use, reproduction, modification, maintenance, servicing, improvement or continued operation of the Services, in whole or in part or which is contained or disclosed in any drawings, or data provided under this Agreement. The Contractor will not do any act, which may compromise or diminish OPG's ownership rights and will perform any acts required to confirm or document OPG's ownership rights set out in this section 2.9(a) including

obtaining assignments of rights from the Contractor's Personnel if so required by OPG, at the Contractor's expense, and at OPG's cost, providing access to the Contractor's Personnel to assist OPG so that it may fully protect its Intellectual Property rights.

(b) **Contractor's Rights.** Contractor's Rights. Subject to OPG's Unrestricted Licence but notwithstanding any other term in this section 2.9, the Contractor will retain all of its rights in its proprietary information and property including, without limitation, its methodologies and methods or analysis, ideas, concepts, expressions, know-how, techniques, skills, knowledge and experience in respect of the Retained Intellectual Property.

(c) **Licence.** Notwithstanding any term in section 2.9(a) Intellectual Property which the Contractor has identified to OPG before its incorporation into the Services and can establish through written records existed before the date of this Agreement, or the commencement of any Services in respect of this Agreement, whichever is earlier, will remain the property of the Contractor or a third party supplier of such Intellectual Property, whichever the case may be (the **"Retained Intellectual Property"**). The Contractor will provide to OPG all such Retained Intellectual Property and any supplemental information requested by OPG which is reasonably required to allow OPG to use, reproduce, modify, maintain, service, improve or continue operation of the Services and all Intellectual Property owned by OPG as set out in section 2.9(a), including all assessments and reports (including electronic and hard copy formats) in forms reasonably acceptable to OPG. The Contractor grants to OPG an irrevocable, perpetual, royalty free and fully paid-up right to use, exploit, reproduce, copy, transmit, modify and create derivative works from (with a right to sublicence all or any part of these rights to an Affiliate and other third parties) (collectively, the **"Unrestricted Licence"**) to the Contractor's Retained Intellectual Property and information provided respecting the Contractor's Retained Intellectual Property. The Contractor will, before incorporating any third party Retained Intellectual Property into the Services or any assessment, report or data developed or provided under this Agreement, obtain the written consent of OPG and secure for OPG an Unrestricted Licence in all such third party Retained Intellectual Property.

(d) **Representation.** The Contractor represents and warrants to OPG that, before transferring ownership in the Intellectual Property to OPG, or licensing the Retained Intellectual Property to OPG:

(1) the Contractor is the exclusive owner of, and has good and marketable title to, all the Intellectual Property;

(2) the Contractor has obtained waivers of all moral rights in respect of the Services;

(3) that other than this Agreement, there is no ownership interest, agreement, option or other right, title, benefit, interest or privilege outstanding in favour of any Person for the purchase or licence from the Contractor of, or any lien or other encumbrance, in favour of any other Person, in any of the Intellectual Property;

(4) the Contractor has the right to grant the licence rights in the Retained Intellectual Property and has obtained such rights as contemplated by this Agreement; and

(5) the Contractor will not incorporate into the Services any Intellectual Property or Retained Intellectual Property the use of which by OPG violates the proprietary rights of third parties.

(e) **Defence.** The Contractor will defend all claims, actions or proceedings against OPG relating to any allegation that all or any part of the Services (including modifications to the Services by the Contractor) constitutes an infringement of any Intellectual Property rights. The Contractor will indemnify OPG for any and all Losses suffered by OPG in respect of any allegation. OPG will give the Contractor Notice of any such allegation and, at the request and expense of the Contractor, OPG will provide the Contractor with available information, assistance and authority for the defence. If all or any part of the Services is in any action or proceeding held to constitute an infringement of an Intellectual Property Right of a third party, or if OPG is enjoined from using all or any part of the Services as a result of an infringement claim, the Contractor will promptly:

(1) secure for OPG the right to continue using the Services;

(2) replace the infringing Services with non infringing Services, while maintaining the full functionality and integrity of the Services; or

(3) modify Services so that they no longer infringe, while maintaining the full functionality and integrity of the Services.

2.10 Confidential Information

(a) **Definition of Confidential Information.** In preparation for, and in the course of, providing the Services, OPG will disclose to the Contractor or the Contractor's Personnel certain information which is confidential, a trade secret or otherwise proprietary to OPG (the "**Confidential Information**"). Confidential Information does not include information that the Contractor is able to demonstrate to OPG's satisfaction, acting reasonably was or becomes generally known to the public through no fault of a member of the Contractor or any of the Contractor's Personnel, or was specifically known by the

Contractor before disclosure by OPG and was not subject to any confidentiality obligation.

(b) **Ownership and Treatment of Confidential Information.** All Confidential Information remains, at all times, the exclusive property of OPG. The Contractor will not disclose any Confidential Information except to the Contractor's Personnel for the purpose of providing Services under this Agreement.

(c) **AECL Confidential Information.** The Contractor acknowledges on its own behalf and on behalf of its employees, agents, and Subcontractors that Confidential Information includes certain confidential information that was created, licensed or owned by Atomic Energy of Canada Limited ("**AECL**") and such confidential information when identified as being created, licensed, or the property of AECL, is herein defined as "**AECL Confidential Information**" pursuant to one or more agreements between AECL and OPG.

The Contractor hereby covenants and agrees on its own behalf and on behalf of its employees, agents and Subcontractors that it will use the AECL Confidential Information only in respect of fulfilling its obligations set out in this Agreement and for the sole purpose of providing goods and/or Services to OPG and agrees that each of AECL and Her Majesty the Queen in Right of Canada are third party beneficiaries of the covenants in this section 2.10(c) with respect to the AECL Confidential Information, and are entitled to enforce the confidentiality obligations with respect to the AECL Confidential Information against the Contractor, including its employees, agents and Subcontractors. The Contractor will ensure that, before disclosing any AECL Confidential Information to any of its Subcontractors, it will obtain from such Subcontractors in writing the same covenants that the Contractor is providing to OPG and the third party beneficiaries under this section 2.10(c) with respect to the AECL Confidential Information. Except as expressly set out in this paragraph of this section 2.10(c), the Contractor, its employees, agents and Subcontractors have no right to use or disclose any AECL Confidential Information for any purpose whatsoever.

(d) **Return of Confidential Information.** On OPG's instructions, the Contractor will promptly return to OPG or destroy any Confidential Information, including all reproductions and any documents which include any of the Confidential Information.

(e) **Remedies.** The Contractor acknowledges that OPG would not have an adequate remedy at law for money damages if the Contractor fails to fulfil any of its obligations under this section 2.10. Accordingly, in addition to any other remedies under this Agreement, OPG will be entitled to any injunction, specific performance or other remedy in law or equity (without being required to post

a bond or other security), in respect of any breach or threatened breach of this section 2.10 and, in which case, the Contractor consents to any such injunction, specific performance or other remedy in law or equity. The Contractor will indemnify and hold harmless each member of the OPG Group, from and against all Losses suffered or incurred by a member of the OPG Group and all claims, demands, actions, suits or proceedings for Losses made against any member of the OPG Group by any Person, to the extent arising in respect of a breach or threatened breach of this section 2.10.

(f) **Application of Freedom of Information and Protection of Privacy Act (Ontario).** The Contractor acknowledges and agrees that OPG is subject to the *Freedom of Information and Protection of Privacy Act* (Ontario) ("**FIPPA**"). FIPPA applies to all Confidential Information in the custody or control of OPG and may require the disclosure of some or all of such Confidential Information to third parties. The confidentiality provisions in this Agreement are expressly subject to FIPPA.

2.11 [Intentionally Deleted]

2.12 Site Services

(a) **Requirements for Site Services.** Where the Contractor's Personnel carry out any Services at the Site, the following additional conditions will apply:

(1) the Contractor will ensure that all the Contractor's Personnel are properly trained to conduct the Services safely prior to carrying out any Services at the Site;

(2) the Contractor or any of its Subcontractors will not bring any construction equipment, material, waste material or nuclear waste material to the Site;

(3) the Contractor, the Contractor's Personnel and Subcontractors will follow all applicable safety rules and regulations, including those established by OPG;

(4) the Contractor will take reasonable and proper care of OPG's property which may be in the Contractor's possession or control;

(5) the Contractor acknowledges that smoking at the Site is allowed only in designated areas and will enforce such rule with the Contractor's Personnel;

(6) the Contractor's Personnel will be qualified as nuclear energy workers if required;

(7) the Contractor and each Subcontractor will comply with Applicable Laws, including those related to matters of health and safety and environmental protection;

(8) the Contractor and each Subcontractor will bring any concerns of their personnel regarding radiological safety, environmental safety, nuclear safety or workplace harassment to the attention of OPG immediately; and

(9) the Contractor and each Subcontractor will cause all of their personnel to abide by OPG's policy regarding substances that impair judgment and, therefore, safety. While present at the Site, drinking intoxicants or using illegal drugs is strictly prohibited. The Contractor's Personnel under the influence of intoxicants or illegal drugs will not be permitted to work. The Contractor and each Subcontractor will ensure that their personnel will not bring, or permit anyone else to bring intoxicants or illegal drugs to the Site.

(b) **Access by Other OPG Contractors and OPG Personnel.**

(1) The Contractor acknowledges that OPG will from time to time grant other OPG contractors and OPG personnel access to all or parts of the Services and/or Site or that the Contractor may require access to other OPG contractors' projects and/or sites; and

(2) If the Contractor requires access to other OPG contractors' projects and/or sites, the Contractor will comply with OPG's N-FORM-11584: Access Protocol – Contractor Access Request Form as amended from time to time (the "**Access Request Protocol**"). Other OPG contractors will also be required to perform their work in accordance with the Access Request Protocol.

2.13 Public Announcements

Except to the extent required by Applicable Laws or with the prior written consent of OPG, the Contractor will not make any public announcement relating to this Agreement or the Services provided hereunder.

SECTION 3 - INSURANCE, LIABILITY AND INDEMNITY

3.1 Required Insurance

(a) **Coverages to be Maintained.** The Contractor will maintain in full force with financially responsible insurance carriers (who maintain AM Best ratings of at least A- or a Standard & Poor's rating of at least BBB) of recognized standing acceptable to OPG, or with the appropriate Governmental Authorities, all

coverages referred to in this section 3.1. The Contractor represents to OPG that each of these coverages is currently in full force. The Contractor will ensure that all these coverages will cover all Subcontractors, will be maintained continuously in force from the date of this Agreement until 60 days after the expiration or termination of this Agreement and will cover all Services provided by the Contractor.

(b) **Workers' Compensation.** The Contractor will maintain or cause to be maintained workers' compensation coverage as required by the *Workplace Safety and Insurance Act, 1997* (Ontario) and any other Applicable Laws in any jurisdiction respecting the Contractor's Personnel.

(c) **Additional US Requirements.** In respect of all of the Contractor's Personnel who provide any of the Services in the United States, the Contractor will maintain or cause to be maintained workers' compensation coverage in each applicable state. Subject to annual renewal, the Contractor will also ensure that any such coverage includes employer's liability with a limit of US [redacted] and, to the extent applicable, a foreign coverage endorsement, *Merchant Marine Act* (United States), *Longshore and Harbor Workers' Compensation Act* (United States) and *Federal Employers' Liability Act* (United States) coverage.

(d) **Commercial General and Excess Umbrella Liability Insurance.** The Contractor will maintain commercial general liability and excess umbrella liability insurance, on an occurrence basis, in an amount of not less than [redacted] inclusive for bodily injury, including death, personal injury and damage to property, including loss of use thereof, for each occurrence. The Contractor will ensure that the excess umbrella liability insurance is in excess of the coverages under sections 3.1(c) and 3.1(e) (to the extent the coverages under those sections include employer's liability). The Contractor will also ensure that the commercial general liability and excess umbrella liability coverage specifically includes the following:

(1) blanket contractual liability;

(2) damage to property of OPG or any of its subsidiaries, including loss of use thereof;

(3) products and completed operations;

(4) cross liability;

(5) severability of interests;

(6) employer's liability;

(7) non-owned automobile liability; and

(8) broad form property damage.

(e) **Motor Vehicle Liability Insurance.** The Contractor will maintain motor vehicle liability insurance, covering all licensed motor vehicles owned, rented or leased and used in respect of the Services. The Contractor will ensure that this coverage will cover bodily injury and property damage liability to a combined inclusive minimum limit of [redacted] per occurrence and mandatory accident benefits.

(f) **Errors and Omissions Insurance.** The Contractor will maintain professional liability insurance for all engineering, architectural, design or other professionals or consultants in an amount of not less than [redacted] aggregate limit, covering the period from the date of this Agreement until its termination or expiration and for a further discovery period of one year from the date of its termination or expiration and will contain a cancellation clause requiring the insurer to give OPG 30 calendar days prior written Notice of any cancellation of such policy.

(g) **Other.** The Contractor will maintain at OPG's expense, any other insurance for such risks and in such amounts as OPG may require from time to time.

3.2 General Insurance Terms

(a) **Certificates of Insurance.** Both on the date of this Agreement and no more than 60 days and no fewer than 30 days before starting any Services, the Contractor will deliver to OPG certificates of insurance completed by each of the Contractor's insurers certifying that the coverages required under section 3.1 are in effect. The Contractor will ensure that each certificate will state that the coverages will not be cancelled, will not fail to be renewed and will not be materially changed by endorsement or through issuance of any other policy of insurance which restricts or reduces coverage, without 30 days advance Notice by courier given to OPG's Representative, with a copy delivered by fax as follows:

Ontario Power Generation Inc.
Risk Management and Insurance
700 University Avenue H18-H18
Toronto, Ontario, Canada M5G 1X6

Attention: Director – Risk Management & Insurance
Fax: 416-592-4775

Subject to annual renewal the Contractor is required to maintain any coverages under section 3.1 in force after final payment of all amounts owing to the Contractor, the Contractor will deliver to OPG, at the time that the Contractor submits its final invoice for payment, a certificate of insurance completed by a duly authorised representative of such Person's insurer certifying that such insurance will remain in force for the period of time required under section 3.1.

(b) **Copies of Policies.** Promptly upon request by OPG, the Contractor will allow OPG to review a certified copy of any insurance policy referred to in section 3.1. Such review shall be subject to a confidentiality agreement and unless required by Applicable Law, OPG shall not be provided a copy of the policy. OPG may only make a request following an occurrence where OPG may have coverage under the policy.

(c) **No Waiver by OPG.** If OPG fails to demand any certificate referred to in this section 3.2 or otherwise fails to demand other evidence of full compliance with sections 3.1 or 3.2 or fails to identify a defect from evidence provided, OPG has not waived, and OPG will not be deemed to have waived, any of the Contractor's obligations. The Contractor's obligation to purchase and maintain insurance under this Agreement will in no way limit or otherwise qualify the liabilities or obligations of the Contractor under this Agreement.

(d) **No Approval by OPG.** If OPG receives and accepts any certificate or other evidence under this section 3.2, OPG has not approved or agreed, and OPG will not be deemed to have approved or agreed, that the Contractor has satisfied any of its obligations under sections 3.1 or 3.2.

(e) **OPG May Purchase Insurance.** If the Contractor fails to maintain any insurance required under section 3.1 (including for failure to obtain insurance of sufficient scope as to comply with section 3.1), OPG may purchase any such insurance, at the Contractor's sole expense or OPG may terminate this Agreement immediately due to default by the Contractor in accordance with section 8.1.

(f) **Deductibles.** The Contractor will pay the amount of all deductibles for insurance it is required to maintain under this Agreement and may not charge back any such amount to OPG.

(g) **Insurance Not Contributory.** With the exception of the insurance referred to in section 3.1(e), the Contractor will ensure that all other insurance referred to in section 3.1 will specify that such insurance is primary coverage and not contributory with, or in excess of, any insurance that may be maintained by OPG.

(h) **Subrogation.** The Contractor will ensure that each insurer which provides insurance under section 3.1 will provide a waiver of subrogation to each member of the OPG Group, the Contractor, and all the Subcontractors. OPG agrees to waive all rights for recovery against the Contractor for damage covered by OPG's property insurers for the Refurbishment Program.

(i) **OPG as Additional Insured.** The Contractor will ensure that each insurer that provides insurance under section 3.1(d) will include OPG and any applicable subsidiary of OPG as an additional insured and, where applicable, as a loss payee, under such insurance.

(j) **No Invalidation by Contractor.** The Contractor will ensure that no insurance referred to in section 3.1 will be invalidated or vitiated by any action or failure to act by the Contractor, any applicable subsidiary of the Contractor or the Contractor's Personnel or by any breach by the Contractor or any other Person of any declarations, warranties or other terms in such policies.

(k) **Notice of Claim.** The Contractor will deliver a written Notice to the OPG Representative within five Business Days of asserting any claim under any insurance referred to in section 3.1. The Contractor will include in the Notice the date of the events giving rise to the claim, a summary of the circumstances respecting the claim and the amount of the claim. The Contractor will provide OPG any additional information respecting the claim that may request.

3.3 Indemnity

The Contractor will indemnify and hold harmless each member of the OPG Group from and against:

(1) all Losses suffered or incurred by a member of the OPG Group arising in respect of the Services, to the extent that any such Losses are attributable to bodily injury, sickness, disease or death, or to damage to or destruction of tangible property;

(2) all Losses arising from claims, demands, actions, suits or proceedings made against any member of the OPG Group by any third Person; and

(3) all Losses to the extent arising from any claim or finding that any of the Contractor's Personnel are employees of OPG, including any liability imposed by the Canada Revenue Agency under the *Income Tax Act* (Canada) or any other Applicable Laws to make contributions, withhold or remit any monies, make deductions from payments, or to pay any related interest or penalties in respect of the Contractor's Personnel.

but only in each case to the extent such Losses are caused by any negligent or wrongful act or omission of any of the Contractor's Personnel. The Contractor will indemnify all Losses suffered or incurred by a member of the OPG Group arising in respect of the Services, to the extent that any such Losses are attributable to bodily injury, sickness, disease or death, or to damage to or destruction of tangible property and all Losses arising from claims, demands, actions, suits or proceedings made against any member of the OPG Group by any third Person where such Losses result from OPG's failure to reasonably mitigate damages following or connected with a breach of this Agreement by the Contractor. The obligations of the Contractor under this section 3.3 will not be affected in any way by any certificate, acceptance, approval, payment, or any other act, matter or thing done or omitted under this Agreement.

SECTION 4- COMPENSATION

4.1 Billing Rates

(a) **Billing Rates.** The Billing Rates to be charged under this Agreement are set out in Schedule 4.1. The Billing Rates are fixed for each year of the Agreement and constitute the basis for the total compensation payable to the Contractor for providing the Services. In particular, the Billing Rates include:

(1) all costs fully burdened, respecting the provision of labour (including premiums paid for overtime and shift premiums); and

(2) all other corporate, executive and management expenses, general administration expenses, benefits, Taxes (except for Canadian goods and services tax/harmonized sales tax levied under the *Excise Tax Act* (Canada) ("**GST/HST**")), currency exchange risks and costs or changes to any indices, including CPI, any underlying labour agreements respecting the Contractor's Personnel, insurance required to be provided by the Contractor, and all other costs and expenses of every kind respecting the Services.

For greater certainty, the Billing Rates do not include GST/HST.

(b) **[Intentionally Deleted]**

(c) **Adjustments to Billing Rates.** The only adjustment(s) which can be made to the Billing Rates are those adjustments required to reflect a change in the Contractor's Personnel as set out in section 2.2(e). Further to section 2.2(e), any new Contractor's Personnel, including any new members of the Key Personnel, whose name(s) are not included in Schedule 2.2(c) and whose Billing Rates are not included in Schedule 4.1 as of the date of this Agreement, Personnel are subject to OPG's prior written approval. Upon approving such Contractor's Personnel, including members of the Key Personnel, and their

Billing Rates, OPG's Representative will issue a written Notice, which will evidence such approval and reflect the necessary changes to Schedules 2.2(c) and 4.1.

(d) **Subcontractors.** OPG will reimburse the Contractor for the Services provided by Subcontractors (including by the Contractor's Personnel provided by a Subcontractor) based upon the Billing Rates set forth in Schedule 4.1, net of discounts, rebates and other refunds, provided such amount was included in the relevant Budget. The Contractor will be reimbursed for such expenses, supported by receipts, without mark-ups of any kind.

(e) **Reimbursable Expenses.** OPG will reimburse the Contractor in accordance with the Business Expense Schedule set out in Schedule B.

SECTION 5- PAYMENT

5.1 ARIBA

The Contractor acknowledges that OPG has implemented an electronic invoicing system ("**ARIBA**") and the timely payment of amounts owing to the Contractor requires that the Contractor provide invoicing information in accordance with this system.

The Contractor will be responsible for maintaining access to the Internet. The Contractor will be responsible for the accuracy and timeliness of the data entered into ARIBA. OPG will not be responsible for any delays to payments as a result of the Contractor's errors and omissions arising from the misuse of ARIBA.

The Parties agree to work co-operatively to minimize each other's costs associated with the implementation and ongoing access and use of ARIBA.

The Contractor is aware and accepts that OPG will review, accept and approve of the Contractor's data submitted via ARIBA prior to any issuance of payment. Nothing in this section 5.1 diminishes or amends OPG's rights set out in the remainder of this Agreement. For certainty, this section 5.1 will apply only if the Contractor is required to use ARIBA.

5.2 Invoicing Process

(a) **Payment.** Unless the Contractor is required to use ARIBA, the Contractor will prepare and submit to OPG invoices, and OPG will pay the Contractor in accordance with 0 and this section 5.2.

(b) **Draft Invoice** Contractor will submit a draft invoice to OPG on a monthly basis for each Project on or before the 15th day of each month unless otherwise specified by OPG, in respect of the Services rendered during the immediately preceding month. Invoices will include the hours billed, Billing Rate for each

employee, a listing of all Reimbursable Expenses, and, copies of receipts and invoices in respect of all Reimbursable Expenses.

(c) **Review of Draft Invoice** The Contractor will submit each draft invoice to OPG's Representative for review. OPG's Representative will review and provide comments, if any, in respect of the draft invoice within five Business Days after receipt thereof. After addressing the comments and receiving OPG's Representative's acceptance, Contractor will deliver a final invoice to OPG for payment.

(d) **Invoices.** After receiving OPG's Representative's acceptance, the Contractor will electronically deliver to OPG an invoice for payment in .pdf, .tif or other format and at an electronic mail address specified by OPG. Each invoice must contain the following information:

(1) the total amount owing by OPG (and expressly stating any amounts invoiced in a currency other than Canadian dollars);

(2) shown separately all amounts due as Canadian goods and services tax/harmonized sales tax levied under the *Excise Tax Act* (Canada) (GST/HST);

(3) the Contractor's full name and address, and the name of a contact individual at the Contractor, with a telephone number;

(4) electronic transfer instructions;

(5) the Contractor's invoice number (which must be unique for each invoice);

(6) the invoice date (which must be the date the invoice is delivered);

(7) the value of Services provided in Canada and outside Canada, identified separately; and

(8) the Contractor's 15 digit registration number for the purposes of Part IX of the *Excise Tax Act* (Canada).

5.3 Payments

(a) **Payment Terms.** OPG will aggregate all outstanding invoices received and accepted by OPG for payment before the 25th day of each month. Subject to any Applicable Laws, OPG will pay the Contractor this aggregate amount electronically on the 25th day of the following month. All payments are conditional, however, on the Contractor fulfilling its obligations and making satisfactory progress in providing the Services before the date payment is made.

OPG's Representative will determine whether or not such obligations have been fulfilled and progress is satisfactory.

(b) **Refusal of Payments.** OPG may refuse to make any payment, in whole or in part, or set off from any payment otherwise payable to the Contractor under this Agreement, an amount to be determined by OPG on account of:

(1) Services required that have not been entirely provided;

(2) Losses suffered or incurred by any member of the OPG Group or claims, demands, actions, suits or proceedings for Losses having been made against a member of the OPG Group by any Person in respect of which the Contractor is required to indemnify under this Agreement; or

(3) any other terms of this Agreement or rights under Applicable Laws entitling OPG to a set off against the invoiced amount.

5.4 Taxes

(a) **Goods and Services Tax/Harmonized Sales Tax ("GST/HST").** The Contractor represents and warrants to OPG that the Contractor is duly registered for the purposes of Part IX of the *Excise Tax Act* (Canada) and that the Contractor's 15 digit registration number is [redacted]. The Contractor will deduct all GST/HST recovered or recoverable by the Contractor on the payment of expenses before submitting any invoice to OPG covering any such expenses. The Contractor will ensure that each invoice will separately set out all GST/HST payable by OPG under this Agreement.

(b) **Responsibility to Taxes.** The Contractor is solely responsible for any Taxes levied in respect of any goods or materials (including test equipment, notebook computers, construction equipment, or tools) brought into Ontario for temporary use in respect of the Services.

(c) **The Contractor's Income Taxes and Withholdings.** OPG will have no liability for:

(1) any Taxes in respect of the Contractor's Personnel, including Taxes respecting income, Canada Pension Plan ("**CPP**"), Employment Insurance ("**EI**"), Employer Health Tax and Workplace Safety and Insurance Board ("**WSIB**");

(2) any of the Contractor's income or capital taxes imposed by any Governmental Authority respecting this Agreement; or

(3) any withholding (except for any amount withheld by OPG under section 5.4(f)), collection, payment, remitting or reporting of any

Taxes paid or payable by the Contractor in respect of this Agreement, including in respect of any of the Contractor's Personnel.

(d) **Remittal of Benefits.** The Contractor will withhold and remit, or undertakes to ensure that members of the Contractor's Personnel withhold and remit, all Taxes (e.g., income tax, Employer Health Tax), all benefit coverage and related remittances (e.g., CPP, EI, WSIB, health place coverage), and fulfil any obligations under the Employment Standards Act (Ontario) with respect to the Contractor's Personnel and OPG will have no responsibility for any such Taxes, benefits remittances and obligations with respect to the Contractor's Personnel. The Contractor will indemnify and save harmless all members of the OPG Group from and against any and all Losses suffered or incurred by any member of the OPG Group on account of claims made or grievances filed by any members of the Contractor's Personnel or by union on account of any breach by the Contractor of the obligation to remit benefits in the course of providing the Services. This includes any liability imposed by a court of law, ad administrative body or tribunal, or by the Canada Revenue Agency under the *Income Tax Act*, or any other Statute, to make contributions, withhold or remit any monies and/or make deductions from payments in respect of the Contractor's Personnel.

(e) **Refund of Taxes.** All remissions or refunds of any Taxes other than income or capital taxes paid or payable by any Governmental Authority in respect of the Services are the exclusive property of OPG. All amounts received by the Contractor or a Subcontractor by way of a remission or refund of any Taxes will constitute trust monies to which OPG is exclusively entitled. The Contractor will promptly forward all such amounts to OPG. The Parties will co-operate with each other and take all actions required or desirable to apply for any applicable remission or refund of Taxes. Upon request by OPG, the Contractor will execute, or cause any Subcontractor to execute, all required or desirable documentation to allow OPG to act in the name of the Contractor or a Subcontractor, as the case may be, to apply for and receive any such remission or refund.

(f) **Withholding for Non-residents.** Notwithstanding any term in this Agreement, OPG may withhold any amount that is required to be withheld by any Applicable Laws respecting Taxes. OPG will have no obligation to gross up or otherwise increase payments made to the Contractor or any Subcontractor because OPG withheld any amount in respect of Taxes. Where OPG so withholds any amount, OPG will remit such amount to the applicable Governmental Authority. If OPG is entitled to set off an amount owing by OPG under this Agreement against an amount owing to OPG under this Agreement and OPG is also required to withhold an amount under any Applicable Laws respecting Taxes, then OPG will set off an amount owing by OPG against an

equal amount owing to OPG. For example, if OPG owes the Contractor $100 and of that amount OPG is required to withhold $15, and the Contractor owes OPG $95, then:

(1) OPG would withhold and remit to the Canada Revenue Agency $15; and

(2) the Contractor would pay OPG $10.

These payments would thus entirely extinguish both OPG's obligation to the Contractor and the Contractor's obligation to OPG.

SECTION 6 – DOCUMENTATION AND RIGHT OF AUDIT

6.1 Documentation of Services and Records

The Contractor will compile and maintain at the Site and/or provide electronic access from the Site or as otherwise requested by OPG, in accordance with this Agreement and Applicable Laws, detailed, itemized records of all items covered by each application for payment, including all Services (including documents, plans, reports, information and other deliverables and data). On an ongoing basis, the Contractor will provide such records in a useable format to OPG. The Contractor will maintain these records for the period expiring on the latest of:

(a) seven years following expiration or termination of this Agreement;

(b) the period of time as may be required by Applicable Laws; and

(c) such other period as OPG may set out in a Notice to the Contractor.

6.2 Audits

(1) **General Obligations.** The Contractor will ensure that, for all Services performed on a reimbursable costs basis (which, for certainty, includes Services performed under any fixed/firm price subcontracts), the Contractor and the Subcontractors retain all such records and documents, on a "single set of books" basis (which, for certainty, means a separate set of books kept specifically for the Services that includes all required records and documents from the Contractor and Subcontractors) for the Agreement, including all records and documents from Subcontractors, as may be requested by OPG on an ongoing basis, which will include proper timesheets, equipment-related records, accounts, invoices, payroll records and bank records which are necessary for OPG to verify the nature and quality of such reimbursable Services and the accuracy of invoices for actual costs incurred by the Contractor hereunder for the Services performed. Timesheets will identify the provider of the reimbursable Services, the Services performed, the location of the Services, the relevant period of time during which the

Services were performed and the hours incurred. The Contractor's actual costs, including actual labour rates, for all Services performed on a reimbursable costs basis will be "open book" and will be subject to audit by OPG on an ongoing basis during the Term of this Agreement. Actual costs will only be reimbursed if they are capable of being fully audited from source documents and if OPG is reasonably satisfied, on the basis of documentation provided to OPG by the Contractor, that such costs are not disallowed. The Contractor's completion of milestones will also be subject to audit by OPG on an ongoing basis during the Term of this Agreement. The Contractor will, and will cause its Subcontractors to, maintain all such records for seven years following expiration or termination of this Agreement and such records will remain available, upon reasonable written Notice by OPG, for review and inspection by OPG or its designates. In addition to the Contractor's obligations under section 6.1 above, the Contractor and any Subcontractor will provide copies of any or all such records to OPG upon request. For certainty: (i) OPG will not audit cost inputs for fixed price Services and firm price Services, if any; and (ii) OPG will audit fixed price Services and firm price Services performed on a reimbursable costs basis under a fixed/firm price subcontract for compliance with this Agreement, except that OPG will have full audit rights with respect to all fixed price Services and firm price Services performed on a reimbursable costs basis under a fixed/firm price subcontract entered into with a Subcontractor that is an Affiliate of the Contractor, or in which the Contractor or any of its Affiliates has a direct or indirect beneficial interest of ten per cent (10%) or greater. Any Dispute between the Contractor and OPG with respect to the scope of any such audit will be settled in accordance with section 10.1.

(2) **Cooperation.** The Contractor and Subcontractors will fully cooperate with OPG in respect of any audits conducted by OPG, through its own auditors or auditors designated by OPG, under this section 6. If the Contractor or any Subcontractor fails to provide any such records or other information, OPG may make any reasonable assumptions in the absence of such records. The Contractor will correct or remedy, and will cause any Subcontractor to correct or remedy, any errors or discrepancies identified during OPG's audit.

(3) **Compliance with Agreement.** OPG may, at any time during the Term of this Agreement and within three years of the termination or expiration of this Agreement, require from the Contractor satisfactory evidence of any aspect of the Contractor's compliance with the Contractor's obligations under this Agreement. OPG may, through its own auditors or auditors designated by OPG, inspect, audit and copy all records and

other information, and interview all relevant Contractor's Personnel, respecting such compliance. The Contractor will provide such auditors prompt and unrestricted access to all premises, the Contractor's Personnel, books, records and other documents, whether in written, electronic or other format, required to substantiate any calculations or compliance with this Agreement. The Contractor will provide OPG's auditors with reasonable work space at the Contractor's facilities to conduct any inspection, audit, copying and interviews.

(4) **Specific Obligations.** Without in any way limiting OPG's rights under section 6.2(c), where any cost calculations are made for purposes of this Agreement, OPG may, at any time, require from the Contractor satisfactory evidence of the calculation and substantiation of any cost figures supplied by the Contractor. OPG may, through its own auditors or auditors designated by OPG, inspect, audit and copy all records and other information, and interview all relevant Contractor's Personnel, respecting such calculations, so long as OPG directs such review to be performed within three years of the termination or expiration of this Agreement. The Contractor will provide such auditors prompt and unrestricted access to all premises, the Contractor's Personnel, books, records, accounts, reports, files, correspondence, drawings, estimates, estimating worksheets, agreements and other documents, purchase orders, invoices, receipts, notes, diaries, policies, procedures and any other information, whether in written, electronic or other format, required to substantiate any such calculations or compliance with this Agreement. The Contractor will provide OPG's auditors with reasonable work space at the Contractor's facilities to conduct any inspection, audit, copying and interviews. If the Contractor fails to provide any such records or other information, OPG may make any reasonable assumptions in the absence of such records. All payments made by OPG are subject to readjustment based on any such audit at any time before the expiry of the 50th month after the expiration or termination of this Agreement. If any audit reveals that OPG was overcharged for any reason (including because costs charged to OPG are inadequately calculated or substantiated), the Contractor will (i) promptly pay OPG the amount of such overcharge(s), and (ii) promptly reimburse OPG for all of OPG's audit costs. For certainty, OPG may set off any such amounts as provided for under section 10.6. If any audit reveals that OPG was undercharged for any reason, OPG will promptly pay the Contractor the amount of such undercharge net of any audit costs incurred by OPG reasonably related to the audit of the undercharged part of the Services (such audit costs not to exceed the undercharged amount).

6.3 Access to Information by Governmental Authorities

The Contractor acknowledges that OPG is subject to supervision and regulation by Governmental Authorities, including, for certainty, and without limiting the foregoing, the Canadian Nuclear Safety Commission, the Ontario Energy Board and the Independent Electricity System Operator, and is required to comply with Applicable Laws and that OPG may take additional steps or actions to provide Governmental Authorities with explanations or information that is supplemental to the information that OPG is required to provide under Applicable Laws. Accordingly, the Contractor agrees that OPG will have the right to:

(a) provide a Governmental Authority with access to and copies of any documents (including Confidential Information) prepared by or for the Contractor, a Subcontractor or OPG in respect of the Services, including audit reports and associated working papers and recommendations; and

(b) with respect to any audit, monitoring or inspection rights of OPG under this section 6.3 or elsewhere in this Agreement, permit a Governmental Authority to attend with OPG or, at the request of OPG, attend independently.

SECTION 7 – WARRANTY

7.1 Inspection

OPG's Representative, or designate, may inspect any part of the Services at all times and may reject any part of the Services which is found to be not in accordance with this Agreement. Where, in the opinion of OPG's Representative, or designate, the remedy can be practically applied, the Contractor, at its sole expense, will promptly re-provide such Services. Re-provision will include all information prepared by the Contractor under this Agreement that is found to be incomplete or inaccurate, within a period of nine months following the date of the provision of the relevant services to OPG.

7.2 Warranty

The Contractor warrants and guarantees to OPG that:

(a) notwithstanding any term in this Agreement, the Services will, in all respects, be performed in accordance with the Standard of Care; and

(b) all Services will be provided in accordance with requirements set out in this Agreement, including the Scope of Services.

7.3 Access to Services

The Contractor will provide access to all Services and the premises of the Contractor and its Subcontractors, at all reasonable times and from time to time, to OPG's Representative, and at the request of OPG's Representative, to OPG's designated delegates, for the purposes of viewing, performing surveillance on, inspecting, testing and/or accepting the Services, in whole or in part, including to monitor compliance with any applicable quality management

program. At the request of OPG's Representative, the Contractor will promptly provide to OPG's Representative and/or OPG's designated delegates a copy of all the documents respecting any subcontract for Services subject to viewing, performing surveillance, inspecting, testing and/or accepting. No such viewing, performing surveillance, inspecting, testing and/or accepting by OPG will relieve the Contractor of any of its obligations under this Agreement. The Contractor will advise each applicable representative of OPG of the Contractor's or Subcontractor's applicable site safety procedures and policies. The Contractor will provide each such representative with proper and safe transportation and conditions for such access.

SECTION 8 – DEFAULT

8.1 Events of Default

Each of the following events and circumstances constitutes an event of default by the Contractor and / or Indemnitor under this Agreement:

(a) the Contractor and / or Indemnitor commences dissolution, liquidation or wind-up or has instituted or has had instituted against it, a proceeding seeking a judgement of insolvency or bankruptcy or any other relief under any bankruptcy or insolvency law;

(b) the Contractor and / or Indemnitor breaches any of its obligations under this Agreement and fails to cure the breach to the satisfaction of OPG within seven Business Days following receipt of Notice from OPG specifying the breach, or if the breach cannot be cured within such seven Business Day period, after such longer period of time as is reasonably required to cure the breach (but no longer than 60 days in any circumstances), so long as the Contractor diligently and constantly endeavours to cure the breach during such extended period;

(c) Contractor and / or Indemnitor is in any way responsible for a fatality respecting the Services;

(d) the Contractor and / or Indemnitor, or any Subcontractor, any of their shareholders, directors, officers, partners, members, representatives, agents or any Contractor's Personnel gives or offers to give (directly or indirectly) to any Person, a bribe, gift, gratuity, commission or other thing of note, as an inducement or reward:

(1) for doing or forbearing to do any action in respect of this Agreement; or

(2) for showing favour or disfavour to any Person in respect of this Agreement; or

(3) otherwise in connection with any other project of OPG;

(e) the Contractor and / or Indemnitor assigns or attempts to assign this Agreement, in whole or in part, except in a manner expressly permitted in section 10.2; or

(f) the Contractor and / or Indemnitor breaches the nuclear security requirements that are set out in Scope of Services related to security clearance of the Contractor's Personnel.

8.2 Notice

OPG may terminate this Agreement immediately and without any cost to OPG by delivering a Notice to the Contractor on the occurrence of any event of default set out in section 8.1.

8.3 OPG's Recourse

If OPG may terminate this Agreement under section 8.2, OPG may, in addition to its rights under section 8.2 and whether or not this Agreement is terminated:

(a) eject and exclude from the provision of the Services the Contractor and any Contractor's Personnel;

(b) entirely finish the Services, in whole or in part, by whatever means OPG deems appropriate under the circumstances (and the Contractor, at no additional charge to OPG, will promptly, and in any event within three (3) Business Days, co-operate with OPG in this regard);

(c) direct the Contractor in a Notice to assign any specified subcontracts with Subcontractors;

(d) enforce any indemnity, letter of credit, performance bond, guarantee or other security provided by the Contractor, a Subcontractor or any other Person with respect to the applicable Services (although, if the terms of any such document permit earlier enforcement under any such document, OPG may enforce such rights in accordance with the terms of such other document);

(e) engage in a contract directly with any Contractor's Personnel involved with the provision of the Services; and

(f) withhold, without interest, all payments, in whole or in part, to the Contractor under this Agreement until the Contractor's liability to OPG is determined.

8.4 Deemed Termination

If at any time after OPG terminates this Agreement under section 8.2 or exercises its rights under section 8.3, it is determined for any reason that an event of default had not occurred or that a default was cured in a timely manner in accordance with section 8.1(b), the rights and obligations of the Parties will be the same as if the termination of this Agreement by OPG had occurred under section 9.3.

8.5 The Contractor's Liability

If OPG terminates this Agreement under section 8.2 or exercises its rights under section 8.3, the Contractor will be liable to OPG for:

(a) all costs reasonably incurred by OPG as a result of the default; and

(b) all other Losses suffered or incurred by OPG in respect of any event of default arising in respect of section 8.1.

OPG may set off such amount, in whole or in part, as OPG determines is owing by the Contractor to OPG under this section 8.5, against any amount otherwise owing by OPG to the Contractor.

8.6 OPG's Liability

Notwithstanding any term in this Agreement, the Contractor may not make any claim against OPG for breach of this Agreement by OPG unless the Contractor, within three Business Days of the breach, gives Notice to OPG describing the breach and the anticipated claim for the breach. The Contractor will be estopped from making any claim against OPG unless it provides this Notice in the time period required by this section 8.6. Notwithstanding any term in this Agreement, OPG's maximum liability for any claim for breach of this Agreement by OPG, other than failure to pay any part for the Services otherwise due to the Contractor, will not, in the aggregate, exceed an amount equal to [redacted]

8.7 Limitation of Liability

Subject to section 8.8, the total liability of the Contractor respecting all claims by OPG against the Contractor arising in respect of this Agreement will not exceed:

(a) in the first year of the Term, an amount equal to [redacted]; or

(b) in each of the subsequent years of the Term, an amount equal to the greater of [redacted]

8.8 Exceptions

The limitations of liability set out in section 8.7 will not apply, however, to:

(a) the Contractor's obligations under sections 2.2(h), 2.9(d), 2.10(e), 3.3, and

(b) Losses suffered or incurred by a member of the OPG Group or any claims, demands, actions, suits or proceedings for Losses made against any member of the OPG Group by any Person, to the extent arising in respect of:

(1) the deliberate or wilful breach of this Agreement by the Contractor; or

(2) liability for contribution or indemnity for injury or damage to third parties arising in respect of the Contractor's negligence.

Except where recoverable under insurance and except for the Contractor's obligations under sections 2.2(h), 2.9(d), 2.10(e) and 3.3, neither Party will be liable to the other Party for consequential liabilities, damages, losses, costs or expenses, including loss of profits or revenues, loss of production and loss of use.

In addition, the Contractor will not be liable for any costs or expenses incurred by the OPG Group due to the failure of the Darlington Refurbishment Program to meet its expected budget, schedule, performance requirements or guarantees; or any additional costs incurred by the OPG Group for any construction or engineering delays, changes in scope or force majeure events impacting the Darlington Refurbishment Program in any way, provided (with respect only to this section 8.8) that such additional costs were not incurred as a result of the Contractor's negligence.

SECTION 9 – TERM, SUSPENSION OF SERVICES AND TERMINATION

9.1 Term

This Agreement will be in effect for the period commencing on the date of this Agreement and ending on the date that is ten years following the date of this Agreement or, if OPG exercises its option to extend, such other later date that OPG will identify in its prior Notice to the Contractor, unless earlier terminated in accordance with this Agreement (the "**Term**"). OPG will be entitled, at its option, to one or more extensions of the Term of this Agreement by giving a Notice to the Contractor that OPG is exercising its option to extend the Term for the number of years specified by OPG in such Notice. If OPG elects to extend the Term of this Agreement, OPG will give such Notice of extension to the Contractor no later than 90 days prior to the expiry of the then current Term.

9.2 Suspension of Services

OPG may at any time from time to time, for any reason without affecting the validity of this Agreement, suspend the providing of the Services in whole or in part for such period of time as OPG may notify the Contractor. Except to the extent any such suspension arises in respect of any default by the Contractor or any negligent or wilful act or omission of the Contractor, OPG will pay the Contractor the reasonable extra direct damages suffered by the Contractor arising from the suspension. Severance costs respecting the termination of any Contractor's Personnel do not constitute direct damages. In no circumstances whatsoever will OPG be liable to the Contractor for consequential or indirect loss or damages, loss of profit, economic loss, interest or any other damage or loss suffered or incurred by the Contractor in respect to such suspension. Before OPG pays the Contractor for such extra direct damages, the Contractor will provide to OPG such reasonable evidence of such damages as OPG may request. In addition, before making any payment, OPG may conduct an audit of such damages in accordance with section 6.2. Immediately following a Notice of resumption delivered by OPG to the Contractor, the Contractor will resume providing the Services in accordance with the schedule agreed to between OPG and the Contractor.

9.3 Termination

Without cause and without affecting the validity of this Agreement OPG may immediately terminate this Agreement by delivering a Notice to this effect to the Contractor. Except to the extent any such termination arises in respect of any event of default by the Contractor, OPG will pay the Contractor:

(a) for Services completed in accordance with the terms of this Agreement, and for which OPG has not made any payment; and

(b) the reasonable extra direct damages suffered by the Contractor arising from the termination (such as the reasonable out-of-pocket costs of demobilisation).

In no circumstances whatsoever will OPG be liable to the Contractor for consequential or indirect loss or damages, loss of profit, other economic loss, interest or any other damages or loss suffered or incurred by the Contractor in any such termination. Before OPG pays the Contractor, the Contractor will provide to OPG such reasonable evidence of such amounts and damages as OPG may request. In addition, before making any payment, OPG may conduct an audit of such losses or damages in accordance with section 6.2. Title to all the Services that have not already vested in OPG will vest in OPG on payment by OPG under this section 9.3.

9.4 Orderly Transition

On any termination of this Agreement under section 8 or section 9, the Contractor will co-operate with OPG to ensure an orderly transition of the provision of all Services to OPG or to such party as OPG may direct so as to ensure that any disruptions to the Services caused by the termination are minimised. The Contractor will return promptly, and in any event within

ten Business Days following receipt of Notice under section 8.2: (i) any and all documentation, data and information, whether in written or electronic form, provided to the Contractor by OPG or otherwise made available under this Agreement, including any such documentation, date and information provided by OPG together with any Intellectual Property, and (ii) any work product developed by the Contractor prior to the date of termination. The provisions of this section 9.4 will survive the termination of this Agreement.

SECTION 10 – GENERAL

10.1 Disputes Referred to Arbitration

(a) **General.** The Parties will work co-operatively to resolve any dispute, disagreement, controversy, question or claim (including a claim for indemnification) (collectively, a "**Dispute**"). If the Parties are unable to resolve a Dispute, all disputes, disagreements, controversies, questions or claims arising out of or relating to this Agreement, or in respect of any legal relationship associated with or arising from this Agreement, including with respect to this Agreement's formation, execution, validity, application, interpretation, performance, breach, termination or enforcement, will be finally determined by arbitration pursuant to the National Arbitration Rules of the ADR Institute of Canada, Inc. (as amended from time to time, the "**Rules**"). Unless otherwise agreed in writing, there will be three arbitrators, appointed in accordance with Rule 14 of the Rules. The place of the arbitration will be Toronto, Ontario. The language of the arbitration will be English. The law of the arbitration will be the law of the Province of Ontario.

(b) **Non-Application.** For certainty, neither a panel of arbitrators appointed in accordance with this section 10.1, nor any court, may restrict the right of OPG to suspend or terminate this Agreement in accordance with sections 9.2 and 9.3.

(c) **Confidentiality.** In addition to the provisions of Rule 33 of the Rules, the Parties will keep confidential, and not disclose to any other Person, the arbitration and all matters arising directly or indirectly from the subject matter of the arbitration (including all documents exchanged, the evidence and the award), except that a Party may disclose any such information to the extent required:

(1) to obtain assistance from Persons to conduct the arbitration;

(2) by Applicable Laws (including the *Freedom of Information and Protection of Privacy Act* (Ontario)) or securities exchange rules; or

(3) by a disclosure requirement with a shareholder, lender or potential lender (including any advisor to any such recipient Person), so long as such Person is informed of the confidential nature of such information and such Person agrees to be bound, subject to Applicable Laws, by such confidentiality obligation.

(d) **Final and Binding.** All interim awards, partial final awards and final awards of the arbitrators will be final and binding upon the Parties regarding all matters submitted to arbitration, with no rights of appeal, even on questions of law.

(e) **Enforcement.** Either Party may have recognized and enforced any interim awards, partial final awards and awards rendered by the arbitrators in any court having jurisdiction.

(f) **Costs of Arbitration.** Subject to Rule 46 of the Rules, if the arbitrators do not specify the costs and expenses of the arbitration, each Party will bear its own costs and will share the costs of all three arbitrators equally.

10.2 Assignment and Benefit

The Contractor may not assign this Agreement, in whole or in part, without the prior written consent of OPG. This Agreement enures to the benefit of and binds the Parties and their respective successors and permitted assigns. OPG may from time to time transfer, assign, sell, lease or otherwise dispose of certain assets relating to one or more electricity generating stations or other business units of OPG (each station or other unit being a "**Business Unit**"). Notwithstanding any term in this Agreement, OPG may, without the consent of the Contractor, assign this Agreement, in whole or in part, and sublicense, assign or transfer OPG's rights respecting the Intellectual Property (as defined in section 2.9(a)) in whole or in part, to any owner, operator, lessee or any other successor in interest of, or lender to, a Business Unit (an "**Assignee**"). Upon and to the extent of such assignment or transfer, OPG will be relieved from all of its obligations under this Agreement. OPG may disclose to an Assignee or a proposed Assignee any information and documentation respecting this Agreement.

10.3 Amendments

Any officers of OPG of equal or higher authority than the signatory of this Agreement are the only individuals authorised to execute any Amendment on behalf of OPG. Except as expressly provided in this Agreement, no amendment (including an Amendment), restatement or termination of this Agreement in whole or in part is binding unless it is in writing and signed by each Party.

10.4 Notice

Except as otherwise provided in this Agreement, every Notice required or permitted under this Agreement must be in writing and may be delivered in person, by courier, by e-mail (if the applicable e-mail address is provided) or by fax to the applicable Party, as follows:

If to OPG,	if to the Contractor:
Ontario Power Generation Inc. 700 University Avenue Toronto, ON M5G 1X6 Canada	Burns & McDonnell Canada Ltd 525 28th St SE, Suite 210 Calgary, AB T2A 6W9 Canada

Attention: Mark Skuce Email: mark.skuce@opg.com With a copy to: Ontario Power Generation Inc. 1340 Pickering Parkway Pickering, ON, L1V 0C4 Canada Attention: Kay Ahn Email: kay.ahn@opg.com	Attention: Chris Lehan Email: clehan@burnsmcd.com With a copy to: Burns & McDonnell 9400 Ward Parkway Kansas City, MO 64114 Attention: Patrick Guevel Email: pguevel@burnsmcd.com

or to any other address, fax number or individual that a Party designates by Notice. Any Notice under this Agreement, if delivered personally or by courier will be deemed to have been given when actually received, if delivered by fax before 3:00 p.m. on a Business Day will be deemed to have been delivered on that Business Day and if delivered by fax after 3:00 p.m. on a Business Day or on a day which is not a Business Day will be deemed to be delivered on the next Business Day.

10.5 Currency

Unless otherwise specified in this Agreement, all amounts to be paid or calculated under this Agreement are to be paid or calculated in Canadian dollars.

10.6 Set Off

OPG may set off any amount owing to OPG from the Contractor from any amount otherwise owing by OPG to the Contractor.

10.7 Waivers

No waiver of any term of this Agreement is binding unless it is in writing and signed by all the parties entitled to grant the waiver. No failure to exercise, and no delay in exercising, any right or remedy, under this Agreement will be deemed a waiver of that right or remedy. No waiver of any breach of any term of this Agreement will be deemed to be a waiver of any subsequent breach of that term.

10.8 Cumulative Remedies

OPG's rights and remedies under this Agreement and under any security held by OPG for the Contractor's performance under this Agreement are cumulative and are in addition to and not in substitution for any other rights and remedies available at law or in equity or otherwise. No single or partial exercise by a Party of any right or remedy precludes or

otherwise affects the exercise of any other right or remedy to which that Party may be entitled.

10.9 Survival of Obligations

The terms of this Agreement will survive the termination or expiration of this Agreement to the extent necessary to preserve the rights of the Parties that were in existence immediately before or on the termination or expiration of this Agreement.

10.10 Relationship of Parties

The relationship between the Parties is that of a purchaser and an independent contractor. The Contractor will have no authority to bind OPG or to assume or create any obligation or responsibility express or implied on OPG's part or in its name, nor will the Contractor represent to anyone that the Contractor has such power or authority, except as expressly provided in this Agreement.

10.11 No Third Party Beneficiary

This Agreement is solely for the benefit of the Parties and, to the extent expressly and specifically made, beneficiaries of this Agreement. In particular, the Parties hold the rights of all third party beneficiaries in trust for the benefit of such third party beneficiaries. Otherwise, no term of this Agreement will be deemed to confer upon other third parties any claim, remedy, reimbursement or other right. The Contractor represents and warrants to OPG that the Contractor is entering into this Agreement solely on its own behalf and not as agent for any other Person.

10.12 Acknowledgement as to Negotiation of this Agreement

Each Party acknowledges that all Parties have participated in the drafting of this Agreement. Accordingly, no term of this Agreement will be interpreted less favourably to any Party because that Party or its counsel was primarily responsible for the drafting of that term.

10.13 Choice of Language

The Parties confirm that it is their wish that this Agreement, as well as any other documents respecting this Agreement, including Notices, schedules and authorisations, have been and will be drawn up in the English language only.

10.14 Counterparts

This Agreement and any Amendment, restatement or termination of this Agreement in whole or in part may be signed and delivered in any number of counterparts, each of which when signed and delivered is an original but all of which taken together constitute one and the

same instrument. Any counterpart signature transmitted by sending a scanned copy by electronic mail or similar electronic transmission will be deemed an original signature.

The Parties have duly executed this Agreement.

ONTARIO POWER GENERATION INC.

By:

Name: Robert De Bartolo
Title: Director, Supply Services

BURNS & McDonnel Canada, Ltd

By:

GIL
CMS

Name: Christopher Lehan
Title: Vice President, Energy

Schedule A - Amendment Form

AMENDMENT AGREEMENT NUMBER [1]

This Agreement is made as of [•], between

ONTARIO POWER GENERATION INC., a corporation existing under the laws of Ontario ("**OPG**"),

and

BURNS & McDONNELL CANADA, LTD, a corporation existing under the laws of Ontario (the "**Contractor**").

Recitals

A. OPG and the Contractor entered into an independent oversight services agreement dated as of **[DATE]** (the "**Original Agreement**"). Under the Original Agreement, the Contractor is obliged to [•] on the terms and conditions set out in the Original Agreement.

B. OPG and the Contractor have agreed to amend the Original Agreement to [•].

For value received, the Parties agree as follows.

1. Interpretation

Any defined term used in this Agreement that is not defined in this Agreement has the meaning given to that term in the Original Agreement. In this Agreement, the following terms have the respective meanings set out below.

(a) **[Insert any definitions required in this Agreement.]**

2. Change to Section [•] (Title of Section)

Section [•] of the Original Agreement is deleted in its entirety and replaced with the following. OR Section [•] of the Original Agreement is deleted in its entirety. OR The following section is added as a new section [•] to the Original Agreement.

3. Change to Section [•] (Title of Section)

Section [•] of the Original Agreement is deleted in its entirety and replaced with the following. OR Section [•] of the Original Agreement is deleted in its entirety. OR The following section is added as a new section [•] to the Original Agreement.

4. Original Agreement Remains in Full Force

Except for changes to the Original Agreement set out in this Agreement and any previous Amendment, the Original Agreement remains in full force, unamended.

The Parties have duly executed this Agreement.

ONTARIO POWER GENERATION INC.	**CONTRACTOR**
By: _____	By: _____
Name:	Name:
Title:	Title:

SCHEDULE B

STANDARD FORM

BUSINESS EXPENSE SCHEDULE

Effective June 17, 2009

For

ONTARIO POWER GENERATION INC.

Updated July 27th, 2010

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BUSINESS EXPENSE SCHEDULE

RECITALS

A. Ontario Power Generation Inc. ("**OPG**") entered into an agreement (the "**Agreement**") with the other party to the Agreement (the "**Contractor**"). This schedule (this "**Schedule**") forms part of the Agreement. Under the Agreement, OPG agreed to reimburse the Contractor for certain business expenses incurred by employees of the Contractor ("**Eligible Employees**") in performing work for OPG under the Agreement.

B. This Schedule sets out the terms on which OPG will reimburse the Contractor for business expenses incurred by Eligible Employees in performing work for OPG.

SECTION 1 – INTERPRETATION

1.1 Three Types of Reimbursement

OPG will reimburse the Contractor for expenses that are eligible for reimbursement in accordance with this Schedule. OPG will make the reimbursements in one of three ways respecting each Eligible Employee in respect of whom reimbursements are payable. The three ways of reimbursement are:

(a) reimbursement of individually incurred Allowable Expenses as set out in section 2 through section 5;

(b) payment on a flat rate daily basis as set out in section 6; or

(c) payment on a flat rate monthly basis as set out in section 7.

Except as expressly set out in section 6 or section 7, if OPG pays the Contractor the daily or monthly rate in respect of an Eligible Employee, OPG will reimburse the Contractor no Allowable Expenses in respect of that Eligible Employee.

1.2 Definitions

In this Schedule, the following terms have the respective meanings set out below:

(a) **Agreement** is defined in Recital A.

(b) **Allowable Expenses** is defined in section 2.1.

(c) **Business Day** means any day other than a Saturday, Sunday, New Year's Day, Family Day, Good Friday, Easter Monday, Victoria Day, Canada Day, Civic Holiday, Labour Day, Remembrance Day, Thanksgiving Day, Christmas Day and Boxing Day.

(d) **Contractor** is defined in Recital A.

(e) **Eligible Employees** is defined in Recital A.

(f) **Home Base** means the permanent residence of the Eligible Employee.

(g) **OPG Representative** is defined in section 2.1(d).

(h) **Schedule** is defined in Recital A.

(i) **Work Site** means a location at which the Eligible Employee is ordinarily required to provide services to OPG under the Agreement.

1.3 Headings

The division of this Schedule into sections, the insertion of headings and the provision of a table of contents are for convenience of reference only and are not to affect the construction or interpretation of this Schedule.

1.4 Expanded Definitions

Unless otherwise specified, words importing the singular include the plural and vice versa and words importing gender include all genders. The term "**including**" means "including without limitation", and the terms "**include**", "**includes**" and "**included**" have similar meanings. The term "**will**" means "shall".

1.5 Business Day

If under this Schedule any payment or calculation is to be made on or as of a day which is not a Business Day, that payment or calculation is to be made on or as of the next day that is a Business Day.

1.6 Payment Currency

Except as expressly set out in the Agreement, amounts to be paid or calculated under this Schedule will be paid or calculated in Canadian dollars. Any amounts to be paid or calculated which are denominated in a foreign currency will be converted into Canadian dollars, within three Business Days of the invoice date, using the Bank of Canada nominal noon exchange rate, as posted on the Bank of Canada website (currently located at www.bankofcanada.ca).

1.7 Conflict

If there is conflict between any term of this Schedule and any term in another part of the Agreement, the relevant term in the other part of the Agreement will prevail.

1.8 Notice

Any notices to be given under this Schedule will be given in accordance with the notice terms set out elsewhere in the Agreement.

SECTION 2 - REIMBURSEMENT OF ALLOWABLE EXPENSES

2.1 Allowable Expenses

OPG will only reimburse the Contractor for the following eligible expenses ("**Allowable Expenses**") to the extent they otherwise meet the requirements of this Schedule and the rest of the Agreement:

(a) air, rail and bus travel expenses permitted under section 3;

(b) vehicle expenses permitted under section 4;

(c) lodging expenses permitted under section 5; and

(d) any other expenses which have been approved in writing by the OPG individual managing the Agreement (the "**OPG Representative**").

2.2 Expenses Minimised

Notwithstanding any term in this Schedule, the Contractor will use all reasonable efforts to ensure that Eligible Employees minimise Allowable Expenses and the Contractor will ensure that all Allowable Expenses are reasonable and properly incurred in a manner consistent with effective and efficient business practice. OPG is not obliged to reimburse any expenses which are not so incurred. Eligible Employees who normally live together are expected to share accommodations and vehicle expenses, where reasonable.

2.3 Excluded Items

Notwithstanding any term in this Schedule, OPG will not reimburse any amounts to the Contractor or any Eligible Employee for any hospitality, food or incidental expenses, including, but not limited to, in respect of the following:

(a) meals, snacks, alcoholic and non-alcoholic beverages

(b) any expense whatsoever if the one way distance between the Eligible Employee's Home Base and the Work Site is less than 100 kilometres;

(c) gratuities;

(d) airline or railway club dues, fees or other charges;

(e) personal service expenses, including hair care, shoe shine, toiletry and spa treatment expenses;

(f) laundry, dry cleaning or valet expenses;

(g) hotel telephone charges or internet access

(h) personal telephone calls;

(i) cellular telephones, data devices (for example, Blackberries) or other communication devices;

(j) entertainment or recreation expenses, including pay-per-view, video, compact disk or DVD rental, in-room entertainment, games, gaming, reading, sports or exercise expenses;

(k) headsets or other in-flight expenses;

(l) dependant care expenses

(m) pet care expenses;

(n) mini bar charges or sundry items (including gum and snacks);

(o) credit card interest or other credit card expenses;

(p) automobile washes;

(q) fines or other expenses assessed or otherwise incurred in respect of traffic or parking violations; or

(r) fees or other expenses for toll highways or vehicle rental agency administration charges for use of toll highways.

2.4 Method of Reimbursement

OPG will reimburse the Contractor for Allowable Expenses which otherwise meet the requirements of this Schedule and the rest of the Agreement in accordance with the following terms.

(a) **Monthly Invoice.** The Contractor will deliver to OPG, to the address indicated in the purchase order or Agreement, on a monthly basis, an invoice for Allowable Expenses in a form and manner acceptable to the OPG Representative, acting reasonably. The Contractor will deliver to the OPG Representative, a copy of the invoice and will ensure that the invoice legibly itemises and, if necessary, briefly describes all Allowable Expenses. The Contractor will not invoice or otherwise charge OPG for any expenses other than Allowable Expenses. The Contractor will ensure that all expenses claimed on each such invoice meet the requirements of this Schedule and the rest of the Agreement and are first approved by the Contractor. If the Contractor fails to deliver an invoice to OPG for an expense within six months of the expense being incurred, OPG will not be obliged to reimburse the Contractor for such expense.

(b) **Receipts.** The Contractor will deliver to the OPG Representative, together with a copy of the invoice, original official itemised receipts for each Allowable Expense claimed (including airline, railway or bus ticket passenger coupons or electronic tickets, boarding passes, vehicle rental contracts, itemised hotel bills and travel itineraries). The Contractor will separate expenses for each Eligible Employee. Debit card and credit card receipts are not acceptable without the

itemised receipt. OPG will not accept electronic, photocopied or fax copies of receipts.

(c) **GST/HST Deducted.** The Contractor will deduct all Canadian goods and services tax/harmonized sales tax levied under the *Excise Tax Act* (Canada) recovered or recoverable by the Contractor on the payment of expenses before submitting any invoice to OPG covering any Allowable Expenses. The Contractor will ensure that each such invoice will separately set out all Canadian goods and services tax /harmonized sales tax levied under the *Excise Tax Act* (Canada) and reimbursable by OPG under this Schedule.

(d) **Reimbursement.** OPG will reimburse the Contractor for Allowable Expenses which meet all of the requirements of this Schedule, received and approved by OPG before the 25th of each month on the 25th of the following month.

The Contractor will ensure that all Eligible Employees initially pay for expenses using their own payment methods. OPG will not provide any advances respecting Allowable Expenses. The Contractor is exclusively responsible for the reimbursement of expenses to all Eligible Employees. Failure by the Contractor to comply with the requirements of this Schedule and the rest of the Agreement may result in delay of reimbursement of expenses or rejection of any invoice in whole or in part.

2.5 Travel Agency

OPG has and may in the future negotiate rates with a travel service to reduce travel and lodging expenses. Unless OPG provides the Contractor with written notice stating otherwise, or the Contractor can demonstrate it can obtain lower rates from providers other than American Express Business Travel, the Contractor will ensure that all Eligible Employees process travel requirements through American Express Business Travel. OPG also encourages the Contractor to have all vehicle rental and hotel arrangements made through American Express Business Travel. American Express Business Travel may be reached in Canada and the United States at 1-866-868-4441. The Contractor will ensure that all Eligible Employees travelling for the purpose of providing services under the Agreement identify themselves to American Express Business Travel as such.

2.6 Confirming Rates

The Contractor will ensure that the rates booked by it or an Eligible Employee are the same or lower than that listed on the travel itinerary.

2.7 Home Base and Work Site

Where applicable, the Contractor will specify in each invoice the Home Base and the Work Site for each Eligible Employee. At OPG's request, the Contractor will provide written confirmation from each Eligible Employees as to the employee's permanent residence and street address. A post office box is not an acceptable street address.

SECTION 3 – AIR, RAIL OR BUS TRAVEL

3.1 Air, Rail or Bus Travel

The expense of air, rail and bus travel is an Allowable Expense to the extent the actual amount of airfare or, rail or bus fare was incurred by an Eligible Employee in providing services to OPG under the Agreement and to the extent of compliance with the other requirements of this Schedule and the rest of the Agreement. The Contractor will cause Eligible Employees, to the extent possible, to take advantage of hotel and airport shuttles where available. OPG will reimburse the Contractor for the expenses actually incurred by an Eligible Employee for travel between the Eligible Employee's Home Base, Work Site or hotel and the airport, railway station or bus terminal where the Eligible Employee arrives or departs. In addition, the amount of any such reimbursement may not exceed the lesser of:

(a) the expense of the taxi fare or other similar out of pocket charge to travel to or from the airport, railway station or bus terminal; and

(b) if applicable, parking charges at the airport, railway station or bus terminal.

3.2 Economy Class

Air expenses are not Allowable Expenses unless the Eligible Employee travels on economy class or equivalent. Rail expenses will be permitted for travel by VIA 1 or equivalent.

3.3 Vehicle Instead of Air, Rail or Bus Travel

OPG will only reimburse the Contractor for use of a personal vehicle or rental car for trips which would customarily be travelled by air, rail or bus, for the amount which is equal to the lesser of:

(a) the expense of the airfare, rail fare or bus fare that would have been reimbursed by OPG to the Contractor under section 3; and

(b) the amount that would otherwise be reimbursable by OPG to the Contractor for vehicle travel pursuant to section 4.

OPG will not reimburse the Contractor for any lodging that would not have been incurred had the trip been made by air, rail or bus.

3.4 Visits Home

OPG will reimburse air, rail or bus travel expenses for a maximum of one round trip home per month for each Eligible Employees on assignment at a Work Site where the duration is more than 45 days and the Home Base of that employee is greater than 400 kilometres from the Work Site.

3.5 Minimising Expenses

The Contractor will, to the extent possible, cause all air travel, to be by "lowest logical airfare", to take advantage of weekend specials and other discount fares and to reduce overall expenses and plan ahead (booking at least two weeks before the departure date is expected).

SECTION 4 - VEHICLES

4.1 Reimbursable Vehicle Expenses

The expense of rental vehicles or personal vehicles used by Eligible Employees will be an Allowable Expense to the extent that:

(a) the use of the vehicle was for official OPG business;

(b) the one way distance between the Eligible Employee's Home Base and the Work Site is greater than 100 kilometres or the Eligible Employee is required to provide services at a location other than the Eligible Employee's Work Site;

(c) the use of the rental vehicle was pre-approved in writing by the OPG Representative; and

(d) the expense otherwise meets the requirements of this Schedule and the rest of the Agreement.

4.2 Terms of Rental

The Contractor will make all bookings of rental vehicles through American Express Business Travel or directly with one of the OPG approved rental car agencies. The Contractor will book only mid size or smaller vehicles unless otherwise approved in writing by the OPG Representative where circumstances require it (for example, a van to carry equipment or a large group). When the Contractor books a rental vehicle, the Contractor will make the following selections when asked to select insurance coverage:

(a) where collision damage waiver is provided through the credit card company, the Contractor will decline collision damage waiver insurance; and

(b) where collision damage waiver is not provided through the credit card company, the Contractor will accept collision damage wavier insurance.

Where the Contractor fails to comply with sections 4.2(a) or 4.2(b), any additional expense that is incurred by failing to comply with either of those sections will not constitute an Allowable Expense.

4.3 Personal Vehicle

OPG will not reimburse the Contractor for use of a personal vehicle by an Eligible Employee for the first 200 kilometres of any trip (round trip), except if the Eligible Employee is required to provide services at a location other than the Eligible Employee's Work Site. If otherwise in accordance with the terms of this Schedule, OPG will reimburse the Contractor as an Allowable Expense for all personal vehicle travel by an Eligible Employee in excess of 200 kilometres (round trip), at the published rates per kilometre on the date of invoice, for vehicle expenses for Ontario set out on the Canada Revenue Agency website (http://www.cra-arc.gc.ca/tx/llrts/menu-eng.html). This Canada Revenue Agency amount covers all vehicle related expenses, except parking.

4.4 Reducing Expenses

The Contractor will use all reasonable attempts to reduce the expenses of vehicle travel by:

(a) arranging for employees to share vehicles to minimise travel expense;

(b) requiring Eligible Employees to use a rental vehicle and refuel it before returning it;

(c) considering a long-term lease for lengthy work assignments (that is, more than 30 consecutive days) when the Eligible Employee requires a rental vehicle; and

(d) requiring Eligible Employees to use public transit when travelling to locations within or around urban centres.

4.5 Multiple Users

OPG will only reimburse the Eligible Employee whose vehicle is used when two or more Eligible Employees travel in one vehicle. If two or more Eligible Employees share a rental vehicle, OPG will only reimburse the Eligible Employee who incurred the expense.

SECTION 5 - LODGING

5.1 Overnight Accommodation

The expense of overnight accommodation for Eligible Employees will be an Allowable Expense to the extent that the overnight stay was pre-approved in writing by the OPG Representative and to the extent that the expense otherwise meets the requirements of this Schedule and the rest of the Agreement. The OPG Representative will not approve any overnight accommodation unless:

(a) the presence of the Eligible Employee is required at a Work Site which is more than 200 kilometres (one way) from that Eligible Employee's Home Base; or

(b) poor weather creates hazardous driving conditions and the Eligible Employee cannot safely return to the Eligible Employee's Home Base.

The Contractor will include a written explanation for all overnight accommodation with the invoice.

SECTION 6 - DAILY RATES

6.1 Daily Rates Instead of Allowable Expenses

To the extent this section 6 applies to any Eligible Employee, none of the terms of section 2 to section 5 apply, except for any Allowable Expenses for air, rail or bus travel between an Eligible Employee's Work Site and Home Base that is reimbursable in accordance with section 3.

Notwithstanding the previous sentence, the temporary residence (where the Eligible Employee resides while working on the OPG project) will be considered the Home Base for the purposes of calculating Allowable Expenses in the event the Eligible Employee is required to travel to a location other than the Work Site.

6.2 Daily Rates

Before the commencement of, or at any time during, a work assignment for any Eligible Employee, OPG may elect based on the remaining duration of the work assignment, the distance between the Eligible Employee's Home Base and the Work Site or for other reasons to pay the Contractor a daily rate in respect of that Eligible Employee rather than to reimburse the Contractor for Allowable Expenses.

6.3 All Inclusive

Except as expressly set out in this section 6, the daily rate set out in section 6.4 is inclusive of all expenses whatsoever that will be reimbursed by OPG, including expenses respecting accommodation, local transportation, work permits and fees, utilities, communication charges, furnishings, insurance and any Allowable Expenses that would otherwise be reimbursable to the Contractor under section 2 to section 5.

6.4 Rates

Subject to adjustment under section 6.5, the following are the daily rates that OPG will pay the Contractor in respect of Work Sites:

(a) City of Toronto [redacted]; and

(b) all other locations, [redacted] (including Mississauga, Pickering, Whitby and Darlington).

6.5 Application of Rate

Where OPG has elected to pay the daily rate for an Eligible Employee, OPG will pay the daily rate to the Contractor on a monthly basis for that Eligible Employee for each full day that the Eligible Employee provided services under the Agreement and for each weekend day unless the Eligible Employee surrendered his or her accommodations. The daily rate will not be paid for any period of an unexcused absence or when the Eligible Employee has surrendered the Eligible Employee's accommodation during a home visit or absence (includes unavailability to work on weekends if trip home was taken on the weekend). The daily rate will be reduced by [redacted] for each day of approved trips home and on the last day of providing services under the Agreement. Where OPG has elected to pay the daily rate for Eligible Employees who normally live together, the Eligible Employees are expected to share accommodations. Adjustments may be made to the daily rate set out in section 6.4 if Eligible Employees share accommodations and other expenses.

6.6 Method of Reimbursement

OPG will pay the Contractor the applicable daily rate in accordance with the following terms.

(a) **Monthly Invoice.** The Contractor will provide OPG, on a monthly basis, with an invoice listing the number of Eligible Employees for whom the Contractor is claiming the daily rate and the number of days being claimed for each Eligible Employee. The Contractor will ensure that the invoice includes a description of the work package or project name and project number (and work breakdown structure element if applicable).

(b) **Evidence of Expenses.** The Contractor will provide OPG with original itemised receipts and time sheets evidencing that the Eligible Employee attended the Work Site and made use of temporary accommodation on each day for which the daily rate is being requested. Debit card and credit card receipts are not acceptable without the itemised receipt.

Failure by the Contractor to comply with the requirements of this Schedule and the rest of the Agreement may result in delay of reimbursement of expenses or rejection of any invoice in whole or in part.

6.7 Absences

Unless authorised in writing by the OPG Representative, OPG will not be required to pay the daily rate for an Eligible Employee where that Eligible Employee was absent from the Work Site without having been excused by the OPG Representative or where that Eligible Employee did not make use of the Eligible Employee's accommodation during an absence from the Work Site (other than an absence required to perform services to OPG under the Agreement). The OPG Representative may consider authorising payment of the daily rate for absences such as an infrequent sick day or medical appointments requiring exams or tests.

SECTION 7 – MONTHLY RATES

To the extent this section 7 applies to any Eligible Employee, none of the terms of section 2 to section 6 apply, except for any Allowable Expenses for air, rail or bus travel between an Eligible Employee's Work Site and Home Base that is reimbursable in accordance with section 3. [redacted] All the terms of section 6 apply to the calculation of this monthly rate, with such modifications as the circumstances require.

Schedule C – Scope of Services

Introduction

Ontario Power Generation Inc.'s ("**OPG**'s") Canadian Deuterium Uranium (CANDU®) reactors are designed to provide decades of safe and reliable electricity generation. Mid-way through the reactor's life, replacement of some of the key reactor and station components is required to allow for continued operation for approximately 30 additional years. OPG is moving forward with plans for the mid-life refurbishment of the Darlington Nuclear Generating Station Refurbishment Program (the "**Refurbishment Program**" or "**DRP**"). For more information on the Refurbishment Program please visit www.opg.com. The purpose of this Scope of Services document is to provide an outline of OPG's requirements for independent oversight of the Refurbishment Program (the "**Services**"). The entity retained to perform the Services (the "**Independent Advisor**") will report directly to the Darlington Refurbishment Committee (the "**DRC**"), which is a subcommittee of OPG's Board of Directors. The Independent Advisor will: (i) receive its assignments from the DRC; (ii) provide its reports to the DRC: and (iii) provide its reports to others as directed by the DRC.

1. Purpose of the Independent Advisor

The purpose of the Independent Advisor is to advise the DRC on the project management aspects of the Refurbishment Program as a whole and any specific projects that are part of the Refurbishment Program (each, the "**Refurbishment Project**" and collectively, the "**Refurbishment Projects**"). The Independent Advisor will be responsible for making impartial assessments to ensure that the DRP management team's (the "**Refurbishment Team**") actions are meeting expectations and commitments. The DRC, supported by the Independent Advisor, is part of a four layer reporting structure, as follows:

- **SVP – Nuclear Projects:** The SVP – Nuclear Projects ensures that the resources, processes, programs and reports needed to promptly identify deficiencies and trends, and to correct those conditions and the underlying causes, are established and effectively implemented. These processes include those implemented by the contractors supporting the Refurbishment Program, as well as those implemented by OPG.

- **Chief Nuclear Officer ("CNO"):** The CNO, through the implementation of the Nuclear Management System, is accountable for ensuring the effective assessment and oversight of the Refurbishment Program and for taking corrective action when the Refurbishment Team oversight or effectiveness is lacking. If the SVP – Nuclear Projects is not detecting and correcting problems, the CNO must be in a position to identify the shortfall and step in to ensure the situation is corrected, and that the underlying oversight gaps are corrected.

- **Chief Executive Officer ("CEO") and Enterprise Leadership Team ("ELT"):** The CEO ensures that the programs and approach to the Refurbishment Program are appropriate and that the CNO is effectively carrying out his role and accountabilities. The CEO also ensures that the ELT is properly applying other company-wide support to the Refurbishment Program such as safety, finance, supply chain, regulatory cost recovery, human resources, ethics, risk, and communications.

- **Board of Directors**: The Board of Directors ensures that a committee structure (the DRC) is

established such that each of the major elements supporting a successful refurbishment are periodically examined by the Board, through the DRC. The DRC will retain independent assessment resources (the Independent Advisor) to periodically evaluate the accuracy and completeness of information provided by the CEO and ELT, and to determine if management is effectively identifying and resolving issues.

Additional details of this structure are available in Appendix A.

In order to enable the Independent Advisor to effectively perform the Services, OPG will provide the Advisor access to information related to the Refurbishment Program and access to any logistical or other support that the Advisor may request from OPG from time to time.

2. Independent Advisor Team

The Independent Advisor will establish a suitably qualified and experienced team of approximately two to four individuals with the appropriate mega-project experience and other necessary expertise to provide the Services. The Independent Advisor may retain additional experts from time to time if required. All such individuals must be agreed to by the DRC. It is acknowledged that the identity of these individuals may change over time. The Independent Advisor will provide the Services by providing the DRC with quarterly independent assessments and reports, as more particularly described below.

3. Description of the Scope of Services

a) The Independent Advisor will evaluate the accuracy and completeness of information provided by the Refurbishment Team to determine if management is effectively identifying and resolving issues. The Independent Advisor will determine how best to achieve this, however, it may include the following activities:

- Identify emerging trends and/or potential risks with respect to costs, schedules, resourcing, contractor oversight, etc.;
- Review all internal oversight reports to determine if the Refurbishment Team is identifying and correcting issues and adverse conditions in an effective manner;
- Review OPG's and the contractors' corrective action programs (CAP) to determine if they are capturing adverse conditions and providing effective solutions;
- Review Refurbishment Program and Refurbishment Projects metrics to ensure they are appropriate and to determine accuracy and fidelity;
- Review Board of Directors' reports for accuracy and fidelity;
- Identify whether there are any significant unresolved challenges.

b) The Independent Advisor will independently test the effectiveness of the Refurbishment Projects' programs. The Independent Advisor will determine how best to achieve this, however, it may include the following activities:

- Evaluate proposed or existing project organization, processes, and systems;

- Execute specific monitoring, reviews and oversight to ensure that the Refurbishment Program remains on track;
- Identify weaknesses in Refurbishment Program controls and systems, and provide recommendations for improvement;
- Evaluate the Refurbishment Team's readiness for key transitions;
- Evaluate effective progression of key Refurbishment Program activities;
- Periodically assess the effectiveness of issue resolution, risk mitigation, contingency planning and deployment;
- Independently evaluate the integrated effectiveness of the OPG and contractor teams;
- Confirm that the expectations and outcomes for each functional group as explicitly stated in such group's program management plans are current, complete and correct and are being executed effectively and efficiently;
- Confirm the readiness OPG and the contractors' Supply Chain to deliver equipment and materials when needed.

c) The Independent Advisor will evaluate the internal oversight and assurance programs confirming they are robust, built on clear roles and accountabilities and to the extent possible are free of redundancy. The Independent Advisor will determine how best to achieve this, however, it may include the following activities:

- Confirm that assurance processes are in place and are working;
- Align assurance activities with the Darlington Refurbishment Assurance Plan to avoid overlap (i.e., independent resource should focus assurance activities on project management, vendor performance, contractor and subcontractor management, contingency and risk management and retube and feeder replacement construction and tooling);
- Evaluate the Darlington Refurbishment Assurance Plan and report on its effectiveness;
- Assess whether processes are in place to address risks identified in Enterprise Risk Management reports and findings from other external assessments (e.g., the WANO Corporate Peer).

4. Performance of the Services and Reporting

a) The focus of the Independent Advisor is to be forward looking; advising the DRC of any future risks. In addition, the Independent Advisor is to identify trends, any real or perceived blind spots that the Refurbishment Team is unaware of, or is not adequately addressing.

b) It is expected that the DRC will advise the Independent Advisor at the beginning of each year of the dates of the DRC meetings at which a report from the Independent Advisor will be required (approximately quarterly).

c) Approximately one month before each such DRC meeting, OPG will provide the Independent Advisor with the materials and information described in section 5 below.

d) The Independent Advisor will conduct visits prior to each such DRC (various Refurbishment Project and contractor sites) to examine the Refurbishment Team performance in order to report on the matters described in section 3 above. These visits would typically involve observing the

Refurbishment Project and would involve a large amount of interaction with the Refurbishment Team.

e) At any time the Independent Advisor sees a major issue that is or will impact the performance of the Refurbishment Project, the Independent Advisor will communicate it immediately to the Refurbishment Team or OPG management.

f) After completing the visits and reviewing the materials and information described in sections 4(c) and (d), the Independent Advisor will prepare a draft written report to be reviewed by the Refurbishment Team for accuracy approximately two weeks prior to the DRC meeting. The Independent Advisor will use its judgement to determine which comments from the Refurbishment Team should be included. In the report, the Independent Advisor will summarize all findings and will include recommendations if requested by the DRC. The written reports information will be prepared at an appropriate level for the DRC members.

g) The final written report will be provided to the DRC members approximately 10 days in advance of the DRC meetings. The Board of Directors' meetings are usually held in: March, June, August and November.

h) All information is the property of OPG and must remain confidential.

5. Support Provided by OPG for Board Reporting

In order to enable the Independent Advisor to complete its reports, OPG will provide the Independent Advisor with the following:

a) Access to all non-confidential Refurbishment Program information. Confidential information will be provided pending approval from OPG;
b) Access to OPG facilities as necessary to complete the assessments/reports;
c) Any additional support (i.e., coordinating meetings, security clearances, training, etc.) necessary to complete the assessments/reports.

Appendix A: Darlington Refurbishment Program: Oversight and Assurance

The purpose of this Appendix A is to: i) describe the robust and layered framework for oversight of the Refurbishment Program; ii) clarify the key roles, responsibilities and accountabilities; and iii) clarify the Board of Directors' roles and accountabilities within the framework.

Key Roles and Accountabilities in Oversight and Assurance

The DRP oversight and assurance program structure, by design, incorporates multiple layers of oversight to support building and maintaining internal and external confidence.

Each layer must be constructed in a manner that avoids supplanting the management decision making process, and that reinforces accountability for finding and fixing problems at the lowest applicable organizational level. These successive layers of oversight must focus on evaluating the effectiveness of subordinate programs, and on testing the accuracy and completeness of information.

The key roles in providing oversight of the Refurbishment Program are:

- **SVP – Nuclear Projects:** SVP – Nuclear Projects ensures that the resources, processes, programs and reports needed to promptly identify deficiencies and trends, and to correct those conditions and the underlying causes, are established and effectively implemented. These processes include those implemented by the contractors supporting refurbishment, as well as those implemented by OPG.

- **Chief Nuclear Officer ("CNO"):** The CNO, through the implementation of the Nuclear Management System, is accountable for ensuring the effective assessment and oversight of the Refurbishment Program and for taking corrective action when the Refurbishment Team oversight or effectiveness is lacking. If the SVP – Nuclear Projects is not detecting and correcting problems the CNO must be in a position to identify the shortfall and step in to ensure the situation is corrected, and that the underlying oversight gaps are corrected.

- **Chief Executive Officer ("CEO") and Enterprise Leadership Team ("ELT"):** The CEO ensures that the programs and approach to the Refurbishment Program are appropriate and that the CNO is effectively carrying out his role and accountabilities. The CEO also ensures that the ELT is properly applying other company-wide support to the Refurbishment Program such as finance, supply chain, regulatory cost recovery, human resources, ethics, risk, and communications.

- **Board of Directors**: The Board of Directors ensures that a committee structure (the DRC) is established such that each of the major elements supporting a successful refurbishment are periodically examined by the Board of Directors, through the DRC. The Board of Directors has tasked the DRC to provide oversight of the Refurbishment Program, including through independent assessment resources (the Independent Advisor), on behalf of the Board of Directors. The Board of Directors also retains supplemental independent assessment resources to periodically evaluate the accuracy and completeness of information provided by the CEO and ELT, and to determine if management is effectively identifying and resolving issues.

Detailed Accountabilities and Reporting

***SVP – Nuclear Projects* – Accountabilities and Reporting**

The SVP – Nuclear Projects and his Refurbishment Leadership Team are accountable for execution of a robust set of oversight and assurance programs and resources to ensure that issues are identified, reported, evaluated and corrected. These programs and structures look at all elements of the Refurbishment Program and report up to the CNO:

Nuclear Projects Leadership Team	Actively monitors and assesses project performance to determine if activities are progressing on plan and that safety, quality schedule and cost requirements are being met.
Project Planning & Controls Organization	Ensures cost and schedule compliance, complete and accurate metric and progress reports, conducts surveillances of the project and contractors and raises any gaps promptly.
Quality Management Organization	Through direct assessment and intervention confirms that contractors, subcontractors and suppliers are meeting quality expectations and that all needed regulatory documentation is being created and maintained. Performs specialized and regulatory required quality inspections.
Project Assurance Organization	Maintains Management System and associated programs and projects, conducts assessments to determine effectiveness and facilitates implementation of any corrective actions. Provides support for management of contracts used in execution of the Refurbishment Program.
Project Management	Oversees project deliverables and the day-to-day progress of the projects, removing barriers to expedite the work and ensuring that quality requirements are achieved on time and on budget. Project Managers maintain specific metrics for safety, quality, cost and schedule and promptly document and escalate any significant performance shortfall.
Contractor Executive Steering Committees	Steering committees have been established for each major contractor to address any emerging issues, ensure issues are escalated, ensure ongoing dialogue at all levels and share oversight findings.
Contractor Quality	During contract formation, provisions were included that require implementation oversight and assurance processes on the part each contractor. Engineering, procurement and construction (EPC) contractors are responsible for establishing and executing these programs to ensure that their activities, and those of their subcontractors, meet expectations. OPG will monitor contractor compliance in this area.

***CNO and Nuclear Management System* – Accountabilities and Reporting**

The CNO, through the Nuclear Management System and the Nuclear Leadership Team, is accountable for execution of robust oversight and assurance to ensure the established DRP programs are properly implemented and effective in finding and correcting issues:

Nuclear Leadership Team	Provides assurance that project performance is following the Nuclear Management System and that the Refurbishment Leadership Team is consistently finding and correcting their own issues.
Regulatory Affairs	External regulators such as the Canadian Nuclear Safety Commission (CNSC), Ministry of Labour (MOL), Ministry of Environment (MOE), perform assessments of compliance. OPG anticipates and addresses issues in a way that maintains and builds regulatory confidence.
Industry Assistance and Assessment (WANO/INPO)	Nuclear industry organizations are utilized to provide assistance in risk significant areas to help the team understand the current state of performance, to compare to industry standards and to help develop needed gap closure plans. They periodically evaluate corporate and station performance, comparing performance to established industry standards and highlighting significant gaps. The results of these evaluations are reported to the CNO and CEO who direct the development and implementation of plans addressing the areas for improvement. This information is shared with the Board of Directors.
Nuclear Safety Review Board ("NSRB")	NSRB provides independent assessment of continued safety of operating units, application of the Nuclear program, quality assurance, and the safe return to service of units.
Nuclear Oversight Organization	Nuclear Oversight Organization conducts audits, surveillance and assessments to ensure that the Refurbishment Program meets the requirements of the Nuclear Management System. The findings are reported to the CNO for action and are shared with the NSRB/Refurbishment Program Review Board (RPRB), and the Nuclear Oversight and Darlington Refurbishment Committees of the Board of Directors.

***CEO and Enterprise Leadership Team (ELT)* – Accountabilities and Reporting**

The CEO is accountable for the execution of robust oversight and assurance to ensure that the CNO and Nuclear Management System are properly implemented and effective in finding and correcting issues. In addition, the CEO utilizes the broader ELT to ensure that the company's financial, risk, legal, human resources and ethics programs and standards are properly applied to the refurbishment program, and provides timely and complete reports to the Board of Directors:

Enterprise Leadership Team Quarterly Review	Reviews the performance of the Darlington Nuclear Refurbishment Program on a quarterly basis, including: ➢ CNO report on quality, safety, schedule and cost; ➢ Chief Financial Officer (CFO) report on financial controls application, and other financial implications; ➢ Chief Rick Officer (CRO) report on enterprise risks that stem from or impact the Refurbishment Program and on the effectiveness of the risk management program; ➢ SVP – Law, Regulatory Affairs and Environment and Chief Ethics Officer report on legal and ethics issues; ➢ Human Resources report on staffing, training, and safety performance; ➢ Internal and external audit and assessment reports; ➢ Insights provided by the Refurbishment Program Review Board (RPRB).
Refurbishment Program Review Board ("RPRB")	RPRB is being created to provide independent oversight of the Refurbishment Program, similar to the role of the NSRB at the operating stations. Three senior experts with regulatory, mega-project and plant expertise will review the status of the project and report to ELT on a quarterly basis.
Internal Audit	Internal Audit verifies that management has designed and operated processes and controls to meet project and enterprise objectives. The Strategic Audit Plan includes risk-based audits aligned with the top risks and objectives identified by management. The ELT will review and act to resolve the findings and recommendations resulting from the Strategic Audit Plan.

Board of Directors – Accountabilities and Reporting

i) Board of Directors Independent Resources

To assist the Board of Directors in maintaining the capability to independently test the effectiveness of the DRP programs, and to confirm the accuracy and completeness of information provided by the Refurbishment Team, the Board of Directors will retain ongoing or periodic resources and receive reports from the following:

Board of Directors Independent External Assessment Resource	The Board of Directors, through the DRC, retained an expert advisor The Board of Directors will retain an independent external resource for the Execution Phase.
Minister of Energy's	The Minister of Energy has currently retained an expert ([redacted]) who is co-located with the Refurbishment Team and

Independent Assessment Resource	regularly reports on the health of the Refurbishment Program to the Minister. The Minister of Energy plans to retain an individual through [redacted] to participate on the DRC in an "ex-officio" capacity, co-reporting to the Minister with the Chair of the Darlington Refurbishment Committee.
Internal Audit	The Internal Audit team has functional independence from management. Audit results regarding key gaps in meeting operational, compliance or regulatory objectives are reported quarterly to the Board of Directors.
Nuclear Safety Review Board (NSRB) - Annual Report to the Nuclear Oversight Committee	NSRB will provide an annual presentation to the Board of Directors regarding its independent view of nuclear plant operations, the impact of the Refurbishment Program on the operating units, and readiness of the unit in refurbishment outage for return to service.
Refurbishment Program Review Board (RPRB) - Annual Report to Darlington Refurbishment Committee	The RPRB will provide to the Board of Directors with an annual report on incremental oversight of the scope and execution of the Refurbishment Program.

ii) Board of Directors Reporting

Given the breadth and scope of the Refurbishment Program on OPG's finances and operations, reporting to the Board of Directors will occur across a number of Board of Directors committees:

Darlington Refurbishment Committee	Focus: Execution performance of the Refurbishment Program Principle ELT Rep: CNO and SVP-Nuclear Projects External Input: Insights provided by the Independent Advisor; Infrastructure Ontario; RPRB, as applicable Audit Feedback: Results applicable to the Refurbishment Program
Nuclear Oversight Committee	*Focus:* Potential impacts of the Refurbishment Program on operating unit safety, the health of training programs needed to support refurbishment activities, and the process for ensuring the safe return to service of the units at the completion of refurbishment *Principle ELT Rep:* CNO *External Input:* Insights provided by the NSRB and RPRB as applicable. *Audit Feedback:* Results applicable to nuclear operations
Audit and Finance Committee	*Focus*: Application of internal control environment, financial implications of Refurbishment, impact on cash flow and financing and financial implications of cost recovery

	Principle ELT Rep: Chief Financial Officer *External Input:* External Auditor; specialized resources as needed. *Audit Feedback:* Performance of Strategic Audit Plan and audits related to the Refurbishment Program internal controls
Compensation and Human Resources Committee ("CHRC")	*Focus:* Succession planning, compensation, incentives and retention in support of the 10 year Refurbishment Program *Principle ELT Rep:* SVP, People and Culture *External Input:* Management's compensation advisors (presently Towers Watson), CHRC's independent compensation advisors (presently Hugessen) *Audit Feedback:* Results applicable to succession planning and HR policy application to the Refurbishment Program
Risk Oversight Committee	*Focus:* Enterprise risks that stem from or impact the Refurbishment Program as well as the effectiveness of the risk management program *Principle ELT Rep:* Chief Risk Officer *External Input:* As needed/requested *Audit Feedback:* Results applicable to risk management processes and principles as they are applied to the Refurbishment Program
Governance and Nominating Committee	*Focus:* Internal and external communications and reputation management strategies, plans and metrics *Principle ELT Rep:* VP, Corporate Relations and Communications *External Input:* Communications and issue management support as needed *Audit Feedback:* Results applicable to the effectiveness of internal / external communications related to the Refurbishment Program

CONCLUSIONS

The Refurbishment Program Assurance Model is designed to ensure that: 1) the Refurbishment Program will meet all safety, quality, cost and schedule expectations; 2) any issues will be identified and resolved expeditiously at the lowest applicable organizational level; and 3) transparent and accurate information flows up to the Board of Directors in a way that supports Board of Directors oversight effectiveness and decision making.

The program structure incorporates multiple layers of oversight to support building and maintaining internal and external confidence. However, each layer must be constructed in a manner that avoids supplanting the management decision making process, and that reinforces accountability for finding and fixing problems at the lowest applicable organizational level. These successive layers of oversight must focus on evaluating the effectiveness of subordinate programs, and on testing the accuracy and completeness of information.

ACRONYMS

CAP	Corrective Action Program
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CHRC	Compensation and Human resources Committee
CNO	Chief Nuclear Officer
CNSC	Canadian Nuclear Safety Commission
CRO	Chief Risk Officer
DRC	Darlington Refurbishment Committee
DRP	Darlington Nuclear Generating Station Refurbishment Program
ELT	Enterprise Leadership Team
INPO	Institute of Nuclear Power Operations
MOE	Ministry of Environment
MOL	Ministry of Labour
NSRB	Nuclear Safety Review Board
OPG	Ontario Power Generation Inc.
RPRB	Refurbishment Program Review Board
SVP	Senior Vice President
VP	Vice President
WANO	World Association of Nuclear Operators

Schedule 2.2(c) - Contractor's Personnel and Key Personnel

Project Team

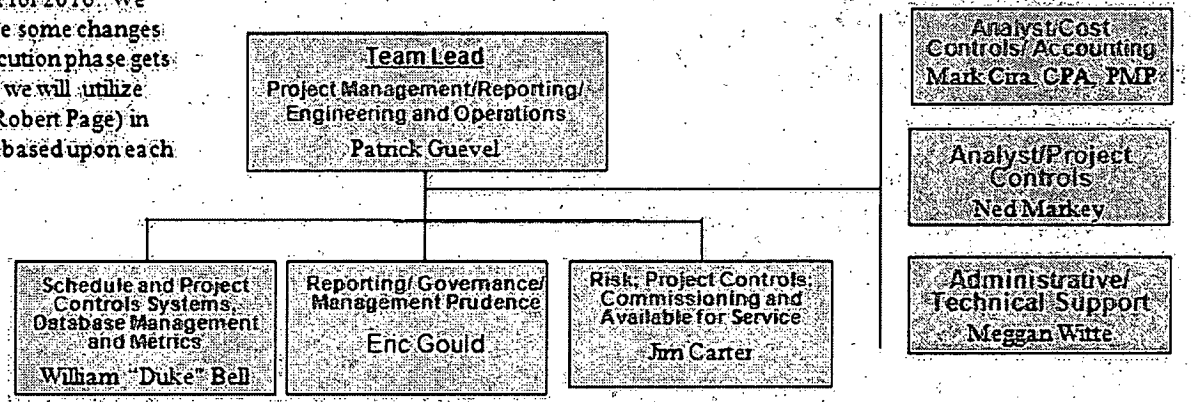
*Oversight Services for 2016 Darlington Nuclear Station***

BURNS McDONNELL

ONTARIO POWER GENERATION

KEY PERSONNEL

** This is our organizational chart for 2016. We recognize that there may need to be some changes to the Key Personnel once the execution phase gets going in 2017. We anticipate that we will utilize our experts to fill these roles (i.e. Robert Page) in order to provide the best expertise based upon each phase of the Project.



EXPERTS

Schedule 2.7(a) - Subcontractors

[NTD: TO BE PROVIDED BY CONTRACTOR]

Schedule 4.1(a) - Billing Rates

All Billing Rates below are fully burdened and fixed for each year in Can$; however, these Billing Rates do not include expenses which will be paid in accordance with Schedule B.

Name	Role	2016	2017	2018 (+3%)	2019	2020 (+5%)	2021	2022 (+5%)	2023	2024 (+5%)	2025
Patrick Guevel	Team Leader	[redacted]									
William "Duke" Bell	Project Control Mgr										
Eric Gould	Project Controls										
Carrie Okizaki	Partner										
James Carter	Sr. Consultant										
Mark Cira	Sr. Consultant										
Edward "Ned" Markey	Sr. Consultant										
Meggan Witte	Admin Support										
Robert Page	Expert*										
Joe Byce, P.E.	Expert*										
GiWon Lee	Expert*										
E.Y. Hwang	Expert*										
Terry Garrett	Expert*										
Jim Wilson	Expert*										
Daniel Meyer	Expert*										

* The services from experts will only be utilized upon written request from OPG and rates will escalate over time by the same percentages as the Key Personnel.

ONTARIO POWER GENERATION

Records File Information:
Records 08133.3-P

Internal Use Only

OPG-FORM-0073-R005*

Document Transmittal Record

Mail to: **EXECUTED DOCUMENTS PROCESSING**
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AUTHOR(S) (e.g., External Counterparties)
OPG and Burns & McDonnell Canada Ltd.

S 197

TITLE (e.g., Document or Contract Title)	DOCUMENT DATE (MM/DD/YYYY)
Independent Oversight Services Agreement for the Darlington Refurbishment Program	**April 11, 2016**

DOCUMENT IDENTIFIER

General:	☐	
Amendment	☐ (provide G#)	G-
Commercial Operations:	☐	
Amendment	☐ (provide C#)	C-
Real Estate:		
(P# or X# assigned by Real Estate)		P- / X-
Supply Chain:	☒	
Amendment	☐ (provide S#)	S- 197

Check "Amendment" and record the document number in the appropriate box if:

- The new document is associated with a previously registered document (e.g., the new document is an amendment, addendum, or sub-contract); and
- It is to be filed with the previously registered document.

If no document number is recorded, a new number will be assigned by the Executed Documents Processing Centre.

KEYWORDS (i.e., words not in document)	REFERENCE
(a) **Independent Oversight**	PO/Reference/External Document No. **PO 00261258**
(b) **Darlington Refurbishment**	Effective Date (if applicable: MM/DD/YYYY) **May 18, 2016**
(c)	Expiry Date (if applicable: MM/DD/YYYY) **Dec. 31, 2025**
Geographic Loc'n:	Sender(s): **Kay Ahn**

ORGANIZATION ☐ Energy Markets** ☐ Law*** ☐ Real Estate ☒ Supply Chain

** Due to CorDoc restrictions, Energy Markets cannot reflect the name change to Commercial Operations

*** By default, Law has access to all

SECURITY CLASSIFICATION ☒ OPG Confidential (default) ☐ OPG Confidential Exclusive

(For further information, refer to OPG-STD-0030, Classification, Protection, and Release of Information)

CUSTOM2 (OPG Commercial Operations only)

☐ D ☐ D-DSA ☐ D-DSA-A ☐ I ☐ I-BIO ☐ I-COAL ☐ I-EEI ☐ I-EXCH ☐ I-URAN
☐ D-EA ☐ D-EA-A ☐ D-ISDA ☐ I-GAS ☐ I-ISDA ☐ I-LFC ☐ I-OIL ☐ I-TRANS

If applicable, select appropriate sub-folder below.

PERMISSION SUB-FOLDER – G, P, S OR X DOCUMENTS (REAL ESTATE, BUS. DEV., LAW/RISK, SUPPLY CHAIN)

☐ Business Development	☐ Credit Risk (Letters of Credit)	☐ Fund Management
☐ Niagara Plant Group	☐ Northeast Plant Group	☐ Northwest Plant Group
☐ Ottawa/St. Lawrence Plant Group	☒ Supply Chain	
☐ Small Hydro	☒ Nuclear ☐ Hydro / Thermal ☐ Indirect ☐ Other:	
☐ Dam Safety & Water Resources		

PERMISSION SUB-FOLDER – C DOCUMENTS

☐ Confirmations	☐ Emission Reductions	☐ Interconnected & Transaction (I, I-EEI, I-EXCH, I-ISDA, I-LFC)
☐ Customer Collateral Documents	☐ Legacy (Generic)	
☐ Domestic (D, D-EA, D-EA-A, D-ISDA)	☐ Interconnected & Transaction (I-BIO, I-COAL, I-GAS, I-OIL, I-TRANS, I-URAN)	☐ Operating Committee Agreements
☐ Domestic (D-DSA, D-DSA-A)		☐ Verifications

The following information is required for information purposes only. It will **not** be added to CORDOC.

Contact Name: Kay Ahn	Location: P84	Tel: 905.421.9494

*Associated with OPG-PROC-0019, Records and Document Management

SEC Interrogatory #095

Interrogatory

Reference:
D2-3-9, p. 13-14

Question(s):

With respect to PRP Oversight and External Assurance:

a) Please detail the regular reporting that is provided to the Chief Projects Officer, and the OPG Executive Leadership Team regarding the PRP. For each regular reporting mechanism (weekly, monthly, and annual reporting), please provide the latest copy.

b) Please provide all reports to date provided by OPG management, and the Nuclear Oversight function, with the Major Projects Committee of OPG's Board of Directors related to the PRP regarding PRP progress, and any issues that have arisen to date.

Response

a) Refer to Attachment 1.

b) Refer to Attachments 2 and 3.

Pickering Refurbishment Program (Units 5 – 8)

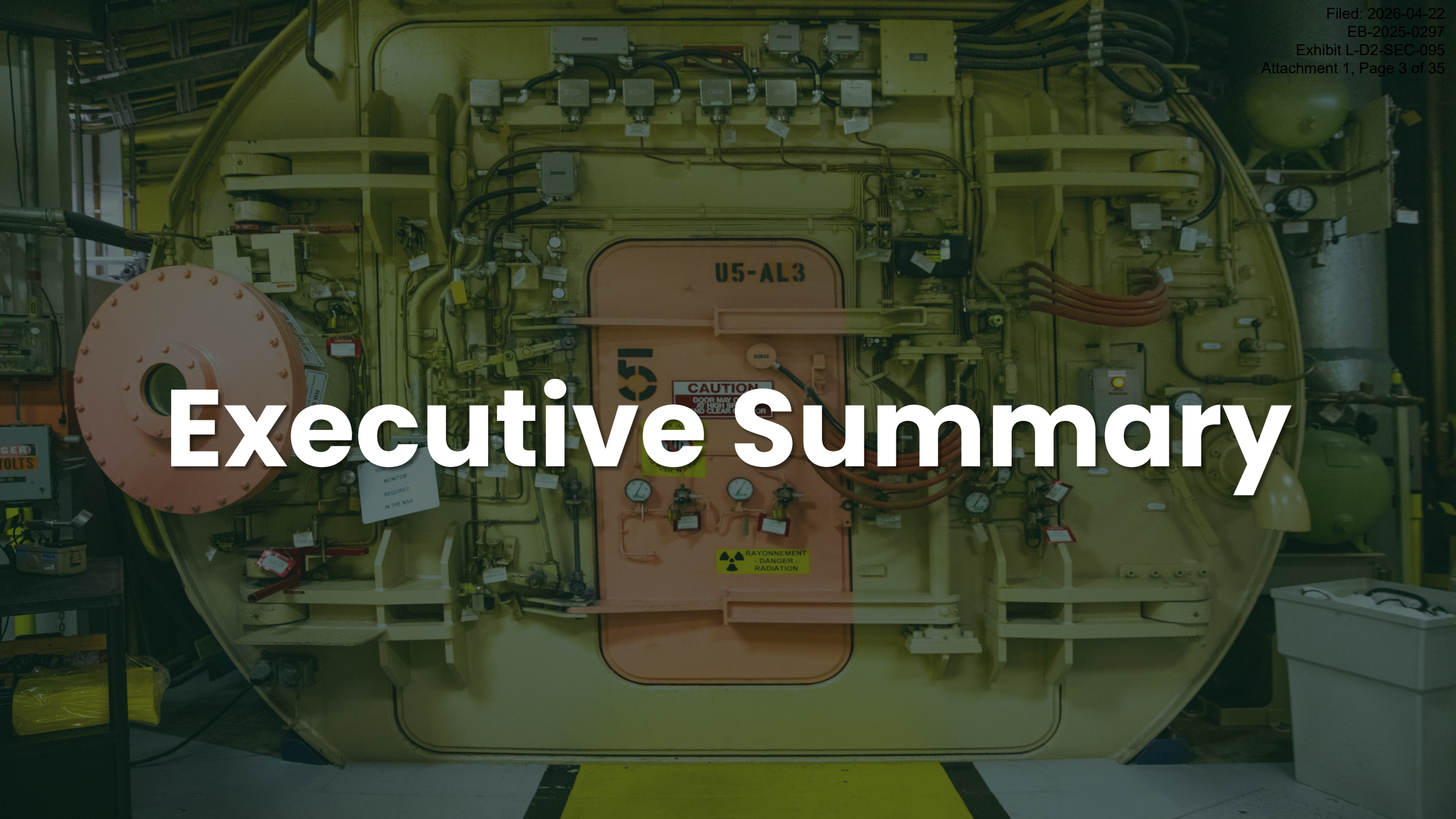
Q4 2025 ELT Update

February 27, 2026

Confidential and Commercially Sensitive

Agenda

1. **Executive Summary** – Luca C.
2. **Indigenous Engagement** – Katie H.
3. **PNR Program Performance (Cost and Schedule)** – Luca C., Vijay S., Nahil R., Shawn D., Jeff M., Mehri M., Samad K, Andy E. & Jason W.
4. **Commercial Management** – Stephen S., Jennifer L. and Kristina B.
5. **Key Issues & Challenges** – Samad K., & Luca C.
6. **ELT Support** – Luca C.
7. **Appendices**
    - **Bundle / Functions Updates**



Executive Summary

Pickering Projects' top five priorities

Indigenous engagement and partnership with the Williams Treaties First Nations as Rights Holders remains as an overarching priority for Pickering Refurbishment

1 Facilities and Infrastructure & Pre-requisite

Retube and Feeder Replacement Island Support Annex, Security upgrades, Common Services Building, Pickering Component Storage Structure, Deep Water Intake logistics, Mock-up Building, Buried Services and Traffic and capacity management.

2 Execution Readiness

Ensure execution readiness by focusing on people and workforce readiness, Segment 0 readiness, and execution planning.

3 Detail Design progression

Complete Unit 5 segment 1 and 2 detailed design ready for execution.

4 Ontario Energy Board (OEB)

Resolution of all interrogatories and public hearing to support OPG rate application.

5 Program Check Estimate

Validate overall cost estimates, risk and contingency assessments and schedule (Rev 0 Unit 5)

Updated as of January 20th, 2026

RRB Visit # 6 Recommendation

Work Management	• Implement segment specific monitoring to ensure work progress (hours), float, and readiness are clearly tracked, communicated, and the impact is assessed. • Validate Operations readiness through a dedicated challenge meeting focusing Segment 1.The Fleet has agreed to support, and this could use a combination of a “CNO style” challenge meeting and an “Outage style” self assessment.
Logistics Issues	• The plan needs to address how each logistics risk area will be addressed. • Specifically for the control of worksites/ laydown areas and the management of material deliveries to the protected area (which are difficult and challenging issues), a planned full-scale trial needs to be performed to test and assess the proposed process. It will be critical to obtain customer / vendor feedback during the trial to both improve the process and obtain support for the solutions. The testing and validation must occur during Segment 0 to ensure a successful implementation by the start of Segment 1.
Process Efficiency Improvements	• The implementation of these efficiency improvements will need to be tracked and monitored and completed in a manner to ensure the full benefit of the change is being achieved.
Engineering Deliverables	• Complete the assessments to investigate the impacts on interfacing systems for the installation of modifications and as necessary, develop the designs to mitigate these impacts. • Continue to support the Design Service providers to improve the schedule, quality and responsiveness metrics from meeting standards to exceeding standard expectations.

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Indigenous Relations

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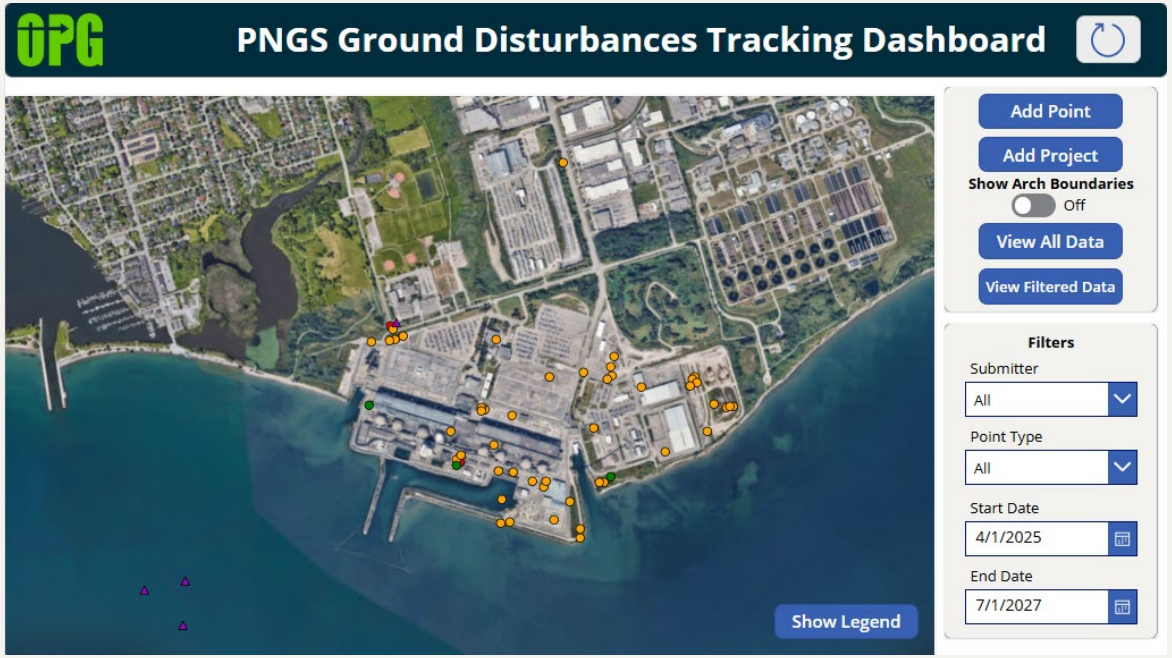
Indigenous Relations



Status / Highlights

- PN Operating/Waste Relicencing decision expected Dec 2026
- Duty to Consult has been triggered (via CNSC)
- Terrestrial archaeology: Stage 1 accepted. Stage 2 to be accepted by Q4
- Marine archaeology – Deep Water Intake Structures Marine Arch Overall Draft Report expected early March
- Spoils Management – MSFN onboarded consultant
- MSFN on-site monitoring throughout 2025/2026

Opportunities

- OPG-wide Archaeology protocol/process
- Offset planning
- Shoreline Design plan in coordination with MSFNs
- Site tour planned for Q2 2026

Challenges and Risks

- Nation's capacity issues
- Lakebed jurisdiction, offsetting decisions, shoreline protection, DWI dredging and disposal plans without effecting cost and schedule
- Indigenous opposition could impact budget and timelines
- Unforeseen accommodation costs

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Pickering Refurbishment

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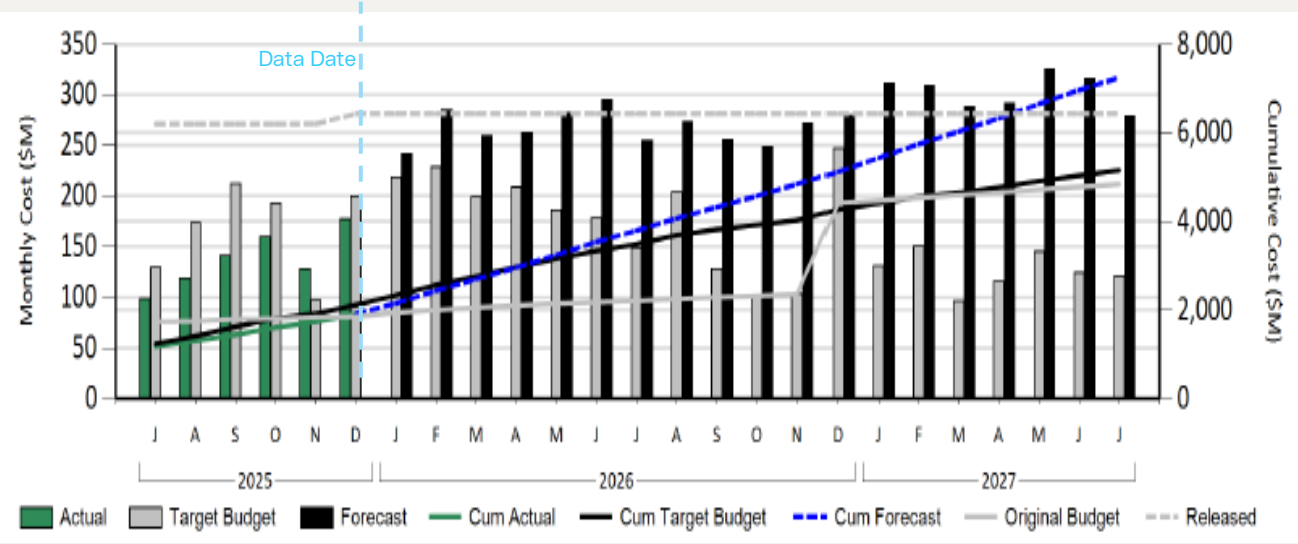
Program Performance Dashboard - Dec ME

Cost Forecast



Look-Ahead Milestones (3-6 months)

Milestone	Baseline Date	Forecast Date	Status
Segment 0 Design Mods Complete	Nov 30, 2025	May 4, 2026	Recovery
Ops & Mtce LLM PO's Issued	Dec 31, 2025	Feb 20, 2026	Complete
Segment 0, Materials PO's issued for Known Materials	Jan 31, 2026	Jan 31, 2026	Complete
Segment 1 (Unit 5) Design Mods Complete	Mar 4, 2026	Mar 4, 2026	On Track
Segment 1, (Unit 5) Materials PO's issued for Known Materials	Apr 1, 2026	Apr 1, 2026	On Track
Revision B (Units 6,7,8) Schedule Issued	Apr 30, 2026	Apr 30, 2026	On Track

Release Check Estimate

Targeting: Aug 2026

Schedule Variance

- F&I (36,185 hours): 64% complete vs 69% planned.
- RFR (22,259 hours): 49% complete vs 50% planned.
- BoP (11,192 hours): 49% complete vs 51% planned.
- O&M (10,947 hours): 11% complete vs 12% planned.

Contingency Health

Total: $3,764 M Remaining: $3,764 M

Social License

Indigenous Economic Empowerment Spend

Actual: $ 32.9 M Target: $ 3 M

Supply Chain Diversity Program

Actual: $10 M Target: $1.5 M

Project Excellence

Project % Complete
(for current phase of project)

Actual: 44%
Planned: 45%

SPI

0.97

Project % Spent Of Release

Actual: 16%
Planned: 18%

CPI

0.99

Released Budget ($ M): $ 26,840 M

Actual: $ 1,910 M Planned: $ 2,112 M
Overall Committed: $ 5,251 M

Financial Strength

Fit-For-Purpose Cost Saving ($M)

Realized Saving: $ 244 M
Target: $ 190 M

Key Drivers:
- DWI Tunnel QA Program
- U5 Turbine Upgrades Not Required
- Reactor Face Bridge Cranes

See Engineering Performance Dashboard for details

Dashboard – Segment 0

Look-Ahead Milestones

Milestone	Baseline Date	Forecast date	Status
Segment 0 Design Mods Complete	30-Nov-25	4-May-26	Recovery
Segment 0, Materials PO's issued for Known Materials	31-Jan-26	31-Jan-26	Complete
PCSS building (excludes tie-ins) substantial completion -	20-Sep-26	15-Aug-26	On-Track
CSB Substantial Completion (EPO Scorecard)	30-Sep-26	30-Sep-26	On-Track
Security Building Complete – MSB (EPO Scorecard)	15-Nov-26	15-Nov-26	On-Track
RFRISA - Building Shell / Modules Installed	27-Nov-26	27-Nov-26	On-Track
West Sally Port Substantial Complete (EPO Scorecard)	30-Nov-26	30-Nov-26	On-Track
Breathing Air Finish of Install RBA	15-Aug-26	15-Aug-26	On-Track

Schedule Performance Index

SPI	% Completed	Backlog hours
1.01	54%	10k hours ahead

Key Contributors

Project	Project name	SPI	Backlog hours (K)
88538	F&IP - MSB/ASB/West Sally Port Modifications	0.8	(16.2)
88192	U0 DW - Security Fence Relocation	2.82	13.8
88536	Pickering Campus Electrical Upgrades	1.25	(11)

Risks/Mitigation

Risk ID	Project	Risk	Action/Mitigation	Current Risk Score	Post Risk Score
72072	88192 - U0 DW - Security Fence Relocation	Legacy Issues and Field Discovery Issues may lead to Installation Delays and Cost Impacts	Perform field scans in South PA as well as Hydro Vac to identify buried cabled and lines	16	12
68783	88538 Security Expansion	Challenges during commissioning of Security mods potentially impact AFS	Working closely with One Commissioning Team and utilizing OPEX to mitigate	12	9
	88328 - U5 - BREATHING AIR SYSTEM	Discovery or delays on an already compressed schedule may challenge ability to have increased capacity available for breaker open	Enhanced readiness process in place and in parallel developing execution strategies to prioritize installation and commissioning to meet demands of U5 and U6 first.	12	9

PNR Segment 0 Level 1

2026

Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec

Q4 2026 PNR Shutdown

Retube & Feeder Replacement
- Detailed Design Complete
- Modular 1st floor SOI
- Modular 2nd floor SOI
- Modular 3rd floor SOI
- Island Support Annex Building Tie-ins
- AFS DEC26

Common Service building
- Foundation Complete
- Modular Delivery
- Modular SOI
- Building Tie-ins
- Commissioning
- AFS 30SEP26

Security Expansion
- Foundation Complete
- Modular Fabrication commence
- MSB SOI
- Modular Delivery
- Modular SOI
- ASB interior SOI
- MSB interior SOI
- Commissioning
- AFS 30SEP26

Pickering Maintenance Facility
- Foundation/Detailed Design Complete
- Pre-Eng Building SOI
- Salt Storage Building SOI
- DEMO P20 (existing salt storage shed
- Salt Storage Commissioning
- Commissioning
- AFS DEC26

Construction Parking and Montgomery Park Road Upgrades
- SOI Montgomery & Parking
- FOI Montgomery & Parking

Pickering Component Storage (PCSS)
- Tilt Walls Complete
- Tie in Design Complete
- Building Substantial completion

Deep Water Intake – Site Prep
- DSM Transfer FOI
- Security Fence move SOI
- Bridge- Road Widening SOI
- Security Fence move FOI
- Forebay Infill SOI

Data Date

Segment 0 Prior to Breaker Open

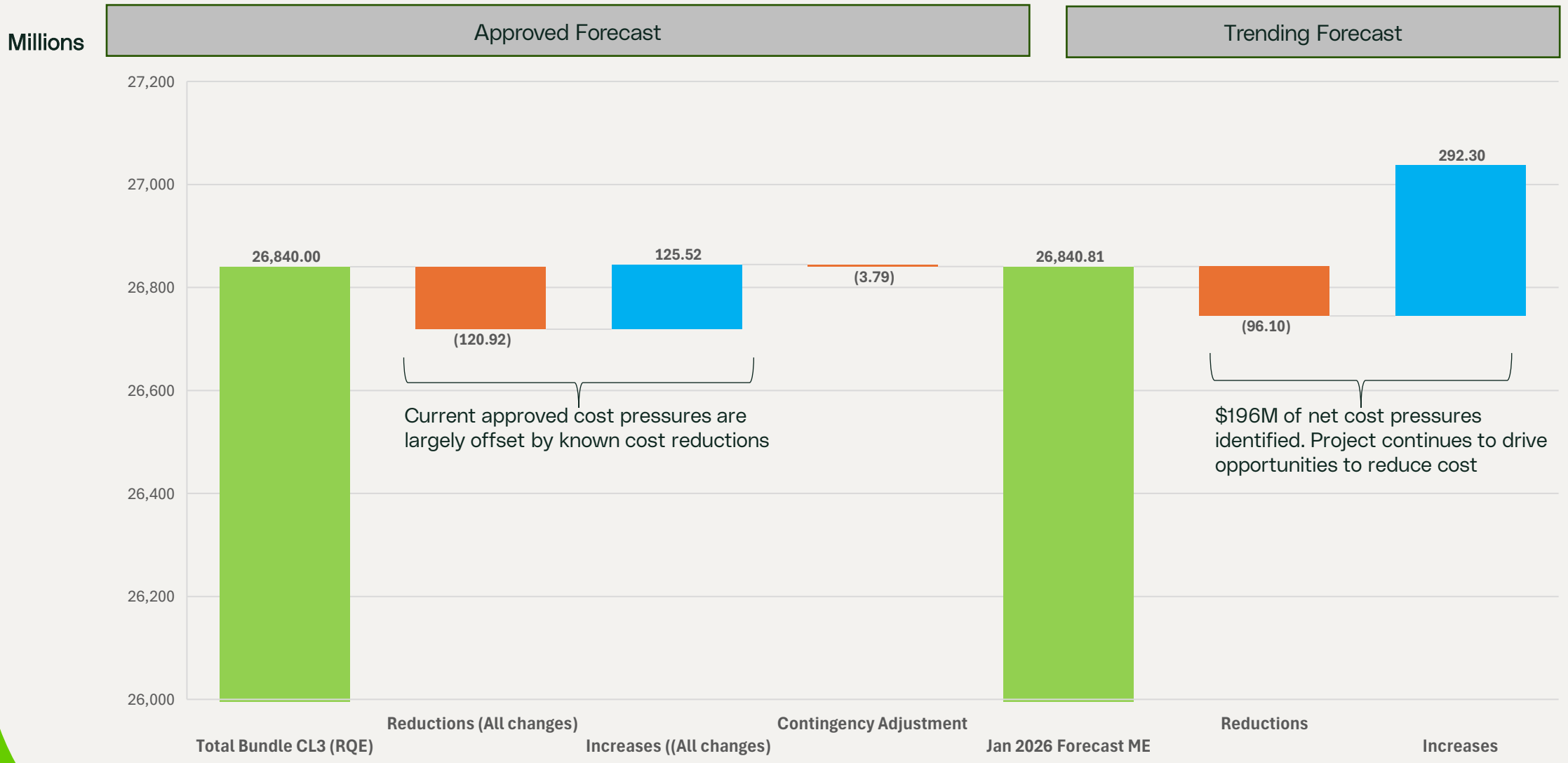
SOI – Jan 5/26

Partial AFS

- Breathing Air – Pre-req
- Retube and Feeder Replacement– Pre-reqs
- Turbine Pre-reqs
- Balance Of Plant /Operations & Maintenance – Pre-reqs/Defuel

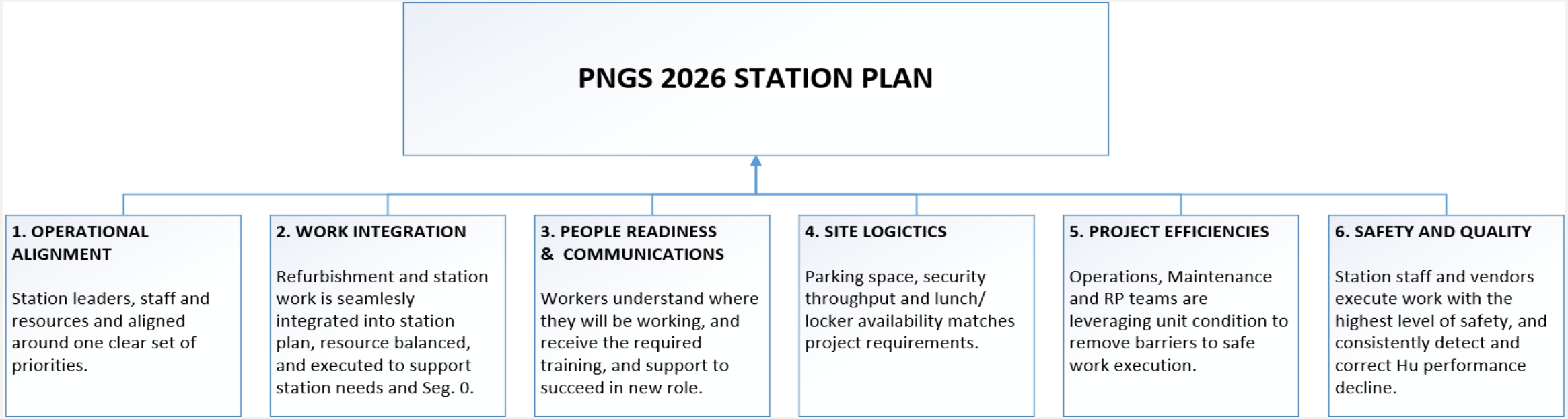
FOX CONSTRUCTORS LTD. | Black & McDonald | SIEMENS energy | AECON | VINCI CONSTRUCTION | CANATOM POWER GROUP | MAKHOS INC. bird JOINT VENTURE | framatome

Overall Program EAC Cost Trend Report



PNR “LEAD IN” CHANGE MANAGEMENT STRATEGY

- PNR “Lead” In plan objectives were analyzed by a PNR-Station leadership team, to fully understand risks, and determine where cross departmental collaboration is required.
- Team is aligned around 6 foundational pillars, which will ensure refurbishment project success.



Site Capacity & Logistics: 2026 Readiness and Risks

Map: 2026 Roadway Construction & Site Access Risks

Site capacity and logistics remain critical to project readiness for 2026.

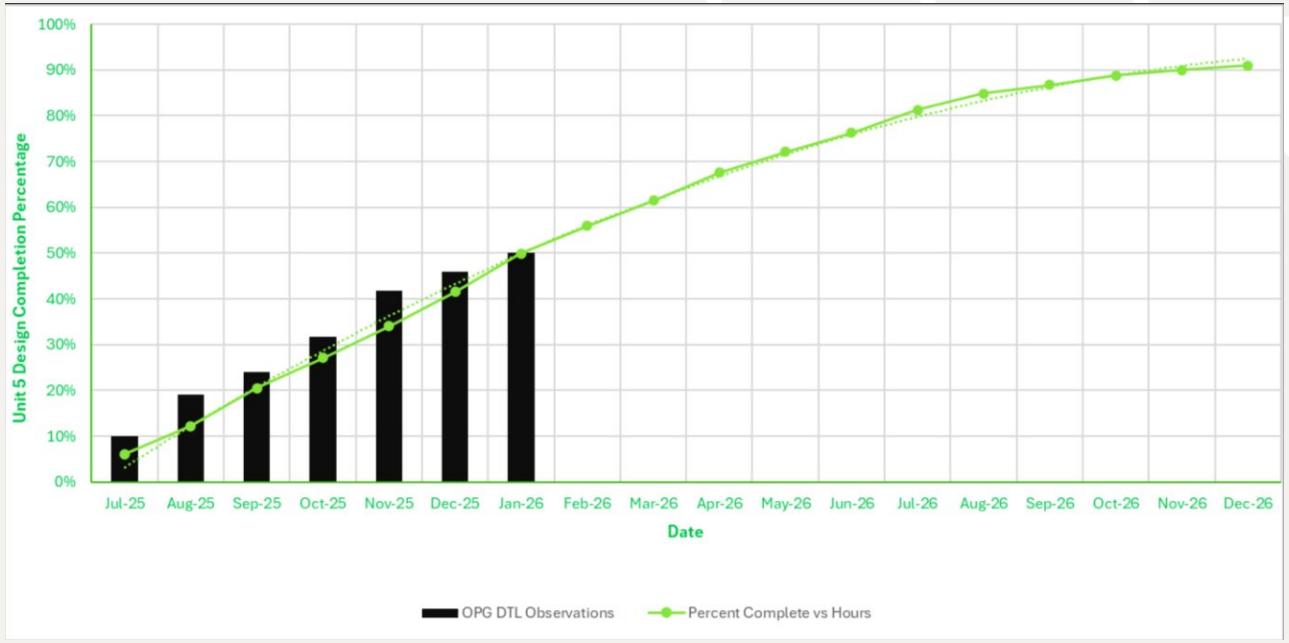
Major risks have been identified across site access, parking, shuttle services, security, food service, equipment management, and material deliveries.

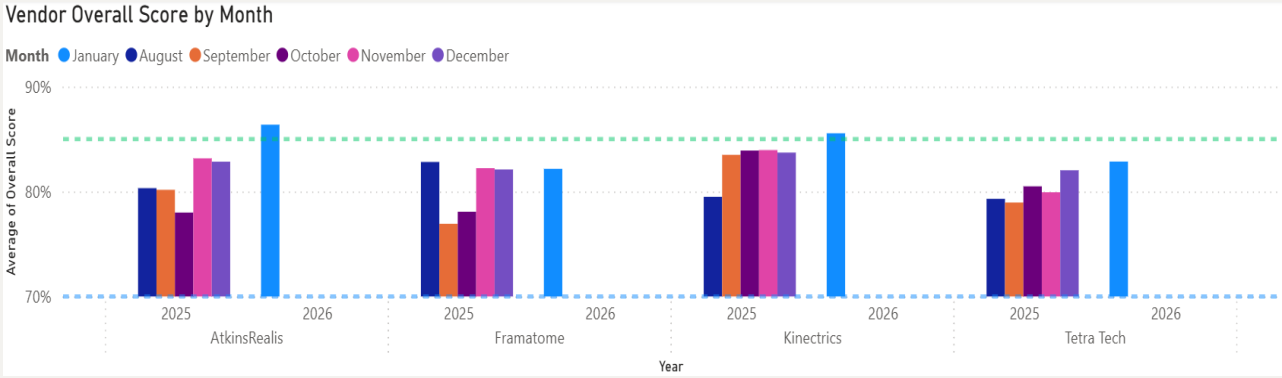
Targeted mitigation actions are underway—including scheduling optimizations, expanded shuttle and food service, and digital tools—to ensure workforce productivity and minimize operational bottlenecks as site activity ramps up.

Ongoing monitoring and timely execution of these mitigations are essential to maintaining project momentum and supporting our growing workforce.

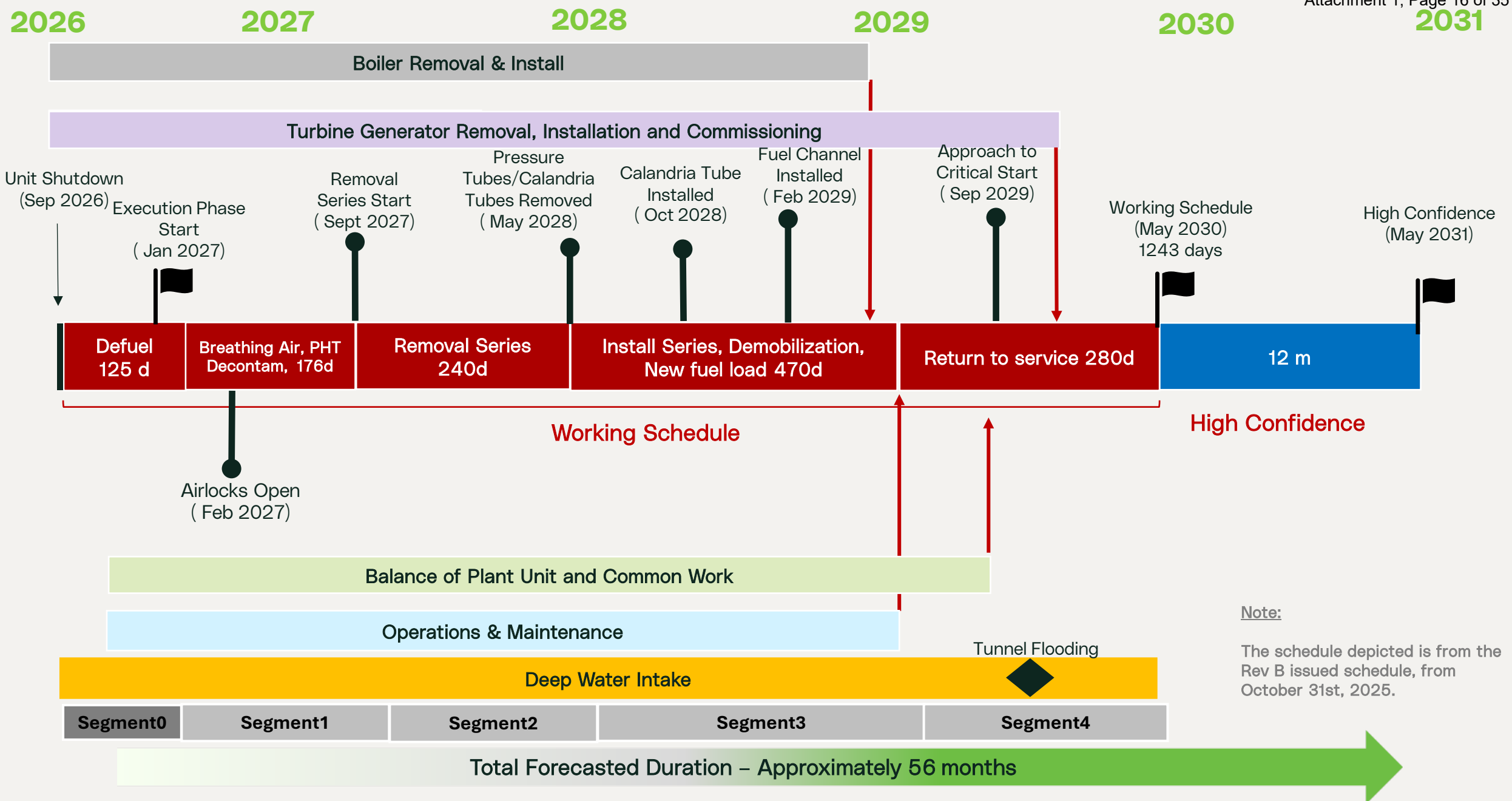
Detailed Design Progression

- Detailed design progression is tracking to plan across all project bundles
- Regular and continued DTL observations and interactions with the design service providers have shown steady progression
- Target completion for 2026 is 85% with a stretch target of 90%
- Vendor quality continues to show a consistent result of meeting expectations, and vendor specific improvement plans have been developed to increase overall performance with support from the OPG oversight team
- Vendor design agencies have committed to working 5 days/wk in the office.





Unit 5 Schedule and Key Milestones



Note:

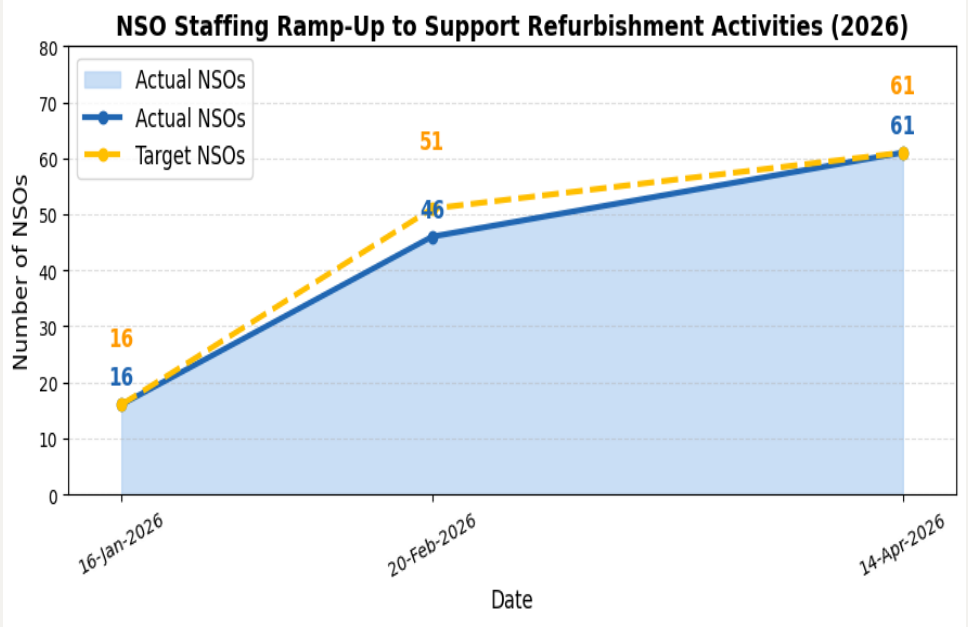
The schedule depicted is from the Rev B issued schedule, from October 31st, 2025.

Security Update

- **Updated 2025 Nuclear Security Regulations (NSRs)**
  - Revised NSRs released in Q4 2025 – New Regs are **Performance Based vs Prescriptive**
  - Security Programs currently working with other utilities and the CNSC to seek further clarifications.
    - 2-year implementation window in place for OPG to meet new regulations.

- **Equipment**
  - Vehicle X-Ray – Stakeholder challenges ongoing related to issuing PO prior to having CNSC Class II License in hand.
    - Projects PM assigned on **13FEB26**
  - SHOK Pilot – PO issued for pilot SHOK
  - Security Huts – PO in progress

- **Staffing:**
  - Security Training / Onboarding HIT established in Q4 2025. Results included successful implementation of BTOC Part A strategy.
  - BTOC Part A was completed on **24FEB26,** with 30 additional officers deployed across crews to support refurbishment activities.
  - On track to have all 61 refurbishment-funded officers onboarded by Q2 2026.



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Commercial Management and Licensing

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Pickering Refurbishment 2026 Commercial/Supply Chain Roadmap

Legend: Prep work; Negotiations; Milestones

Bundle	Q1 2026	Q2 2026	Q3 2026	Q4 2026
TG	Scaffold Strategy; Execution Target Workshops	U5-8 Exec Target Draft; U5-8 Exec Target Finalization		
RFBR	Execution Target Prep Workshops	U5 Exec Target Draft; U5 Exec Target Finalization		*U6/7/8 target set in 2028*
DWI	Forebay Cutoff Wall EPC Agreement	CW Exec Target Workshops; DWI Exec Target Workshops	Cutoff Wall Exec Target Draft; DWI Execution Target Drafting	Cutoff Wall Execution Target Finalization; DWI Execution Target Setting
F&I/BOP	U5 Execution Phase Contracts; ESMSA Next Phase Workshops; Design Replic.; CNSC Audit; Last MBJV Agreement Execution		Breathing Air AFS	
O&M	U5 Seg 0, Awarded	U5 Seg 1, Awarded	U678 Seg 1, Awarded; U5 Seg 1, All Materials on-site	U678 Seg 1, On-site

Regulatory & Licensing

Key Dates

2025: PROL + WFOL Renewal Application Submitted
2026: Licence Renewal Hearings + Licence Renewed

Updates

- Licence Renewal Application submitted to Canadian Nuclear Safety Commission (CNSC) - requested 10-year licence duration
- Preliminary Request For Review submitted to DFO to enable early consultation with First Nations and CNSC

Challenges

- Periodic Safety Review - PSR3 not complete prior to hearing -> regulatory risk mitigated by understanding expected outcomes of the PSR and committing to station improvements to enhance safety of the plant
- June/October Hearing – CNSC required additional time to complete meaningful consultation with the Nations -> A summary of decision is expected by end of 2026. The OPG teams are working to ensure a timely CNSC decision.

Opportunities

- Efficiency gained with consolidation of PROL and WFOL - one set of renewal hearings instead of two
- Regular engagement with CNSC staff will allow continued support for review and approval timelines that support the project schedule
  - Additional review of Project work allowed under current Licence

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Key Issues & Challenges

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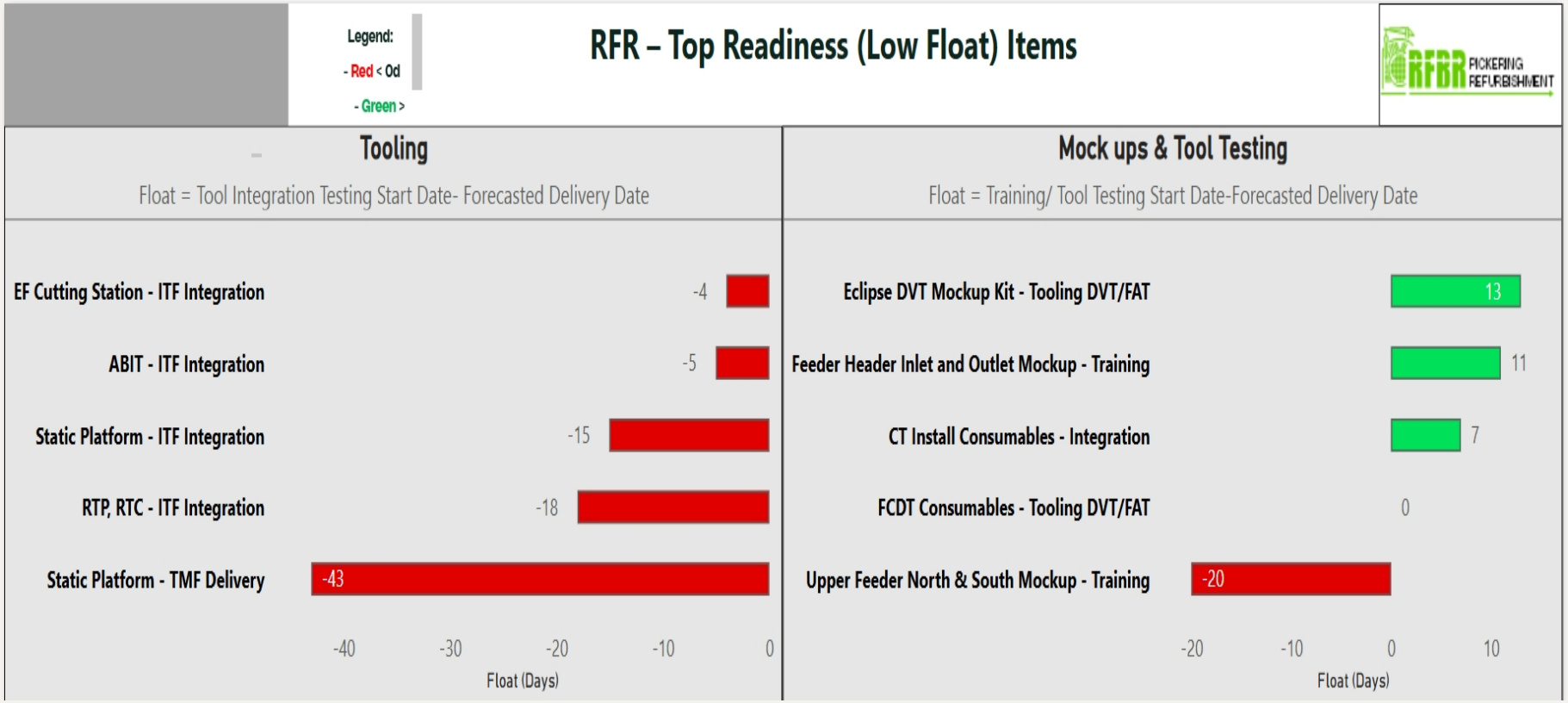
RFR Low Float Readiness Packages



- Apr 1, 2027, readiness Date provides 4 months buffer to actual start date.

- Tooling remains critical path focus for readiness
  - Float is tracked separately for integration testing vs. Training (more margin available for training/execution readiness)
  - U5 Readiness is NOT directly linked to the integration schedule completion

Key Program Risks and Opportunities

Risk	Description
Site Capacity constraints	Projected peak shift employee head count at 4,800 vehicular traffic and upwards of 500 trucks daily poses infrastructure challenges (parking, security, lunchrooms).
Balance of Plant	A large volume of scope is planned to be executed from 2027 to 2034 through both the Refurbishment project and the sustaining portfolio. As the project matures and detailed design progresses, there continues to be a risk of additional scope growth.
Procurement	Procurement and delivery of extensive volume of non-long lead material poses a risk to the Project as delays to manufacturing and material delivery may impact execution.
Facilities & Infrastructure	Current plans the City, Region and Ministry of Transportation have scheduled over the next 10 years will impact access/egress from site with significant potential to challenge PNR Schedule. Road Servicing Agreement in place with City of Pickering to advance construction where possible to prior to breaker open.
Security Implications	The introduction of new security regulations brings uncertainty and potential impacts to Refurbishment project scope and mitigation strategies. OPG, together with other utilities, is actively engaging with the CNSC to clarify requirements and assess potential effects on current and future projects.

ELT Support Required

Issue / Challenge	Description	Support Required
Facilities & Infrastructure	• Current plans the City, Region and Ministry of Transportation have scheduled over the next 10 years will impact access/egress from site with significant potential to challenge PNR Schedule	• Commercial/stakeholder relations are supporting interface with City and Regional staff/officials. Infrastructure escalation or agreement progressing to advance rehabilitation of key access roads.
Efficiency	• Some Work Protection Efficiency Initiatives require timely changes to corporate software Equipment Status Monitoring (ESM) and tripartite (PWU and Society) acceptance of code changes	• On-going support from CIO and CFAM to develop and execute the strategy
Security	• The introduction of new security regulations presents unknown risks to our Refurbishment projects. It is expected that interpretations and compliance requirements may evolve, leading to potential changes in project scope and the need for additional mitigation measures.	• On-going support from Reg Affairs, Security Programs and Compliance to obtain prompt clarifications from the regulator.

Appendices

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Bundle / Function Updates

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Internal Infrastructure

2025/2026 Major Milestones

Issues / Challenges

- Common Services Building (CSB), Security Expansion, Pickering Maintenance Facility (PMF): Condensed timelines for design/construction to support PNR readiness
- Security may be challenged to resource and support multiple projects in similar execution windows
- Large scope of facilities and infrastructure work with interfaces to multiple bundles and station may compete with the resources leading to delay in-service date.

Mitigation / Support Required

- CSB, Security Expansion, and PMF are in various stages of construction. Foundations were expedited and completed in Q4 2025. Offsite Modular fabrication complete TCD Q1 2026.
- Security has an approved resource plan to support PNR projects. Security SPOCs have been integrated into the project teams to support project needs.
- Refurb bi-weekly review of PNR work program. (T-4, T-0). Additional weekly integrated update with stakeholders, reviewing Level 2 schedules ensuring critical path and near critical path are on track and alignment on priorities.

Retube Feeder & Boiler Replacement

2026 Major Milestones

Issues / Challenges

- Feeder execution has very low float to critical path
- Critical path schedule assumes proficient resources are transferred over to Pickering.
- Tooling readiness is on critical path for RFR readiness.
- Low boiler delivery float for subsequent units

Mitigation / Support Required

- Feeder Execution PPQ in progress, and implements all known/contingency repair types
- Review of Chemical Decon to ensure experienced feeder BM dose is managed closely
- Intrusive oversight of Tier 2/3 suppliers ongoing to manage schedule risk
- BWXT has introduced lean manufacturing concepts, added equipment & shop capacity to improve float, Canatom is working with BWXT on developing optimized schedule to incorporate improvements & reflect improved float.

Turbine Generators

2025/2026 Major Milestones

Q4 2.025
-RQE Approval
-30% Detailed Design – 9/10 MECs
-60% Detailed Design – 3/10 MECs

Q1 2026
-Scaffolding strategy defined
-30% Detailed Design – 10/10 MECs
-60% Detailed Design – 4/10 MECs

Q2 2026
-U5 Rev C Execution Schedule
-Execution Target Challenge Meeting
-60% Detailed Design – 8/10 MECs
-90% Detailed Design – 5/10 MECs

Q3 2026
-Execution Target Established
-60% Detailed Design – 10/10 MECs
-90% Detailed Design – 6/10 MECs
-100% Detailed Design – 2/10 MECs

Q4 2026
-Execution work on U5 commenced
-90% Detailed Design – 9/10 MECs
-100% Detailed Design – 7/10 MECS

Issues / Challenges

- Siemens Energy design work for generator scope has experienced delays
  - #1- Generator end core heating
  - #2- Generator skids and aux
- Scaffolding strategy to be finalized, options being evaluated is to keep with Aecon or utilized shared services vendor (Aluma)
- Excitation system descoped from Siemens Energy due to obsolescence concerns
- Detailed design schedule potential impact on construction planning

Mitigation / Support Required

- Generator design delays- OPG approved recovery plan #1 was completed with ~2 month delay, recovery plan #2 under development by vendor
- Enhanced scaffold estimates being produced by both vendors and will be evaluated against one another to support project decision
- Descope project change directive was approved in Q4. New purchase order for ABB Excitation hardware & detailed design purchase order to Tetra Tech were also issued in Q4. Construction purchase order plans to be issued in Q1.
- Work at risk release (WARR) memos being utilized to obtain design authority approval to support construction on equipment removals and tie 100% detailed design completion to the installation. 4 of 8 WARR memos fully approved to date & remaining to be approved in Q1, construction inspection and test plans for the removal windows now in development.

Deep Water Intake

2025/2026 Major Milestones

Q4 2025
- Preliminary Design Complete
- DSM Transfer -Commenced

Q1 2026
- Cutoff Wall Contract Award
- DSM Move- Complete
- Marine Archaeological assessment

Q2 2026
- 100% Design Site Prep
- 60% Design - Tunnel Intakes
- Bridge Construction –Commenced
- Permit- DFO RFR issued

Q3 2026
- Security Fence move -Complete
- Site Prep -Commenced
- Permit- DFO FAAA issued

Q4 2026
- Execution Target Established
- Forebay Infill - Commenced
- Launch shaft/ Starter construction Commenced

Issues / Challenges

- **Delay on Obtaining Permits** Delays may arise in securing necessary permits, Offset strategy and lakebed easement, and conducting meaningful Indigenous Engagement, which are essential for project progression and required for long lead DFO permit application.
- **Spoils Management**: The rock byproduct and soil handling present significant logistical challenges. Offsite transfer would lead to substantial local traffic increases, creating disruption.
- **Space Constraints at Site and associated frequent changes of space allocations for DWI** result in multiple laydown plans needing to be planned and replanned by the EPC vendor, construction island/MOU refinements, and multiple handling of transient items during execution that would result in delay and cost increase

Mitigation / Support Required

- Issue preliminary RFR to DFO to enable early consultation with First Nations and CNSC; Continue Coordination with environmental agencies on permits and offsetting, and engagement with Indigenous Nations for input and collaborative solutions.
- Assessing options for aquatic disposal, reopening east landfill, offsite disposal, and beneficial reuse of excess soils. Exploring the possibility of revoking the ECA on East Land field
- Collaborating with F&I to optimize reduced project space and coordinating with Water Treatment Project to find optimum execution time to minimize impact on Refurbishment execution.

Balance of Plant

2025/2026 Major Milestones

Q4 2025 (COMPLETE)
- U5 Segment 0 Designs Complete

Q1 2026
- U5 Segment 1 Designs Complete
- Breathing Air – SOI
- Screenhouse Security upgrade - SOI

Q2 2026
- Relocation/replacement of buried services in south yard-SOI

Q3 2026
- U5 Segment 2 Designs Complete
- Refurb Breathing Air – FOI
- RB Ventilation – SOI
- Relocation/replacement of buried services in south yard-FOI

Q4 2026
- U5 Moderator ACU upgrades – SOI
- 078-SG3 Demolition

Issues / Challenges

- Insufficient laydown areas in powerhouse for project material deliveries, tools and equipment due to high volume of work in the station
- Scope Changes from Inspection Findings - Unexpected issues found during inspections could increase costs and delay the project
- Segment 0 Execution Readiness due to compressed timelines for construction planning post Nov. 30/25 design complete M/S.

Mitigation / Support Required

- Space allocation coordinator assigned to perform workflow analysis and manage project requirements / transient material laydown allocations
- Off-site warehouse secured and located in close proximity to station to facilitate just-in-time material deliveries.
- Coordination with other work groups for allocation of optimal window of execution without impacting critical path work
- Alignment with Work Management on set of critical readiness milestones and development of KPIs demonstrating construction readiness
- Establishing recovery plans in collaboration with vendor partners for identifying and tracking open items.

Operations & Maintenance

2025/2026 Major Milestones

Q4 2025

- Seg 0 Scope Execution Start
- U0&5 Rev. B schedule issued.
- U6,7&8 Rev A schedule issued.
- Support Docs Identified/Revised complete (U5/0 – Seg 1)
- Detailed Design Modification complete (U5/0 – Seg 1)

Q1 2026

- U0/5 B1 schedule issued
- U5 Seg 1/2 Detailed Assessing Complete
- U5 LLM & Seg 0 material POs issued
- MSA award for RP Aurum Technology awarded
- FFA detailed Design complete
- PHT Decontam Hazard assessment completed

Q2 2026

- U6 Seg 1 Detailed assessing
- U7 Seg 1 initial assessing
- U6/7/8 Rev B Schedule issued
- U5 Seg 1 material POs issued
- Defuel Auto-sequence mods Complete
- AURUM technology device delivery to support integration testing

Q3 2026

- U5 Seg 1 Material Staged
- U5 Rev C and Rev 0 issued
- Breaker open – all four units
- Work Protection MA-12 updates and ESM3 Changes Complete

Q4 2026

- U7 Seg 1 Detailed Assessing Complete
- FH Scissor Lift delivery
- Cranes AFS Completed (TH/Annex/274 RAB)

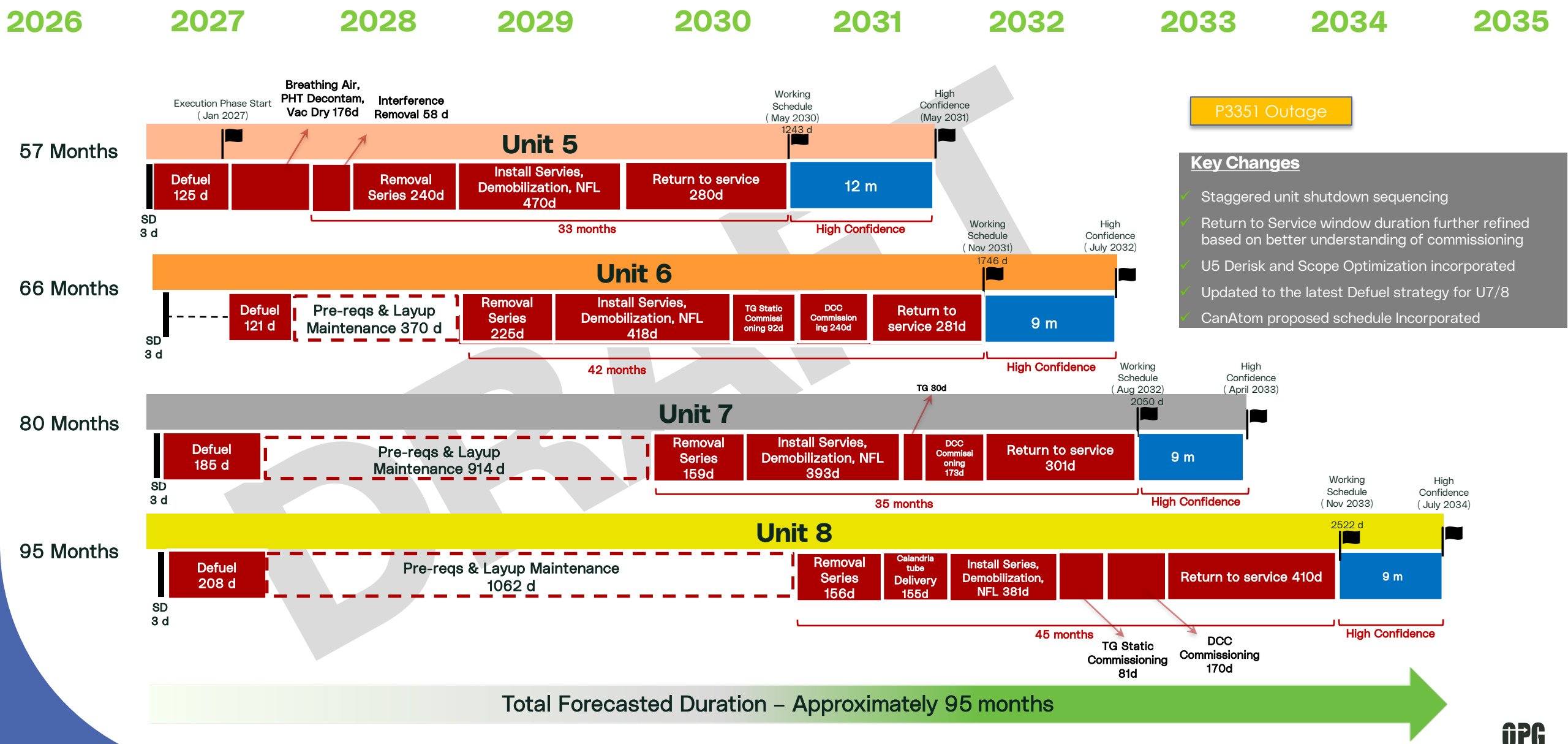
Issues / Challenges

1) Sufficient ready work at breaker open to engage the available PWU staff to execute O&M Project scope.
2) Overall Pickering station priorities conflict with PRP milestones and Segment 0 scope execution.
3) Parts procurement will be a challenge to procure by the window execution start dates.

Mitigation / Support Required

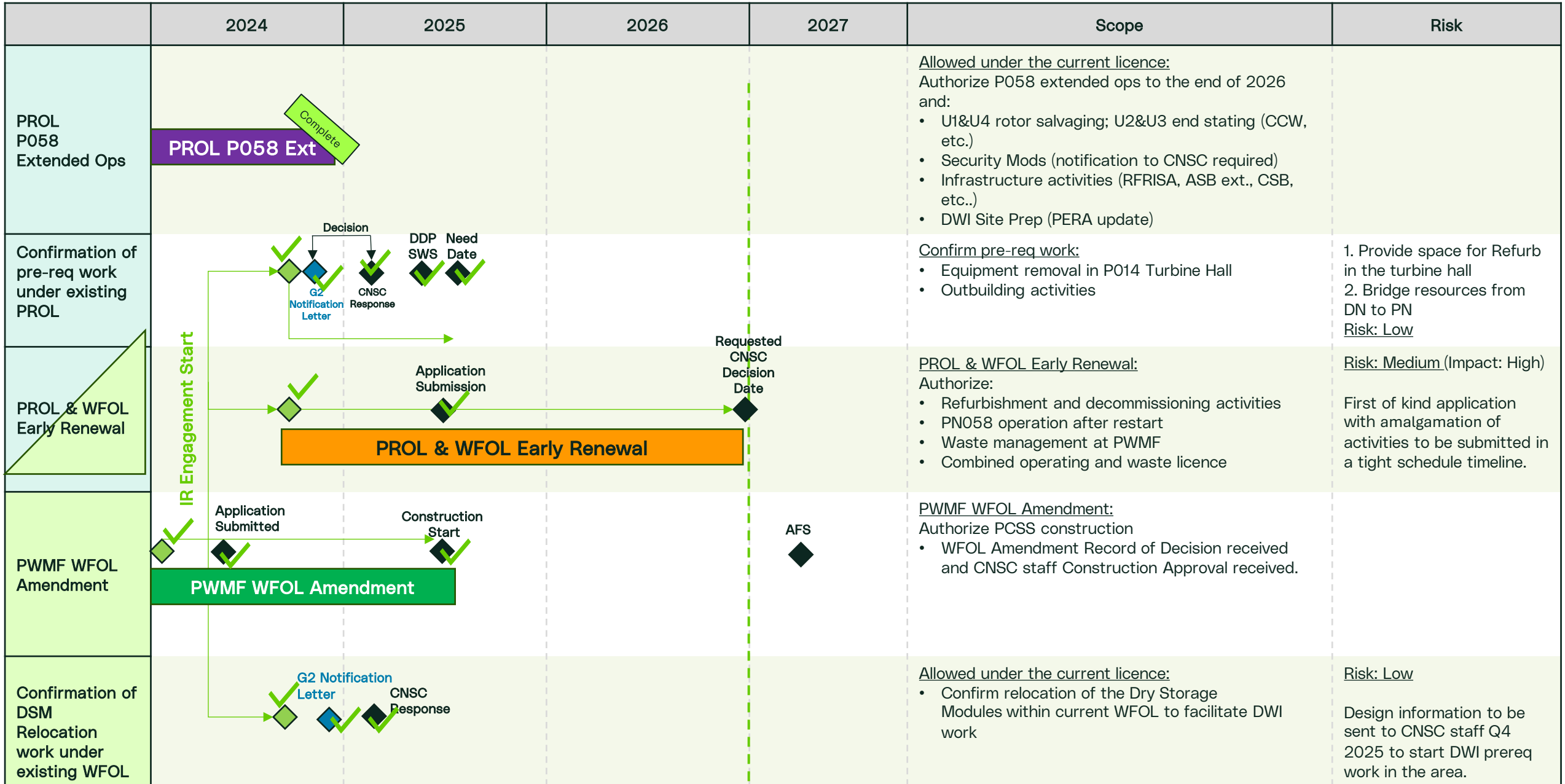
1) 4 Unit Execution Script developed for 7 months from U0&5 Breaker Open to prioritize O&M project work readiness through Segment Milestones (Assessing, Design, Procurement and Schedule development) for effective PWU resource utilization.
2) Establish Station (Online/Outage) and P058 Refurb Pre-Decision Logic for program alignment through Segment 0 execution window. Also, develop Segment 0 PWU project scope (Level 3 WO tasks) for integration into Station Work Management processes (Online/Outage). Both are elements of the Lead-in change management plan (via Implementation roadmap and 7 associated pillars)
3) High-Impact Team established to support prioritization of material procurement with focus on Segment 1 work.

Pickering Refurbishment – Schedule



Note: Pickering Refurbishment is currently in Planning and Definition phase. This schedule is subject to change.

PNGS Licensing – Bigger Picture



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FOR INFORMATION to the Major Projects Committee

March 11, 2026

Pickering NGS (5-8) Refurbishment Program

REASON FOR REPORT

This report provides a status update of the Pickering Nuclear Generating Station (PNGS), Units 5-8 Refurbishment Project for the period ending December 31st, 2025, and any current achievements of interest.

CONCLUSIONS

The project is currently progressing through planning and procurement activities, which are on plan. Highlights for the fourth quarter of 2025 include:

- There have been no significant quality issues over the reporting period. One safety event occurred on the U2/3 Risk Reduction Project where a beam trolley with chain fall fell 12 feet onto a boiler feed pump, no injuries were sustained. This was rated a PSIF (Potential Serious Injury or Fatality). Lessons Learned have been implemented that also look forward to P5-8.
- On November 26, 2025, the Ontario government announced the approval for the $26.8B refurbishment of the Pickering Nuclear Generating Station Units 5-8.
- Critical path for the program continues through the Re-tube Feeder and Boiler Replacement (RFBR) Tooling Program, which remains on track to begin the removal tooling integration phase in June 2026.
- Ministry of Transportation has completed their engineering assessment of a dedicated northbound right turn lane off Brock Rd onto 401 East. Following a formal approval process, MTO will begin construction activities in Q2 with completion in October 2026, in conjunction with the 401 bridge rehab work. The selected option maintains four full lanes on the northbound bridge.
- The Pickering Site licence renewal application was submitted to the Canadian Nuclear Safety Commission (CNSC) in June 2025, requesting a 10-year licence. Hearings are now set to be held in June and October of 2026. CNSC staff required additional time to complete meaningful consultation with the Michi Saagig Nations. A summary of CNSC licence renewal hearing decision is expected by the end of 2026.
- The cost forecast remains on plan within the approved budget of $26,840 million. The life-to-date program expenditure is $1,910 million, against a target of $2,112 million, the variance is mainly due to timing differences. Overall total commitments is $ 5,251 million.

HIGHLIGHTS

Safety and Quality – There have been no significant quality issues over the reporting period for Pickering Refurbishment. One safety event occurred on the U2/3 Risk Reduction Project where a beam trolley with chain fall fell 12 feet onto a boiler feed pump, no injuries were sustained. This was rated a PSIF. Extent of condition checks have been completed across Units 5-8. Safety & Quality Oversight strategy has been established and is supported by Construction Centre of Excellence (CCOE), Maintenance and all Vendor partners performing execution activities.

Program – As of December 31, 2025, the current definition phase of the project is 44% complete and on plan.

Indigenous Engagement – OPG continues to collaborate with the Michi Saagig Nations on Refurbishment and Decommissioning, focusing on archaeological assessments, offsetting planning, Permitting and Deep Water Intake spoils management, with the Nations supported by a third-party consultant.

In December, a joint workshop with the Michi Saagig Nations aligned next steps for engagement on Pickering Operating and Waste Licensing. In 2026, OPG will seek further opportunities for on-site engagement and deeper Indigenous involvement.

Engineering – Detailed design is progressing on plan. The overall detailed design is approximately 44% complete and tracking to the various schedule milestones.

Segment 0 design modifications are in recovery, with one remaining design engineering change (EC) on track for completion in May 2026. This is related to the Fuel Handling software EC and has not impacted downstream planning.

A total of 15 Periodic Safety Review (PSR3) Safety Factor reports were developed in accordance with the PSR3 Basis Document and submitted (in 4 batches) per the CNSC Protocol schedule. PSR3 Global Assessment Report development is continuing and on track for August 2026 submission.

Formal written correspondence was submitted to the CNSC identifying the Probabilistic Safety Assessment (PSA) update strategy, which was accepted by CNSC on November 25, 2025.

Pre-requisites and Infrastructure Requirements – The Retube & Feeder Replacement Island Support Annex (RFRISA), Common Services Building (CSB), Security Expansion, Pickering Maintenance Facility (PMF) and Pickering Component Storage Structure (PCSS) are all in various stages of execution. All major infrastructure projects are on track to be delivered by Q4 of 2026

Phase 1 of the city road upgrades including Montgomery Park and Sandy Beach roads were completed in 2025. Phase 2 is scheduled for completion by Q3 2026.

The Engineering Services Building upgrade is complete adding 180 workstations for Refurbishment staff and vendor partners.

Re-tube and Feeder Replacement (RFR) – The critical path tooling package Retube Tooling Platform (RTP) is on track for completion by May 2026, with recent technical challenges being managed through enhanced oversight processes. Removal and Install Tooling packages continue to progress through their respective phases with a number of removal tools having entered the assembly phase on February 9, 2026. The Tooling Program remains on track to begin the removal tooling integration phase in June 2026.

End fitting procurement performance has improved and is on track to its recovery plan for Unit 5 supply.

Unit 5 Feeders and subcomponents are progressing from the pre-production qualification (PPQ) phase and into production with no major risks to upper feeder delivery by end of year.

Boiler Replacement – Unit 5 boiler manufacturing is tracking to the installation need date in support of schedule. The manufacturer has introduced significant lean manufacturing actions and capacity additions which is expected to support the schedule.

Materials for Unit 6 have started to arrive and manufacturing of Unit 6 boilers have started. Engineering is in progress and all EC's 50% Design Completion is on track.

The offsite mock-up for dome cutting on a flat surface is complete. Preparations have commenced for offsite mockup for dome cutting on curved surface which is simulated to containment dome. Additionally, the RFBR team continues its readiness for field work in Unit 2 for mock-up / training / rehearsal purposes, such as boiler cut/reweld and large tooling positioning.

Turbine Generator (TG) –Detailed design is tracking on plan to meet execution timelines with 28 of 28 packages having achieved 30% design and 4 of 28 packages having achieved 60% design. Construction work packages are now underway with the first packages now submitted to OPG for review. Manufacturing is tracking to meet the committed delivery dates for all major components.

The project team is collaborating with Pickering A Component Removal Project, started on October 6, 2025; to capture lessons learned and integrate these insights into the ongoing Unit 5 to 8 planning phase to enhance project execution proficiency and risk mitigation.

Balance of Plant (BOP) – Segment 0 detailed design was completed on schedule on November 30, 2025. Breathing air compressor installation is underway, with major equipment arriving in March. Digital Control Computer detailed design is progressing following successful prototype testing. Standby generator (SG), 078-SG3, demolition design remains on track for March, with demolition work scheduled for October ensuring readiness for the 056 Boiler Crane mat installation.

Deep Water Intake (DWI) – The definition phase for the DWI project and associated site modifications is progressing toward key design milestones and on track to complete all site modification definition designs by the end of June. The Geotechnical Data Reports (GDR) and the Geotechnical Interpretative Report (GIR) are completed on February 10, 2026.

Operations and Maintenance (O&M) – Unit 6 Segment 1 Initial Assessment was completed successfully; Unit 5 Detailed Assessment for Segment 0 and Segment 1 work is on track to complete in March 2026. This Unit 5 planning continues to form the basis to support the subsequent units. Four-unit execution scripting has been developed for the first seven months of the Refurbishment window. Long-lead material (LLM) procurement progresses, with measures in place to minimize risk of delivery delays.

Licensing – The licence renewal application hearings are scheduled for June and October of 2026, with a decision expected by the year end by CNSC.

Cost Summary – As of December 31, 2025, the project is tracking on budget against the current funding release of $26.8 Billion. The life-to-date (LTD) spend is $1,910 million against a budget of $2,112 million, the variance is mainly due to timing differences **(Refer to Appendix 3)**.

Table 1 – Program Performance

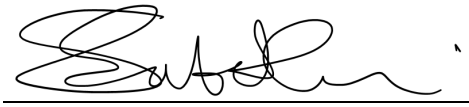
Units	Life-to-Date Performance ($M)			Life Cycle Forecast ($M)		
	Target Budget	Actuals	Variance	Target Budget	Forecast	Variance
Unit Common, Unit D and Unit F	515	376	-139	2,944	2,944	0
Unit 5	1,080	1,012	-68	8,792	8,792	0
Unit 6	219	216	-2	5,270	5,270	0
Unit 7	147	151	3	4,908	4,908	0
Unit 8	151	155	4	4,926	4,926	0
Total	**2,112**	**1,910**	**-203**	**26,840**	**26,840**	**0**

Key Risks – The following represent major risks that are being tracked as part of the overall Refurbishment project:

- **Site Capacity Constraints**: Projected peak shift employee head count at 4,800 vehicular traffic and upwards of 500 trucks daily poses infrastructure challenges (parking, security, lunchrooms), Scheduling and tracking on-time movement of people, materials including warehouse management, material pre-security clearances, PNGS loading bay utilization will be managed through the constrained roadways and site.

- **Balance of Plant:** A large volume of scope is planned to be executed from 2027 to 2034 through both the Refurbishment project and the sustaining portfolio. Scope optimization of the Pickering Refurbishment BOP portfolio was completed as part of Release Quality Estimate (RQE). The project will continue to monitor risk of additional scope growth as the project matures and detailed design progresses.
- **Procurement:** Procurement and delivery of extensive volume of non-long lead material poses a risk to the Project as delays to manufacturing and material delivery may impact execution. Where reasonable, the team is actively working to secure manufacturing slots prior to full completion of negotiations.
- **Facilities & Infrastructure:** A Road Servicing Agreement has been established with the City of Pickering as the City, Region and Ministry of Transportation have scheduled projects over the next 10 years that will impact access/egress from the Pickering Site. Renovation of ESB1 building and Service Wing are complete and full occupancy is achieved.
- **Security Implications:** The introduction of new security regulations brings uncertainty and potential impacts to Refurbishment project scope and mitigation strategies. OPG, together with other utilities, is actively engaging with the CNSC to clarify requirements and assess potential effects on current and future projects.

Submitted by:



Subo Sinnathamby
Chief Projects Officer

The information contained in this memo is current as of **February 26, 2026**.

APPENDICES

1. Program Major Milestones
2. PNR Segment 0 Level 1
3. Program Cost Overview
4. PNGS Campus Plan
5. Field Photos

ONTARIO POWER GENERATION

APPENDIX 1: PROGRAM MAJOR MILESTONES

Filed: 2026-04-22
EB-2025-0297
Exhibit L-D2-SEC-095
Attachment 3, Page 1 of 8

Data Date: 23-February-2026

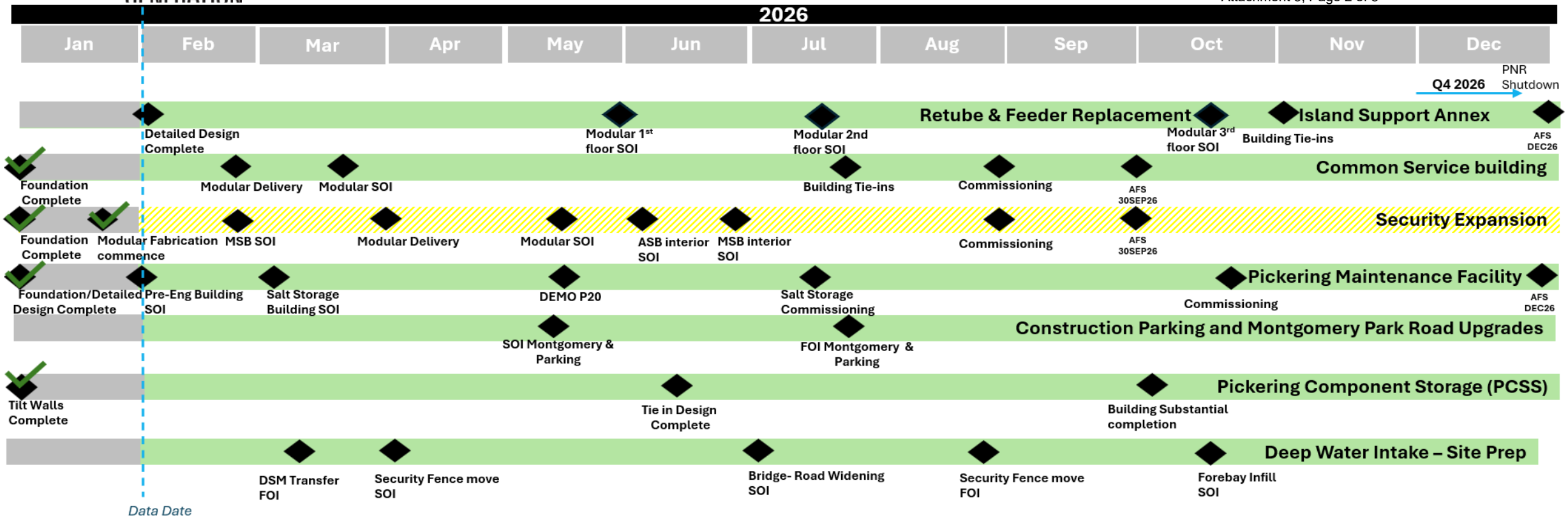
	Milestone Name	Baseline	Forecast	Status
1	Release 1B-RQE / Class III Estimate	Nov 30, 2025	Nov 30, 2025	Complete
2	Segment 0 Design Mods Complete	Nov 30, 2025	May 4, 2026	Recovery
3	Ops & Mtce LLM PO's Issued	Dec 31, 2025	Feb 20, 2026	Complete
4	Segment 0, Materials PO's issued for Known Materials	Jan 31, 2026	Jan 31, 2026	Complete
5	Segment 1 (Unit 5) Design Mods Complete	Mar 4, 2026	Mar 4, 2026	On Track
6	Segment 1, (Unit 5) Materials PO's issued for Known Materials	Apr 1, 2026	Apr 1, 2026	At Risk
7	Revision B (Units 6,7,8) Schedule Issued	Apr 30, 2026	Apr 30, 2026	On Track
8	Revision C (Unit 5) Segment 1 Schedule Issuance	June 1, 2026	June 1, 2026	On Track
9	Regulatory Approvals Obtained	June 1, 2026	June 1, 2026	On Track
10	Execution check estimate	Aug 12 , 2026	Aug 12, 2026	On Track
11	Revision 0 (Unit 5) Segment 1 Schedule Issued	Aug 15, 2026	Aug 15, 2026	On Track
12	Revision 0 (Units 6,7,8) Segment 1 Schedule Issued	Aug 30, 2026	Aug 30, 2026	On Track
13	Segment 2 (Unit 5) Design Mods Complete	Sept 1, 2026	Sept 1, 2026	On Track
14	Final Execution (Rev 0) Schedule Issued	Sep 03, 2026	Sep 03, 2026	On Track

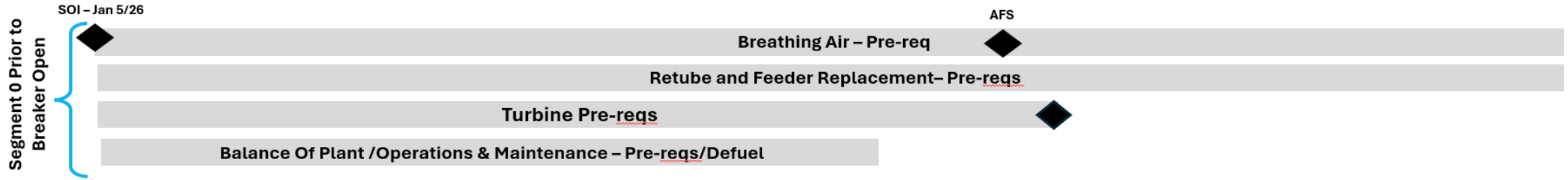
ONTARIO POWER GENERATION

APPENDIX 2: PNR SEGMENT 0 LEVEL 1

Filed: 2026-04-22
EB-2025-0297
Exhibit L-D2-SEC-095
Attachment 3, Page 2 of 8

Data Date: 21-January-2026





FOX CONSTRUCTORS · Black & McDonald · SIEMENS energy · AECON · VINCI CONSTRUCTION · CANATOM POWER GROUP · MAKHOS INC. bird JOINT VENTURE · framatome

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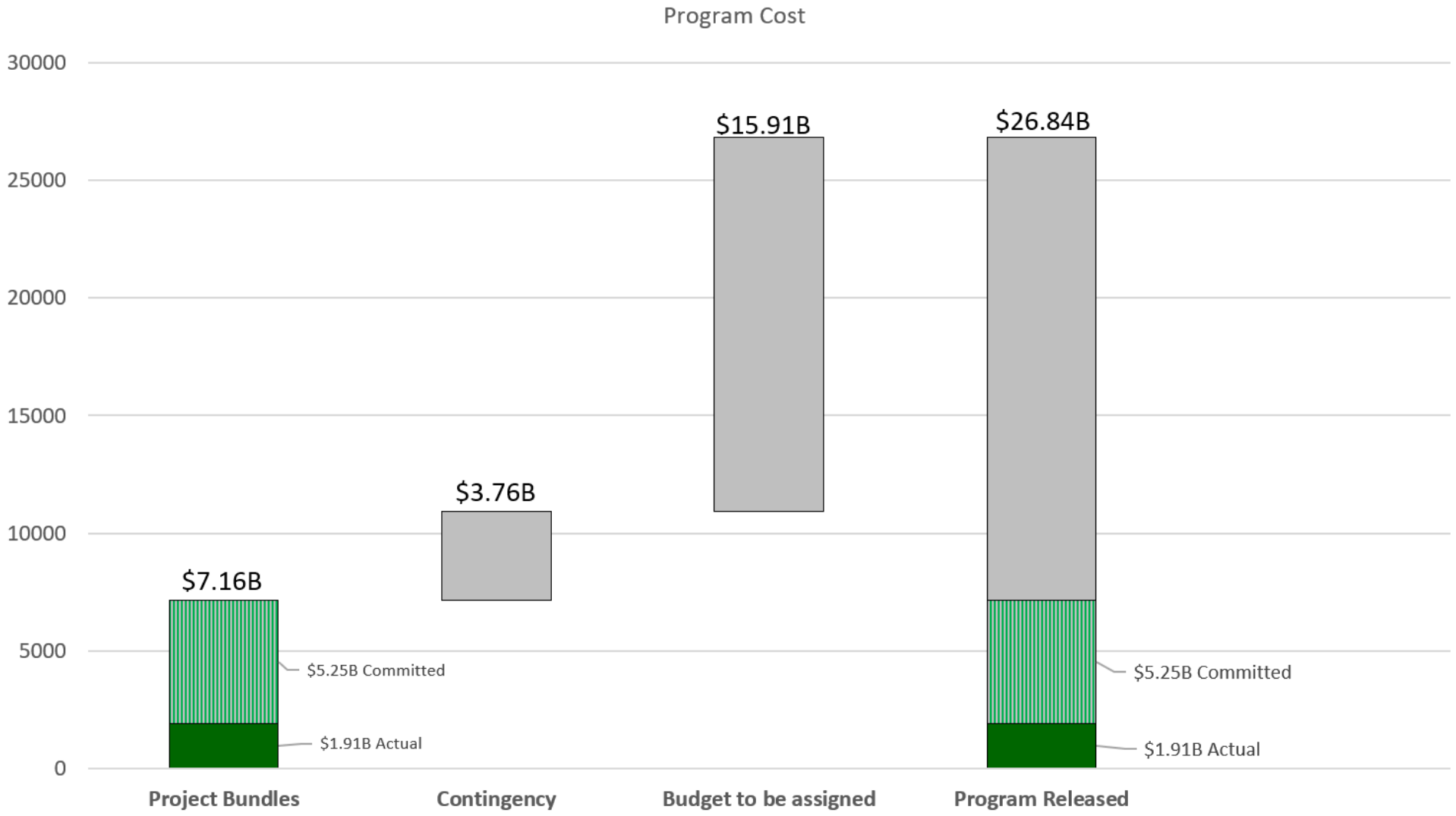
APPENDIX 3: PROGRAM COST OVERVIEW

Filed: 2026-04-22
EB-2025-0297
Exhibit L-D2-SEC-095
Attachment 3, Page 3 of 8

Data Date: 23-January-2025



APPENDIX 4: PNGS CAMPUS PLAN

Filed: 2026-04-22
EB-2025-0297
Exhibit L-D2-SEC-095
Attachment 3, Page 4 of 8

West Sally Port
SOI- Aug 10, 2025
FOI- Sep 30, 2026

RFRISA
SOI- Q2, 2025
FOI- Dec 2026

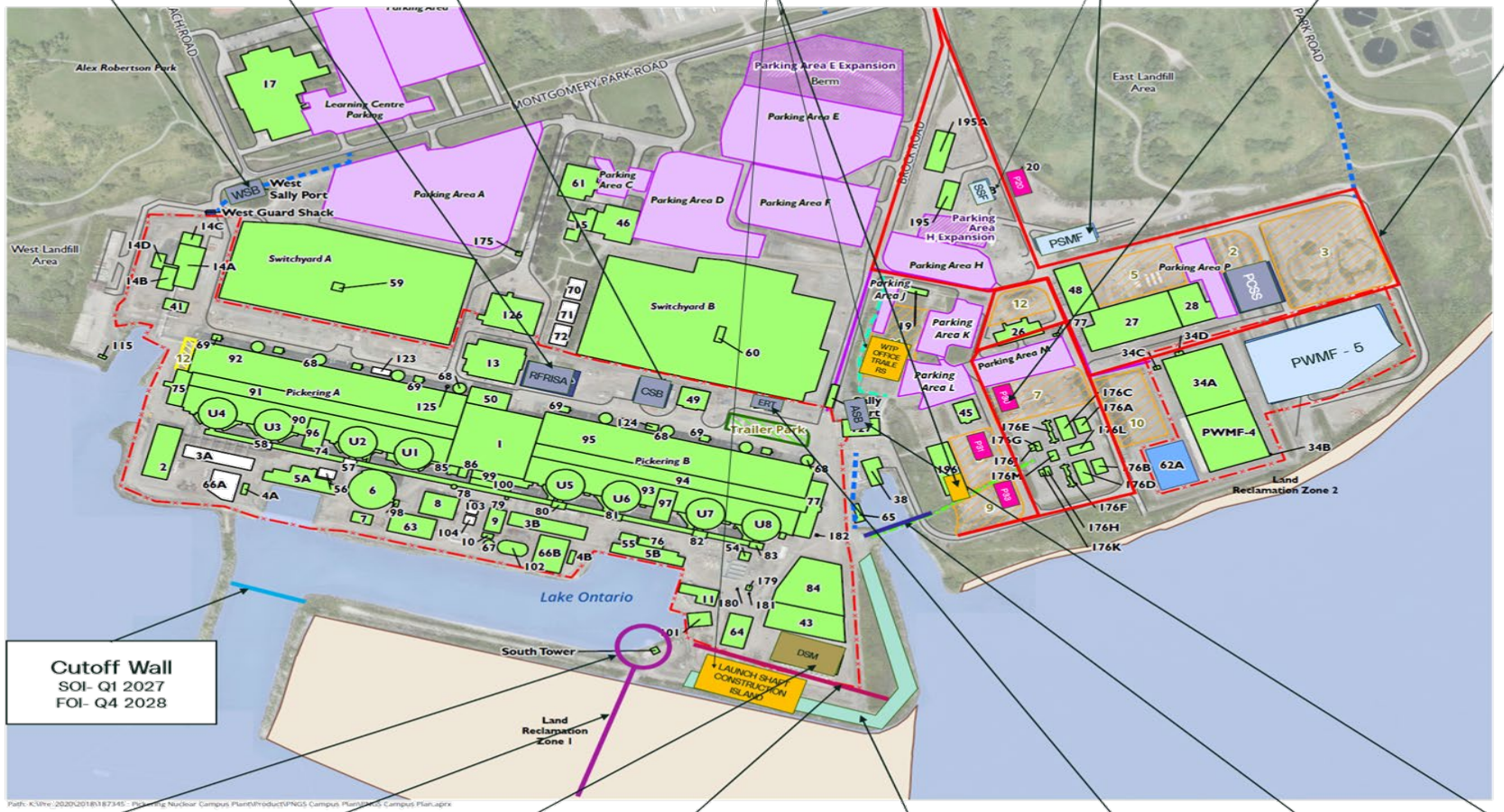
CSB
SOI- May 5, 2025
FOI- Sep 30, 2026

DWI Office Trailers & Construction Island
SOI- Q2 2026
FOI- Q1 2030

PSMF & SSF
SOI- Jul 31, 2025
FOI- Dec 30, 2026

Demolishing P33, P31 and P30 (On Hold), P20
Q4 2026 - Q1 2027

Roads and Parking Lot
SOI- Jun 23, 2025
FOI- Oct 30, 2026



Cutoff Wall
SOI- Q1 2027
FOI- Q4 2028

Launch Shaft
SOI- Q4 2026
FOI- Q1 2030

Starter Tunnel
SOI- Q2 2027
FOI- Q2 2029

DSM
SOI- Q4 2025
FOI- Q1 2026

PA Boundary Fence
SOI- Jan 2026
FOI- Sep 2026

Dike Road widening
SOI- Q3 2026
FOI- Q4 2026

ERT
SOI- Nov 11, 2024
FOI- May 30, 2025

Bridge
SOI- Q2 2026
FOI- Q2 2027

ASB Expansion
SOI- Aug 10, 2025
FOI- Sep 30, 2026

Legend
SOI: Start Of Installation
FOI: Finish Of Installation

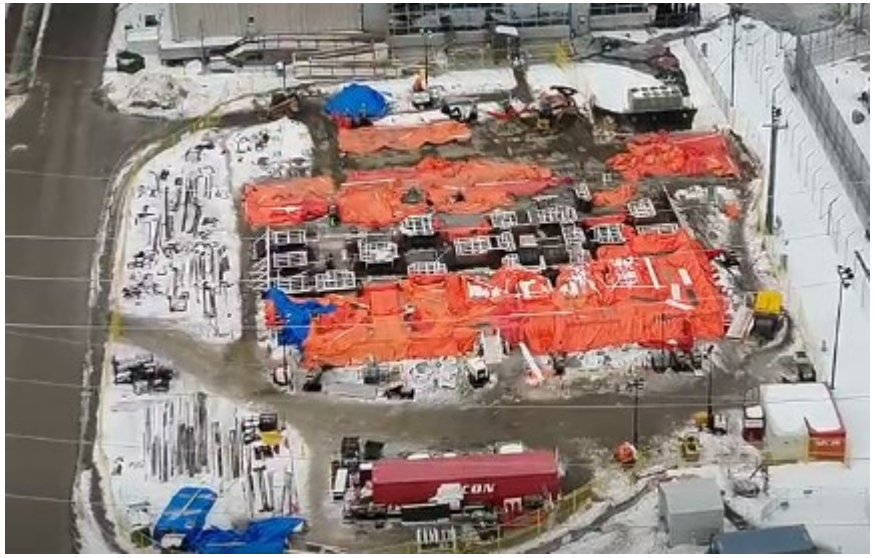
ONTARIO POWER GENERATION

APPENDIX 5: FIELD PHOTOS

Drone shots obtained February 5th, 2026

Filed: 2026-04-22
EB-2025-0297
Exhibit L-D2-SEC-095
Attachment 3, Page 5 of 8

Retube Feeder Replacement Island Annex (RFRISA)



RFRISA (offsite fabrication)

Common Services Building (CSB)

CSB (offsite Fabrication)

ONTARIO POWER GENERATION

APPENDIX 5: FIELD PHOTOS

Drone shots obtained February 5th, 2026

Filed: 2026-04-22
EB-2025-0297
Exhibit L-D2-SEC-095
Attachment 3, Page 6 of 8

Auxiliary Security Building Expansion (ASB)

Pickering Component Storage Structure

ONTARIO POWER GENERATION

APPENDIX 5: FIELD PHOTOS

Drone shots obtained February 5th, 2026

Filed: 2026-04-22
EB-2025-0297
Exhibit L-D2-SEC-095
Attachment 3, Page 7 of 8

DSM relocation (foreground) and PWMF Kiosk (background)

Sandy Beach and Montgomery Road improvement

Pickering Waste Management Facility Storage Building 5

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APPENDIX 5: FIELD PHOTOS

Drone shots obtained February 5th, 2026

Filed: 2026-04-22
EB-2025-0297
Exhibit L-D2-SEC-095
Attachment 3, Page 8 of 8

West Sally Port (WSP)

Pickering Maintenance Facility

Road Upgrade

SEC Interrogatory #096

Interrogatory

Reference:
D2-3-9, p. 13
D2-4-9, p. 16-17

Preamble:

With respect to the PRP and DNNP Oversight, SEC would like to understand how the current and proposed third-party oversight mechanisms for these projects are similar or different for those in place for the DRP.

Question(s):

a) Please provide a copy of the terms of reference, and all other governing documents, including any contracts, retainer agreements or other agreements, between OPG and Burns McDonnell/Modus Strategic Solutions regarding their engagement on behalf of the OPG's Board of Directors regarding oversight of the definition and execution phase of DRP Unit 2, and execution estimate of Unit 3.

b) Please explain the basis for any material differences in the scope of the engagement, including but not limited to reporting, access to OPG Staff and information, independence, and independent support staff, as set out in part(a) compared to the PRP Refurbishment Review Board and the DNNP Small Modular Reactor Review Board.

Response

a) OPG's Board of Directors did not engage with Burns McDonnell/Modus Strategic Solutions in respect of the PRP. Major Projects Committee of the OPG Board of Directors supports program-level oversight by OPG's Board of Directors. As part of this oversight, the Major Projects Committee has retained the Refurbishment Review Board to provide independent assessments of the PRP.

b) The SMR Review Board, the DNR Review Board and the PRP Review Board serve materially the same purpose, aside from specific skill sets tailored to the work scopes being executed.

SEC Interrogatory #097

Interrogatory

Reference:
D2-4-1, p. 5

Question(s):

With respect to the selection of BWRX-300 as the specific technology:

a) Please provide a detailed explanation of the technology selection process.

b) Please provide all materials provided to the OPG Board of Directors regarding the selection of the BWRX-300 as the specific technology.

c) Please provide a copy of any internal document that was created that provides a summary of the outcome of the selection process, a review of the other potential technologies that were considered, and a recommendation for the selection of the BWRX-300.

d) Did OPG undertake any third-party reviews of the selection process? If so, please provide a copy of their report (or similar documents).

e) Please confirm that OPG is the first company to construct a BWRX-300 reactor.

f) As part of the selection process, did OPG (or related entities) receive any preferential benefits with GE-Hitachi regarding preferential benefits to OPG for being the first company to construct a BWRX-300 reactor? If so, please provide details.

Response

a) A detailed explanation of the technology selection process was provided at EB-2023-0336, Ex. H1-1-1, p. 39 and EB-2023-0336, Ex. L-H-CCC-08 including Attachment 1 (confidential). The associated costs were decided in EB-2023-0336, in which OPG sought cost recovery for that process. The Applicants are not seeking recovery of any costs related to the DNNP technology selection process in this proceeding. The issue of DNNP technology selection is not within the scope of the current proceeding and the Applicants will not be refiling the EB-2023-0336 materials.

b) Materials provided to the OPG Board of Directions regarding the selection of the BWRX-300 as the specific technology were provided in EB-2023-0336 in response to Ex. L-H-CCC-08, Attachment 2 (confidential). For the reasons set out in part (a) above, the Applicants will not be refiling these materials.

c) and d)

Refer to part (a).

e) The Applicants confirm that OPG is the first company to receive a construction licence and commence construction of a BWRX-300 reactor. The construction is continuing through DNNP LP.

f) Refer to Ex. L-A1-CCC-012, part (a) (iii).

SEC Interrogatory #098

Interrogatory

Reference:
D2-4-1, p. 6

Preamble:

The evidence states with the technology selection process complete, OPG's Board of Directors approved the move to the Initiation Phase which included execution of initial commercial agreements.

Question(s):

a) Please provide a copy of the materials provided to the OPG Board of Directors for their decision to move to the Initiation Phase.

b) Please provide details regarding the initial commercial agreements.

c) Did OPG develop any cost estimate for the project at the Initiation Phase? If so, please provide a copy.

Response

In accordance with the Motions Resolutions letter filed on May 4, 2026, the Applicants have revised this interrogatory response.

a) and c)

For the OPG Board of Directors approval memorandum for the funding release to proceed with the Initiation Phase for the DNNP, refer to Attachment 1 (confidential).

Having provided this information in accordance with the Motions Resolutions letter filed on May 4, 2026, the Applicants maintain that this interrogatory seeks materials that have been superseded by the Release Quality Estimate ("RQE") provided at Ex. D2-4-8, Attachment 1. The RQE is the basis on which the Applicants are undertaking the work and the basis of the Application before the OEB. Any previous cost estimates prior to the RQE are not relevant to evaluating the issues in this proceeding, consistent with OEB Procedural Order No 5.

b) Refer to Ex. D2-4-4, Attachment 1(confidential) and Ex. L-A1-CCC-012, part a) (iii). The Applicants decline to provide any initial commercial agreements as they are not relevant to issues in this proceeding.

ONTARIO POWER GENERATION

OPG Confidential Exclusive

FOR APPROVAL by the Board of Directors

November 10, 2021

Darlington New Nuclear Project – Approval of Technology and Start of Site Preparation

DECISION REQUIRED

Ontario Power Generation Inc. (OPG) is seeking approval from the Board of Directors to proceed with the first phase of a Small Modular Reactor (SMR) capital project at the Darlington New Nuclear Project (DNNP) site (SMR Project) with the selected SMR technology developer and funding of up to $200 million for this phase. This first phase covers engineering work, project development, submission of an application for a Licence to Construct (LTC) to the Canadian Nuclear Safety Commission (CNSC), and the initial site preparation work to be undertaken in 2022. This project is being initiated with a view towards completing the first SMR about the end of 2028 and aspiring to eventually deploying multiple SMRs on the site for a total of approximately 1200 MWe at an average Levelized Cost of Electricity (LCOE) in a range of about [redacted]. For clarity, separate approval will be requested for subsequent phases and prior to the start of reactor construction.

ISSUE

Ontario needs to increase its supply of non-greenhouse-gas (non-GHG) emitting baseload electricity generation in the early 2030's. This need is expected to become more pronounced as a result of increased electrification. To supply all the capacity and energy needed, a diverse supply mix will be required. Both international expert reports, and OPG's own analysis, have identified that additional nuclear power needs to be part of a non-GHG emitting supply mix, along with renewables. Small Modular Reactors have been identified as cost competitive against other clean energy options and provide job and economic benefits that intermittent renewables cannot. Consistent with OPG's Strategic Objectives and Climate Change Plan, enabling additional nuclear generation through SMRs will position OPG as an Energy Industry Leader and be a catalyst for a net-zero economy. As a result of the long deployment timeline for new nuclear, it is recommended to initiate preliminary capital project work now, building on the efforts undertaken to-date. While the primary rationale is related to Ontario needs this will also enable OPG growth opportunities by supporting other jurisdictions interested in deploying new nuclear. OPG is advancing the development of SMR potential (SMR Program) as a strategic initiative.

ANALYSIS

Background

OPG holds an Environmental Assessment approval (EA) and a CNSC Licence to Prepare Site (Licence). The CNSC Licence was renewed for another 10 years, effective October 12, 2021. This EA and Licence are valuable assets, the only of their kind in Canada, which uniquely position OPG to progress new nuclear development several years ahead of any other party.

OPG has been analysing new nuclear technology options, and in particular SMRs since 2018, with the objective to identify the SMR technology developer most suited to Ontario and the DNNP site.

During 2021, OPG thoroughly analysed the three leading SMR options, GE-Hitachi Nuclear Energy Americas LLC's (GEH) BWRX-300, Terrestrial Energy Inc.'s (TEI) Integrated Molten Salt Reactor IMSR-400, and X-Energy LLC's (XE) Xe-100, to identify developer-specific risks, challenges, benefits, and opportunities, so as to be able to present OPG's Board of Directors with the preferred option and appropriate rationale.

The importance of the assessment areas can be summarized as follows:

- Design readiness: Ensure design is appropriately advanced, because a design that is too incomplete or has too much research and development (R&D) still to do has greater uncertainty on cost, schedule and licensability.
- Safety: Assess the safety features associated with the technology, as a plant with passive or inherent safety features will have greater social licence and potential for an emergency planning zone at the station fence, which offers opportunities to reduce cost of emergency response teams.

- Fuel: Examine the developer's fuel design status, approval for use ("qualification"), and availability, as a fuel that is still under design has risks on schedule and approval; a fuel that is hard to obtain creates risks to deployment and operability
- Waste: Determine the ability to manage the plant's radioactive waste, especially its used fuel, with minimal technical challenges and risk, environmental impact (e.g., volume), and cost. Nuclear waste is perhaps the most significant social licence challenge for nuclear power in Canada.
- EA: Assess the ability for the design to fit within OPG's existing EA, without which the SMR Project would have increased risk in licensing as well as schedule. A design considered to be inconsistent with the EA creates a risk of not being able to proceed at all (e.g., due to a potential judicial review challenge).
- Regulatory: Assess the likelihood of being able to receive a CNSC licence on the required timeline. A design with significant uncertainty or challenges related to acceptability to the CNSC brings additional risks to the schedule and cost (e.g., should major redesigns be required by the regulator).
- Project management and schedule: Determine the potential for the first plant to be deployed on the right timeline with minimal risks to the schedule. Failure to meet the schedule challenges the credibility of nuclear new build.
- Cost: Assess the potential to be deployed at a competitive cost to other non-emitting options providing comparable energy and capacity.
- Economic value and future potential: Determine the potential for supply chain development in Ontario, and the opportunities for a potential fleet (i.e., growth opportunities as well as efficiency gains from multiple deployments). These factors are important because OPG does not want to build a "one of a kind" reactor; rather OPG wants to enable a fleet so as to have a greater positive impact on climate change, and enable growth opportunities for jobs and GDP benefits to the Province of Ontario.
- Contracts: A judgement of the value of potential benefits of contracts and ease of working with each developer.

Taking account of all of these areas, the SMR technology developer judged to provide the best overall balance is GEH, and OPG recommends proceeding with this developer and its design (BWRX-300). A summary of the preferred option and associated rationale are presented in Appendix 1.

SMR Project Oversight

To ensure the SMR technology developer option review process was conducted with integrity and that OPG was thorough in its approach, several independent parties were retained to provide assistance or oversight.

- OPG issued a protocol to each of the three SMR technology developers, which provided information on how the process would be conducted. A Protocol Monitor (Bill Mocsan - Lakeland Consulting) was appointed to act as an ombudsperson and be available to address any complaints and concerns with respect to the conduct of OPG. To date, none of the SMR technology developers have issued concerns to the Protocol Monitor.
- The Ontario Ministry of Energy (MoE), OPG and MZConsulting Inc. entered into an agreement for Energy Advisory Services so Milt Caplan, the president and principal advisor of MZConsulting Inc., could be retained by the Ministry to provide it with independent oversight over the technology selection process, as well as over the work being undertaken by OPG to plan and prepare for the execution phase of the SMR project. This oversight mechanism is expected to continue for the next phase of the SMR Project if approved.
- The New Nuclear Review Board (NNRB), currently consisting of five independent industry experts and supported by OPG personnel, was commissioned by OPG executive leadership to independently monitor and provide advice to the DNNP, and has provided two reports to date. OPG will continue to utilize a NNRB on an ongoing basis.

Indigenous and Stakeholder Engagement and Support

OPG continues to engage Indigenous communities with interests in the DNNP lands, including provision of capacity funding agreements. OPG's goals in this regard include providing project information, receiving feedback, learning of Indigenous knowledge and perspectives and incorporating those into OPG's environment programs where appropriate, providing training and jobs opportunities, ensuring Indigenous-owned businesses have project opportunities, and exploring opportunities for commercial participation of Indigenous communities in the SMR Project.

An SMR at the DNNP site is strongly aligned to and supports the work under the Memorandum of Understanding on SMRs signed by Ontario, Saskatchewan, New Brunswick and Alberta. Additionally, the

project has strong support from the local community around the Darlington site, consistent with their ongoing support for the Darlington and Pickering nuclear generating stations.

The Provincial Government, on July 8, 2021, through the Minister of Energy, wrote to OPG's Board Chair instructing OPG to continue planning and preparation work for the development of a potential on-grid SMR at the Darlington site, including completion of the SMR technology selection process; and to include continued advancement of the SMR Project at the Darlington site in OPG's next business plan.

The Canadian federal government continues to signal the importance of low-emitting technologies in its fight against climate change, and to signal that nuclear power must be part of the solution, e.g., through publication of its SMR Action Plan in late 2020.

Cost Recovery:

An SMR at the DNNP site is expected to be a rate-regulated facility. On September 14th, 2021, the MoE posted for public comment an amendment to Ontario Regulation 53/05 (O. Reg. 53/05) the purpose of which is to include the Darlington SMR as a regulated facility and allow OPG to recover all prudently incurred costs of the SMR Project from electricity ratepayers under the oversight of the Ontario Energy Board (OEB). Approval of this amendment is expected in November 2021.

Business Case

During 2021, OPG has performed a business case analysis which demonstrates that an SMR Program at the DNNP site can provide reliable baseload power for about 60 years at a LCOE in the [redacted]. This figure has been identified through OPG analysis as a target cost based upon other non-emitting options such as wind plus batteries, or solar plus batteries, providing roughly comparable energy and capacity. Assuming that ultimately about 4 plants of the same design (around 1200 MWe) are constructed at DNNP, a LCOE sensitivity analysis was performed on the recommended developer technology which results in a range from [redacted].

An economics benefits assessment was performed in 2020 by the Conference Board of Canada (CBoC) and published in 2021 through the Feasibility Study issued under the Provincial MOU on SMRs, identifying the jobs and GDP and taxation benefits of one SMR at DNNP (and of additional plants built in Saskatchewan). OPG's analysis, based in part on data provided by the three developers, is broadly consistent with the CBoC study findings.

Financing

To ensure cost effective financing, OPG would finance the SMR work through OPG's balance sheet, in conjunction with opportunities for securing low-cost financing. Negotiation of a [redacted] loan with the Canadian Infrastructure Bank (CIB) is progressing. [redacted]. Even without CIB financing OPG believes the economic benefits and LCOE will support continuing with the project.

Project Proposal and Budget Request

Preliminary cost estimates have been developed for a potential SMR Program, which would enable a number of SMRs based on the preferred technology, at the DNNP site. This SMR Program would occur through a phased approach similar to OPG's approach for the Darlington Refurbishment Project (DRP). Only after having finished the design, and with greater cost and schedule certainty would OPG propose beginning nuclear construction for the first SMR Project, and only after proving a path to success with the first SMR Project, and with continued support from Indigenous communities and stakeholders, would OPG recommend moving on to additional deployment(s) at the DNNP site.

For the first SMR Project phase, occurring in 2022, OPG proposes to work with a single preferred developer in order to maximize progress on the schedule, while ensuring prudent expenditures should it be determined that the larger project will not advance beyond 2022. If approved to proceed for 2022, OPG will: progress to a formal "definitive agreement" with the preferred developer; further develop the project schedule and engineering for the preferred design; prepare an LTC application and submit it to the CNSC; commence the first phase of critical path site preparation activities; and obtain an improved class of cost estimate for the November 2022 Board meeting. Further details of project deliverables for 2022 are provided in Appendix 2.

RECOMMENDATION / RESOLUTION

1. That the Board of Directors authorizes and approves:
   I. OPG proceeding with the SMR Project to develop the plan to construct the first SMR plant, on the DNNP site, subject to provisions below.
   II. OPG to proceed with the first phase of the SMR Project with GEH as the selected SMR technology developer, which first phase shall be to progress the SMR Project in 2022, including additional engineering, advancement of project planning, scheduling, and improved cost estimate classification, development of a definitive agreement with the selected SMR technology developer, and development of a CNSC construction licence application.
   III. OPG to proceed with the first stage of site preparation of the DNNP site in respect of the SMR Project under the auspices of OPG's Licence to Prepare Site issued by the CNSC.
   IV. Release of a $200 million funding envelope for the approximate 2021 – 2022 period substantially consistent with the project deliverables set out at Appendix 2, which includes the activities referenced in paragraphs (II) and (III) above.
   V. Delegation of approval authority to the OPG President and CEO for the release of funds within the funding envelope referenced in (IV) above.

2. The Board of Directors requires that if there are any material changes to the premises and assumptions set out in this Memorandum that relate to the SMR Project that impact the authorizations and approvals in paragraph (1) above, OPG shall report these to the Board in a timely way and seek further approvals from the Board as it may require.

Recommended by:

Dominique Miniere
EVP, New Nuclear Domestic & Int. Strategy

Approved for submission to the Board of Directors by:

Ken Hartwick
President and CEO

This Board memo was reviewed and approved for submission to the Board of Directors by the Generation Oversight Committee at their meeting of November 9, 2021.

APPENDICES

1. Rationale for Preferred SMR Technology Option
2. DNNP Project Deliverables for 2022

APPENDIX 1: RATIONALE FOR PREFERRED SMR TECHNOLOGY OPTION

OPG has completed the assessment of the ability of each of the three SMR technology developers to meet the following overarching goals (Overarching Goals):

1. the SMR technology fitting within the existing environmental envelope for the DNNP site, as outlined within the existing EA and the Licence, both of which were obtained by OPG for the DNNP site in 2012;
2. submission of the licence to construction application incorporating the SMR technology to the CNSC in 2022; and
3. achieving an in-service date during 2028 for a first unit using the SMR technology.

As described in more detail in the body of the Memorandum, the OPG assessment process included analyses in the eleven assessment areas, with each of the eleven assessments having been conducted by a separate assessment team, and subsequently the OPG challenge team having compiled results of each assessment in the assessment report. A representation of this assessment, as of the time of writing the Memorandum, is included in Figure 1 below.

Figure 1: Assessment Summary

Green is lower risk or higher benefit, and red is higher risk or lower benefit

Final deliverables from each of the SMR technology developers are due on October 29th, 2021. To the extent new information is provided that significantly changes the assessment, Management will verbally update the Board of Directors. Based on the results of the assessment as of the date of writing this Memorandum, Management views GEH's BWRX-300 technology as the option that is most likely to allow OPG to achieve the Overarching Goals and, therefore, recommends proceeding with GEH as the preferred SMR technology developer. The following paragraphs summarize the rationale behind the recommendation to proceed with GEH:

- The BWRX-300 design is the most similar to designs considered at the time of the Joint Review Panel, which formed the basis of the DNNP EA. There are some differences, such as the depth of plant embedment below ground, and the fact that the reactor coolant goes directly to the turbines, removing one barrier to potential radiation release; however, there is low risk that these features will require adjustments to the EA.
- The BWRX-300 is GEH's tenth generation design and is heavily based on a previous generation. GEH's engineering design is the most advanced of the three in terms of schedule, with the least R&D work required before the design can be completed. The fundamentals of boiling water reactors BWR are well understood by the industry and international regulators. The BWRX-300 is based on many operating reactors, which have been licensed and safely operated in different countries. Further, GEH has the largest and most-experienced project and design team, the strongest overall balance sheet and an existing, established, robust nuclear management system.

- The fuel required for the BWRX-300 (Global Nuclear Fuels GNF2) is already in widespread use (though remains to be qualified for this new reactor design) and is readily available with a secure supply.
- As a result of the current design status and licensing risk, the BWRX-300 is believed to be the only SMR technology that could potentially be in service by the end of 2028, albeit with a great deal of work necessary to achieve that aggressive objective.
- From a cost perspective, while further design progress is required, the BWRX-300 was assessed as having the most certainty and lowest LCOE when looking at a multi-unit deployment at the DNNP site.
- The BWRX-300 design is of strong interest to number of companies interested in deploying SMRs in the early 2030's following an OPG deployment; including, Synthos in Poland, Fermi Energia in Estonia and the Tennessee Valley Authority (TVA) in the U.S. Further, SaskPower has identified that it considers the GEH design acceptable, and is willing to partner with OPG on deployment of this design in Saskatchewan. This interest increases the probability of sharing costs, future OPG opportunities and reduces the risk of being "only of a kind".
- Economic development potential in Ontario is expected to be comparable to the other SMR options. GEH has identified a considerable number of Canadian supply chain partners, and GEH projects a large percentage of Canadian based manufacturing.
- From a contractual perspective, it is believed that satisfactory terms could be reached with GEH.

Proceeding with GEH as the SMR technology developer is not without its known, and unknown challenges or disadvantages. Some of the known challenges include:

- Disposal of the used fuel in the Nuclear Waste Management Organization (NWMO) deep geologic repository (DGR) is technically feasible; however, it will require use of a larger used fuel container than contemplated by NWMO's current design, which has been optimized for CANDU fuel. This will require a redesign of aspects of the DGR, which will in turn generate a higher cost for fuel disposal.
- The BWRX-300 does not have the "inherent" safety features of the other two designs; however, it does have increased passive safety features compared to existing BWRs. The design has sufficient cooling water and battery supply for at least 7 days without any significant operator action, and is designed to allow external replenishment to be supplied after that.
- There are some licensing challenges remaining, such as whether the CNSC will accept the safety case which does not include two independent and diverse fast-acting shutdown systems, and whether CNSC will accept GEH's SteelBricks™ construction design technique; however, regulatory licence approval of the GEH design at DNNP is not considered to be high risk, with no identified regulatory showstoppers.
- The BWRX-300 is not well suited for advanced technology or heavy industry deployments. For example, two oil sands companies aware of OPG's assessment process indicated the GEH design was not of interest to them, as it is unable to provide suitable super-heated steam for their applications.
- Given the ability to leverage existing supply chains some components will likely be manufactured in other countries; as an example, GEH's primary proposal for fuel manufacturing is based in the U.S. and the possibility of replacing this with an embedded Canadian supply chain is low.
- Based on reputation and experience [redacted] than the other, smaller companies.

These risks are viewed as manageable, and pose fewer challenges than presented by the other two options. Further, there was not enough additional upside benefit associated with either of the other two SMR technology developer's options to justify selecting an option that is viewed to be more uncertain at this time.

APPENDIX 2: DNNP PROJECT DELIVERABLES FOR 2022

If approval to proceed is received from the Board and the Shareholder, the Project is proposed to proceed into the preliminary planning phase and will execute the following activities from January to November 2022. Project updates will be provided throughout 2022 and in November 2022, the team will return to the Board for approvals to proceed to the detailed planning phase, assuming satisfactory progress. The project will proceed in the following areas:

Program

- Issue a detailed project management plan on the managed systems for planning and controlling the project (includes such items as scope change process, division of responsibilities between OPG and the Developer, etc.)
- Update cost estimate to class 4
- Update the Business Case
- Update program schedule
- Continually update risk registry
- Put the project organization in place including project management, oversight engineering, licensing, operations and maintenance, and support teams (relying on matrix organization and service level agreements where appropriate)

Indigenous Relations

- Engage with Williams Treaty First Nations in advanced discussions related to environmental impacts and feedback with respect to mitigation by design. Have in place Indigenous knowledge agreements with at least one community, which is likely to include environmental monitoring co-operation for site preparation activities.
- Engage with other Indigenous communities with interests in the project
- Develop Indigenous investment term sheets in discussion with the participating communities
- Establish agreements with the SMR technology developer and other partners related to early goals for Indigenous employment, training, and Indigenous business engagement

Environment & Licensing

- Agree with CNSC on a Protocol for construction licence submission and review process
- Submit technology-specific first revision LTC application plan update and submission to CNSC for concurrence
- Prepare a LTC application for target submission before year-end 2022
- Completion and submission of OPG commitments related to early site preparation work
- Establish environmental monitoring program and EA follow-up plan

Engineering

- Progress SMR design through engagement and oversight (including completion of conceptual design, and preliminary and detailed design initiation, where not already done), ensuring OPG input
- Review and accept developer's Preliminary Safety Analysis Report (PSAR)
- Perform oversight of engineering deliverables and interfaces in accordance with commercial agreements
- Advance engineering programs development in support of LTC, IT strategy, and technical knowledge retention strategies
- Implement Management System Transition Plan from Licence to LTC
- Advance site preparation engineering and finalize scope for readiness for the next phase of execution in 2023
- Support establishment of SMR commercial relationship through requirements definition and Contractor-Owner Interface Requirements supportive of effective engineering oversight and technical support to operations
- Support all technical aspects of all project/program areas, as required

Commercial/Procurement

- Issue SMR technology developer contract ("definitive agreement"), supporting architect/engineering contract, and prime constructor contract
- Put in place project delivery model based on updated contract strategy
- Award contract(s) for site preparation
- Issue Contractor Owner Interface Requirements (COIR) document
- Identify long lead materials

Site Preparation

- Prepare site preparation construction work packages and have permits issued
- Execute early works (site services and early infrastructure construction)
- Complete next phase of geotechnical work

SEC Interrogatory #099

Interrogatory

Reference:
D2-4-1, p. 6

Preamble:

The evidence states "[i]n December 2022, OPG's Board of Directors gave approval for the project to proceed to the Definition Phase."

Question(s):

a) Please provide a copy of the materials provided to the OPG Board of Directors for their decision to move to the Definition Phase.

b) Did OPG develop any cost estimate for the project at the Definition Phase? If so, please provide a copy.

Response

In accordance with the Motions Resolutions letter filed on May 4, 2026, the Applicants have revised this interrogatory response.

a) and b)
For the OPG Board of Directors approval memorandum for the funding release to proceed with the Definition Phase for the DNNP, refer to Attachment 1 (confidential).

Having provided this information in accordance with the Motions Resolutions letter filed on May 4, 2026, the Applicants maintain that this interrogatory seeks materials that have been superseded by the Release Quality Estimate ("RQE") provided at Ex. D2-4-8, Attachment 1. The RQE is the basis on which the Applicants are undertaking the work and the basis of the Application before the OEB. Any previous cost estimates prior to the RQE are not relevant to evaluating the issues in this proceeding, consistent with OEB Procedural Order No 5.

ONTARIO POWER GENERATION

OPG Confidential Exclusive

FOR APPROVAL by the Board of Directors

December 1st, 2022

Darlington New Nuclear Project (DNNP) – SMR Unit 1 Definition Phase Funding Release

DECISION REQUIRED

The purpose of this memo is to provide an update on the status of the four-unit Darlington New Nuclear Project (DNNP) Program and request approval to release additional funding in the amount of **$1,099 Million** to proceed with the definition phase of the Small Modular Reactor (SMR) Unit 1 project (SMR 1).

This release covers the period from January 2023 until December 2024 for definition phase planning, engineering, procurement, and site preparations, including $58 Million for interest & escalation and $95 Million of contingency, which would bring the project life-to-date funding total to **$1,299 Million.**

The current estimate to complete the four-unit SMR program is [redacted] with a risk adjusted levelized cost of electricity (LCOE) in the range of [redacted] and an output capacity of 315MW Net per unit.

BACKGROUND

In November 2021, OPG's Board of Directors approved **$200 Million** to initiate the DNNP SMR Program based on the selected technology developer.

Since that time, management has progressed initiation phase planning and engineering, advanced design work related to site preparation and submitted an application for a License to Construct (LTC) to the Canadian Nuclear Safety Commission (CNSC). As part of the planning process, management has also updated the cost estimate and schedule development and performed an updated risk and contingency analysis.

The current total four-unit SMR Program cost estimate is [redacted] for SMR 1. The SMR 1 cost estimate is considered a Class 4 estimate with a P90 Confidence factor and includes [redacted] in common costs related to the four-unit infrastructure. The four-unit estimate remains economically competitive with an LCOE of approximately [redacted] and reflects a number of significant changes including a larger facility output of 315MW Net per unit compared to 285MW as previously reported, adjustments in scope for common infrastructure facilities to support four SMR units, updated escalation impacts and interest assumptions, as well as additional cost and schedule contingency given the risks inherent in this First of a Kind (FOAK) program.

The project is adequately prepared for progression, and management is now requesting Board approval to proceed with the definition phase of the program in order to progress the following major activities.

- Progress detailed engineering and complete the Standard Plant design using a design to cost approach
- Obtain LTC approval from the CNSC
- Complete construction planning
- Procure long lead items
- Complete site preparation activities
- Prepare the Release Quality Estimate (Class 3) for the execution funding release
- Continue to engage in meaningful discussions with the Williams Treaty First Nations

DISCUSSION

Throughout the initiation phase, the project team has completed all major activities required to proceed with the next phase of the program:

- A LTC Application has been submitted including the Preliminary Safety Analysis (PSAR) and Environmental Impact Statement (EIS) to the CNSC
- Engineering design has progressed to support the LTC application and develop scope definition
- A Class 4 Estimate for SMR 1 has been developed and supported by a third-party review
- An Integrated Project Delivery (IPD) team has been established with the technology provider (GE-Hitachi or GEH), Architect Engineer (SNC Lavalin or SNC-L) and Constructor (AECON). The IPD agreement is substantially completed and agreed to by the parties conditional on this approval, and
- The Project team has been established and staffed to required levels.

OPG also progressed and substantially completed the following agreements in support of the project:

- Technology Collaboration Agreement (TCA) between OPG, TVA, Synthos and GEH to develop the BWRX-300 reactor plant technology for deployment. Each contributor will fund a portion of the Standard Plant design costs, with the objective of technology sharing to deploy the reactor design in their respective jurisdiction. OPG's share for the estimated Standard Plant cost design is set to [redacted]. The TCA also provides each contributor with [redacted].
- Benefits Agreement between OPG and GEH that provides OPG certain additional economic and risk mitigation benefits related to the project, including [redacted]
- Collaboration Agreement between OPG and TVA to support sharing of information, access to Boiling Water Reactor expertise, and joint development of technology support structures such as training programs and common supply chain
- [redacted]

The Cost Estimate to Complete the Four-Unit DNNP SMR Program is [redacted] including [redacted] to execute SMR 1

The current four-unit DNNP SMR Program cost is at approximately [redacted] including Interest, Escalation and Contingency. The estimate is comprised of a Class 4 estimate for SMR 1 and a Class 5 estimate for the three subsequent units (SMR 2-4). In addition to project specific Contingency, this includes an additional Program level contingency of [redacted] to be held at the executive level for events and risks that are likely to arise in FOAK mega-projects. This amount has been attributed to SMR 2-4 for cost estimation purposes. The estimated cost breakdown for SMR 2-4 is outlined in **Appendix 1: Cost Breakdown by Category for multi-unit**.

The Class 4 estimate for SMR 1 is approximately [redacted] and reflects improved project definition and design maturity from 2% (initiation phase estimate) to 18% as part of the Class 4 estimate. The Class 4 estimate for SMR 1 includes [redacted] of project specific Contingency and [redacted] for Interest and Escalation.

The SMR 1 estimate also includes updated scope and costs for common infrastructure facilities at the site. These common facilities are necessary to accommodate and support the deployment of SMR 2-4 and are most cost effectively executed with SMR 1.

OPG had prepared a business case analysis in support of the initiation phase for the DNNP SMR Program during 2021 that included a Class 5 cost estimate for a single SMR facility and preliminary cost estimates for a four-unit SMR facility, totalling [redacted]. The current estimate cost breakdown including changes from the initiation phase estimate to the Class 4 estimate for SMR 1 are outlined in **Appendix 2: Cost breakdown by Scope for SMR 1**. The major drivers for changes in the cost estimates include:

- An update of 2022 inflationary impacts which are currently projected over 10% for non-residential construction

- Design progression during the initiation phase for this FOAK reactor including increase in the diameter of the reactor building associated with a shielding issue
- Condenser Cooling Water Tunnel length and associated piping increases to accommodate the most optimal location
- Infrastructure scope now sized for four units which was not included in the previous estimate.
- Scope definition increases and added items which were previously not fully defined or available.

Interest is based on an average rate of approximately [redacted] for SMR 1 and [redacted] for SMR 2-4. For SMR 1, this includes the recently negotiated loan from the Canadian Infrastructure Bank for a portion of pre-construction costs and a similar loan assumed for a portion of execution phase costs. On a forward looking basis, Escalation is based on a nominal 2% per year, with certain inflationary risks considered in Contingency as well as management reserve discussed below.

The cost estimate of the four-unit DNNP SMR Program consists of the IPD vendor partner costs and OPG owner's costs.

The table below shows the current and cumulative release amounts for the program ($M):

Release	Total (Released	Release (Request)	OPG	IPD	IPD + OPG	Contingency	Interest & Escalation	Total (Request)	Grand Total
2A	$200	3A/B	$309	$637	$946	$95	$58	$1,099	$1,299

The contingency requested for this release has been determined through a percentage of the request with supporting comparisons of a preliminary Quantitative Risk Analysis and Monte Carlo simulation.

Unit Capacity has increased to 315MW from 285MW

The unit output increased from 285MW in the original estimate to 315MW with the optimization of the heat cycle, reduction of the electrical consumers for the house load and the introduction of the air compressed generator.

The Levelized Cost of Electricity remains economically competitive

The LCOE for the four-unit DNNP SMR Program is calculated at [redacted] based on current cost estimates and using an after-tax discount rate of approximately [redacted]. In addition to capital project costs, the LCOE considers operating and end-of-life costs for a facility, as well as tax impacts. Based on a risk analysis of the cost estimates, the current LCOE range for purposes of economic comparisons is between [redacted] for the four-unit SMR Program.

The higher LCOE range could accommodate an additional [redacted] in project costs outside of the current estimate. **See Appendix 3: DNNP Estimate Progression** for increased certainty over time within the upper LCOE range. The updated LCOE range of [redacted] compared to the initial estimate range of [redacted] remains broadly in line with renewable technologies such as wind or solar paired with batteries providing similar energy and capacity. These technologies have been experiencing rising costs over the past year due to ongoing inflationary pressures and supply chain challenges. Overall, the DNNP SMR Program is well positioned to help cost effectively meet increasing demand for electrification, reduce emissions, and support long-term grid reliability.

The above LCOE analysis does not include the impact of a 30% refundable tax credit for investments (ITC) in SMRs and other clean energy technologies recently announced by the federal government. Along with other provincially owned entities that are exempt from federal tax, OPG is working to clarify that the federal government would provide a payment in lieu of this ITC to such entities to ensure that they are treated the same as taxable generators. Such payment in lieu mechanism is available under the US Inflation Reduction Act. Based on preliminary assessments, the payment in lieu would potentially reduce the LCOE estimates by about [redacted].

The Schedule to Complete SMR 1 is December 2028 with Commercial Operation by June 2029

The current project schedule has the SMR 1 substantially completed in December 2028, with commercial operation expected in June 2029. The risk analysis based on the current project maturity adds approximately [redacted] for a high confidence schedule. The schedule will be further developed during the definition phase and a high confidence target date will be established as part of the Release Quality Estimate.

Current planning assumptions for SMR 2-4 stagger each facility's completion by a year, with the overall schedule for the DNNP SMR Program provided in **Appendix 4: Schedule for SMR 1-4**

Management and OPG's vendor partners are continuing to progress planning and engineering efforts and are prepared to execute the next phase of the project including the following major deliverables:

- Progress detailed engineering and complete Standard Plant design
- Obtain LTC approval from CNSC
- Complete construction planning
- Develop supply chain strategy for BWRX-300
- Procure long lead items – Reactor Pressure Vessel, Turbine Generator, Tunnel Boring Machine
- Complete site preparation activities including major excavation and required shoring systems
- Prepare SMR 1 Release Quality Estimate (Class 3) for the execution release
- Establish Operations Training program including simulator design and implementation plans
- Complete Value engineering and establish Design-to-Cost targets for each system.

Further details can be found in **Appendix 5: Project Deliverables for next phase**.

Benefits to Ontario and Canada

The DNNP SMR Program supports Canada in becoming a global leader in SMR technology and creating a thriving localized clean energy sector, providing benefits to future generations of Canadians. A successful first deployment of grid scale SMR technology is expected to enable a new generation of safe nuclear power as a clean source of electricity that can be adopted for multiple applications.

GEH estimates that the associated work to develop the BWRX-300 Standard Plan design will require over 1.8 million hours of labour to be performed in Ontario which will peak at over 250 jobs. In addition to the GEH scope of work, SNC-L and AECON combined are expected to have over 6 million hours of labour to be performed in Ontario over the course of designing, constructing, and commissioning SMR 1. Further, the direct impact on the Canadian supply chain of this work is estimated at over $200 million, with at least seven major components potentially supplied from Canada.

According to the Conference Board of Canada study, the first GEH BWRX-300 SMR is expected to:

- Create over 1,600 Ontario based high-skilled jobs during manufacturing and construction, and over 200 jobs to support ongoing operations
- Generate approximately $2.5 billion in Ontario Gross Domestic Product (GDP) and contribute around $0.9 billion in federal, provincial, and municipal tax revenues during manufacturing, construction, and operations

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Key Program Risks

The key program risks used in the current analysis are as follows:

Risk Title	Risk Description	Mitigation
Additional Cost Escalation	Substantial Cost escalation/inflation and equipment delivery above supply chain base % due to: Macro-economic and geopolitical factors including pandemic and on-going situation in Ukraine/Russia, Logistic and Freight price fluctuation.	Monitor escalation and inflation rates to minimize unforeseen changes in market. Develop a dedicated DNNP procurement strategy.
Regulatory Approvals	Risk that required regulatory approvals are not obtained prior to start of site preparation activities.	Continue collaborative approach with regulatory agencies with mutually agreed plans in place. Stakeholder and Indigenous engagement. Develop and execute mock-up for the Steel Bricks which is a first of a kind in nuclear applications.
Resource Availability	Availability of key resources with the required skillsets may not be adequate and may impact the project's ability to meet its milestones.	Present SMR program to trades unions. Develop training programs with key building trades. Complete jurisdictional assignments. Explore project specific agreement with EPSCA to allow for more flexibility.
FOAK Cost Increase	Risk that any further significant increases from Class 4 to Class 3 would impact the economics of the project.	Complete Design-to-Cost Value engineering and update the estimate in November 2023 before any further spending in 2024. Confirm non-nuclear safety related systems will be executed with the most efficient construction methodology.

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RECOMMENDATION / RESOLUTION

That the Major Projects Committee recommends that the OPG Board of Directors approves the following:

I. A release of funds in the amount of $1,099M to complete the definition phase of the DNNP SMR1 project in order to obtain the Licence To Construct from the CNSC, progress construction planning, procure long lead items and complete site preparation execution activities:
II. Requires that OPG provides the cost estimate update in November 2023 as a pre-requisite for 2024 spending;
III. Delegation of approval authority to the OPG President and CEO for approval of the various commercial agreements needed to support the project; and
IV. If there are any material changes to the premises and assumptions set out in this Memorandum that relate to the DNNP SMR Program that impact the authorizations and approvals above, OPG will report these to the Board in a timely way and seek further approvals from the Board as it may require.

Recommended by:

Mike Martelli
Chief Projects Officer

Approved for submission to the Board of Directors by:

Ken Hartwick
President and Chief Executive Officer

This Board memo was reviewed and approved for submission to the Board of Directors by the Major Projects Committee at their meeting of December 1, 2022.

APPENDICES

Appendix 1 Cost Breakdown by Category for multi-unit
Appendix 2 Cost Breakdown by Scope for SMR 1
Appendix 3 DNNP Estimate Progression
Appendix 4 Schedule for SMR 1-4
Appendix 5 Project Deliverables for next phase
Appendix 6 Schedule for SMR 1
Appendix 7 Release Strategy
Appendix 8 Contingency

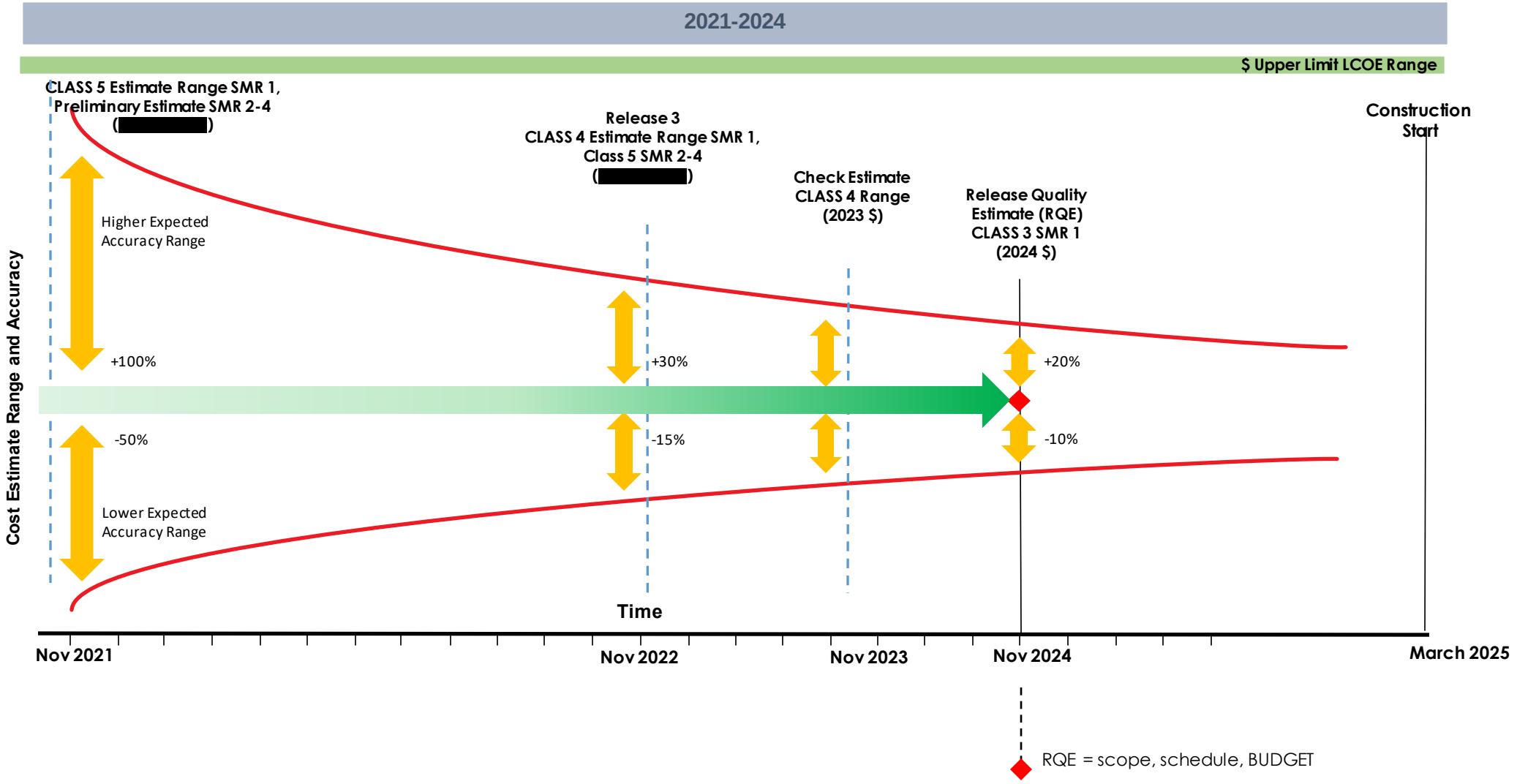
Appendix 1: Cost Breakdown by Category for multi-unit

DNNP PROGRAM COST SUMMARY - 4- Unit - Class 4 Estimate							
Category		SMR 1	Unit 2	Unit 3	Unit 4	Total	Notes
Design & Build -Capital							
IPD Costs	Capital Costs (Power Block & Non-Power Block)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	• Subsequent unit costs are based on efficiency factors assumed. • IPD scope include non-power block scopes: CCW Tunneling, Switch Yard, Security Infrastructure. • Intake, outfall and forebay structure is common for 4 units. • Security building, Switch Yard building are built for 4 units during the first unit.
Owner's Oversight	Program Oversight and IPD Integration	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	• Program Oversight Includes Program Management, Engineering & other functional support
Total Design & Build Cost (4 SMR Facilities)		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Infrastructure & Licensing- Capital							
Non IPD Project Costs	Project Costs (Infrastructure)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	• Include Site Preparation, Digital Strategy, Grid Connection (Hydro One Scope), EME, Met Tower, Shore Line Protection. • Admn Building, warehouse are built for 4 units during Unit 1
Licensing Fees	EA & Licensing, Environment, Reg. Affairs, and H&S Fees	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Include Fee for LTC, LTO, EA Commitments
Miscellaneous	Grounds Maintenance, Funds, etc.	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Include Project Insurance, Maintenance, cost of utilities during construction, fee for province, municipalities, etc.
Total Non-IPD Costs and Licensing		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Total Projected 4 Unit Costs		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	Common Infrastructure costs ($870M) are spent during the first unit: • 4 Unit Admin Building & Warehouse • Tunneling, Piping, Pumphouse for 4 units • Switch Yard building for 4 units ; Grid Connection for 4 Units • Security building for 4 Units • Digital Strategy infrastructure for 4 units.
Contingency		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Total Projected Multi Facility Overnight Costs With Contingency		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Other Costs	Escalation	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
	Interest	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Total Projected Multi Facility Costs With Contingency, Interest & Escalation		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Program Contingency (incl. Escalation/Interest)			[redacted]	[redacted]	[redacted]	[redacted]	
Total with Program Contingency		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	
Total MW Output		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	

Appendix 2: Cost Breakdown by Scope for SMR 1

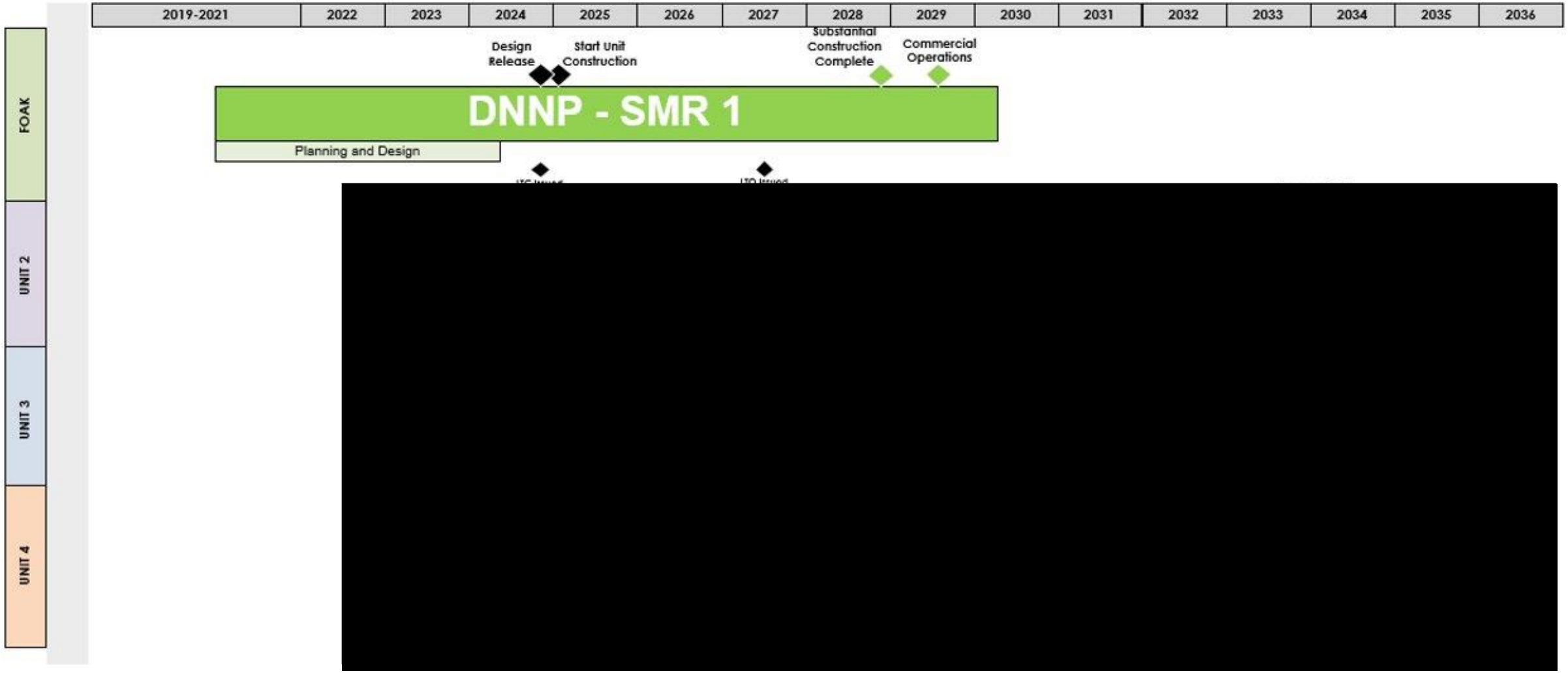
[redacted]

Appendix 3: DNNP Estimate Progression



Note: The Estimate accuracy % range assumed for projections are based on AACE Lower band from Class 4 to Class 3 including an additional 10% variability for First of a Kind Project

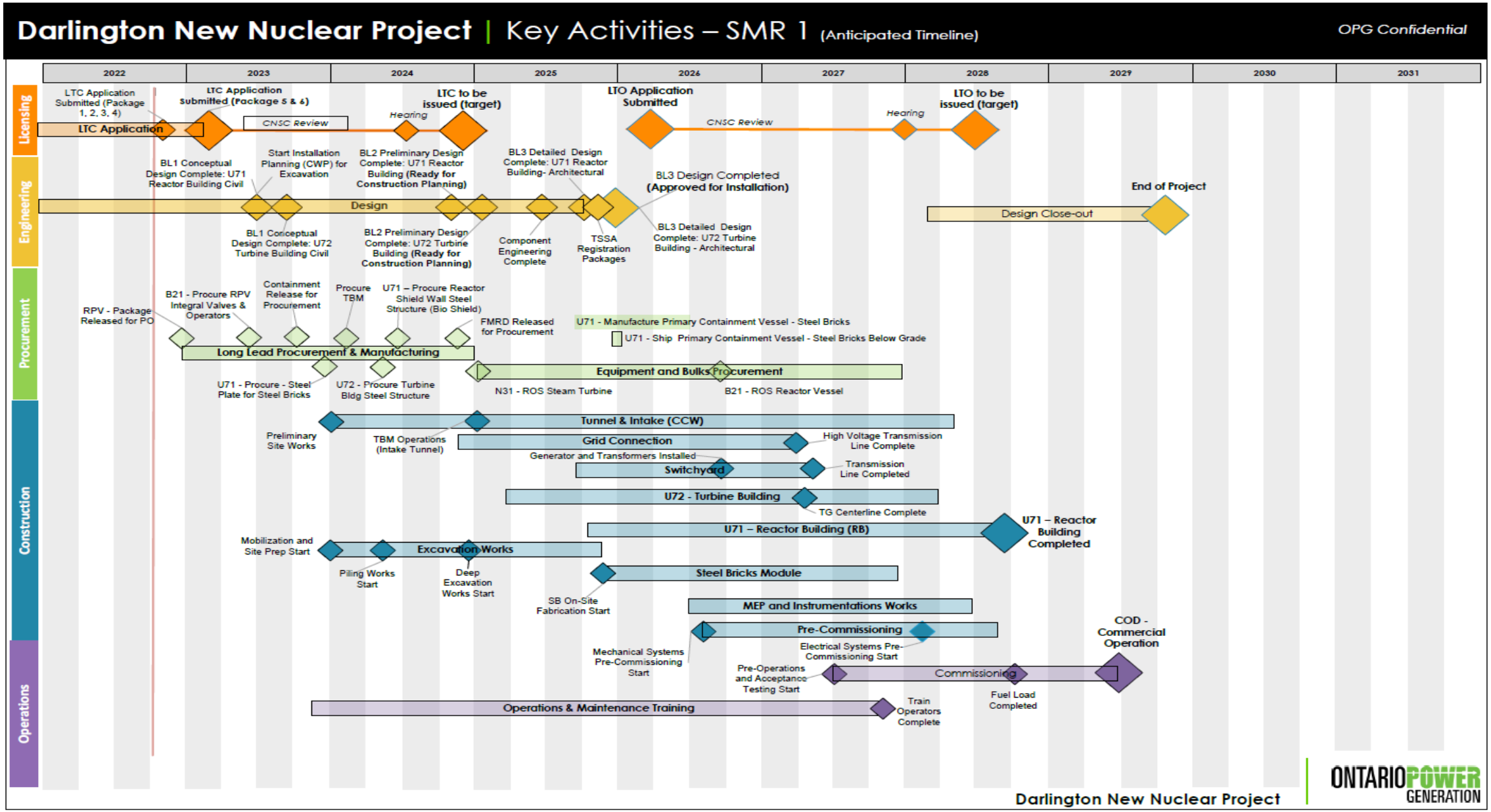
Appendix 4: Schedule for SMR 1-4



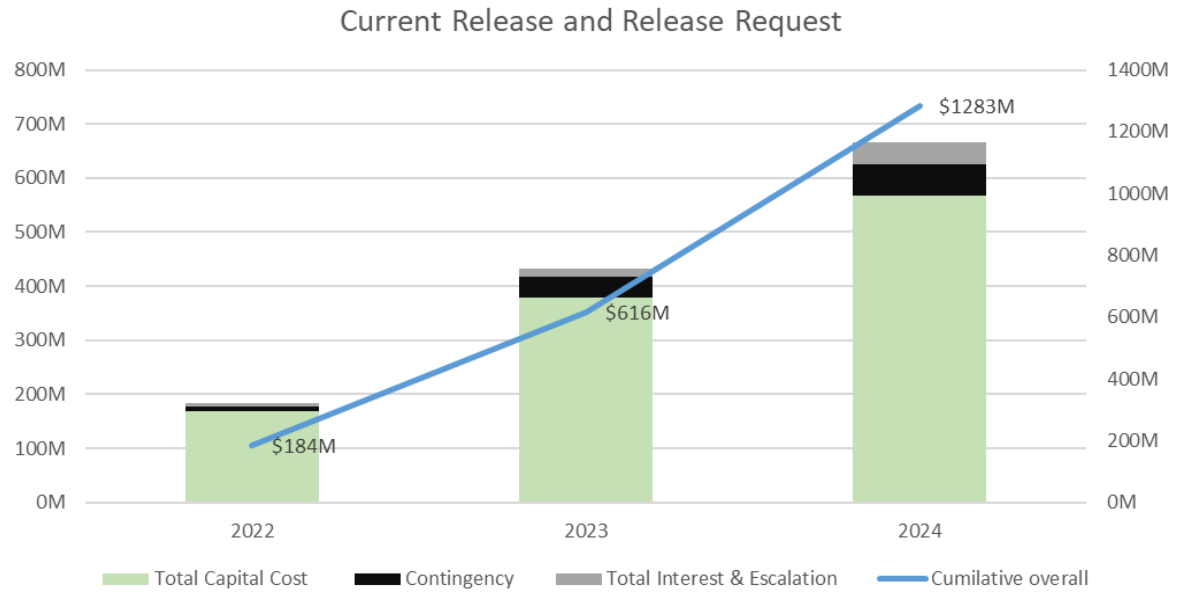
Appendix 5: Project Deliverables for Next Phase

Program Management - OPG	• Program integration, IPD Development, Alignment, Execution plans development • Project Planning, Gate Progressions, Estimate refinement for Check estimate and for Class 3 and Program controls development with IPD partners • Support License to construct application, hearing & issuance, Prepare for License to Operate application requirement • Operations procedure development and staffing, Training planning • Engineering oversight through Baseline (BL) 2 & BL 3 progression
Site Preparation	• Early works Site Clearing and excavation, Temporary facilities, • Holt Road widening • Engineering completion for Main Site Preparation activities
Digital Strategy	• Business Requirements • Scope of Work • RFP and vendor selection • Development of systems
Grid Connection (Hydro One)	• Environment assessment for transmission line (22km) • OEB Section 92 approval • IESO System Impact Assessment and Hydro One Connection • Impact Assessment • Design • Obtaining required permits • Long lead procurements
Switchyard	• IESO System Impact Assessment and Hydro One Connection Impact Assessment • Design • Obtaining required permits • Long lead procurement
Power block	• Progress on Engineering BL2 • Procurement of RPV, Turbine Generator set, Isolation valves, bulks(steel), and other major engineered equipment • Construction mobilization • Site mobilization – equipment, trailers, offices, rental equipment, shoring design • Early start excavation • Project Planning and Management • Security Building Eng and Design
CCW	• Engineering, Tunnel Boring machine Procurement

Appendix 6: Schedule for SMR 1



Appendix 7: Release Strategy



	2022	2023	2024
IPD Scope (Power Block)			
Project Management	39M	65M	96M
Engineering			
Standard Plant Design	19M	44M	20M
Project Specific Plant Design	29M	51M	68M
Engineering - Licencing Support	10M	7M	10M
Procurement	1M	52M	145M
Construction	0M	5M	33M
Commissioning	0M	0M	0M
Closeout			
Adjustments			
Total - Power Block	98M	223M	372M
IPD Scope (Non-Power Block)			
CCW - Cooling Water Intake'	0M	11M	21M
Hydrology/FIA	0M	0M	0M
Waste Management	0M	1M	0M
Switch Yard	0M	2M	3M
Security Building - Eng and Design	0M	1M	2M
Total - Non-Power Block Scopes	**0M**	**15M**	**27M**
Total -IPD Scope	**98M**	**239M**	**399M**
Non-IPD Scope (EPC)			
Site Preparation-Early Works	5M	32M	6M
Site Preparation-Main	1M	28M	51M
Geotechnical	13M	2M	
Shore Line Protection		0M	1M
Grid Connection	0M	3M	30M
Digital Strategy		8M	11M
EME Equipment			
Met Tower			
Miscellaneous		7M	7M
Total Non-IPD Scopes	**20M**	**80M**	**107M**
Program Management	44M	48M	52M
EA & Licensing Fees	7M	12M	11M
Total Program Management	**51M**	**60M**	**63M**
Total Capital Cost	**169M**	**379M**	**568M**
Contingency	9M	38M	57M
Total Capital with Contingency	**178M**	**416M**	**624M**
Escalation	4M	8M	25M
Interest	2M	7M	17M
Total Interest & Escalation	**6M**	**16M**	**42M**
Capital Grand Total -SMR 1	**184M**	**432M**	**667M**

- Includes 10% Contingency to cover scope for 2 years
- EA & Licencing Fees include CNSC payments
- Miscellaneous includes Construction utilities, Project and site insurance, and Provincial Fees
- Program Management is based off current actuals plus forecasted resource planning
- Savings and minor delay costs of 16M to be carried over into 2023

Appendix 8: Contingency

*Contingency Usage from Current release is inclusive of the totals in the table. Not incremental and should be Reduced from SMR 1. ~20M

Cost Contingency Modelling update ($)

SMR	Updated Contingency (Project Specific)	Program Contingency Held at Executive Level	Reserve & Uncertainty (Outside of Current Estimate)	Updated Totals (Contingency & Reserve)	Assumptions
SMR 1	[redacted]		[redacted]	[redacted]	Assumed to carry Class 5 Estimate Project Specific Contingency and within range of Preliminary Risks analysis Monte Carlo.
SMR 2-4	[redacted]	[redacted]	[redacted]	[redacted]	First of kind risk reflected in Program Contingency rather than Project Specific Contingency.
Total	[redacted]	[redacted]	[redacted]	[redacted]	Management Reserve & Uncertainty in line with LCOE Range

Schedule Contingency Model

Current Schedule	P50 – Medium Confidence	P90 – High Confidence	Assumptions
Commercial Ops Q2 2029	[redacted]	[redacted]	Preliminary assessment based current schedule

SEC Interrogatory #100

Interrogatory

Reference:
D2-4-1, p. 8

Question(s):

OPG is seeking approval of $113.5M of CCR interest amounts over the rate term regarding Units 2-4. If the OEB ultimately determines in a future proceeding, that in whole or in part, the costs of Unit 2-4 are imprudent, what happens regarding the CCR interest paid on those expenditures?

Response

The CCR mechanism for the Darlington New Nuclear Program outlined in this Application is established by O. Reg. 53/05, with requirements with respect to DNNP LP set out in section 14(2)5 and section 12. A summary of the requirements can be found in Ex. I1-1-3, Section 3.0.

Under the operation of the CCR mechanism as prescribed by the regulation, there are no adjustments to CCR interest amounts that have already been recovered.

SEC Interrogatory #101

Interrogatory

Reference:
D2-4-1

Question(s):

With respect to the business cases and budgets:

a) Please provide a table that shows every cost estimate (e.g. internal, class, release, and phase) developed for the project, broken down by category. For each estimate, please provide the date, phase, reason for the change.

b) Please provide a copy of each business case (for each class and release) developed for the DNNP.

Response

a) The Applicants decline to provide the requested information on the basis of relevance. This interrogatory seeks a table from the Applicants that shows every cost estimate developed for the project. This analysis has been superseded by the Release Quality Estimate provided at Ex. D2-4-8, Attachment 1 and is not relevant to any issue in this proceeding.

b) The DNNP Release Quality Estimate business case is documented within the OPG Board of Directors' approval memorandum (Ex. D2-4-8, Attachment 1). Additionally, refer to Ex. L-D2-Staff-118, Attachment 1 (confidential) for the estimate presented to management for approval.

The DNNP Release Quality Estimate business case is the basis of the DNNP and is the basis on which the Applicants seek approvals in this Application. All previous business cases are irrelevant since they do not represent the basis for the project under consideration.

SEC Interrogatory #102

Interrogatory

Reference:
D2-4-2, p. 6-8

Question(s):

OPG is using the IPD model for the DNNP.

a) Please provide all materials provided to OPG's Board of Directors and Senior Management where approval of the IPD was sought.

b) Please detail all potential risks and downsides of the IPD model and how OPG has mitigated each.

Response

a) OPG did not seek formal approval for use of the IPD model from its Board of Directors. The selection of the IPD model was decided by OPG's DNNP project lead as endorsed through the execution of the Integrated Project Agreement ("IPA") by OPG's President and Chief Executive Officer. Refer to Ex. L-D2-AMPCO-088, Attachment 5 for a copy of the DNNP Contracting Strategy.

b) Refer to the following:
   i. Ex. D2-4-10 Attachment 1, pp. 31-34.
   ii. Ex. L-D2-SEC-108 which describes the benefits, risks and mitigation strategies of the DNNP contracting structure.

SEC Interrogatory #103

Interrogatory

Reference:
D2-4-2, p. 13-14

Question(s):

How many OPG FTEs have or will work on the DNNP each year between 2024 and 2031? Please provide a breakdown of those FTEs into the various work bundles and functional teams.

Response

The Applicants interpret the question to be a request for OPG FTEs for Unit 1. These details are provided in Chart 1 below using OPG organizational groupings, which are representative of the functions described in the pre-filed evidence. These functional groupings are used to describe the functional program as it relates to the IPD scope of work. OPG's role includes both oversight and support to the overall functional programs.

Chart 1 – Breakdown of OPG DNNP Unit 1 FTEs (2024-2031)

Organization	2024 Actual	2025 Budget	2026 Budget	2027 Budget	2028 Budget	2029 Budget	2030 Budget	2031 Budget
Project Management	30	40	42	38	30	20	6	0
Owner's Engineering	54	60	60	48	34	26	6	0
EA Licensing & Support	17	17	17	17	15	5	1	0
Operations and Maintenance	16	8	15	45	105	126	41	0
Project Controls	12	20	20	17	15	8	1	0
Construction Center of Excellence	6	14	15	15	14	7	1	0
Supply Chain/ Quality Audits	7	12	12	7	8	2	1	0
Other Departments	22	25	27	25	23	9	2	0
Total OPG FTEs	**165**	**195**	**207**	**210**	**243**	**202**	**59**	**0**

SEC Interrogatory #104

Interrogatory

Reference:
D2-4-2, Attachment 1 and 2

Question(s):

With respect to the Opinions of Howard Ashcraft:

a) [Attachment 1, p.5] Please provide a copy of the referenced Ashcraft 2022 paper.

b) [Attachment 2, p.2] Please provide a copy of the "redline prepared by Torys to highlight where the Amendment affected or developed provisions in the existing IPD agreement."

Response

a) Refer to Attachment 1.

b) The requested document is over 1,100 pages and would require an unreasonable amount of effort for the Applicants to review and redact all confidential information within it. Instead, the Applicants have provided a summary of the key changes from the Amendment as Attachment 2 (confidential).

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Oxford Review of Economic Policy, Volume 38, Number 2, 2022, pp. 369–384

Transforming project delivery: integrated project delivery

Howard Ashcraft*

Abstract: The design and construction industry has long suffered low productivity and poor project outcomes. Collaborative approaches to project delivery offer an opportunity to transform outcomes by creating incentives in an environment that incentivizes high performance. This paper examines integrated project delivery (IPD), a collaborative contractual approach that alters a project's fundamental commercial, organizational, and legal structures to minimize dysfunction and stimulate performance. IPD's basic structures are introduced, followed by a critical examination of current and new research on IPD augmented by the author's insights from structuring over 150 IPD projects. An online appendix provides additional information regarding the reasoning behind the IPD structures.

Keywords: infrastructure, project delivery, integrated project delivery, IPD, alliancing

JEL classification: K2, L7, O2

I. Introduction

For decades, experts and commentators have despaired over projects failing to meet essential cost, schedule, and functionality goals (Latham, 1994; Egan, 1998; Miller *et al.*, 2000; CURT, 2004, 2006; McKinsey, 2015; World Economic Forum, 2016). Their concerns, insights, and conclusions are equally relevant today.

This universal dissatisfaction with infrastructure performance is compounded by the size of the problem. The World Economic Forum estimates that the total annual revenue for the construction industry is almost USD 10 trillion and accounts for 6 per cent of the global gross domestic product (World Economic Forum, 2016). Estimates of non-value activity exceed 30 per cent (Egan, 1998; Miller *et al.*, 2009). Labour

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I would like to thank those who have laboured with me to improve infrastructure delivery, including the American Institute of Architects, California Council IPD Task Force; Martin Fischer, Atul Khanzode, and Dean Reed, my co-authors of *Integrating Project Delivery*, with whom I have shared many discussions regarding project delivery; Philip Bernstein, Renée Cheng, the many clients who have entrusted me with their projects and allowed me to turn IPD from a theory to a practice; and my wife, Marilyn Ezzy, and our family who have supported my passion for improving project delivery.

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productivity studies indicate that construction productivity has fallen approximately 20 per cent during the same period where manufacturing productivity has improved by 250 per cent (Teicholz, 2004, 2013). McKinsey Global estimates that the productivity losses account for USD 1.6 trillion—essentially half the cost of the world's infrastructure needs (McKinsey, 2017). Even assuming some error in estimating waste and productivity loss, the size of the problem is staggering.

Moreover, the problem is especially severe in megaprojects[1] where cost overruns of 50–100 per cent in real terms are common, and overruns above 100 per cent are not unknown (Flyvbjerg *et al.*, 2003). Megaprojects have consistently underperformed (Miller *et al.*, 2000). Merrow found that 65 per cent of the 318 industrial megaprojects he studied failed even using very lenient measures of success (Merrow, 2011).[2] McKinsey is even more critical, finding that 98 per cent of megaprojects suffer cost overruns of more than 30 per cent, and 77 per cent are at least 40 per cent late (McKinsey, 2015). The average cost overrun was 80 per cent, and schedule slippage averaged 20 months (McKinsey, 2015). As noted by Merrow, megaprojects have mega-failures. They don't go slightly wrong; they tend to fall entirely apart (Merrow, 2011).

Rampant failure might suggest insoluble problems. But industry analysts have long recommended the elements required to achieve improved outcomes. For example, the Egan and CURT reports seek to transform the industry by creating fully integrated and collaborative project teams with shared risk-reward aligned to project outcome (Egan, 1998; CURT, 2006). Their recommendations are very similar to the formula proposed by CURT, AIA, AIACC, the World Economic Forum, and McKinsey Global Institute (CURT, 2004, 2006; AIA/AIACC, 2007; AIACC, 2007, 2014; World Economic Forum, 2016; McKinsey, 2017). However, achieving these experts' recommendations requires fundamental changes in project delivery that challenge stakeholders (Ebrahimi and Dowlatabadi, 2019).

IPD principles are proposed as a key strategy in breaking the failure cycle that has confounded the design and construction industry. Several project delivery methods, such as 'partnered contracts', 'project alliances', and 'integrated project delivery', can be configured to include many recommended elements (Lahdenperä, 2012). IPD is the most prescriptive, including all required elements.[3]

This paper introduces the key IPD elements, examines the research on its effectiveness, including new research by the author, comments on research limitations, discusses the purpose behind the structural changes in IPD, and concludes with recommendations for further research and analysis. The conclusions are supported by the referenced information and the author's experience in structuring over 150 IPD projects. The discussion uses the industry terms that are defined below.

[1] Generally accepted as projects with costs exceeding USD 1 billion.

[2] Merrow's 'thresholds for failure' were: Cost overruns > 25%; Cost competitiveness > 25%; Schedule slippage > 25%; Schedule competitiveness > 50%; and Production vs plan—significantly reduced production into year 2. Fifty per cent of all projects, and 78 per cent of petrochemical projects failed at least one of these criteria. As noted by Merrow, very few projects failed on only one dimension (2011, Table 3.1, pp. 36–7).

[3] Figure 11, *Elements of a Collaborative Partnerships* (World Economic Forum, 2016), is virtually identical to the requirements in *Integrated Project Delivery: An Updated Working Definition* (AIACC, 2014), particularly p. 13, *Optimized IPD*.

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(i) Terminology

Building information modelling (BIM)

There are many definitions of BIM that reflect the definer's particular focus. Essentially, it uses digital software to develop and represent a project from conception through operations. It can be used for design development, optimization, construction simulation, facilities management, and operation, and is characterized by creating data-rich, three-dimensional visualizations.

Construction management at risk (CMR)

CMR is a form of contracting where the prime contractor retains the specialty contractors and they, perhaps in combination with the contractor, perform the actual construction work. The contractor is referred to as a construction manager to emphasize its planning and coordination role. The construction management is 'at risk' because compensation is either a fixed amount, or more commonly, is a cost-plus arrangement limited by a guaranteed maximum price (GMP) cap. In CMR, the owner retains the contractor after design or during the design period to provide constructability and cost information.

Design–Bid–Build (DBB)

In this project delivery method, architects and engineers complete the design on the employer's behalf. The employer then seeks bids from interested builders and awards a construction contract. Although the owner need not award to the lowest bidder, many employers using this approach must, or prefer to, award the work to the lowest responsible bid. Because bidding requires a complete design, the process is inherently sequential and does not permit the involvement of the builders and suppliers during the design period.

Design–Build (D–B)

In this project delivery method, the employer retains a single organization to provide design services and execute the project. The design-builder may be a single organization, a joint venture, or special purpose entity, or a party that contractually engages other parties to provide either design or construction services. D–B has many variations reflecting different compensation approaches (fixed price, cost plus, cost plus with a guaranteed maximum price) and different project scopes (D–B with operation, maintenance, financing, or any combinations of these). Flexibility also varies. Some D–B projects only require adherence to performance specifications; others require compliance with a provided preliminary design. Any of these variations can affect the project outcome.

Early contractor involvement

In early contractor involvement, a contractor and key specialty contractors provide the designers with cost, constructability, and systems information. 'Design assist' is a similar term, although it often implies a less comprehensive integration of builders and suppliers into the project development process.

Fixed price or lump sum

These are synonymous with contracts that pay a set amount—subject to change orders/variations—for the project.

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Guaranteed maximum price (GMP)

A GMP is a cap on compensation often used with CMR and D–B project delivery methods. If the incurred costs, as defined in the contract, are less than the GMP, the owner only pays the actual cost. If the costs exceed the GMP, the owner pays the GMP. A GMP may include a shared savings provision that splits the difference between cost and the GMP, retaining a portion for the owner and providing the remainder to the contractor.

Lean construction or design

'Lean' is the application of philosophies and processes developed by Toyota Motor Corporation to design and construction. It emphasizes 'waste' reduction. Waste is any activity that does not provide value to the 'client'. For example, rework, excess inventory, searching for tools or information do not provide value. Lean, therefore, seeks to structure work to minimize waste activities. Almost any project delivery method can incorporate some Lean practices, although the more collaborative project delivery methods can suit Lean best. The Lean Construction Institute (leanconstruction.org) and the International Group for Lean Construction (iglc.net) are the leading information sources. There are also local and national Lean groups.

Non-value activity (waste)

In Lean terms, non-value activity is any resource expenditure that does not directly result in output that a customer would be willing to purchase. Unused and discarded material, labour spent looking for information, tools, or material, and rework are examples of non-value activity. Non-value activity is also referred to as waste.

Target cost

The target cost in an IPD project is an amount that serves as a goal and a metric to evaluate project success. If the target cost is exceeded, the IPD team's profit is diminished. If the project is delivered below target cost, a percentage of the savings is added to the team's profit. The specific savings formula and target cost elements may differ between IPD projects and are specified in the IPD agreement.

As this glossary indicates, merely stating that a project is CMR omits significant factors affecting performance. Within CMR, the compensation method could be fixed price, cost plus, GMP, GMP with shared savings. The project could be a sequential DBB project or some form of 'Early contractor involvement'. D–B has even more variations. The upshot is that drawing statistical inferences without considering—and normalizing—the variability in project delivery types and compensation schemes is fraught with potential error, compounded by the differences between projects themselves.

II. Principles of integrated project delivery

IPD was developed in the early 2000s to address dissatisfaction with project outcomes and the existing systems that did not optimize cost, schedule, and quality. In response, two groups explored alternatives to existing project delivery systems. A group of Lean proponents worked to increase project value but soon realized that the deep collaboration among key project participants required for Lean was challenging to achieve

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using traditional project delivery methods. To overcome the limitations, they created a multiparty agreement where the key parties pooled their proposed profit, jointly managed the project through consensus, and used Lean processes during execution. William Lichtig incorporated these principles into a multiparty contract referred to as an Integrated Form of Agreement (IFOA) (Lichtig, 2006). Around the same time, the American Institute of Architects, California Council (AIACC) examined how structural issues affected project performance and hindered using new technologies, such as BIM. Like the Lean proponents, the AIACC group concluded that a new contractual approach was required. The two approaches are now intertwined. Current IPD implementations include Lean, BIM, co-location, and other high-performance elements (Lahdenperä, 2012).

The AIACC's IPD Task Force published the first set of IPD principles and standards (AIACC, 2007) that the American Institute of Architects (AIA) subsequently adopted in the AIA/AIACC IPD Guide (AIA/AIACC, 2007) and incorporated into published AIA contract templates.[4]

The AIA initially defined IPD as a general statement of principles.

> Integrated Project Delivery (IPD) is a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction. (AIA/AIACC, 2007)

As IPD developed, these principles developed into specific business and contract elements reflected in a multiparty contract that integrates the key participants in a virtual organization aligned to the project goals. These IPD elements are summarized in Table 1.

These elements avoid the dysfunctions of traditional, segregated contracts and promote efficiency and innovation (Fischer *et al.*, 2017; Ashcraft, 2021). Fischer and Allison discuss specific steps for implementing the principles (Fischer *et al.*, 2017; Allison *et al.*, 2018). In combination, the IPD structures interact to create a project delivery system that is relational, collaborative, and includes specific structural and behavioural components. IPD is relational and collaborative, but it is also contractual. The online appendix explains the reasons behind IPD.

III. Review of IPD research

As IPD projects proliferated, researchers examined whether IPD provided better performance than alternative delivery systems. Recent literature surveys list currently available information (Engebø *et al.*, 2020; Viana *et al.*, 2020). Investigators have differed in their methods and differ moderately in their conclusions, but support using IPD.

The principal investigative methodologies are case studies, subjective comparisons, weighted indices, simulations, and quantifiable data. As discussed below, each approach has strengths and limitations. The author's research blends subjective comparisons with

[4] AIA Contract Documents C-191 and C-195 (2008).

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Table 1: Elements of integrated project delivery

Structural elements of IPD		Behavioural elements of IPD
Business model	*Contract structure*	*Enabling behaviours*
Profit separated from cost	Early involvement of key participants	Optimize the whole, not the parts
Costs guaranteed to completion	Jointly developed and validated targets/goals	Trust
Limited entitlement to change orders	Shared risk/reward, based on project outcomes	Integration of information, people, and systems
Profit based on agreed project outcomes	Joint project control and decision-making	Continuous improvement/learning
	Reduced liability among risk/reward members	Appropriate use of technology
		Collaboration

Source: AIACC, 2014.

quantified data to overcome some limitations of prior studies. The studies are summarized in Table 2 and then discussed in detail.

The initial case studies commissioned by the AIA examined six IPD projects and reported favourably, although the projects were in progress (Cohen, 2010). Cheng extended this case study by adding an additional example, providing greater detail, and integrating survey data that indicated participants were very satisfied with design quality and efficiency (Cheng, 2012). Her conclusions were positive, but she recognized that the sample was limited. The same research group expanded their survey significantly and reported detailed information on each project (Cheng, 2015). Respondents compared their experience on IPD projects with their experience on other project delivery approaches concerning schedule predictability, cost and budget control, building quality, change quantity, change handling, morale, and overall value delivered. Approximately 85 per cent of the respondents deemed schedule predictability and cost control better or significantly better. Ninety per cent found that the overall value was better or significantly better (Cheng, 2015). The author's independent research reinforces these subjective comparison findings. Other researchers have used case studies to evaluate why IPD is successful (Tillmann *et al.*, 2012).

Investigators have also used a comparative case study model, choosing similar projects and comparing outcomes on specified criteria. Bilbo compared two healthcare projects delivered by the same design and construction firms that used CMR and IPD, respectively. The IPD project had significantly higher cost savings (–10.27 per cent from budget) compared to CMR (–3.13 per cent), but more schedule growth (+16.63 per cent) compared to (–1.72 per cent) (Bilbo *et al.*, 2015). The IPD team claimed the lower average cost ($271/sq. ft. compared to a market cost of $360/sq. ft) was due to early collaboration, and that the delays may have been due to weather and permit delays, not project performance (Bilbo *et al.*, 2015). Adamtey compared two transmission control buildings constructed using D–B and IPD. The projects used similar structural systems, although the IPD project was more extensive and complicated. The IPD project was approximately 12 per cent less expensive than the D–B project, had less schedule growth, one-third fewer change orders than the D–B project, and, unlike the D–B project, had negative cost growth (Adamtey, 2021). The IPD team credited their close collaboration

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Table 2: Summary of IPD research

Methodology	Investigators	Conclusions
IPD case studies	Cohen, 2010; Cheng, 2012; Cheng, 2016	IPD had a positive effect on cost, schedule, quality, and team morale.
Comparative case studies	Bilbo *et al.*, 2015; Adamtey, 2021	Bilbo determined that the IPD project was significantly less expensive than the CMR comparison but did not meet schedule goals for extraneous reasons. Adamtey found that the IPD project was less expensive than the D–B comparison, although the IPD project was larger and had less schedule growth.
Subjective surveys	Cheng, 2015; LCI, 2016; Choi *et al.*, 2019, and Ashcraft, as reported in this paper	Investigators found a significantly higher satisfaction with IPD on cost, schedule, and quality than other project delivery systems. Ashcraft also found that 86.1 per centof the IPD projects reported an increase in the profit pool due to an indication of performance exceeding initial expectations.
Quantitative comparisons	Cho and Ballard, 2011; El Asmar *et al.*, 2013; Bilbo *et al.*, 2015; Ibrahim and Hanna, 2019; Ibrahim *et al.*, 2020; Kelly and Ilozor, 2020	When compared to all other project delivery methods, IPD was superior. In pair-wise comparisons, the results varied. In a smaller study focused on the Last Planner System™, Cho and Ballard did not detect a statistically significant difference between project delivery outcomes. Kelly and Ilozor agreed, but found a small benefit for IPD at the 90 per cent confidence level. Kelly and Ilozor 'cautiously recommended' IPD. The other pair-wise studies found that IPD was statistically superior in some aspects, although the specific benefits differed among studies.
Weighted ratings and simulations	El Asmar *et al.*, 2016; Hanna, 2016; Mesa *et al.*, 2016	El Asmar and Hanna developed a weighted rating system to compare project delivery systems and reported that IPD projects outscored other project delivery systems. Mesa and Molenaar created a predictive model using characteristics correlated with project success that predicted better outcomes using IPD for complex projects.

during co-location and the extensive BIM use (Adamtey, 2021). These are factors that other researchers have found correlated with project performance (Molenaar *et al.*, 2014). Overall, Cheng, Bilbo, and Adamtey's case studies provide insight into the IPD project details and why they can outperform other project delivery systems. However, they are limited to only comparing two project pairs, cannot be assumed to apply universally, and are very sensitive to project choice.

Several researchers have attempted to quantify the IPD performance against other project delivery methods. The studies that compare IPD against non-IPD projects generally support IPD use. The studies that attempt to compare IPD to specific individual project delivery methods find a statistically significant improvement over design-bid-build. Compared to design-build and CMR, IPD fares well, but the improvement is less

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clear. However, even the least favorable studies cautiously recommend IPD. (Kelly and Ilozor, 2020) No study found that IPD was statistically inferior in any aspect.

El Asmar, Hanna, and Loh compared quantitative statistics from12 IPD projects to 23 non-IPD projects concluding at a 95 per cent confidence level that IPD provided better quality, delivery speed, communication performance, profitability. At a 90 per cent confidence level, IPD outperformed the non-IPD projects in 8 out of 9 performance levels. (El Asmar *et al.*, 2013) They did not find a statistically significant difference in cost parameters but concluded that IPD provided significant advantages in quality at no additional cost. (El Asmar *et al.*, 2013)

Hanna compared 32 projects and found they were statistically superior in communications and cost management (Hanna, 2016). Ibrahim and Hanna studied 109 projects and statistically cross-compared them between DBB, CMR, D–B, and IPD. They concluded that at a 95 per cent confidence level, IPD outperformed DBB in eight metrics, outperformed CMR in two metrics, and D–B in two metrics. No project delivery system outperformed IPD, and the authors recommended moving from DBB towards IPD (Ibrahim and Hanna, 2019).

Ibrahim, Hanna, and Kievit performed pair-wise statistical analyses of 109 projects using 12 metrics. At a 95 per cent confidence level, IPD outperformed DBB on all performance metrics, outperformed CMR on two performance metrics, and a third metric at the 90 per cent confidence level. IPD outperformed D–B on two performance metrics at the 95 per cent level and an additional metric at the 90 per cent level (Ibrahim *et al.*, 2020). No project delivery method outperformed IPD on any metric at 90 or 95 per cent confidence levels.

In contrast, Kelly and Ilozor's study did not support a statistically significant difference between IPD and D–B or CMR at the 95 per cent level (Kelly and Ilozor, 2020). Their results were similar to an earlier comparative study of the Last Planner ™ Lean scheduling system that compared 12 IPD projects (Cho and Ballard, 2011). Interestingly, Ballard participated in a later case study on why IPD projects are successful (Tillmann *et al.*, 2012).

While Kelly and Ilozor did not find significance at the 95 per cent level, at the 90 per cent level they concluded that IPD had less cost growth than DBB and CMR with a guaranteed maximum price and less schedule growth than DBB. Interestingly, they discussed several reasons why their study might not have wholly captured IPD's benefits and 'cautiously recommend' IPD. All the projects were from a single contractor, except for six projects where data from AIA case studies were used. Moreover, the data set was heavily weighted (approximately 80 per cent) from one geographic region, but the report did not include the regional project distribution.

Quantitative analyses are superficially attractive, but they may be no more accurate, and even less accurate, than subjective comparisons. As noted in the terminology discussion, a project delivery designation may include many variants that differ significantly. Kelly and Ilozor, for example, found differences between CMR with a guaranteed maximum price and CMR with cost-plus compensation (Kelly and Ilozor, 2020). Error can be introduced if these variances are not considered and controlled.

Project delivery is also a very noisy environment where it is difficult to normalize differences among projects. Project complexity, geographic location, logistics, market conditions, labour conditions, management and team competence, estimation accuracy, available technology, weather or other environmental events, community and

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government support (or opposition), changes in rules and regulations, supply chain disturbances, and, most recently, pandemics, may all affect project outcomes. Even incidents on other projects may affect a project if it detracts from a participant's ability to complete its tasks on the studied project. Moreover, there may be correlations between project difficulty and project delivery choice. D–B and fixed price CMR, for example, may be differentially chosen for projects that are relatively straightforward and well defined. Unless one can confidently say that projects are similar in all but project delivery, statistics should be used cautiously and only if supported by other methods.

The subjective comparisons are subject to bias errors, notably self-selection, availability, and confirmation (Ariely, 2008; Kahneman, 2011). However, in comparing IPD to other project delivery systems, the survey participants can account for differences between projects and filter out noise that affects quantitative comparison. Subjective assessments must also be used cautiously and in combination with other methods.

El Asmar, Hanna, and Loh attempted to avoid the complexities in quantitative comparisons by using a weighted composite index—Project Quarterback Rating (PQR)—that blends 23 criteria from seven categories. Essentially, they use factors believed to be correlated with performance and index projects by the factors. Interestingly, they found a continuous improvement in PQR from DBB (–0.66) to CMR (–0.03) to D–B (0.25), and IPD (0.53) (El Asmar *et al.*, 2016). This is consistent with studies that correlate team cohesion and integration with increased performance (Molenaar *et al.*, 2014; Mesa *et al.*, 2016; Franz *et al.*, 2017; Choi *et al.*, 2019). Composite indices have promise but need to be validated by other researchers as they are sensitive to weightings. Mesa *et al*. have used a computational simulation that predicts superior performance by IPD (Mesa *et al.*, 2016).

IV. Hanson Bridgett composite survey

The author undertook a combined qualitative/quantitative survey of IPD projects that used a novel method to evaluate project success. The survey was sent to owners and team members on projects in the Hanson Bridgett client roster, publicized on LinkedIn, and announced on the Integrated Project Delivery Alliance and the LeanIPD blog websites. The data are not random because they rely on self-reporting.

Eighty-one survey responses were received representing 55 unique projects, 46 of which reported outcomes (the balance are projects that are not yet complete). The average project value (design plus construction cost) was USD $102,250,333 and the largest completed project was valued at USD $1,500,000,000. Several larger projects within the survey were still in the design or construction phases. Two projects exceeded USD 1 billion; both were completed below budget and on schedule—a tiny sample, but notable given the failure rate of megaprojects.

There are several unique aspects to the survey. Because IPD projects adjust the team profit based on project outcome, the increase or decrease in the profit pool is a measure of project performance. An increase or decrease in profit is a direct measure of project outcome because the profit adjustment is based on the difference between planned and actual project outcome. Moreover, target cost adjustment during the project factors out extraneous reasons for cost growth. It provides quantitative confirmation of subjective perception of success.

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However, a profitability metric is subject to the accuracy of initial targets. Survey participants assessed the accuracy of the initial targets to account for possible errors. On a scale of 1 to 5, they assessed the cost targets from 'significantly understated' to 'significantly overstated', where 3.0 was a correct estimate. The average design score was 2.92, and the average construction score was 3.1. Thus, the respondents believe the estimates at target cost were reasonably accurate. No other study has reported assessing initial target accuracy, although this significantly affects quantitative assessments.

Thirty-six projects reported the increase or decrease in the profit pool due to project outcome, which is summarized in Table 3. Figure 1 displays the distribution of the positive outcomes.

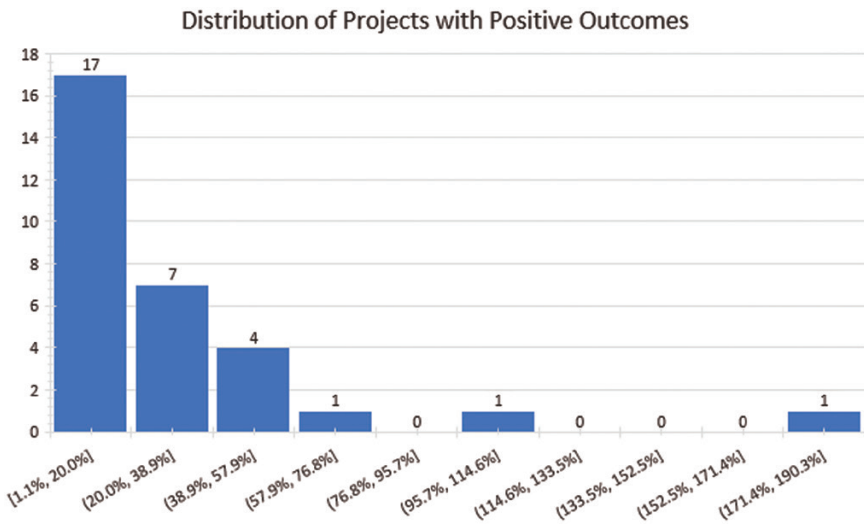
Because the 'negative' projects reduced but did not eliminate the profit pool, these projects did not increase the owner's project cost. Thus, from an owner's perspective, 94.44 per cent of the projects were completed within budget. From the participants' perspective, 86.11 per cent of the projects were completed below target cost.[5] The profit

Table 3: Profit adjustment based on project outcome

Profit adjustment	Sample size	Sample percentage	Average profit adjustment from initially anticipated profit (%)
Increase	31	86.11	29.02
Decrease	3	8.33	(32.77)
Loss	2	5.56	(100)

Source: Hanson Bridgett Survey, 2021.

Figure 1: Distribution of projects with positive outcomes



Source: Hanson Bridgett Survey, 2021.

[5] All projects increased or decreased profit based on the difference between the contractual target cost and actual cost. Two projects also used other factors.

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histogram (Figure 1) displays the distribution of positive profit outcomes. As noted, two projects were at or over budget.

The respondents subjectively assessed four areas: the accuracy of the initial design and construction estimates; whether they agreed or disagreed with certain statements about their IPD projects; whether they would use IPD for a similar project; and whether they would recommend an IPD project to others. The responses are summarized in Table 4. In addition, they provided general comments regarding why IPD worked or did not work, how IPD could be improved, and a final open-response item for anything the respondent wanted to add (see appendix). The comments overwhelmingly favoured using IPD.

The respondents were asked to 'strongly disagree' or 'strongly agree' with the following statements on a scale of 1 to 5. A midpoint of 3 indicates ambivalence.

The differences in outcome between questions are slight. However, it is interesting to note that the largest difference was whether IPD projects met the owner's goals (4.81) and the participants' goals (4.65).

Finally, the participants stated whether they would want to use IPD for a similar project in the future. Seventy-six (94 per cent) said yes; 4 (5 per cent) said maybe; and 1 (0.9 per cent) said no.[6]

Many of the respondents had significant IPD experience. In this survey, six respondents had participated in more than ten IPD projects, two respondents had participated in more than 50 IPD projects, and the median experience was four projects. Because the subjective questions drew on their entire IPD experience, the responses reflect many more projects than the objective data.

Another interesting observation relates to the 'negative' and 'loss' projects. One might expect the subjective reviews for these projects to reflect dissatisfaction with the outcomes, but they did not. Even where projects underperformed, the participants indicated that they would use IPD on a similar project and recommend it to others. The

Table 4: Subjective comparision of IPD to non-IPD projects

Assertion	Average	Std Dev.
Compared to non-IPD projects, the project participants better understood the project goals.	4.65	0.73
Compared to non-IPD projects, project participants share information more openly and honestly.	4.69	0.58
Compared to non-IPD projects, project participants dealt with unanticipated problems more collaboratively and effectively.	4.70	0.68
Compared to non-IPD projects, project participants better understood the project goals.	4.75	0.54
Compared to non-IPD projects, the project was more successful in achieving the owner's goals.	4.81	0.45
Compared to non-IPD projects, the project was more successful in achieving the project team's goals.	4.65	0.69

Source: Hanson Bridgett Survey, 2021.

[6] The 'no' response explained that the owner wanted the benefits of IPD but did not want to change any of its behaviours.

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objective data alone incorrectly imply that the participants did not consider these projects successful.[7]

The Hanson Bridgett survey did not request information regarding disputes. However, in the over 150 projects structured by the author, only one project has initiated formal dispute proceedings. Although formal statistics do not exist, disputes in IPD projects appear to be quite rare; this is quite different from the industry at large, where formal disputes are commonplace (Arcadis, 2021).

While the survey adds to the existing research, it is subject to several sources of error. It is not a randomized study but contains self-reported data that could be skewed towards positive outcomes. Confirmation bias and faded memories are other sources of error (Kahneman, 2011). If there were multiple responses for a project, the responses based on reviewing records were used. However, the responses are consistent with prior subjective studies, providing confidence in the outcome.

V. International IPD developments

Integrated project delivery, either explicitly described as IPD or as principles implemented under another project delivery methodology, such as alliancing, continues to develop internationally. In addition to projects in North America, the author has worked on IPD projects in the United Kingdom, Norway, and Ireland. Finland has undertaken almost 100 IPD projects (Saarinen, 2021), and alliances have been undertaken in Australia, New Zealand, Canada, and elsewhere (Miller *et al.*, 2000; Mosey, 2019), Key references have been republished in Chinese (*Integrating Project Delivery*) and German *(IPD: An Action Guide for Leaders*).

In Germany, the Bundesinstitut für Bau-, Stadt-, und Raumforschung (Federal Institute for Research on Building, Urban Affairs and Spatial Development) has commissioned a research project to consider whether alternative contract models could improve the cost and schedule reliability of major projects. The research team concluded that traditional contract models provided little opportunity for optimization. They recommended integrating builders early in the design process, aligning economic interests with common project goals, and cooperatively engaging participants in the design and construction process. The report proposed three multiparty contract models that are consistent with IPD principles and German procurement laws (Breyer *et al.*, 2020). Regulations to implement German IPD projects are currently being developed, and at least 11 significant IPD projects are under way, with over half of the projects being in the public sector.[8]

IPD has also been recognized and recommended by influential global organizations. As noted previously, the World Economic Forum recommendations for delivering major

[7] This affirmation of IPD, even where projects did not meet targets, accords with comments made to the author on projects where participants stated that the projects would have fared much worse under traditional project delivery. For instance, the owner in the worst-performing project in the survey has committed to a 5-year capital programme using IPD. The owner believes the approach coped with adversity better than had another project delivery method been used.

[8] Private communications with Professor Dr Antje Boldt, one of the report's authors and counsel for several German IPD projects.

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projects are almost identical to the optimal IPD definition from AIACC (AIACC, 2014; World Economic Forum, 2016). The International Federation of Consulting Engineers (FIDIC), an influential publisher of standard construction contracts, has recognized the need for more collaborative models and has created a task force to develop a new collaborative contract (FIDIC, 2021).

There is a clear international trend toward more collaborative project delivery methods, and we should anticipate that implementation details will adapt to local conditions, practices, and laws. IPD is influencing and leading this trend. IPD requires fundamentally restructuring project implementation and reversing many years of adversarial behaviour. Fundamental change rarely happens quickly. IPD was first proposed 14 years ago, and the current formulation is only 7 years old (AIACC, 2014). In contrast, 28 years have elapsed since Sir Michael Latham's seminal report on problems in the building industry (Latham, 1994). From this perspective, the trend is encouraging.

VI. Conclusions

Choosing a project delivery method is an important decision. Even minor improvements in productivity result in significant resource savings that can be invested in more or better projects or used for other social purposes. Moreover, the research indicates that quality and satisfaction can also be improved by selecting a collaborative project delivery system.

Projects need to go forward, and project sponsors must choose among project delivery systems. Characterizations of project delivery systems are insufficiently precise, and variables between projects are too significant to expect quantitative certainty.

The totality of the research supports using collaborative project delivery and IPD. The subjective comparisons, case studies, indices, and simulations favour IPD over competitive project delivery systems, and the quantitative comparisons are less definitive but provide some support for IPD. No study had suggested that IPD is less effective than other systems. In addition, IPD's underlying precepts are consistent with research correlating projects success with team integration and cohesion.

While there are considerations other than efficiency and quality when choosing a project delivery method, where these are paramount, sponsors should consider IPD or a similar collaborative project delivery system.

(i) Recommendations for further research

Small sample sizes hampered initial IPD research, which was inevitable given the relative newness of IPD. Increasing the number of projects studies increases confidence in the conclusions.

Reliability and resilience are essential characteristics that are often overlooked. Cheng *et al*. reported that IPD teams were resilient (Cheng *et al.*, 2016). IPD project teams have told the author that the IPD projects coped with the Covid-19 pandemic more successfully than their projects executed with other project delivery systems. In another private conversation, the director of a health care organization noted that only one IPD

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project out of 28 exceeded its project budget and that one project only exceeded the budget by 0.2 per cent. Although the organization was committed to efficient project delivery, it also sought to predict optimal project costs accurately and then deliver at that budget. Variation from a predicted outcome lessened the organization's ability to allocate its resources properly. Anecdotal evidence, such as the private discussions summarized here, and detailed case studies, suggest that IPD improves predictability and reliability because the teams are engaged, aligned, and thoroughly validate the projects (Cheng *et al.*, 2016). Resilience and reliability have not featured in existing research and should be critically investigated.

Uniformity in project delivery factors is also essential. The existing studies examine different characteristics, thus making it challenging to aggregate and compare results. The approach taken in the Hanson Bridgett study was to use the satisfaction conditions established by the project team to measure project success, but this approach may overly emphasize cost. A more comprehensive and consistent set of standards would improve comparisons.

A methodology needs to be developed to 'handicap' projects to normalize comparisons between projects. For example, cost growth associated with a specific project delivery system on a low-difficulty project would be more significant than cost growth on a highly innovative or challenging project. The Construction Industry Institute is engaged in a current research project to identify factors that affect project outcomes.[9] This type of research could lead to developing indices that normalize project data and increase comparison accuracy.

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[9] Construction Industry Institute Research Team RT-383.

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Exhibit L-D2-SEC-104, Attachment 2

Summary of Validation Amendment to the

DNNP Integrated Project Agreement

This Attachment was filed as confidential information in its entirety.

SEC Interrogatory #105

Interrogatory

Reference:
D2-4-2

Question(s):

a) Please provide a summary of key terms of the IPD agreement similar to that provided for the various key PRP contracts (i.e. D2-3-1, Attachment 1).

Response

a) Refer to Ex. D2-4-3, Attachment 2 (Confidential).

SEC Interrogatory #106

Interrogatory

Reference:
D2-4-2, Attachment 3, p. 30

Preamble:

As part of the Project Charter, OPG states as a risk "The Ontario Energy Board (OEB) may not approve full cost recovery through the rate case if the economics exceed existing generation options or if the project exceeds the approved budget."

Question(s):

Please provide all analyses undertaken regarding the economics of the project in comparison to existing or other generation options.

Response

In the course of responding to this interrogatory, OPG identified that Ex. D2-4-2, Attachment 3, p. 30, erroneously stated a risk that the OEB may not approve full cost recovery of the DNNP through the rate-setting process "if the economics exceed existing generation options". This is an incorrect statement with respect to the OEB's mandate and was erroneously identified as a risk. The current version of the Project Charter, which does not include this statement, is provided in Attachment 1.

The DNNP forms part of the Province of Ontario's integrated energy plan ("IEP") which is the Government of Ontario's plan to ensure it can meet growing electricity needs for the period specified by the plan. As the OEB stated in EB-2020-0290:

> The OEB's role in this proceeding is distinct from the IESO and the OEB is not the system planner. As such, the OEB does not have the mandate or authority to consider or adjudicate on analyses and proposals respecting generating asset mixes for the Ontario electricity market in this proceeding.[1]

Therefore, it is not within the jurisdiction of the OEB to be the electricity system planner and consider alternatives to projects such as the DNNP forming part of the IEP. The OEB's jurisdiction is limited to considering the reasonableness and prudence of the

[1] Procedural Order No. 2 and Decision on Motion, EB-2020-0290, April 29, 2021, p. 5.

costs of the project in question for purposes of establishing rates. As such, the question posed is not relevant to these proceedings.

ONTARIO POWER GENERATION

Project Charter

Internal Use Only

Document Number:
NK054-PCH-01210-00002

Revision:
R002

Title:
DARLINGTON NEW NUCLEAR PROJECT

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The Project Charter describes the business vision and scope of the project as defined by the line of business. Sections 1.0 through 5.0 are mandatory. Sections 6.0 onwards are recommended however not compulsory. The sponsor should determine whether completion of these sections is required based on the project cost, complexity and needs.

General Project Information

Project Number:	83274	**Project Level:**	A
Project Name:	Darlington New Nuclear Project	**Facility/Site:**	Darlington
Project Manager:	N/A	**Executing Org:**	Enterprise Projects
Project Manager R2:	N/A	**Sponsor:**	Subo Sinnathamby

Project Charter Approval

Prepared by: Carol Lam Project Director, DNNP	
Reviewed by: Ryan Howard Vice President, SMR Unit 1 Execution	
Approved by: Boris Vulanovic Senior Vice President, SMR Execution **Project Sponsor**	
Accepted by: Subo Sinnathamby Chief Projects Officer **Executing Organization Approval Authority**	 April 13, 2026

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1.0 NEED BACKGROUND AND PROPOSAL

Ontario Power Generation (OPG) is seeking to grow its business and be a leader in energy innovation via the development of Small Modular Reactors (SMRs). Clean energy alternatives to reduce dependencies on fossil fuels is a priority growth opportunity for OPG. As the province moves to electrification additional generation will be needed to fulfill the expected increase in demand for energy.

To supply the capacity and energy needed, a diverse supply mix will be required. SMRs have the potential to be cost competitive against other clean energy options and provide job and economic benefits that intermittent renewables cannot. Consistent with OPG's Strategic Objectives and Climate Change Plan, enabling additional nuclear generation through SMRs will position OPG as an Energy Industry Leader and be a catalyst for a net-zero economy.

OPG has reviewed multiple SMR technologies and, over the course of 2021, worked with three developers to assess whether they would be a good fit at the Darlington site as well as for future deployments in the province. In December 2021 OPG selected GE Hitachi Nuclear Energy's BWRX-300 as its DNNP SMR technology, and OPG's shareholder, the Minister of Energy, instructed OPG to continue planning and preparation at the Darlington site. In July of 2023 the Minister instructed OPG to commence the planning and licencing for three additional SMRs at the Darlington New Nuclear site. In May 2025, the Province of Ontario, following review of the cost estimate for the DNNP, further announced its approval of OPG's plan to begin construction of the first of four SMRs at the Darlington site.

SMR technology will support addressing the following for the Ontario electricity market:

- Initiate path towards zero emissions (Immediate)
- Summer and winter capacity deficit (Short Term)
- Increased energy demand (Long Term)

The IESO has completed an analysis of the impact of one SMR on Ontario's electricity system. The analysis concluded that the addition of any of the three SMR technologies OPG considered for Darlington would help meet system capacity needs, reduce energy shortfalls, and reduce carbon emissions at a cost that is in line with the federal government's carbon rate of $170/tonne by 2030, with a minimal impact on the average annual system cost.

This project charter covers Darlington New Nuclear Project (DNNP) – the first four SMR generating stations in Ontario. OPG already holds an Environmental Assessment ("EA") approval and a CNSC Licence to Prepare Site, which are necessary and valuable assets to start an SMR project. Through the first phase of the capital project, OPG partnered with GE-Hitachi (GEH) to progress design and engineering work. Successful completion of this phase further demonstrated the viability and business case for an SMR at Darlington. In October 2022, OPG completed a significant project milestone with the submission for the Licence to Construct application to the CNSC. The Licence to

Construct for Unit 1 was subsequently issued in April 2025, marking the next step in the deployment of Canada's first SMR at the Darlington site.

1.1 Preliminary Project Level (Cost and Complexity Assessment) and Gate Strategy

The DNNP will be a highly complex program. Table 1-2 lists a preliminary breakdown of major scope areas. Within each of these areas there may be multiple projects.

Given the complexity of developing, designing, and building new nuclear technology, it will be broken down into phases with appropriate decision points and gates for progression. The gate strategy is documented in the Program Management Plan.

Table 1-2. Major Scope Phases

Scope Area		Description	Outcome
I	**Technology Development and Design**	Technology development and design of an SMR for on-grid application. Constructability Reviews including incorporation of modular manufacturing techniques.	Management Plan Strategy. Final technology/partner selection decision. Business Case Approval. CNSC Construction license.
II	**Site Preparation**	Activities required to prepare the site for reactor construction in accordance with the PRSL [1].	Site prepared for reactor construction activities. PRSL commitments met.
III	**Procurement & Manufacture**	Progress long lead items. Develop modular manufacturing capability.	Long Lead item procurement. Manufacture of modular components.
IV	**Construction**	Construction and testing of Reactor and supporting structures & systems.	Construction complete and turnover to Operations for commissioning.
V	**Operations Preparation**	Implementing the Management System, training staff, developing procedures, defining the operating organization, and implementing other tools (software/hardware).	Operations, Maintenance, and Engineering readiness. Procedures issued. CNSC Operating licence.
VI	**Commissioning & Unit Start up**	Commissioning & functional tests, fuel load, and synchronization.	First unit in-service for commercial operation.
VII	**Subsequent Unit Construction**	Complete sequential construction, licensing and turnover to Operations for commissioning.	Units 2, 3 and 4 unit in-service for commercial operation.

2.0 PROJECT OBJECTIVES (CRITICAL SUCCESS FACTORS)

The principal objective of the DNNP is to lead new nuclear technology development to provide safe, clean, efficient, and sustainable power to the Ontario electrical grid in the next decade via an SMR at Darlington. The current goal is to commence construction of the first SMR in 2025, complete construction by the end of 2029, and commercially available by the end of 2030.

Primary Objectives and Success Factors:

1. SMR technology development and design
   (i) Safe
      a. Inherently safe design and passive safety response systems.
      b. Off-site releases resulting from a bounding accident scenario are sufficiently low that the need for emergency actions outside the exclusion zone is eliminated.
      c. Security resilience.
      d. As low as reasonably achievable operator radiation dose and operating radiation emissions.
   (ii) Clean – minimizes environmental impact over the project lifecycle and supports net zero carbon goals.
   (iii) Sustainable – acceptable lifecycle fuel and waste management strategy.
   (iv) Efficient – total cost of generation competitive in the Canadian energy market (carbon cost factored in).
   (v) Adaptable – able to adapt to a range of site specific conditions which will enable deployment of the technology in a fleet approach.
2. Confirm the business case for design and construction of an SMR facility at Darlington.
3. Construction of an SMR facility on the Darlington site, with up to approximately 300MWe to the grid, complete by the end of 2029.
4. Design the site and infrastructure and construct up to 3 additional reactors of the same design on the site.

Supporting Objectives:

5. Support the establishment of a Canadian supply chain related to SMR build and maintenance, maximizing benefits to Durham Region, Ontario and Canada.
6. Partner with Government and other stakeholders to advance SMR regulatory and technical standard frameworks.
7. Engage and provide opportunities to Indigenous communities.
8. Engage, educate and seek support from key stakeholders, local government, and the surrounding community.
9. Support the vision of a Canadian fleet of SMRs, and specifically an SMR in western Canada in 2030=.

3.0 COMMITMENTS, CONSIDERATIONS

3.1 Regulatory Commitments

CNSC licensing required for this project include:

- Site Preparation Licence (current licence 2021-2031)
- Construction Licence
- Operating Licence
- Waste related licence

A primary assumption of this project is that the new nuclear technology/design will fit into the existing Environmental Assessment (EA). This assumption will be reviewed periodically in the design phase of the project to ensure any gaps to this are recognized and managed.

With respect to the licensing processes for construction and operation, OPG has developed the necessary administrative protocols with the CNSC to ensure deliverables are provided and reviewed in accordance with an agreed schedule and key regulatory interfaces are managed. In order to increase regulatory confidence and reduce risk of late design changes related to regulatory approvals, designs should undergo the first two phases of the Pre-licensing Vendor Design Reviews [2].

A Notice of Project has been provided to the Ministry of Labour notifying the Ministry of construction activities on the site. A variety of other Permits will be required and will be managed through the Project.

3.2 Safety Considerations

☐ No **additional safety considerations.**

☑ Yes**, additional safety considerations (provide details).**

Nuclear Safety shall be the primary consideration in the design. The design should incorporate passive safety features. Nuclear safety considerations will be documented in a supporting Safety Analysis Report.

In addition to the Nuclear Safety aspects, the design should incorporate security resilience features.

Conventional and construction safety requirements will follow all applicable municipal, provincial, and federal regulations as a minimum.

3.3 Environmental Considerations

An Environmental Assessment (EA), which includes the Environmental Impact Statement, was prepared and submitted to the Joint Review Panel (JRP) for the DNNP in 2009. The JRP's EA Report concluded that the DNNP Project was not likely to cause significant adverse environmental effects, provided the mitigation measures proposed and commitments made are implemented. Detailed regulatory and environmental commitments are tracked in the DNNP Commitments Report NK054-REP-01210-00078 [3].

As discussed in Section 3.1, a periodic review of the assumptions of the PRSL with respect to the technology design and site preparation activities is required to ensure any gaps to this are recognized and managed.

☐ **No, environmental impact assessment is NOT required for the project.**

☑ **Yes, environmental impact assessment IS required for the project.**

4.0 MAJOR MILESTONES

The DNNP schedule has been developed as part of the definition and front-end planning processes. Milestone targets for the program are provided in Table 4-1.

Table 4-1. Major Milestones

Name	Deliverables/Acceptance Criteria/Rationale for Date	Date
Licence to Construct Application	Regulatory licencing period of 2 years	Q4 2022 (Complete)
Class IV Business Case and Release	Basis for a decision to proceed to Site Preparation construction	Q4 2022 (Complete)
Class III Business Case and Release	Basis for a decision to proceed to Nuclear Construction	Q1 2025 (Complete)
Licence to Construct Issued	Regulatory license required to start construction	Q2 2025 (Complete)
Start of Nuclear Construction	Major phase of project	Q2 2025 (Complete)
Nuclear Construction Complete	Business objective	Q1 2030
Commercially Available	Business objective	Q4 2030

5.0 STAKEHOLDER SUMMARY

Stakeholders of this project include:

- Indigenous Communities with rights or interests in the project
- All levels of government (Province of Ontario, the municipality of Clarington, Durham Region, the Federal Government)
- General public (particularly residents and businesses in close proximity to the Darlington site)
- Other nuclear utilities and nuclear industry organizations
- Special interest groups
- Independent Electricity System Operator (IESO)
- Hydro One
- CN Rail
- Nuclear Waste Management Organization (NWMO)
- St Mary's Cement
- Nuclear suppliers of goods and services

Stakeholders also include potential future business partners of OPG in SMR build and operation.

The project will develop a comprehensive Indigenous & Stakeholder Relations Plan as part of the overall Program Management Plan.

6.0 FUNDING/COST

The full project cost was estimated during the Definition phase, followed by a business case submitted to the OPG Board of Directors for approval. Funding will be requested and released in phases, based on successful completion of key work programs and program milestones, in accordance with an approved release strategy. This strategy will be documented in the DNNP Program Management Plan.

7.0 RESOURCING (PROJECT TEAM)

A partnership between OPG, GE Vernova Hitachi, AtkinsRéalis, and Aecon Kiewit Nuclear Partners (Aecon Kiewit), has been contracted to collectively develop and deploy the BWRX-300 SMR, and its supporting infrastructure at the Darlington Nuclear site in Ontario by the end of the decade. An Integrated Project Delivery (IPD) model has been selected to maximize integration and collaboration with contract partners.

The SVP, SMR Execution, will establish the OPG organization and resources necessary for successful completion of the DNNP.

7.1 Risks

A formal risk management process has been implemented within the DNNP to ensure that risks are identified, managed, and reported on a routine basis. These risks and associated actions are managed in a central database and form the basis of planning as well as on-going risk management.

Key risks within the program include:

(a) Issues related to First of a Kind (FOAK) technology development and design may delay the overall schedule of the project and result in increased cost.
(b) Issues with amendments/interpretation/application of Regulatory requirements for new technology and/or new nuclear construction may delay the overall schedule of the project and result in increased cost.
(c) Delays in contract negotiation/issuance or delays in long lead item procurement may delay the overall schedule of the project.
(d) Specialized resources required to execute the project may not be available due to other competing large nuclear and infrastructure projects, which may delay the overall schedule of the project.
(e) Lack of a positive business case or shareholder support may result in project cancellation.
(f) The Ontario Energy Board (OEB) may not approve full cost recovery through the rate case if the project exceeds the approved budget.

(g) Public and/or Indigenous opposition to new nuclear development may result in legal challenges, and delays or cancellation of the project.
(h) The selected technology may result in gaps to the existing EA resulting in additional public consultation and regulatory reviews/approvals, delaying the project and adding cost.

8.0 REFERENCES

[1] Power Reactor Site Licence, PRSL 18.00/2022, OPG New Nuclear at Darlington Generating Station, Nuclear Power Reactor Site Preparation Licence. Licence to Prepare Site e-Doc 3990795

[2] REGDOC 3.5.4 Pre-Licensing Review of a Vendor's Reactor Design, 2018

[3] NK054-REP-01210-00078 Darlington New Nuclear Project Commitments Report

SEC Interrogatory #107

Interrogatory

Reference:
D2-4-3, p. 2-3
D2-4-4, p. 3

Question(s):

With respect to the Technology Collaboration Agreement:

a) Please provide greater details regarding the agreement contracts, including among other matters, how much OPG contributed versus other contributors.

b) OPG states that the "The TCA also allowed OPG to share the costs associated with developing the first-of-a-kind Standard Plant Design with the Designer and other parties interested in constructing a SMR after OPG." Why would the vendor, not OPG, be responsible for the costs associated with the development of a standard plant design?

c) Who owns the intellectual property regarding the standard plant design and, is or will, OPG be compensated for other entities who construct a BWRX-300 reactor based on that design?

Response

a) and b)

The Technology Collaboration Agreement ("TCA") is primarily a funding agreement for standard plant design. In addition to information already provided in Ex. D2-4-3 and Ex. D2-4-4, Attachment 1 (confidential) to this response provides a summary of material provisions of the TCA.

[redacted]

c) [redacted]. Refer to Ex. L-A1-CCC-12, question(a)(iii) for further details.

Exhibit L-D2-SEC-107, Attachment 1

Summary of Technology Collaboration Agreement

This Attachment was filed as confidential information in its entirety.

SEC Interrogatory #108

Interrogatory

Reference:

Question(s):

Please provide a table that shows the major difference between the contracting structure between the DRP, PRP, and DNNP, and explain why each is best suited for each project, and the risks and the benefits of each as compared to the others used.

Response

The requested information is provided below.

DRP	PRP	DNNP
Contracting Structure		
Collaborative Engineering, Procurement and Construction ("EPC"), with multi-bundle approach broken down into Retube and Feed Replacement ("RFR"), Turbine Generator ("TG") and Balance of Plant, each with separate agreements. This is described in detail in EB-2016-0152, Ex. D2-2-2, pp.1-3, and EB-2020-0290, Ex. D2-2-4, pp. 2-25. Key features of this model include: - Fault- based concepts such as defective work and warranties	Consistent with elements set out in the DRP column, with the addition of the deep water intake bundle. This approach is described in detail in Ex. D2-3-2, pp. 1-3 and Ex. D2-3-3, pp. 3-23.	Integrated Project Delivery model ("IPD") features are described in Ex. D2-4-3, pp. 7-16. Many of these features are consistent with the collaborative EPC model employed for DRP and PRP. The IPD approach differs from the DRP/PRP model in the following ways: - Single, multi-party agreement where contractors assume integration risk between scopes - Solution driven culture between the parties in relation to disputes, errors, mistakes, defects,

- Changes and delay claims for events outside contractor control - Functional scope where contractor is responsible for determining means and methods - Target based contracts - High level functional scope, intended to limit claims or contractual changes. - Financial transparency. - Early involvement of all partners, including constructability planning in design phase.		etc., with costs collectively shared by all parties. - Waiver of liability and limited disputes. - Consensus-based decision making to ensure all parties are aligned with key decisions.
Risks		
Owner/integrator risk: OPG (as owner) has separate contracts with each prime and must integrate the primes' work and remains responsible for the entire program. OPG must coordinate the works so each prime can execute to plan; given project complexity and limited site space, coordination requires extensive planning to prevent claims of delay or increased costs due to inadequate coordination or interference from another	**Similar to DRP with the following addition**: Broader, more complex scope, including boiler replacement and deep water intake, potentially increases the integration risk to OPG. **Mitigation Strategy**: - Incorporation of DRP lessons learned into contracts – eg.	**Complex contract negotiations** requiring the concurrent alignment of four parties. The model requires adoption and integration of IPD behaviours of trust, transparency and collaboration. **Mitigation strategy:** - Providing sufficient time for negotiations to ensure contracts are finalized to support project timelines. - Implementation of a project culture charter, co-

vendor. **Mitigation Strategy**: - Collective planning, collaboration and transparency to encourage timely risk identification and mitigation. - OPG had limited experience managing vendors under this model, making effective vendor oversight more critical and increasing reliance on external resources. **High level functional scope:** With the scope being functional, there was risk of scope creep, and misalignment between OPG and vendors on scope interpretation. **Mitigation Strategy:** - Implementation of robust scope development process. Refer to Ex. D2-2-2, p .8. **Establishing appropriate targets:** Target costs need to be appropriate to drive the incentive/disincentive structure, not too high as to be unrealistic, and not too low as to be ineffective	One Team Principles, integrated scheduling, robust reporting requirements, further application of Target Cost pricing models to align interests.	location to support the development of trust between individuals, team-building events, and promotion of team culture by the Project Leadership Team The shared risk structure, especially for Unit 1 with FOAK risks, is not perceived equally by all NOPs, in particular for NOPs that have smaller or earlier scopes, which may result in a perception that they carry greater risk for longer periods of time. **Mitigation strategy:** - The risk each party has assumed is proportional to their scope of work. Additionally, an incentive model was developed enabling payments to the NOPs throughout the project, while protecting contingency.

in driving desired outcomes: **Mitigation Strategy:** - OPG ensured appropriate DRP target costs by utilizing the Definition Phase period to set and validate the target, conducting rigorous estimate vetting/validation (including independent oversight), and instituting contractual transparency/auditability. Refer to EB-2016-0152, Ex. D2-2-3. **Utilizing the appropriate pricing models for the different scopes**: The major work bundles were structured using a mix of target cost, fixed cost and cost plus. It is imperative that the right model is used for the right scope, accounting for the proper allocation of risks between the parties. **Mitigation Strategies:** - OPG ensured appropriate pricing models for different scopes by matching the pricing approach to the nature of the work (scope definability/uncertainty and risk allocation) and		

then structuring each major work bundle contract accordingly (fixed/firm where definable; target price where uncertainty existed but OPG wanted to avoid risk premiums; reimbursable/cost+mark-up for owner-directed items and commissioning).		
Benefits/ Why Best Suited for Project		
Collaborative EPC combines the cost and schedule certainty benefits of defined scope boundaries and clear contractor accountability with the flexibility for collaborative cost and schedule optimization. This approach enables optimal risk allocation by assigning risks to parties best positioned to manage them while maintaining clear ownership and deploying collaborative mechanisms for addressing unforeseen challenges.	Similar to DRP.	IPD is better suited to the unique risks and uncertainties of a greenfield FOAK nuclear construction project. IPD aligns parties under a single overarching project objective, fosters open collaboration, shared risk and reward, and minimizes claims and disputes by bringing all key partners together under a single contract with transparency and a joint decision-making governance structure. Refer to Ex. D2-4-2, pp. 2-9 for additional benefits of IPD.

1

SEC Interrogatory #109

Interrogatory

Reference:
D2-4-3, Attachment 1

Question(s):

For each scenario, please provide the total cost and the total cost paid by OPG.

Response

Scenario 1
Total Actual Cost = $1.8B
Total cost paid by OPG = $2.28B

Calculation details: $1.8B (total actual costs) + $140M (NOPs' share of the underspent below target cost) + $140M (NOPs' share of the Execution Reward Pool remaining) + $200M (Execution Risk Pool)

Scenario 2
Total Actual Cost = $2.1B
Total cost paid by OPG = $2.37B

Calculation details: $2.1B (total actual costs) +$70M (NOPs' share of the Execution Reward Pool remaining) + $200M (Execution Risk Pool)

Scenario 3
Total Actual Cost = $2.4B
Total cost paid by OPG = $2.46B

Calculation details: $2.4B (total actual costs, including $140M of execution Risk Pool) + $60M (remaining of the Execution Risk Pool)

Scenario 4
Total Actual Cost = $2.7B
Total cost paid by OPG = $2.7B

Calculation details: $2.7B (total actual costs, including $200M of execution Risk Pool)

SEC Interrogatory #110

Interrogatory

Reference:
D2-4-4, p. 8-9

Question(s):

Please provide a more detailed review of the lessons learned from other large projects, and specifically the DRP and other recent large nuclear new build mega projects (e.g. Vogtle). Please provide any reports or analysis undertaken regarding those projects, and lessons learned.

Response

OPG has a comprehensive lesson learned and benchmarking process and currently has over 16,000 project lessons documented within a project accessible database. The Darlington Refurbishment Program ("DRP") accounts for approximately 55% of these lessons.

A summary of the key lessons learned from the DRP, industry best practices such as the Nuclear Energy Institute ("NEI") "Strategic Project Management Lessons Learned & Best Practices for New Nuclear Power Construction" and other large projects such as the Windsor-Detroit Bridge, Hinkley Point C, Vogtle, and Kajima Corporation, is as follows:

- **Design Maturity for Construction** – Having a well-developed and mature design in place before construction begins helps minimize changes, rework, and disruptions during the construction phase. With a mature design, quantity estimates become more accurate, informing labour, cost, and schedule plans. As described at Ex. D2-4-4, p.10, at the time of the Release Quality Estimate, engineering for the DNNP was approximately 70% complete, with over 95% of the major system deliverables for Standard Plant Design issued. Where applicable, the estimates were based on quantities and unit rates in accordance with industry best practices.

- **Ingrained Nuclear Construction Quality and Safety Culture Mentality** – A robust safety and quality culture is essential; without it, projects can experience significant setbacks in schedule and cost. For mega projects, timely production, analysis and validation of quality records throughout the project is necessary to enable seamless completions and turnover to operations. In addition to robust vendor programs, the DNNP has established functional teams including the Health

and Safety Function, Construction Management Function and Quality Assurance and Control Function. These teams provide support, coordination, integration and oversight of project work. Additional details on these functions are provided in Ex. D2-4-2 Section 3.4, and Ex, D2-4-9, Section 2.0 and 9.0.

- **Owner Led Collaborative Contracting Strategies** – A fair and flexible contracting framework should align with the size, complexity and maturity of the project deliverables, with risk allocation and incentives considering design and delivery certainty. Implementation of owner-led integrated project teams with clear roles, responsibilities, and authorities within the project structure, and clear and common mission and goals is essential. NEI describes "Owner led integrated project teams" and "extreme ownership and leadership from the top" as key best practices. OPG has selected the Integrated Project Delivery ("IPD") commercial framework for the DNNP building on the success of the DRP's "One-Team" approach. Details on the IPD model and the DNNP structure are provided in Ex. D2-4-2.

- **Strong Planning to Enable a Productive Workforce** – Invest in strong planning and pre-construction capabilities, securing that activities are performed in the right sequence with the right material, design and skills availability. Manage engineering, procurement, construction and commissioning/turnover packages through implementation of Advanced Work Packaging ("AWP"), a Construction Industry Institute best practice. Integrate all vendors and work into common processes and tools, aligning project management and controls expectations across the program. The DNNP is implementing AWP enabling tracking of work deliverables tied to construction work packages. The program is being managed within a common data environment under a common set of governance, and tools including one integrated schedule.

- **Exploit Learning and Replication** – Ensure learnings from design, procurement and execution are systematically captured and deliberately embedded into each subsequent iteration. Control reference design and replicate the design with disciplined incremental improvement, enabling benefits of nth of a kind ("NOAK") construction. OPG and the non-owner parties have implemented a robust lessons learned program systematically identifying and tracking the lessons learned across the project. Where appropriate, these lessons are being implemented in real-time, and shared cross functionally across the project. Design revisions and opportunities are being tracked and assessed for current unit versus subsequent unit implementation.

- **Build a Sustainable, Capable and Empowered Workforce** – Promote stable and empowered leadership and specialised skillsets throughout the program. Continuity, clear authority and experience and knowledgeable teams are critical to project success. OPG and the Non-Owner Parties have implemented a robust

cross party succession planning process, ensuring that all key positions with the Program have multiple level of succession candidates identified and individual development plans are in place. Within OPG, succession planning is performed across the program, ensuring that depth and breadth of experience within the project teams and functional teams is maintained.

- **Integrated Project Schedule, Owner Control, and Simplified Reporting Systems** – Establish a project management office ("PMO") on site, maintained by dedicated owner-controlled staff. Develop an integrated project schedule and implement timely and transparent progress reporting driving performance to a working schedule. OPG has implemented a centralised owner-led PMO with the controls function being overseen by OPG controlled staff. Key progress reporting is centralised through the PMO using approved information source systems and practices.

- **Early Planning for Commissioning and Turnover** – Ensure commissioning and operations requirements shape engineering and construction from the start (i.e., start with the end in mind). OPG has implemented systems/subsystems, boundaries, and turnover sequence early, aligning schedule and packages to those boundaries. The approach includes progressive turnover which enables early energization and functional testing. OPG is defining all information management and turnover requirements early, ensuring alignment and early collection of information and documentation to support a seamless transfer to operations.

In addition to the above summary, the following key benchmarking and lessons learned reports are provided:

- Attachment 1 (confidential) - Modus – DNNP Lessons Learned and Best Practice Review and meeting minutes of follow-up discussion, 2021
- Attachment 2 - DNR (DRP) Lessons Learned and OPEX, 2023
- Attachment 3 (confidential) - Material benchmarking reports of external projects, 2018-2025.

A detailed review of the lessons learned from other large projects is described by Pegasus-Global in Ex. D2-4-10, Attachment 1, pp. 36-38.

MODUS
STRATEGIC SOLUTIONS

DNNP - LESSONS LEARNED & BEST PRACTICE REVIEW

JULY 2, 2021

DNNP Lessons Learned Report

EXECUTIVE SUMMARY

Modus Strategic Solutions and Worley (Modus/Worley) were tasked with developing an inventory of Lessons Learned from the industry and past nuclear construction projects to support the DNNP program. Specifically, the scope required that Modus/Worley:

> *Distill from recent nuclear new-build projects (as well as other comparable projects), key lessons learned and best practices that should be applied to this project. Compare the findings to OPG's current processes and project plans and provide specific recommendations of how best to apply the lessons/best practices. The scope of this review should include planning, estimating, scheduling, engineering management, commercial strategy, construction strategy, and stakeholder relations.*

In conducting this Lessons Learned (LL) identification project, it became apparent that the volume of relevant lessons and sources is significant. Rather than focus on quantity, the team focused on relevance and qualitative value to OPG and took the approach described herein using the experience and judgement of seasoned veterans of the industry (see Appendix A) to provide a meaningful first tier of information for OPG DNNP. It is possible, if not probable, that further effort and investigation will yield additional lessons in a lower-tier population of sources. However, the Modus/Worley team took the approach described herein to optimize the number of external LL gathered and to avoid spending unnecessary time investigating items that would yield a lower-degree of value in the outcome.

Senior-level subject matter experts (SMEs) identified significant LL based on their relevant experience. Drawing on such experienced individuals allowed the efficient production of meaningful LL. The content is presented in a format that allows OPG to immediately understand the risks the LL present to OPG and the suggested urgency and priority from which OPG can develop a LL Implementation Plan. If required, Modus/Worley can expand or provide further detail on any of the presented Lessons Learned. This future LL Implementation Plan should be prepared and executed in close collaboration with the DNNP Risk Identification process and plan. Ultimately, the Lessons Learned should inform some or all of the Project Execution Plan, commercial strategies and Enterprise and Project risk management efforts. Additional

discussions are recommended to effectively chart each LL implementation strategy to these critical items. It is important to note that in the experience of the team that assembled this report, many Lessons Learned are well known by those who have led major projects, such as the DNNP. Nonetheless, these LL are not always meaningfully adopted by Project Executives and Managers for various reasons such as inadequate time or budget for planning, cultural paradigms, production pressure, contractors who are wedded to "their way", inadequate leadership, perceived commercial and contractual constraints and other such reasons. Therefore, some of the LL identified are well-known and appear to be common sense, but have not been effectively implemented on many projects and merit specific attention.

Overall, 89 Lessons have been identified and are documented with details in the "DNNP Lessons Learned Inventory Workbook" (the "Workbook"), provided with this report. Although all identified Lessons Learned have applicability to DNNP, we selected "Key Lessons Learned" deemed to be of high importance and urgency to OPG and which are indicated expressly in the Workbook Matrix. The Key Lessons Learned are attached to this report as **Appendix B**.

APPROACH AND METHODOLOGY

Before proceeding to identify the Lessons Learned, the Modus team developed a process that would maximize the quality and content of the deliverable at the prescribed budget and schedule. The form and format of the Matrix was aligned with DNNP Project Controls leadership and the EPO Lessons Learned Management Team. The goal was to ensure that the products of this effort could be seamlessly integrated to OPG's EPO Lessons Learned process for ongoing identification, communication and management. It was also made clear with the EPO Lessons Learned team and DNNP team which areas (i.e. internal OPG LL vs. External LL) the Modus/Worley team would focus on. Modus/Worley was to generate a list of "External-to-OPG" LL, which would be submitted to the DNNP and integrated with the EPO LL team which was working on documenting and characterizing the OPG Internal LL. This effort is represented below, in the graphic that was presented to the DNNP team and its various functional stakeholders on May 28, 2021, showing the Modus/Worley team effort and ultimate integration with the EPO risk and LL processes in support of DNNP:

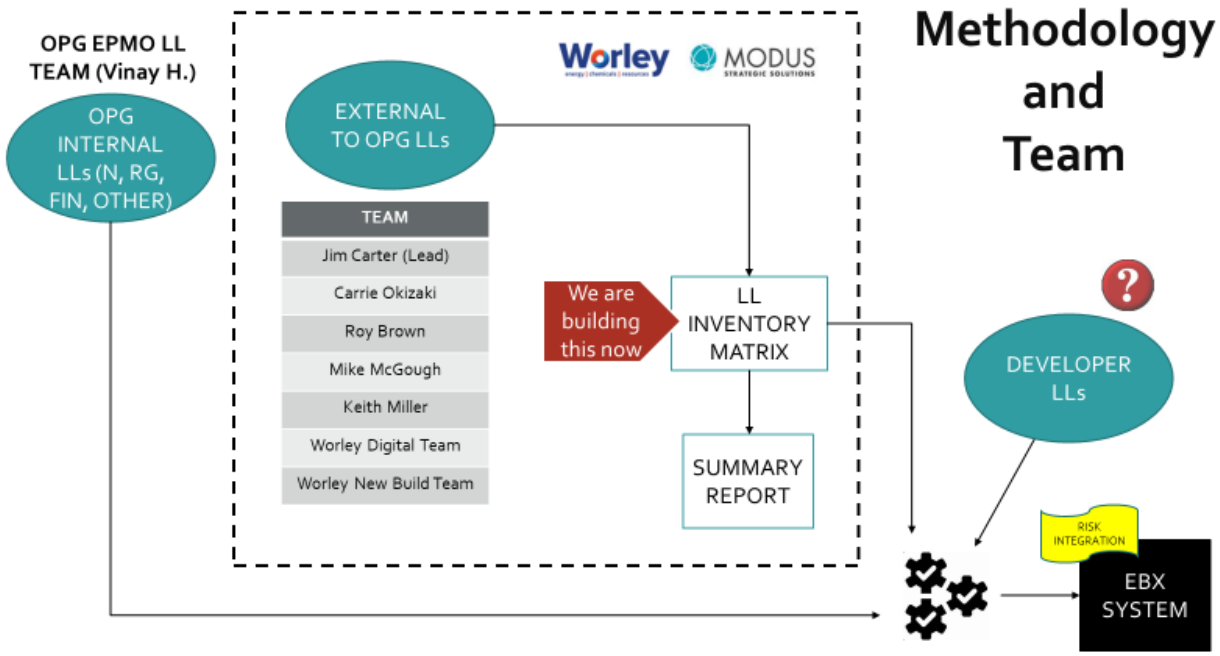


Figure 1: Modus/Worley LL Identification Process and Integration with OPG EPO LL G EPO LL Program

Modus/Worley selected Senior Subject-Matter Experts (SMEs) in the nuclear field who have first-hand direct experience in broad aspects of new nuclear technology and project development including SMRs; contracting and managing the deployment of new build nuclear power plants; and evaluating nuclear new build project performance to identify and develop the LL. The SME expertise included familiarity with OPG project practices to minimize identifying LL that are already known and mitigated by OPG, and to identify other LL that may have particular significance based upon OPG's unique cultural predispositions. The following steps outline the approach the SMEs took to gather, identify and characterize the LL identified in the Matrix:

Step One - As a first step in the Lessons Learned identification process, the SME team identified all the possible sources of LL. This included from industry organizations, nuclear construction projects, conferences, papers and trade organizations. A list of the possible sources included the following:

Organization/ Research Based	Project Based		Developer Based	Misc. Industries
Oak Ridge Labs	[redacted]			Mining
DOE				Oil& Gas
CNL				Transportation
NRCan				
IAEA				
NEI				
WNA				
WANO				
NRC	Confidential			
CNSC				
Maple				

Step Two – Next, the SME team identified lessons from their personal experience. The initial list of Lessons Learned was reviewed and triaged for applicability, duplication, and importance. Details for each lesson were entered into Lessons Learned spreadsheets that are part of an integrated "DNNP Lessons Learned Inventory Workbook" (the "Workbook") which is described below. Many of these Lessons Learned came from personal experience on the projects identified above. Identified lessons were reviewed for relevance, duplication, and importance and populated into specific Lessons Learned spreadsheets.

Step Three - Finally, a limited number of public domain documents were reviewed to extract lessons that may not have been produced in earlier steps. These documents included publicly available papers, conference materials, trade publications, regulatory filings and databases (i.e. the DOE OPEX database). The expertise of the team was applied to formulate Lessons Learned from the available information and details were entered in individual spreadsheets.

As information regarding the lessons was entered into the spreadsheets, the sheets were reviewed for general clarity and consistency. Duplicates were consolidated and a matrix in the DNNP Lessons Learned Inventory Workbook was populated reflecting the source and functional area for each lesson with links to the associated lesson's individual spreadsheet.

We note that this process was not intended to root out every possible Lessons Learned from these sources, but to identify the Key Lessons Learned. These issues tended to pop up on project after project and were part of the SMEs' personal experiences. An initial set of thirty Key Lessons Learned were selected based on a subjective assessment of high impact to OPG. All LL have applicability to OPG and the "Key Lessons Learned" list is not intended to exclude other lessons or opportunities from evaluation and implementation.

DNNP LESSONS LEARNED INVENTORY WORKBOOK

An Excel workbook was developed to identify, describe and navigate the Lessons Learned including the details of each lesson. The workbook is comprised of:

- Individual spreadsheets for each identified lesson which will integrate with OPG's EBX and Lessons Learned identification processes.
- A summary sheet listing the Lesson titles, the applicability to OPG and the impact rating.
- An integrated matrix (Matrix) that provides hyperlinks to each spreadsheet based on the functional discipline/area and the source for the lesson.

The Matrix hyperlinks identify the "Key Lessons Learned", are color coded based on potential impact of the lesson, and identify LL considered to be unique "opportunities" that could have significant impact but should be investigated further.

In order to systematically identify the Key Lessons Learned, Modus/Worley took a wide view of the potential sources of Lessons Learned, making sure to include several different functional areas.

Functional areas in the Matrix are generally classified as:

- Project Planning and Execution (including project management, engineering, inspections, and procurement)
- Project Sanctioning, Social Engagement, and Business Objectives (including stakeholder engagement, commercial and governmental)
- Station Operations, Maintenance and Administration (including information technology and security)

Sources of the Lessons Learned include the following:

- Organization/Research Based
- Project Based
- SME Experience Based
- Developer Based
- Miscellaneous Industry Based (publications, papers, conferences, IAEA, NEI, CNSC and NRC)

A template for documenting the LL was developed in consultation with OPG so that the Excel fields support OPG's Lesson Learned database. Each Lesson Learned includes the following information:

- The direct basis for the lesson (First-hand experience, publications/papers, past project analysis, etc.)
- Details of the lesson
- The applicability to OPG
- The proposed treatment of the lesson by OPG and recommended treatment details.
- Lesson risk description, if applicable
- The lesson impact rating and window

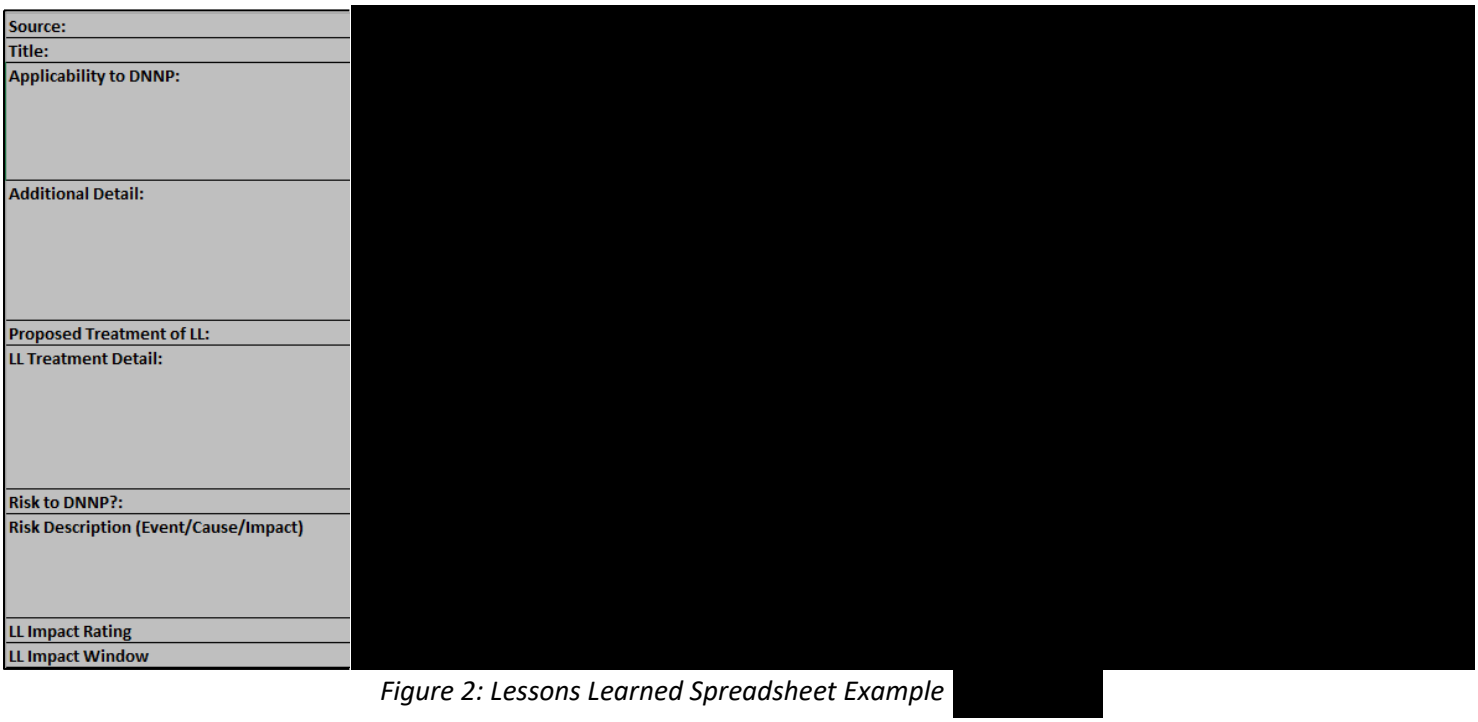


Figure 2: Lessons Learned Spreadsheet Example

RESULTS

The Lessons Learned were associated to applicable functional areas as presented in the Matrix and summarized by quantities in the simplified table below. This breakdown is indicative of the general theme of Lessons identified, meaning that across many separate projects there are common items that lead to project failure that are endemic to these types of efforts. These projects fail to invest in known LL and fall into the "same traps". Some LL are associated with more than one functional area and some LL may not have been associated with all relevant functional areas, especially where only limited association was considered. Nonetheless, OPG should not assume that lessons have only the indicated association.

Lessons were also mapped to the physical source of the Issue (organization, project, developer, industry) and are indicated on the Matrix. In summary, there are 47 Lessons Learned attributed to organization or researched basis, 170 Lessons Learned attributed to project basis, 16 attributed to developers and 8 attributed to miscellaneous (non-nuclear) industries.

	Function	Number of Lessons
Project Planning and Execution	Project Planning	36
	Process/Procedures	15
	Project Management	39
	Engineering	9
	Inspections	3
	Safety	5
	Procurement	5
	Construction	13
	Commissioning	3
	Closeout/Turnover	0
Project Sanctioning, Social Engagement and Business Objectives	Regulatory	2
	Stakeholder Engagement	17
	Indigenous Engagement	2
	Commercial	12
	Environmental	2
	Business Planning	14
	Contract Management	16
	Governmental	4
	Workforce Planning	16
	Legal	0
	Financial	10
	Development and Licensing	1
	Deployment Model	2
	Developer Financial Stability	5
Station Operations, Maintenance and Administration	Operations	5
	Maintenance	2
	Administration	1
	Station Security	1
	Information Technology	0
	Cyber Security	1
	Developer Support and Warranty	0

Figure 3: Lessons Identified for each Functional Area

As indicated in Figure 3, the bulk of Lessons Learned identified focus on planning, procedures, and project management. That concentration is not necessarily due to the experience of the SMEs, but is reflective of the areas where Lessons need to be learned. Pursuing a FOAK SMR project also merits learning lessons related to business matters. Selecting a new technology, potentially from an early-stage company with a unique business model and deployment approach must be based on careful consideration all associated lessons and risks.

KEY LESSONS LEARNED

Included in this report and in the Workbook are Lessons Learned that have been designated as "Key Lessons Learned." As indicated above, the Key Lessons Learned list is not intended to exclude other identified lessons or opportunities from evaluation and implementation. They do, however, represent issues that have been experienced by multiple projects and have caused the most significant impacts. The list of the Key Lessons Learned is attached as **Appendix B**. There are several high-level themes that can be extracted from this Key LL list that need careful consideration:

- **Identification and Agreement on the Project Objectives and Constraints:** At this stage of the project, it is important for the stakeholders (both internal and external), senior management and the project team to clearly understand and align with the project's goals and objectives. Stakeholder alignment to coherent objectives provides opportunities for strategic and targeted action plus communication (internal and external). All the initial key decisions, in particular the commercial strategy, will be based upon these objectives. In order to ensure alignment, these project objectives should be well-documented. Hindsight is always 20/20, but it's important to understand what was known and understood at the time a decision was made. Additionally, a strategic plan for communication of the project's objectives is also important.
- **Putting in Place a Qualified, Experienced Project Team:** At every stage of the project, it is important to have the right resources with the right skills (for that phase). This includes not only the company's internal resources, but also the vendor/contractor resources. Getting the project team right and then augmented with effective succession planning is necessary to ensure the successful execution of the project. In 2016, PMI estimated that poor performance in organizations accounts for more than $122 million wasted for every $1 billion spent. Many of the projects reviewed herein learned how early engagement of appropriate expertise or certain functional group allowed for more streamlined planning, designing and less rework. This includes SMEs in operations, commercial/procurement, specialized engineers, and commissioning and turn-over specialists. With the focus of the OPG SMR team primarily dedicated to issues surrounding technology evaluation, engineering and licensing, a "project pivot" will need to occur quickly and the appropriate resources and leadership must be in place to drive this phase of the program.

- **Requiring Complete and Vetted Foundational Information Prior to Making Key Decisions:** Many of the projects we reviewed made certain key decisions at the very early stages of the project (Initiation and Definition Phases) without having complete or fully vetted information. Incomplete information includes project scope/design, project estimates, and project risk registers. In particular, entering into commercial arrangements without fully understanding the areas of uncertainty or risk meant that the projects did not appreciate the extent to which the costs could increase and the timelines for completion extended. While these increases are often characterized as "cost overruns" or "delays," in reality it was a failure to capture costs or time that should have been included in the base budget and schedule but was missed due to the fast-tracking of the project or rushing key decisions. One-way OPG can mitigate this issue is to insist on absolute rigor to quality at every stage of the gated process, requiring that each product be absolutely bulletproof, and prioritizing getting the deliverables "right" over meeting schedule dates. The phase gate and decision making processes should be built or modified in recognition of the unique nature and risks of SMR technology – both from a technical and business standpoint. Conventional phase gate processes used to deliver the capital projects program may not be appropriate. Time delays at the start of the project in order to properly plan and sanction these projects are insignificant compared to those that will be experienced during execution due to a failure to plan.

It is notable that most of the Lessons Learned referenced in the inventory were generated by failing to follow basic principles of project planning and management, rather than technical issues. These are issues that require skillful handling with a commitment to applying these lessons every day. However, many organizations fail to do so even though these Lessons are often repeated.

RECOMMENDATIONS

The DNNP Lessons Learned Inventory Workbook provides information from numerous sources and insights from experienced senior nuclear new build and technology development managers. Our focus was on those LL that are particularly germane to the DNNP Project and those that could have the most significant impact. There are many more Lessons Learned that are learned every day across the technology and nuclear plant development industry that will be important for OPG to capture as the Project progresses. Too often, Lessons Learned Programs fail to inform mitigating actions by the project team.

Recent nuclear new builds and mega projects in other industries have touted strong lessons learned bases. In reality, the lessons were simply identified, but not really "learned."

The new wave of standardized SMRs and advanced reactors (ARs) is addressing this omission based on embracing the Lessons Learned concept in all areas including project planning, regulatory alignment, means and methods, and commercial operations. Hopefully, with OPG's support, SMR and AR programs can truly learn from the lessons of the past. Therefore, the primary recommendation of this report is quite simply to dig deeper into the details of the summary-level lessons described

1) **Develop a LL Implementation Plan** to track and enforce the application of Lessons Learned, integrated with OPG's risk management processes.
2) **Develop a Communication Plan** to inform the prospective developers and key vendors that these Lessons Learned are available and require them to assess these and generate their own institutional lessons and demonstrate how they will be address and enforced within their organizations. Facilitate a team approach with the selected developer to embed the LL into the DNNP project plan and culture.
3) **Develop and Oversight Strategy and Plan**, monitoring and assessing to ensure the LL identified continue to be reviewed periodically within the selected developer (and their subcontractors) organizations and are integrated with risk management activities.

All Lessons Learned included in the Workbook have merit and should be thoroughly reviewed and assessed for implementation on DNNP and OPG. There are several lessons deemed innovative for OPG, that are designated as "Opportunities" in the Matrix. OPG should consider these and evaluate their potential cost/benefit as they may present new considerations. This opportunity designation is subjective. OPG should consider other lessons or all lessons as opportunities for improvement.

In summary, the content is primarily based on direct experience of senior individuals and is presented succinctly. Additional discussion is recommended to effectively chart each Lessons Learned implementation strategy.

APPPENDIX A

CONTRIBUTORS TO THE DNNP LESSONS LEARNED IDENTIFICATION PROJECT

Background summaries of Subject Matter Experts / Key Contributors are provided below. These are very limited resume synopses intended to highlight experience credentials that contributed to developing the Lessons Learned Inventory. More detailed information about Modus personnel can be found at: [About – Modus Strategic Solutions (modus-group.com)]

- **Jim Carter**

[redacted]

- **Mike McGough**

[redacted]

- **Roy Brown**

[redacted]

- **Carrie Okizaki**

[redacted]

- **Ryan Smith**

[redacted]

[redacted] supported the project by providing independent review of the deliverable product, ensuring the content is relevant and valuable to OPG Leadership and Board decision making processes.

- **Eric Gould**

Eric is co-founder and partner of Modus Strategic Solutions, Inc. [redacted]

- **Steve Woods**

[redacted]

[redacted]

APPENDIX B

KEY LESSONS LEARNED

Key Lessons Learned (Not Ranked)			
LL No.	**TITLE**	**APPLICABILITY TO DNNP**	**IMPACT RATING**
LL1	Conduct Rigorous NSSS Technology Selection Process	Selecting the technology for the nuclear power plant will have enormous ramifications for 100 years+. The wrong decision here can imperil the project from multiple angles. SMRs and ARs involve first of a kind system configurations and components; the reliability and performance of which are critical for successful and reliable lifetime plant operation.	HIGH IMPACT TO DNNP
LL2	Develop a Fact Based Project Business Case	Establishing a solid business case for the project will provide the basis for justification of the resources required to make the project a reality.	HIGH IMPACT TO DNNP
LL12	Ensure all engineering, design is substantially complete before Project Execution Start. FOAK engineered components & systems should be thoroughly analyzed and independently validated by shop testing when possible. This is particularly true for FOAK NSSS.	Starting a project (or individual elements of a project), especially FOAK, before the design is complete can lead to significant cost increases and schedule delays and potential operational problems, as well as, portions of project expenditure at risk due to fast track nature of the work.	HIGH IMPACT TO DNNP
LL15	Greenfield construction projects should not be pursued as station upgrades or modification projects	OPGN very rarely conducts greenfield construction projects. Greenfield projects OPG has previously performed typically had a strong Operations influence	HIGH IMPACT TO DNNP
LL16	Define a Labour Relations Strategy that addresses Modular Fabrication and Installation	SMRs are largely fabricated offsite. For the first time in OPGN history the asset will most likely be constructed in modules off-site, as opposed to commodity by commodity "stick-built" construction. OPG's labour strategy needs to plan for the unique fabrication and installation plan inherent to SMRs.	HIGH IMPACT TO DNNP
LL21	Engineering Needs to be Resident and Operating in Real Time	Most of the Proponents are Remote to the Darlington site but during Construction they need to be at site (virtually or otherwise).	MEDIUM IMPACT TO DNNP
LL24	Assign project leadership based on a pre-established process with mandatory requirements	Building a strong project management/leadership team will enhance identification and problem resolution, motivate project participants, and improve overall planning and execution effectiveness.	HIGH IMPACT TO DNNP

LL25	Developer/ Vendor Project controls maturity should be evaluated using quantitative score card	A quantitative methodology for evaluating a vendor/contractor project controls program can improve the quality of p.c. documents. Consistent assessment of project controls tools and activities based on well-defined criteria stimulates sustained performance accuracy and informs bid evaluation. Refer also to Lesson [redacted]	IMPACT DEFINITION REQUIRES FURTHER INVESTIGATION
LL32	Consider that nuclear plant operators have to deal with nuclear technology and supply chain evolution over facility lifetime.	Nuclear power plants have long term lifetimes. DNNP will likely experience effects of commercial and technological change.	HIGH IMPACT TO DNNP
LL33	Licensing of advanced nuclear power technology is time consuming, expensive, and uncertain.	Selection of a nuclear technology developer requires rigorous assessment of ability to license and permit. The owner needs to fully understand the near-term and long-term cost commitments associated with design and license approval, and understand these costs are at risk.	HIGH IMPACT TO DNNP
LL37	Avoid procedural ambiguity regarding mandatory compliance vs. recommended guidance	Confusion with procedural requirements can lead to excessive, erroneous, or inadequate practices; causing cost, schedule, or safety issues.	HIGH IMPACT TO DNNP
LL39	Understand and avoid numerous historical technical problems with Commercial High Temperature Gas Cooled Reactor	In considering advanced HTGR technology, OPG should carefully review issues that plagued the Fort Saint Vrain gas cooled reactor.	HIGH IMPACT TO DNNP
LL48	Owners often over-estimate the capabilities of their in-house resources and contractor teams.	Assuming individual or company competence without sound basis can lead to project performance problems.	HIGH IMPACT TO DNNP
LL50	SMR developer strategic requirements for Nth of a kind units may conflict with the initial FOAK deployment interests	Considerations associated with a one-off FOAK SMR/AR deployment are different from a long-term multi-unit continuous improvement strategy.	HIGH IMPACT TO DNNP
LL53	Too little oversight and transparency has doomed mega projects.	OPG should continue its successful program for oversight and enhance access to contractor performance and cost data.	HIGH IMPACT TO DNNP
LL54	Deploying advanced nuclear power technology involves considerable expense and time	Developers must have the financial strength to deploy the FOAK unit AND subsequent units to ensure sustained cash flow for growing the business and servicing the fleet.	HIGH IMPACT TO DNNP
LL56	Project leaders often find it difficult to know whether, when, and how to intervene.	To avoid or stop cost overruns and delays, owner and contractor project leaders must professionally and expeditiously confront and resolve problems.	IMPACT DEFINITION REQUIRES FURTHER INVESTIGATION
LL58	Factory assembly and production is not free from problems	DNNP has a significant interest on the success of developer off-site production activity. Shop efficiency and quality control affect DNNP schedule, budget, and product quality.	HIGH IMPACT TO DNNP

LL59	A Rigorous Safety Plan in Place for all Phases of the Project	OPG is a highly safety conscious, risk adverse organization.	HIGH IMPACT TO DNNP
[redacted]	[redacted]	[redacted]	HIGH IMPACT TO DNNP
[redacted]	Integrated Schedule Requirements	Having a comprehensive, integrated schedule linked to the performance baseline of all activities is vital. Identification and consistent monitoring and attention to critical path activities is key to staying on schedule. An integrated schedule must have the right level of detail that is resource loaded, realistic and can provide a clear picture on actual progress, relationship logic but is not overly complex.	MEDIUM IMPACT TO DNNP
[redacted]	Project Managers Need to Understand Project Scope and Project Objectives and Constraints	All team members need to understand the project's goals and objectives/constraints regarding scope, schedule, cost, environmental, commercial and regulatory strategy.	HIGH IMPACT TO DNNP
[redacted]	Development of a skills and resources strategy	Due to the length of the DNNP project, it will be important for the DNNP program to ensure that the competence of its personnel is developed (training) and maintained and that it has a clear succession plan in place for certain key positions.	MEDIUM IMPACT TO DNNP
[redacted]	Early Involvement of the Commercial Team is necessary in order to understand and incorporate the project objectives and constraints into the commercial strategy and to ensure that the commercial documents contain all needed requirements.	Early involvement and integration of the commercial team is necessary to ensure that the commercial team understands the project objectives and determines the most appropriate commercial strategy for the project that is most likely going to achieve the project objectives based upon the company's risk profile and competencies of each of the project participants.	MEDIUM IMPACT TO DNNP
[redacted]	WBS Alignment Between the Estimate and Schedule	The cost code buckets should be in alignment with that work and those tasks in order to measure the hours, materials and equipment needed to complete the task and reconcile them with the associated budget, costs, progress, etc. Therefore, it is important to map the hierarchy of the work breakdown structure (WBS) to a hierarchical CBS.	MEDIUM IMPACT TO DNNP

[redacted]	Lack of Detailed Instructions to the Vendors during the RFP Process Impacted Estimate, Schedule and Risk Reviews	Failure to define specific structure and content for proposal submittals can lead to a variety of submittal formats and content which made evaluations difficult and contributed to omissions in contract requirements.	MEDIUM IMPACT TO DNNP
[redacted]	Poor Quality Construction Work Packages from Contractor	Inaccurate work packages can lead to delays and costs to correct and they can lead to improper construction.	HIGH IMPACT TO DNNP
[redacted]	Timely reporting problems and suggestions can avoid last minute crises and lead to improvements in project performance.	"Reluctance to raise issues inhibits problem identification and solutions. Failure to encourage bona fide constructive communication results in lost opportunity. Reporting safety and quality matters when identified can prevent personal injury and property damage, but also help project management and avoid costly project rework. "	IMPACT DEFINITION REQUIRES FURTHER INVESTIGATION
[redacted]	Design Maturity- Completion of the Design Before Starting Construction	Completing the design before starting construction will reduce the number of required changes and will ensure that a reliable cost estimate and schedule can be produced prior to the start of construction to set a reasonable baseline.	HIGH IMPACT TO DNNP

Lessons Learned Meeting with MODUS - [redacted]

Oct 6, 2021

Attendees: MODUS: Eric Gould, Mike McGough, Roy Brown, Ryan Smith, Carrie Okizaki, Jim Carter

OPG: Carol Gregoris, Mark Guy

General

- Past SMR projects in the U.S. were guilty of underestimating the amount of work and funding required to get it going.

[redacted]

Business Case

- A project needs a Business Case that states and defends: "How much do we plan on spending, before we have a licence in hand".
- Due to the First of a Kind (FOAK) nature, the Gate releases will have to be "beefed up", more quantifying of risk, more detailed reports on variances from plan.
- Need to know whether this is a one-off, or the first of many identical plants. Cost decisions will be affected by this overall strategy.
- Optimism Bias is a real factor. The project doesn't want to lose a business opportunity, however, must understand the big costs associated with a first design.
- Need to include well defined "off ramps". This will build rigour into the plan. It will pre-determine when help will be needed by the project.
- The current Darlington Refurbishment oversight model is very strong and should be considered for a new project.
- Trying to break ground by 2028 will have cost implications. How will the cost be affected if the date was pushed out by 6 months? 1 year? 2 years? Need to consider the overtime costs and risk of mistakes and re-work by moving forward quickly.
- The cost to meet an early date needs to be estimated and weighed.
- Business model needs to accommodate some reasonable amount of delay and unforeseen costs. Contingency planning is very important.
- Need to know how accurate and confident the project is about cost estimates received.
- For a FOAK project, it is very difficult to have a Class II estimate.

Modular Construction

- Has its advantages and disadvantages.
- The main advantage is the lower cost of construction: manufacture can be controlled in a plant setting, no weather impact, higher productivity.
- The companies manufacturing the module construction need to reputable and have good track records.
- Most modular fabricators are non-nuclear and lower quality standards.
- It will probably take a big effort to bring the current constructors up to the required standard.
- What will the site work force look like?
- Using the Chestnut Park Accord, the mark-up meeting could be a little complicated. Each modular element could have piping, electrical, welding, hoisting and other components. The labour assignment could involve multiple (8-10) trades groups. This process would have to be sorted out.

Selection of Technology

- Licencing requirements is a big consideration. Licensing will likely be the critical path to full operation.
- Is the Regulator familiar with the fuel, coolant and overall technology?
- Have plants using similar technology been previously licenced to operate? Have operating staff been trained and qualified using this technology?

[redacted]

- Project was fully planned, funded and built.
- It did not operate due to technical problems.
- It was felt that the technical problems could have been resolved. However, due to contractual issues and the political climate at the time, the project was stopped.

Definition of “Substantially Complete”

- It is important to ensure that Design is 90% complete or “substantially complete” before starting construction, to minimize re-work and extra construction costs.
- Design is not truly finished until the plant is built. How do we assess substantially complete?
- Project needs to map each design component to the construction schedule. Only by determining the completeness of each design component can the 90% Design Complete milestone be assessed.
- Design needs to be complete enough that it can be sent to a manufacturer for fabrication. That means engineering drawings, support calculations, and bill of materials need to be complete.
- Constructability reviews and functionality tests can be used to disposition/mitigate some of the design steps.
- The major piping layout drawings, electrical distribution cable runs, HVAC and control system drawings must be completed before construction can be started.
- “Fast Tracking” can be used where the final design is well understood and there is high confidence there are minimal changes.
- A FOAK design cannot consider using Fast Tracking. With a FOAK design, it will need to be over-engineered to compensate for the unknowns associated with a brand-new design.
- The threshold for substantially complete is high for a FOAK design.
- Having a working prototype of the technology is a big advantage. It also makes it easier for the Regulator to assess the readiness to operate.

LL-8, Financial Wherewithal

- The financial strength of the project partners is very important.
- This has been a major contributor to some new-build failures in the U.S.
- Need to examine potential partners and confirm how they are funded. Do they have strong financial backing? Do they have a strong track record?
- The constructor cannot shed the risk onto the vendor partners. The vendor partners have other less-risky options for work in the market, so they typically will not agree to share the risk.
- The project needs to have confidence about their partners' capabilities and financial strength.

[redacted]

- The project mistakenly assumed they did not need independent oversight.
- Towards the end of the project, the project contracted an independent engineering firm to perform an audit.
- The designer of record had declared their design was complete. It was later determined they were only 82% complete. There were still over 125,000 vendor documents remaining to be dispositioned and added.

NEXT STEPS FOR DNNP

- For each of the Lessons Learned, need to do a deeper examination, and define the risk to DNNP.
- Suggestion from MODUS is to perform a risk analysis now to set a risk baseline.
- MODUS suggested that reviewing the Refurbishment Joint Venture agreements would be helpful for DNNP when planning their own partner agreements.

UNITS THR3E ONE 4OUR
DARLINGTON REFURBISHMENT
BUILDING ON SUCCESS

DNR
LESSONS LEARNED AND OPEX

CCoE
Construction Centre of Excellence

Lessons Learned & OPEX

Organizational

Optimize Efficiency and Effectiveness

Programatic

Adopt the best programs to fit the work at hand

Technical/ Contractual

Best Practices, Technology and Contract implementation

DNR Lessons Learned

Organizational

Optimize Efficiency and Effectiveness

- OneTeam Approach
- Process Optimization
- Communication
- Strategic Initiatives

Programatic

Adopt the best programs to fit the work at hand

- Lessons Learned
- Project Controls
- Planning and Scheduling
- Radiation Protection
- Project Assurance
- Safety & Training
- Quality Management & Construction Oversight

Technical/ Contractual

Best Practices, Technology and Contract implementation

- Tool Improvements & Innovation
- NR Supply Chain End Fitting

DNR Lessons Learned

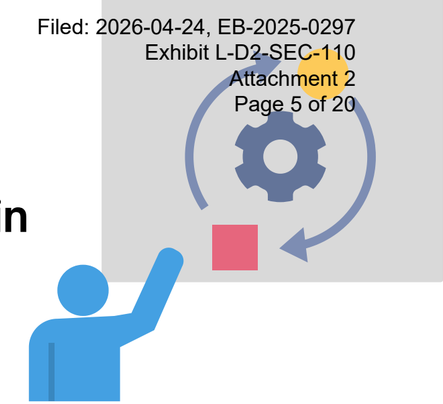
Organizational

Optimize Efficiency and Effectiveness

- OneTeam Approach
- Process Optimization
- Communication
- Strategic Initiatives

CHANGE MANAGEMENT - ONETEAM

Planning and executing a Change Management plan will ensure OPG and Vendors are in complete alignment



ADKAR Model for Change Management

Implement & Sustain Change Management Processes, Tools and Methodologies:

- Adapt, communicate and align on organizational changes
- Organizational and behavioral integration between Vendors
- Open and Transparent Communication
- Manage Alignment between vendors, OPG support groups and external stakeholders

The use of Change Management to implement the ONETEAM Culture on the Darlington Nuclear Refurbishment Project allowed the team to:

- Set and achieve common goals between the vendor partners
- Alignment across leaders on priorities
- Strong communication plans for organizational wide alignment
- Achievements in all four project pillars, Safety, Quality, Cost, and Schedule

#OneTeam THR3E ONE 4OUR

PROCESS OPTIMIZATION

Engineering OneTEAM

Develop one Engineering team to work between organizations to avoid duplication and streamline the process to increase efficiency and turnaround times for Design Packages

Rapid Workshop Implementation will support quick decision making within an IPD model

Design to Execution

Engineering teams prepare for transition from Design to Field Construction. Include all required stakeholders from Construction in the Front end planning and conceptual/ Preliminary Engineering Phases.

Modular Construction Approach

Consider modular approach to the design of construction site plan, and layout to maximize efficiencies for execution Plan for harsh weather conditions.

Engineering Replication

Standardize and implement design replication and complete Design Milestones early in planning to reduce cost

Continuous Improvement - Kaizen

Execute a Kaizen approach to ensure all non-value added activities are eliminated. An example would be enhancements such the off- mock ups that were used in visual representation of installation and welding sequencing for U3 Bulkheads

COMMUNICATION

Effective communication channels to provide updates on project and ongoing work.

Establish dedicated communications team to relay messaging and alignment on upcoming priorites, events, and news features

Leadership Alignment Meeting - Cornerstone

Regular in-person meeting with leadership, focusing on communication to ensure alignment throughout the project, and support teams. The focus of the meeting is on engagement, discussion and progress, rather than tactical action status reporting.

Effective Correspondence across partners

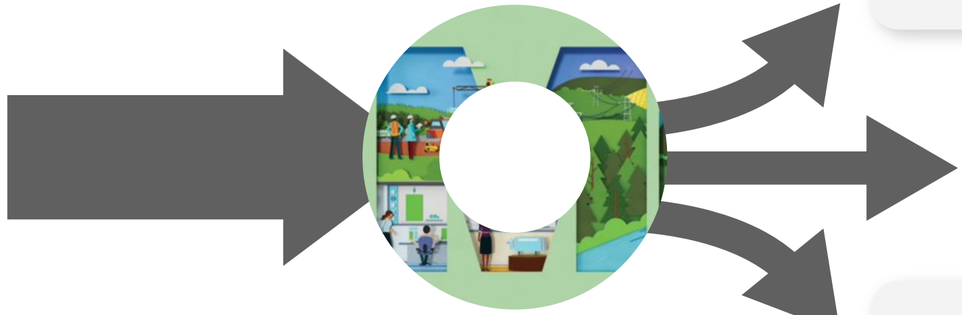
Established frequency for delivery of newsletter, website, and video updates

Digital Strategy Platform

Establish a digital strategy early in the process that all partners will use as a common platform

ALIGN PROJECT STAFF ON IMPROVEMENT INITIATIVES

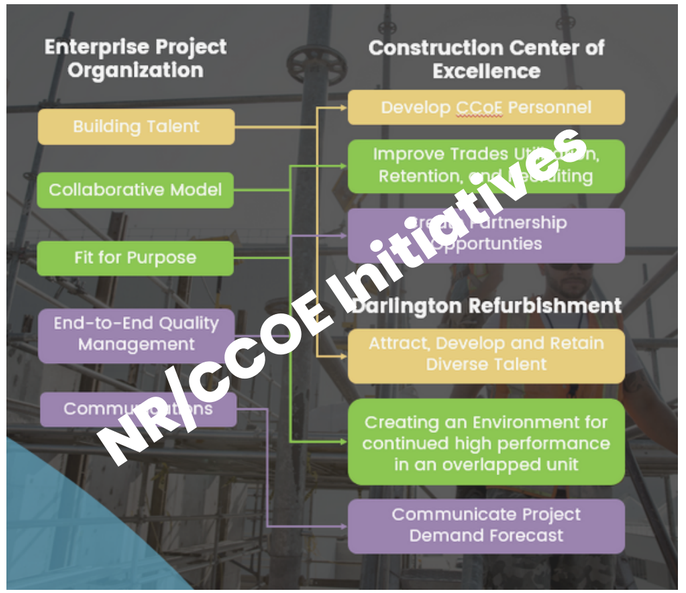
- IPD Leaders
- Engagement Survey
- SMRRB/WANO
- Future M/S
- EPO Alignment
- LL/OPEX
- Staff Input



Our People

Our Project

Our Future



Mega Projects such as the Darlington Nuclear Refurbishment gather staff feedback to determine priorities and get aligned on common initiatives for organizational improvements such as:

- Building a culture to breaking down silos between Vendor Partners
- Improve project performance during forecasted challenges (i.e. Multi-Unit Optimization)
- Develop growth opportunities to ensure sustainability
- Readiness for oversight and project performance reviews

Creation of strategic excellence teams, with effective KPI setting, focusing on improving all aspects of operations, including staff empowerment, project management expertise, and alignment to the corporate vision

DNR Lessons Learned

Programatic

Adopt the best programs to fit the work at hand

- Lessons Learned
- Project Controls
- Planning and Scheduling
- Radiation Protection
- Project Assurance
- Safety & Training
- Quality Management & Construction Oversight

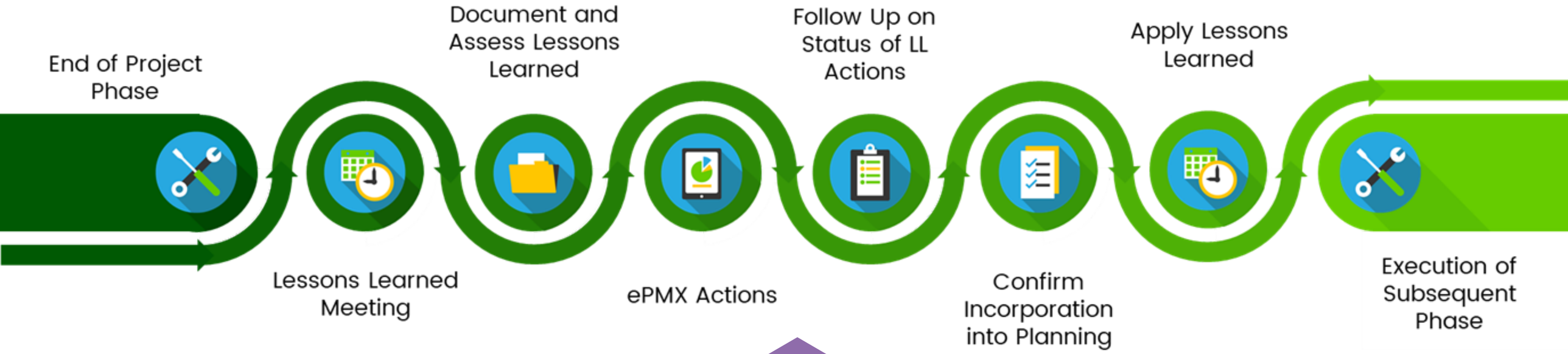
LESSONS LEARNED PROGRAM

- LL program will provide regular & skilled facilitation of meetings, with cross functional teams, to review project performance and opportunities to be implemented into early project planning.
- Identify & eliminate waste to optimize project execution using tools such as LEAN and KAIZEN.
- Strengthen cross functional relationships and integration with the vendors and support centralized reporting.

Improved Performance

Shareholder Value

Enhanced Knowledge & Skills



PROJECT CONTROLS

Expertise in project planning, monitoring, controlling and reporting on project and portfolio performance

Change Control Processing

Simplified change control processing using electronic Change Control Forms to ensure process efficiency while maintaining cost control and clear documentation.

This allows for all project data to be collected from one source system (EBX) and is automatically updated as changes are approved.

Process Estimation

Utilization of an enhanced process based on a maturity matrix modelling (monitoring key deliverables as the estimate matures) with robust tracking of estimate input deliverables and Industry standards from AACE, PMI.

Programmatic Gated Process

Utilization of the Refurbishments Programmatic Gated Process methodology ensures schedules are fully integrated and ready for quality baselines, and cashflows are aligned with risks identified, and performance metrics reported upon.

PLANNING & SCHEDULING

Adequate and efficient management of project resources and progress

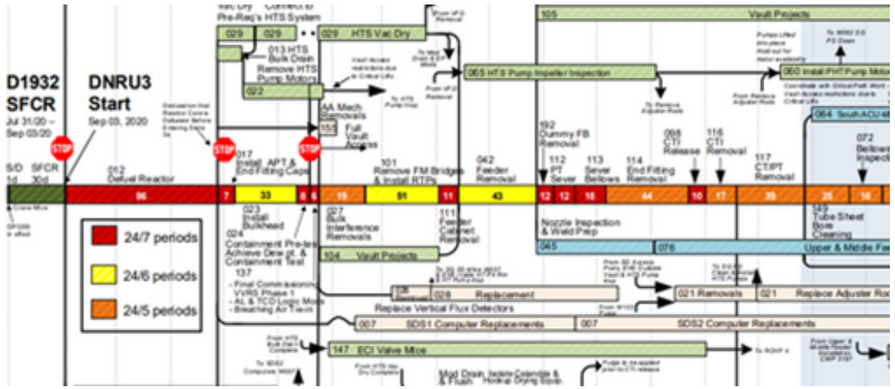


Figure S.1: Hybrid Schedule

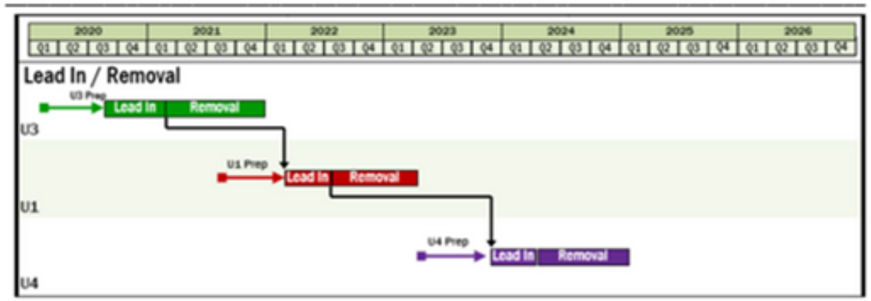


Figure 2: Overlap Schedule - Work Stream Optimization for Lead in and Removal Segments of work

Figure S.2: Specialized Team Allocation

P6 Scheduling Software

The Management of all schedules for OPG and NOP is in one instance of the scheduling software (P6) based on best practices in Refurbishment. This helps optimize costs, identify conflicts, and balance resource utilization

4-D Scheduling

Utilize a 4D model to broadly communicate project progress. 4D schedule was used to interferences and conflicts with different trades and work packages

Hybrid Staff Schedule

Implementation of a hybrid schedule allowed for more productivity and less overtime pay during the Refurbishment project.

Split Shifts

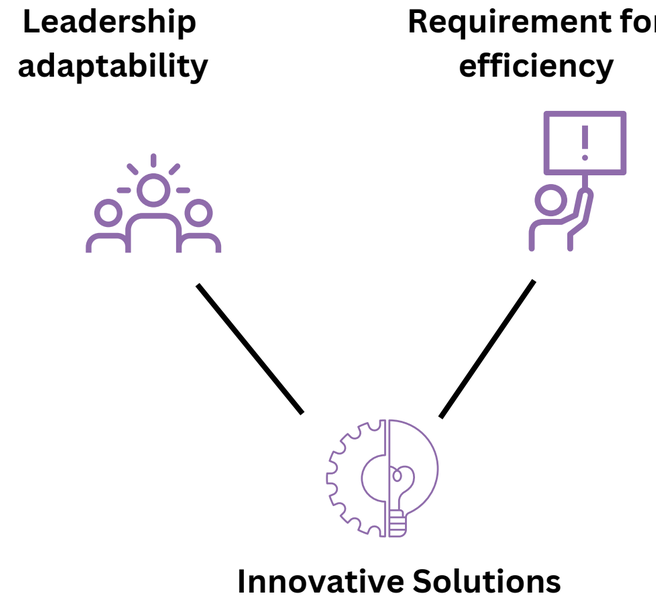
The creation of 4x10 schedule was well received by staff, and can be incorporated in future work

PAPR Innovation

RADIATION PROTECTION INNOVATION CULTURE

Leadership buy-in, and a continous drive to provide innovative systems, helped give rise to the PAPR solution. The implementation has helped drive down dose rates significantly

PAPR qualifications were streamlined by the RP training department such that workers could quickly start training in them for rehearsals and Mock-Up located at the Darlington Energy Complex.



PROJECT ASSURANCE OPEX

A centralized Project Assurance service manages all internal and external oversight activities. This ensures adequate oversight to proactively identify gaps and trends and ensure they are addressed. This results in improved project performance, transparency and readiness for ongoing prudency reviews.

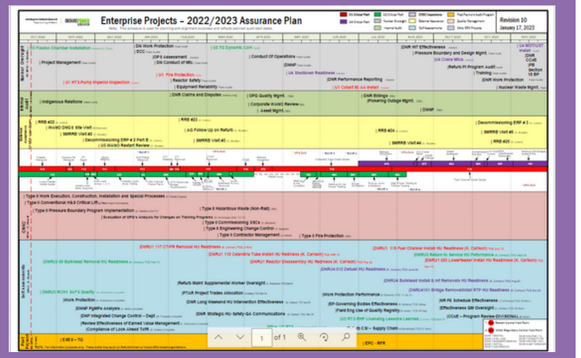


Figure P.1: Assurance Plan

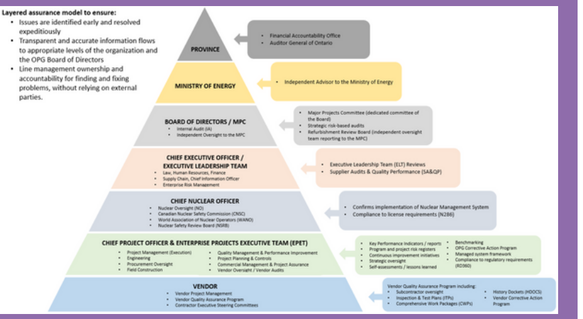


Figure P.2: Oversight Model (Graded Approach)

Audit Integration

Nuclear Oversight and Managed Systems

Ensure clear oversight of management systems governance, specifically the new Nuclear Managed Systems
The following items should be incorporated within the Nuclear Management systems: Graded Approach/ Technological enhancements.

Collaboration Agreements with Utilities

Bruce Power Collaboration
A collaboration agreement between Bruce Power and OPG has helped facilitate OPEX, and Lessons Learned improving Project Performance for Nuclear in the Industry.

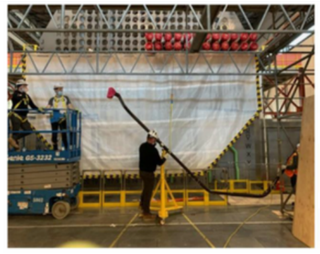
Key Benefits of Assurance

- Transparency to the Board & Shareholders
- Ongoing Collaboration to leverage OPEX and best practices
- Readiness for Prudency Reviews

Bruce Power™ MCR BRUCE POWER MAJOR COMPONENT REPLACEMENT

SAFETY AND TRAINING

Fostering a collaborative, and safe environment ensures teams are pre-dispositioned to achieve success efficiently and event free



LOWER FEEDER TRAINING MOCK UP

Refurbishment Successes

BULKHEAD INSTALL TRAINING JIG

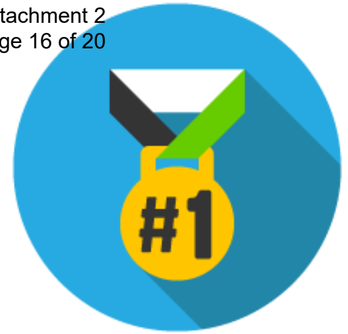
Training Mock up

- Adopt best in class safety practives between vendor partners
- Simulate equipment mockup to increase staff proficiency when performing field work
- Incorporate training with field staff to discover possible efficiencies with tooling and procedural simplification.
- Just-in-Time training and training for proficiency allows for the balancing of resources and skills availability in the labour marketplace and training optimization
- Execute Kaizen sessions to identify non-value-added work and improve cost, and schedule

Safety Implementation Programs

- Falling Objects Prevention Program
- Foreign Material Exclusion Program
- Field oversight by OPG to confirm FME SPOCs are adequately present in field
- Ensure FME materials are adequately stocked and provide help when needed.
- Confirming via observation of PJB that the FME checklists are being used

QUALITY MANAGEMENT & CONSTRUCTION OVERSIGHT



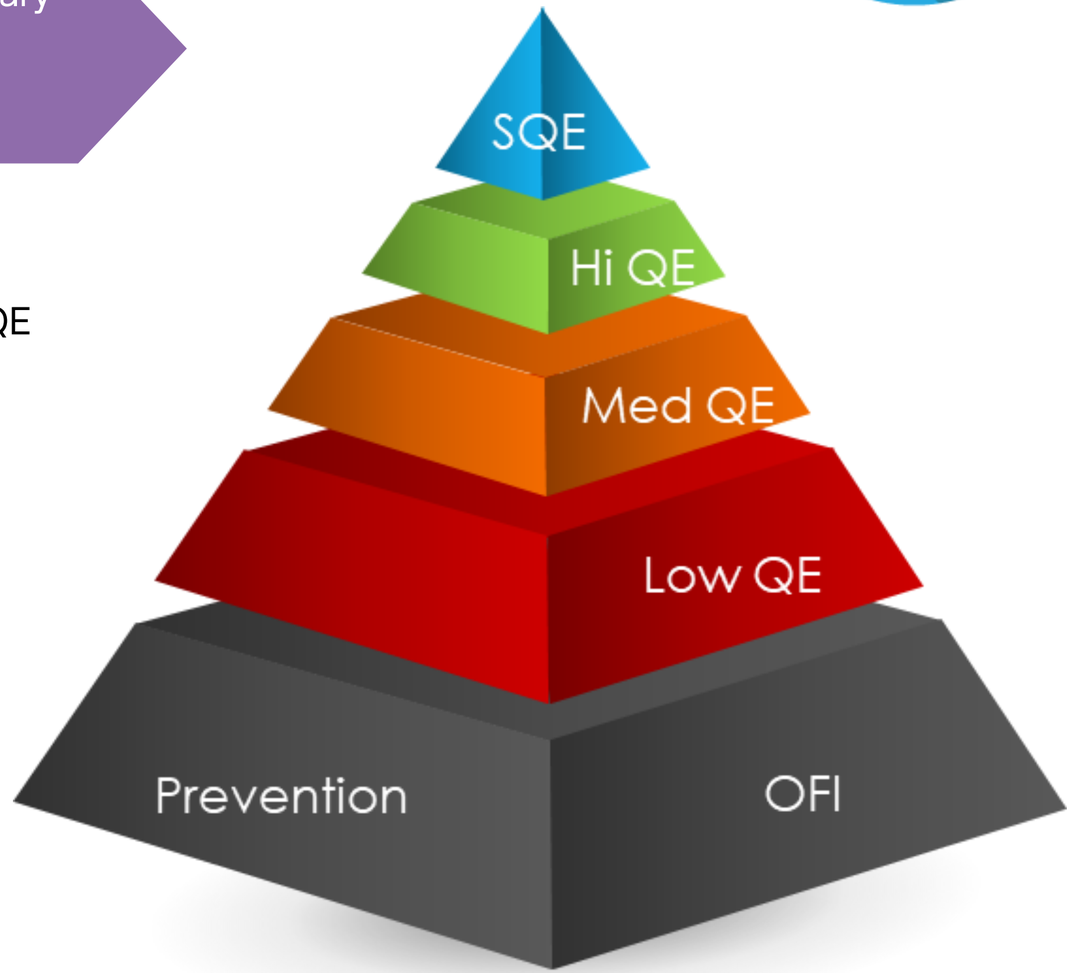
Quality Management provides another layer of defense by conducting secondary checks targeting areas where consequences of failure could have significant impacts to the project.

Use of the quality oversight model resulted in a significant reduction of SQE in the Darlington Refurbishment Project.

The quality program should include:

- Vendor Quality Control/Quality Surveillance teams
- In-process document reviews to confirm compliance with their respective Quality Assurance Program
- Standard quality event criteria/reporting

The quality and oversight support should begin at the early at the design and planning phase to ensure constructability and reduce rework.



Lessons Learned & OPEX

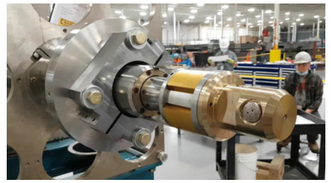
Technical/ Contractual

Best Practices, Technology and Contract implementation

- Tool Improvements & Innovation
- NR Supply Chain End Fitting

TOOLING INNOVATIONS

PT-CT Combined Removal



A combined Pressure Tube (PT) and Calandria Tube (CT) Removal process was developed to effectively remove the PT removal series from critical path in U3 and subsequent units.

MIWT- Multi-Installation Work Table

On Unit 2, and subsequent units, the MIWT was used enabling the team to double the number of toolsets required to install Calandria Tube (CT) and to conduct CTSB conditioning/inspections more swiftly

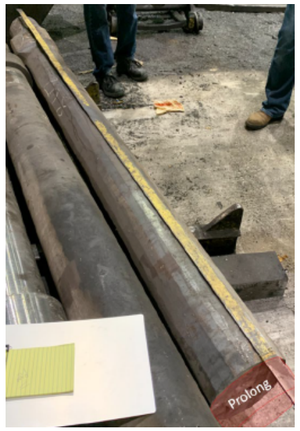
Tooling innovations such as those above were implemented during the Refurbishment phase to deliver savings, and reduce CP duration

Investing in innovations and technology will help advance projects, by creating new pathways to diversify the systems in place and allow for stream optimization

END FITTING LESSONS LEARNED

Problem Statement: Initial end fitting tests did not meet acceptance criteria, including design and fitness for service/defense in depth to support unconditional continued operations

- Develop graded criteria for classification of critical projects and at-risk procurement for all EPO capital projects
- Have governance in place and rolled out for graded criteria for classification of critical projects and at-risk procurement.
- Develop an enhanced process for oversight/ surveillance/ product or service acceptance of critical projects and at-risk procurement. Include oversight of sub-sub suppliers for critical steps, as necessary.
- For critical material purchases ensure the contract requires all test reports to be provided to OPG directly by the testing laboratory.



LESSONS
LEARNED

Benchmarking

Report No	Report#	Status	Last Updated
EP23-000499-BM	Facility: EP	Approved and Closed	

Period From: 2023-01-01
Period To: 2023-03-06

☐ Benchmark has been shared with Site Communications team for possible review in DOM Note

Year: 2023
Entry Date: 2023-03-07
Start Date: 2023-03-06
Target Completion Date: 2023-03-31
Completion Date: 2023-03-31
Time Spent (Hrs): 7

Manager: Herold, Lindsey
Author: VYSKOCIL, Eric
Created By:
Facility: EP
Alert Group / Department: (3410) Project Services
Plan Type: INDUSTRY BEST PRACTICES
Revision Date: 2023-03-31
Rationale for Extension or Status Change:
TCD Extension Approver:

PO & C* (at least one)

PM.1 -- PROJECT MANAGEMENT

References

SCR	A/R Number	Other Ref#

Title/ Activity*

Title

Cost Management Tool Discussion with [redacted]

Applicable Locations

Location/ Contact Description

Meeting was held March 6th, 2023 at 11am - 12pm

Attendees included:
Joe Campa (OPG)
Eric Vyskocil (OPG)
Lindsey Herold (OPG)
[redacted]

Objective/ Scope/ Benefit

[redacted] is an organization with which OPG has had extensive interactions with while developing the Enterprise Project Management Office (EPMO). As an American utility that includes electrical generation and transmission their portfolio of projects is very similar to those at OPG and therefore their project management processes could provide a relevant benchmark against which to measure.

Details/ Discussion/ Best Practices/ Findings

Findings -- click here to open PDF

Recommendations

Mandatory - Document Justification or alternate tracking of actions to be taken

☐ No Action/ Action Tracking Required

Recommendations

No recommendations exist

Actions

No actions, communications of this meeting complete.

Actions - AR

A/R #	AS #	SCR	Due Date	Details

Actions - SCR

SCR: Details

A/R #:

AS #:

Due Date:

Team Members

Full Name
Campa, Joe
VYSKOCIL, Eric
Herold, Lindsey

Team Members (External)

Name

Attachment (50 MB max)	Added On	By

Post Comments

EP23-000499-BM

Findings

Background

[redacted]

[redacted]

Discussion

[redacted] staff assembled a number of questions prior to the meeting concerning OPG's experience implementing and administering a cost management solution for its projects. This included a discussion about the top benefits, key challenges and lessons learned. Additional questions focused on OPG's implementation of Earned Value Management (EVM), change management processes and overall benefits realization from the implementation of project controls tools.

A significant part of the discussion focused on the challenges of obtaining buy-in from all the relevant business organizations and the concessions made by OPG that deviate from international best practices, like the formula for the Cost Variance. [redacted] indicated that they are experiencing similar challenges and different business units have already established certain tools and processes, such as their transmission sector, which have a standard WBS template and use cost loaded schedules in Primavera P6. [redacted] also indicated that another of the challenges they had to overcome related to the technical limitations of assigning a project more than one funding stream (capital or OM&A) and they needed to build a level above that to group projects together when it involved both.

OPG discussed the benefits that it has seen from the implementation of its project controls tools, including the integration of data from various source systems into automated and comprehensive reports. This gives the organization the ability to do data analysis and provide summaries to executive management and external stakeholders that weren't possible before. This makes it difficult to confirm the exact benefits that have been obtained.

Summary

[redacted] lack of an integrated solution for cost management means that it is difficult to obtain much benefit for OPG from these discussions, at the current time. OPG's standardization of processes across its business units is also significantly ahead of [redacted], with all business units using the same tools in the same ways, where [redacted] only has pockets of consistency within certain groups. When [redacted] has implemented its cost management solution it would be useful to benchmark their implementation against that of OPG to determine gaps and areas of potential improvement.

The use of a grouping level above the project number is consistent with OPG's current planned methodology to handle circumstances where projects have both capital and OM&A components.

Therefore, there are no recommendations or actions to be taken as a result of this meeting. Further follow up meetings with [redacted] could be considered to cover other topics.

--EOR-- EP23-000499-BM

Benchmarking

Report No	Report#	Status	Last Updated
EP23-000760-BM	Facility: EP	Approved and Closed	

Period From: 2023-05-30
Period To: 2023-06-14

☐ Benchmark has been shared with Site Communications team for possible review in DOM Note

Year: 2023
Entry Date: 2023-06-14
Start Date: 2023-05-30
Target Completion Date: 2023-06-30
Completion Date: 2023-06-28
Time Spent (Hrs): 16

Manager	Author	Created By
Clark, Brad	Levesque, Richard	

Facility: EP
Alert Group / Department: (3647) DNNP - Ops & Mtnce
Plan Type: INDUSTRY BEST PRACTICES
Revision Date: 2023-06-30
Rationale for Extension or Status Change:
TCD Extension Approver:

PO & C* (at least one)

OE.1 -- OPERATING EXPERIENCE MANAGEMENT (Inactive)

TR.1 -- TRAINING (Inactive)

TR.2 -- CONDUCT OF TRAINING

References

SCR	A/R Number	Other Ref#

Title/ Activity*

Title

Benchmark New Nuclear Training Program - [redacted] Nuclear Operations Training Manager is offering members of the Ontario Power Generation DNNP Training Team an opportunity to benchmark their experiences with building a new plant and new training program and take away key learnings.

Applicable Locations

[redacted]

Location/ Contact Description

[redacted]

Objective/ Scope/ Benefit

Document the findings of the benchmarking performed in a self-assessment along with recommendations for training improvement measures for DNNP.

Details/ Discussion/ Best Practices/ Findings

Findings -- click here to open PDF

Recommendations

Mandatory - Document Justification or alternate tracking of actions to be taken

☐ No Action/ Action Tracking Required

Recommendations

1. Continue to reach out to [redacted] as any new topics and/or questions arise.
2. Future benchmarking opportunities are required for Training lessons learned.
3. Continue to provide oversight throughout the training material development process.
4. Continue to engage the CNSC on licensing examination methodology.
5. Continue to investigate desktop simulator strategy and the cost of multiple simulator licenses.

Actions

1. Involve Fleet Training in Vision implementation. - Implemented as part of the training program
2. Ensure different Training applications communicate between each other. - In progress with Digital Strategies
3. Review staffing plans based upon Staffing models received from [redacted] and other utilities. - Incorporated into the review of the Class III estimate – part of DNNP development (in progress)

Actions - AR

A/R #	AS #	SCR	Due Date	Details

Actions - SCR

SCR:	Details
A/R #:	
AS #:	
Due Date:	

Team Members

Full Name
Henderson, Colin
Clark, Brad

Team Members (External)

Name

Attachment (50 MB max)	Added On	By

Post Comments

Results of this SA will be communicated with the Director, Operations & Maintenance – DNNP and Director Operations Training.

EP23-000760-BM

Findings

Question	Response
What Operating Experiences can you share with us about building a training program from scratch?	Foundation of the program was partnership between [redacted] It's challenging to manage now, 12 years later. Revision of the program in its entirety is required. Early steps should have been taken to review and align the vendors analysis to align to the ACADs more closely. They met the NRC requirement but not the ACADs. The larger fleet was not involved with the site which led to some of the inconsistencies in implementation of their rules and requirements. Existing nuclear and new nuclear was kept separate throughout the process and there was no plan on integrating them into the fleet. Vision was piloted with [redacted] and the rest of the fleet is coming along slowly. Because it was never a consideration early on, there are still challenges. Training program is across many different databases (software interfaces). There was no plan for them to talk to each other. If the fleet all used Vision, there would be significant savings. There would be a business case for full integration into Vision and then transfer it to the other stations in the fleet. Maintenance and Technical programs provided resources which aided in adoption by the larger fleet training organization. Learning station is not being used, so the fleet databases are being used at this time. Looking to use Learning station for continuing training, but they are challenged by their own internal IT issues. All their tests are generated in Vision, they don't take it in Learning Station, paper copies are required.
Which rules (SAT) did you follow? (NRC?, Other?)	Existing plants were based on NRC and ACAD's, including NUREG K&A catalogues used for each PWR and BWR… Worked directly with NRC for specific requirements for the AP1000. NANT and INPO were also contacted for support.
What does your certification plan look like? Duration? CT?	Typically, 18 months initial and 160hrs of CT. They broke their program in half and gave them certified light (9m) to commission and then come back for remainder (9-12m). CT is about 80hrs a year. 24 month program for initial classes after commissioning. First groups during construction had no access to plant, so the initial program was longer. CT hours didn't apply until the staff were in the control room to own the plant. During Commissioning, only refresher training was delivered until they had licenses, they maintained knowledge only and not proficiency. Gap training was included in the refresher as new material was developed. Emergency response procedures were completed and delivered last. This was the biggest gap training requirement, and occurred in the final stages before commercial operation, overall it took 2 weeks to close this gap training segment off.
Continuing Training hours on the simulator?	60-80hrs per year
Do they credit self-learning and peer-to-peer learning?	SSG - JPM is only type they have. SSG is only for continuing training. That would count against their 160 hrs. 6-year cycle backbone and training cycle is 2 years.
Did you have any stumbling blocks with your regulator?	NRC worked very closely from the first licensed class. They co-wrote the first exam with them.
Did you perform your own analysis for all tasks?	The vendor did the analysis.
Did you create all your own training material? Who did? What did the review process look like?	The vendor created the material. It's been updated. Used to look like design docs versus explanation of the system. Feedback wasn't given to the vendor until train the trainer.
Could you share the timeline for staffing numbers and demand? Training staff and plant staff.	All these numbers are Operations - (32 instructors) 16 ops instructors, 3 licensed classes at once, peaked at 40 and then went back to 35. Currently at 25, need closer to 30. 70-80 licensed and 50 non-licensed Massive material updates due to OPEX in the station due to high demand. 6 initial classes 24, 24, 18, 20, 26 Licensed Plant operators from 12-27 class size

Do you have any AR/VR components in your programs? Other technology enhanced learning modules?	Two tools they rely on heavily is the vendor did deliver a full 3D model of the plant. It allowed them to walkdown equipment that hadn't been fully installed yet. No AR/VR. Digital Control room gives them the ability for laptop simulators. Task previews could be done by control room staff. Mouse and keyboard driven simulator. Simulator license is required per laptop and significant costs involved. Ovation based simulator; the vendor built an emulator to reduce costs. They initially explored a site license for it, but they were told that wouldn't work. Full scale simulators have a license transferable and updateable.
Did you use any other technology?	Training building - Outfitted with labs and facilities for students. High-bay lab, control systems lab. There is no 3D scanning/LiDAR of the plant, and it was deemed not required due to the success of using the 3D models provided from the vendor.
What is unique about your training program?	NLO Continuing Training is very plant focused, not classroom. The design was out of necessity to get into the station when systems were turned over with plant engineers.
If you had to do it all over again, what would you do differently?	Vision integration (see above) Task analysis acceptance (see above) Tracking of tasks during testing and startup. Some errors occurred during this stage and they should have had a process to detect and mitigate. Acceptance of material - formal process for review? They would send it to the owner's group for comment and then they would incorporate comments. Only to a certain point in design. For Training Material, updates would be done in house. INPO approves their program not NRC.
Is your LMS integrated with procedures, work management system, etc?	No, the systems are not integrated.
Automated procedures? Who, how is training integrated with it?	Control Room procedures are automated (operator still must perform step) into the plant control systems. The remainder of the procedures are paper based, those not integrated into the control systems.
How are you tracking proficiency for your staff on specific tasks? (Heatmaps?)	Proficiency - Instructors going into the plant for some of the training to incorporate 23-001. Half of CT is in the plant on their own or w/supervisors. Normal continuing training cycle. Sign off on those tasks in the plant. JPE end of year evaluations for NLO.
How are you tracking Crew performance in the simulator?	A couple tools, Simulator trainer will document - crew and individual performance in a narrative log. Scenarios created from OPEX from other stations would be included into the simulator to see how their staff would respond. Scenarios created from events that have happen in the station. There is the ability to re-create the team's response and demonstrate in the simulator. Crew supervision keeps their own records for the crew's proficiency items. Training keeps their own info and reviews this data with the shift leads.
Did you use a Hot License/Cold License at startup?	Cold License early on - NEI 13.06A Hot initial class starts next year. See above.
Challenges with subsequent unit startup during training?	Initial startup testing on [redacted] was pre-core testing. CT was tough to get in during that, so they had to get the operators on the super crews to have less impact on the operators on day and night shift. Two simulators at [redacted] One for IT and the other for CT, to effectively deliver the training segments.
Was gap training required as a result of late engineering changes? How significant was it and how was it handled?	Yes, 2 weeks, see above.
Do they stop training for outages? (do training staff support outages?)	Same model that the fleet does. 18-month outage cycle, IT still happens during outage and CT stops during Outage, half go to the outage and half stay for development.
Continuing Training is 160. Is that the right number?	Likely due to too many tasks not updated to current technology, they would be able to get to 120hrs quite easily.
What does the typical Training day look like?	4 8's or 4 10's if it's a heavy load. For some cases it's 5 8's and 5 10's – commented the operators preferred a 5-day schedule to spread out the learning
How was the Vision integration and what challenges did you overcome?	CIO challenges with Vision integration.
How did you find the learning curve for working in Vision? Intuitive or no?	Yes, intuitive. Smooth transition due to the vendor on board initially.
Are you using the Vision database as the official record?	Vision Database is official record for TTM, JTA. Any student info goes into their records.
Do you use Vision to create tests? How has that experience been?	Yes. But they don't use learning station, so the tests are printouts and results need to be manually entered.
Fueling Engineer Training	Their initial qualification training - not involved, continuing training is supported for proficiency. Unknown at this time what the final continuing training requirement will be.

--EQR-EP23-000760-BM

Benchmarking

Report No	Report#	Status	Last Updated
EP24-000312-BM	Facility: EP	Approved and Closed	

Period From: 2024-04-01
Period To: 2024-04-15

☐ Benchmark has been shared with Site Communications team for possible review in DOM Note

Year: 2024
Entry Date: 2024-02-06
Start Date: 2024-02-05
Target Completion Date: 2024-04-30
Completion Date: 2024-04-15
Time Spent (Hrs): 10

Manager: Elliott, Sarah
Author: Hedges-Chou, Chelsea
Created By:
Facility: EP
Alert Group / Department: (3410) Project Services
Plan Type: EXTERNAL ASSESSMENTS
Revision Date: 2024-04-30
Rationale for Extension or Status Change:
TCD Extension Approver:

PO & C* (at least one)

RM.1 -- INTEGRATED RISK MANAGMENT

References

SCR	A/R Number	Other Ref#

Title/ Activity*

Title

Risk Management Practices for Mega Projects-[redacted]

Applicable Locations

Location/ Contact Description

Objective/ Scope/ Benefit

Details/ Discussion/ Best Practices/ Findings

Recommendations

Mandatory - Document Justification or alternate tracking of actions to be taken

☐ No Action/ Action Tracking Required

Recommendations

1) Carry out a benchmark lessons learned in 1 year to check in on any new lessons learned. Currently all lessons have been incorporated.

2)

3)

...

Actions

1)N/A

2)

3)

...

Actions - AR

A/R #	AS #	SCR	Due Date	Details

Actions - SCR

SCR:	Details
A/R #:	
AS #:	
Due Date:	

Team Members

Full Name

Team Members (External)

Name

Attachment (50 MB max)	Added On	By
OPG [redacted] Lessons Learned Collaboration Meeting Slides.pdf	2024-05-07	ELLIOTSA

Post Comments

OPG [redacted] Lessons Learned Collaboration Meeting

April 15th, 2024

SMR-X Team | Power of Small– SMRs for the Future

OPG

[redacted]

Meeting Purpose/Key Objectives

- Kickstart lessons learned collaboration efforts between OPG and [redacted]nd introduce key team members on both sides.
- Provide an overview of OPG Lessons Learned based on topics of interest identified by[redacted]
- Provide an overview of [redacted]Lessons Learned based on topics of interest identified by OPG.
- Determine next steps and path forward in terms of collaboration.

OPG SMR-X Team

[redacted]

Agenda

- Introductions & Safety Moment (10 mins)
- Lessons Learned Program Overview (5 mins)
- OPG Lessons Learned Topics of Interest (45 mins)
  - Darlington Refurb (10 mins)
  - Early Works (15 mins)
  - Site Establishment (5 mins)
  - Constructability Reviews (10 mins)
  - Q&A (5 mins)
- [redacted] Lessons Learned Topics of Interest (45 mins)
  - Optimized construction processes and programs
  - Project (non-craft) staffing, experience, turnover and loss of key resources
  - Configuration Management and Design Change Control
  - FOAK Risk anticipation and mitigation
  - Procurement Schedule Integration and Alignment (as time permits)
  - Owner Leadership, Roles, Experience and Oversight (as time permits)
  - Q&A
- Path forward and Next Steps (15 mins)

OPG SMR-X Team

[redacted]

Safety Moment: Complacency

Self Satisfaction, especially when accompanied by unawareness of actual dangers or deficiencies

- Complacency is extremely dangerous in the workplace
- We get used to things being “the way they always have been” and underestimate the risks of everyday tasks or become unaware of hazards in our surroundings
- When complacency leads to loss of situational awareness is when incidents occur on day-to-day tasks
- Safety is a **core value**, remaining vigilant is important to creating a safety culture that seeks to eliminate complacency
- We can all work to **build a safer future**

OPG SMR-X Team

[redacted]

OPG Lessons Learned Program

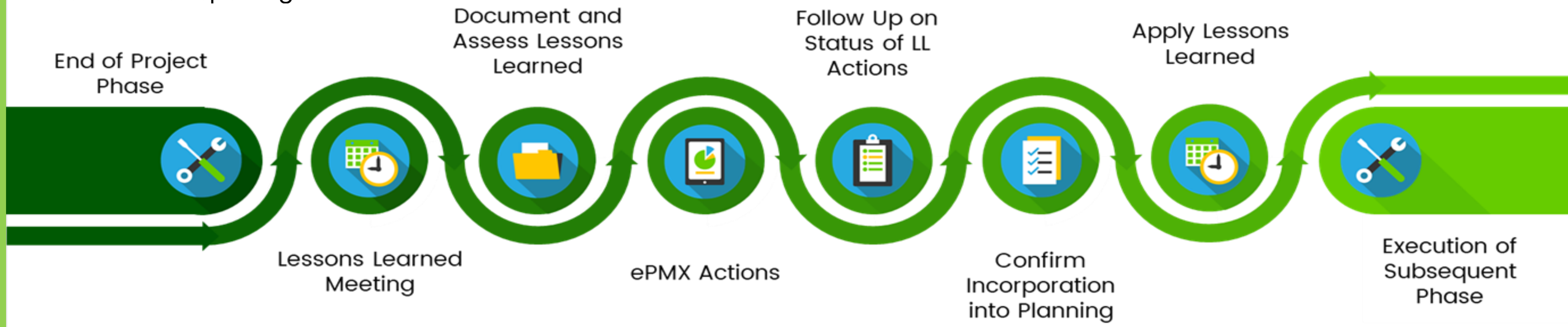
Introduction

- LL program provides regular & skilled facilitation of meetings, with cross functional teams, to review project performance and opportunities to be implemented into early project planning.
- Identify & eliminate waste to optimize project execution using tools such as LEAN and KAIZEN.
- Strengthen cross functional relationships and integration with the vendors and support centralized reporting.

Improved Performance

Shareholder Value

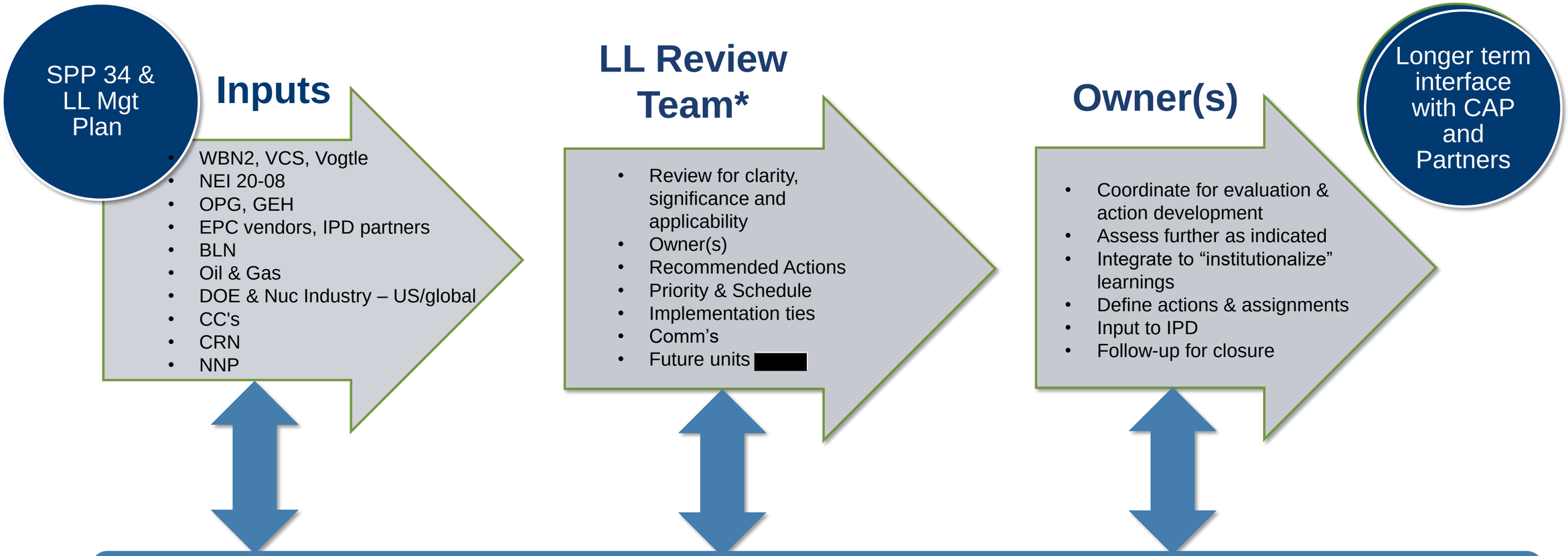
Enhanced Knowledge & Skills



OPG SMR-X Team

[redacted]

[redacted] – Lessons Learned Process Flow



LL Review Team (LLRT) representing key CRN areas:** ***NNP, Licensing, Environmental, Engineering, Construction & Procurement, Project Management, Document Control, Quality

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[redacted]

Lessons Learned SharePoint - [redacted] *Lessons Learned (sharepoint.com)*

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[redacted]

Darlington Refurb Project Controls LLs

Change Control Processing

Simplified change control processing using electronic Change Control Forms to ensure process efficiency while maintaining cost control and clear documentation. This allows for all project data to be collected from one source system (EBX) and is automatically updated as changes are approved.

Process Estimation

Utilization of an enhanced process based on a maturity matrix modelling (monitoring key deliverables as the estimate matures) with robust tracking of estimate input deliverables and Industry standards from AACE, PMI.

Programmatic Gated Process

Utilization of the Refurbishments Programmatic Gated Process methodology ensures schedules are fully integrated and ready for quality baselines, and cashflows are aligned with risks identified, and performance metrics reported upon.

Darlington Refurb Planning and Scheduling LLs

P6 Scheduling Software

The Management of all schedules for OPG and NOP is in one instance of the scheduling software (P6) based on best practices in Refurbishment. This helps optimize costs, identify conflicts, and balance resource utilization.

4-D Scheduling

Utilize a 4D model to broadly communicate project progress. 4D schedule was used to interferences and conflicts with different trades and work packages.

Hybrid Staff Schedule

Implementation of a hybrid schedule allowed for more productivity and less overtime pay during the Refurbishment project.

Split Shifts

The creation of 4x10 schedule was well received by staff and can be incorporated in future work.

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Darlington Refurb Process Optimization LLs

Engineering One Team

Develop one Engineering team to work between organizations to avoid duplication and streamline the process to increase efficiency and turnaround times for Design Packages

Design to Execution

Engineering teams prepare for transition from Design to Field Construction. Include all required stakeholders from Construction in the Front-end planning and conceptual/ Preliminary Engineering Phases.

Modular Construction Approach

Consider modular approach to the design of construction site plan, and layout to maximize efficiencies for execution Plan for harsh weather conditions.

Engineering Replication

Standardize and implement design replication and complete Design Milestones early in planning to reduce cost.

Darlington Refurb Communication LLs

Leadership Alignment Meeting - Cornerstone

Regular in-person meeting with leadership, focusing on communication to ensure alignment throughout the project, and support teams. The focus of the meeting is on engagement, discussion and progress, rather than tactical action status reporting.

Effective Correspondence across Partners

Established frequency for delivery of newsletter, website, and video updates.

Digital Strategy Platform

Establish a digital strategy early in the process that all partners will use as a common platform.

[redacted]

Early Works Lessons Learned (Planning)

During early scoping, the full project scope/footprint should be considered for the purposes of site planning and environmental permits to ensure strategic decisions are made and long lead permits are considered.

Note: For DNNP funding had only been released for the first unit so adequate planning for the full fleet had not been advanced.

Aerial view of the DNNP site – Early Works Project

Early Works Lessons Learned (Planning)

- Capturing all geotechnical and topographical information as early as possible and in advance of issuing a contract for design/construction. This includes a full-site topographic survey and an investigative subsurface investigation.

- Additionally, it is best that all geotechnical work be included within the same design/construction contract, as it provides more visibility on the overall site requirements.

- There are pros and cons pursuing a licence to prepare the site prior to design and technology selection using bounding parameters (nonspecific to chosen technology). While the overall licensing risk is reduced/eliminated, it also creates re-work to verify assumptions and quantify specific impacts to the environment as planning progresses. Follow up public hearings were also required.

Early Works Lessons Learned (Permits)

- 'Just in time' design (prior to execution) has resulted in insufficient time to adequately consult with first nations on necessary environmental permits. It also puts pressure on regulatory agencies to issue new permits and/or permit revisions on aggressive timelines in order to move forward with construction as designs become available.

- An emphasis needs to be place on early (pre-design) consultation with first nations and working with the regulatory agencies to streamline permitting process.

- Long lead permits, including the Endangered Species Act (ESA) permit requires very detailed information on the planned works in order to adequately assess the impact to species.

- The DNNP, this information was not available at the time the application would have been required to be submitted in order to meet the regulatory agency's expectations for permit review and approval.

Early Works Lessons Learned (Permits)

- There was a lack of visibility in terms of the division of roles and responsibilities when it came to the preparation and application of the various permits. A central permitting coordinator was later hired onto the project team to coordinate and streamline the process.

- First-of-a-Kind (FOAK) permits, such as the stormwater permit, was not built in the schedule early enough to manage stakeholder comments, first nation consultation, design changes, preparatory permit activities and adequate agency review times.

Early Works Lessons Learned (Other)

- Project should consider scheduling hold-points to re-define, amend and add details to the milestones. Vendor should communicate milestones to sub-vendors and hold challenge meetings to discuss feasibility of achieving milestones and milestone recovery plans.

- Swelling factor of excavated soil was underestimated in initial projections for site grading scope. Rigorous validation efforts were undertaken in early stages of site grading which allowed for sufficient time to take corrective actions.

Site Establishment Lessons Learned

- SE scope includes Design, Procurement, and Construction of Buildings (Admin., Warehouse, Fab Shop, pre-Assembly), Utilities (Domestic/Fire Water, Sanitary/Sewage System, PA/LAN/Telephone), Stormwater Management, Construction and Permanent Power, Earthworks and Roads.

- Initial scope/Work Breakdown Structure (WBS) should be defined in more details and the basis and assumptions behind the cost and schedule estimates should be clearly outlined.

- There has been a few scope transfers within the DNNP program and between bundles/ areas (updates in WBS) aimed at getting the site prepared and ready for the main phase of execution. Understanding the funding associated with the different sub-scopes and schedule alignment with other projects in progress has been a time-consuming endeavor.

Site Establishment Lessons Learned

- The SMR-X Project is FOAK, and the design is in progress as we start the early construction activities. The continuous evolution of the design has resulted in the project having to revisit the scope on an on-going basis. This often impacts the project timelines and costs as well as project interfaces.

- There has been a fairly high turnover in terms of key resources that were supporting the early phases of the execution activities – resulting in knowledge gaps. It is key to ensure that there is ample cover for critical resources and projects such that any potential knowledge gaps can be minimized.

Constructability Reviews Lessons Learned

- OPG has been conducting constructability reviews on DNNP early in the design phase, particularly focusing on the reactor building excavation and construction phases. These reviews have been helping inform design decisions and optimizing constructability.

- Key constructability method for the reactor building construction being explored is the Diaphragm Plate Steel Composite (DPSC). This composite material will offer enhanced structural strength, corrosion resistance and durability.

- DPSC's superior load-bearing capability will help support the massive reactor weight and will ensure the structural integrity of the building.

- The corrosion-resistance properties will be crucial in environments where ground or soil conditions may accelerate corrosion, as is the case in the DNNP site.

Constructability Reviews Lessons Learned

- Reactor Building excavation presents unique challenges due to the stringent safety and regulatory requirements in place.

- Careful execution and planning are required to ensure surrounding soil and groundwater integrity and to minimize environmental impact.

- DNNP team is considering specialized techniques, such as deepwater excavation shoring systems and groundwater control measures (dewatering techniques) to maintain stability and minimize construction risks.

- Upon excavation being complete, reactor building construction will begin and will adhere to strict quality controls and standards. Use of advanced materials and construction techniques, like DPSC, will ensure structural integrity, safety and longevity of buildings.

Constructability Reviews Lessons Learned

- Key construction considerations for the reactor building by the OPG team include, but is not limited to:
  - Reinforced Concrete Structure
  - Reactor Containment and Shielding
  - Reactor Vessel Support
  - Seismic Design
  - I&C, Ventilation and HVAC Systems
  - Fire Protection
  - QA and Regulatory Compliance

OPG HIGH PRIORITY LL SHARING/DISCUSSION REQUESTS – [redacted]

1. Optimized construction processes and programs
2. Project (non-craft) staffing, experience, turnover and loss of key resources
3. Configuration management and design change control
4. FOAK risk anticipation and mitigation – design risk reduction
5. Procurement schedule integration and alignment (as time permits)
6. Owner leadership, roles, experience and oversight (as time permits)

[redacted]

OPG SMR-X Team

Key Lessons Learned Topics from Large Recent Nuclear Construction Projects

Optimized and integrated construction project processes and programs

Issue:

- Enterprise or operating processes are not always efficient or necessary for large construction projects – can lead to unnecessary impacts and large time delays
- Construction project organizations, functions and activities scopes differ from operating counterparts affecting applicability
- Local decision-making needed for speed and agility
- Separate/different processes among partners can create conflicts, limit visibility and reduce scope control
- Integrated IPD processes and tools must be based on roles and efficiency but also support Owner programs
- Build in back of project transition to operating processes

Actions:

- Review enterprise/operating programs and processes for construction efficiency
- Benchmark effective construction processes from prior projects, e.g., [redacted]
- Incorporate process/program integration within IPD partner contracts and team planning efforts
- Integrate with Digital Strategy development
- Establish prioritized implementation
- Develop plan for operational transition at back end of project

[redacted]

Key Lessons Learned Topics from Large Recent Nuclear Construction Projects

Project staffing, turnover and loss of key resources (non-craft)

Issue:

- Assignment of lower performing or less experienced personnel by partners
- Partners' inability to staff critical positions
- Loss of critical personnel due to heavy industry demand, e.g., field engineers, schedulers, field supervisors, production/area managers
- Obtaining and retaining nuclear-experienced staffing

Actions:

- Establish experience and performance min requirements within partners contracts
- Define critical positions staffing and pipeline
- Establish retention program
- Establish succession planning
- Owner "carve-outs"
- Owner intrusiveness into nuclear skills proficiency training and/or qualifications
- Seconding into organization to meet needs

[redacted]

Key Lessons Learned Topics from Large Recent Nuclear Construction Projects

Configuration management and design change control weaknesses led to construction impacts and schedule delays

Issue:

- Rush to get design to field didn't adequately track issuances against design
- FOAK causes very high level of needed field changes
- Intensive effort to keep up with changes – approve, document, rollup, clear to field
- Knowing "trumping" design and validating execution level
- Field issues, input from FOAK and CAP allowed high level of design changes with limited oversight – lack of scope control
- Multiple organizations and vendors as well as backlogs complicated control
- Delayed documentation and closure to verify correct configuration and execution

Actions:

- Review LL with IPD team
- Establish process controls preventing issue of design until constructability walkdowns are completed and open items resolved – minimize field changes to extent possible
- Review adequacy of engineering and construction related programs, processes and tools to mitigate – limit number of changes without rollup, control backlogs
- Establish appropriate control points for requested changes – scope control, change bases criteria, approvals
- Employ 3D model or other smart tools to both expedite and track and close out in real time

[redacted]

Key Lessons Learned Topics from Large Recent Nuclear Construction Projects

FOAK risk anticipation and mitigation – design risk reduction, change control, growth assumptions, licensing impacts

Issue:

- FOAK implications were not understood and not sufficiently factored into cost or schedule
- FOAK elements add to cost, schedule and risk – should be avoided unless large clear advantage, planned mitigation where applied
- Extrapolations of prior's are often inaccurate – need to be chosen wisely
- FOAK applies to all elements of project, i.e., technology, design, licensing, contracting structure, construction techniques, vendors, etc.
- Growth, contingency and float were not sufficiently assumed
- Lessons learned from FOAK perturbated next of a kind scope, cost and schedule

Actions:

- Review [redacted] elements and impacts with IPD team
- Review all BWRX-300 FOAK elements to identify and mitigate risks – more than engineering, active risk management
- Establish clear change control and criteria to limit perturbations to scope, cost and schedule – from early FOAK LL
- Incorporate scope growth potential into cost and schedule "float", growth and risks, element by element
- Incorporate sufficient constructability and operational/maintenance reviews into FOAK design elements

[redacted]

Key Lessons Learned Topics from Large Recent Nuclear Construction Projects

Constructability of design

Issue:

- Constructability not sufficiently factored into design approach, cost or schedule – engineers often lack experience to properly consider
- Design not aligned with construction technique capabilities, access or congestion
- No or late WP planning walkdowns leading to aborted execution and/or field changes – drives need for high levels of field engineering
- Offsite module construction resulted in quality and tolerance issues impacting site constructability
- Insufficient onsite design support to address constructability issues in timely manner
- Inefficient or weak change processes leading to delays and downstream configuration management issues

Actions:

- Review lessons learned from [redacted] with GEH and IPD partners
- Perform detailed constructability reviews during design to optimize design, validate cost and schedule, and reduce challenges and impacts at each stage.
- Provide sufficient tolerances for fit-ups, conservatism for margin management. Utilize 3D model.
- Conduct sufficient and early vendor oversight to ensure quality conformance
- Schedule early WP constructability walkdowns in advance of WP schedule
- Ensure sufficient field engineering and onsite design support is included in validation estimate for rapid resolution of issues.

[redacted]

Key Lessons Learned Topics from Large Recent Nuclear Construction Projects

Procurement Schedule & Integration

Issues:

- Lack of schedule integration alignment led to long delays and low productivity
- Late WP planning identified material needs non-supportive of schedule
- Module quality and delivery schedules caused very large delays and inefficient work-arounds
- DCAF – design change impacts on fabrication and procurement
- Fragmented ownership and management of related procurement elements
- Construction sequence changes misaligned procurement plan
- Just in time procurement didn't provide sufficient flexibility for workable backlog to maintain productivity
- Receipt inspections delayed or accepted receipts with deficiencies – large backlogs
- Emergent or late design/changes challenged procurements
- Commercial grade dedication resources not aligned with demand

Actions:

- Review LL details with IPD team members
- Establish appropriate [redacted] role in support of IPD partner arrangement for procurement coordination and integration
- Exercise care and utilize established vendors for offsite module fabrication – implement intrusive oversight for early quality issue detection
- Establish comprehensive impact review process with full IPD partner involvement for modifying construction sequence

OPG SMR-X Team

[redacted]

Key Lessons Learned Topics from Large Recent Nuclear Construction Projects

Owner leadership, roles, experience and oversight

Issues:

- Owner lack of large nuclear construction experience contributed to inappropriate extrapolation, inappropriate strategies, and weak project management
- Misapplied Owner roles had negative impacts, e.g., insufficient Owner oversight role, passive Owner role, and insufficient owner intrusiveness; ties to contractual structures, and incentives
- Late, misapplied and/or insufficient Owner intervention in performance
- Owner changes in construction sequence created large inefficiencies
- Insufficient scope and transparency of metrics for appropriate Owner control and oversight
- Owner incremental interface assistance vs early intrusive integration delayed needed improvements, e.g., workforce nuclear skill proficiencies

Actions:

- Ensure sufficient nuclear construction experience in Owner leadership team
- Develop effective project team structure with aligned objectives, risks/rewards and required proficiencies
- Detail owner leadership role in IPD team development and clarify roles and interfaces through Project Execution Plan (PEP)
- Create project team endorsed execution strategy that promotes effectiveness and efficiency supporting project requirements performance criteria
- Establish framework for early integration and escalation for performance gaps – “carve outs”, seconding experience, integration vs interface
- Establish detailed framework for governance and oversight

Q&A

OPG SMR-X Team

[redacted]

Path Forward & Next Steps

OPG SMR-X Team

[redacted]

Thank you.

OPG

SMR-X Team

[redacted]

Benchmarking

Report No	Report# Facility:	Status	Last Updated
EP24-000318-BM	EP	Approved and Closed	

Period From: 2024-01-10
Period To: 2024-01-10

☐ Benchmark has been shared with Site Communications team for possible review in DOM Note

Year: 2024
Entry Date: 2024-02-06
Start Date: 2024-01-08
Target Completion Date: 2024-03-15
Completion Date: 2024-03-11
Time Spent (Hrs): 12

Manager: Popovic, Dragan
Author: Hedges-Chou, Chelsea
Created By:
Facility: EP
Alert Group / Department: (3648) DNNP - Project Support
Plan Type: INDUSTRY MEETING
Revision Date: 2024-03-15
Rationale for Extension or Status Change:
TCD Extension Approver:

PO & C* (at least one)

PM.1 -- PROJECT MANAGEMENT

References

SCR	A/R Number	Other Ref#

Title/ Activity*

Title

INPO New Nuclear Advisory – [redacted] Lessons Learned

Applicable Locations

Location/ Contact Description

INPO New Nuclear Advisory Roundtable Attendee: Dragan Popovic

Project Integration Team:
- Carol Lam (OPG)
- Chad Holby (GEH)
- Gabe Tsang (Aecon)
- LeAnne Bock (AtkinsRealis)

Lessons Learned SPOCs:
- Prashant Megnath (OPG)
- Lindsay Wilkinson (GEH)

Objective/ Scope/ Benefit

The obejective of this Benchmark is to gain nuclear new build lessons learned from [redacted] and apply the applicable items to the Darlington New Nuclear Project (DNNP).

The Benchmark was conducted at the INPO New Nuclear Advisory Roundtable in Atlanta, GA on January 10, 2024, by Dragan Popovic (SVP). A presentation was shared during the roundtable, including open discussions.

The lessons learned that were shared focused on 2 aspects: 1) Strategic Lessons Learned; and 2) Delivery Lessons Learned. These are discussed in the Details/Discussions/Best Practices/Findings section of this report.

Details/ Discussion/ Best Practices/ Findings

Findings -- click here to open PDF

Recommendations

Mandatory - Document Justification or alternate tracking of actions to be taken

☐ No Action/ Action Tracking Required

Recommendations

1) Capture lessons in ePMX for completeness and tracking.

2) Review lessons learned for application to the DNNP.

3) Share these lessons across the Project Management Teams (PMTs).

Actions

1) Capture lessons in ePMX for tracking and future reference.
Owner: Carol Lam
Status: Complete.
ePMX: LL ID# 13577 & 13578 created to capture these lessons.

2) Review lessons for applicability to DNNP and take action to incorporate applicable lessons.
Owner: Project Integration Team
TCD: 31-Mar-2024

3) Share these lessons and action plan with the SMR-X PMT members (including Construction) and Area Leads for awareness.
Owner: Project Integration Team
TCD: 31-Mar-2024

Actions - AR

A/R #	AS #	SCR	Due Date	Details

Actions - SCR

SCR:	Details
A/R #:	
AS #:	
Due Date:	

Team Members

Full Name
Lam, Carol

Team Members (External)

Name

Attachment (50 MB max)	Added On	By

Post Comments

EP24-000318-BM

Findings

The following **Strategic** Lessons Learned from [redacted] were shared at the INPO New Nuclear Advisory Roundtable in Atlanta, GA on Janaury 10, 2024:
> Maintaining Public Trust and Confidence is Essential
> Demonstrate Proactive/Intrusive Owner Management & Oversight
> Stakeholder Management: Interface vs. Integration
> Establish and Demonstrate Organizational Resilience
> Nuclear Development Demands Innovative Contract and Commercial Strategy
> You WILL underestimate FOAK, NOAK and Unique Project Risks

The following **Delivery** Lessons Learned were shared from [redacted] at the INPO New Nuclear Advisory Roundtable in Atlanta, GA on January 10, 2024:
> Select modular construction fabricators with proven success
> Develop a Construction Spare Parts list - it is equally as important as standard testing and operating spare parts list from OEM
> Ensure owner/operator has clear ability to assess and correct quality programs and execution for all programs being utilized
> Utilize a Common Corrective Action Program (Integration vs. Interface)
> Work packages must be built and sized where they can be completed, signed and closed with the work

The above have been entered into ePMX as LL ID: 13577 & 13578 respectively.

--EOR-- EP24-000318-BM

Benchmarking

Report No	Report#	Status	Last Updated
NO23-000064-BM	Facility: NO	Approved and Closed	

Period From	Period To
2022-11-23	2022-11-25

☐ Benchmark has been shared with Site Communications team for possible review in DOM Note

Year: 2023
Entry Date: 2022-10-20
Start Date: 2022-09-05
Target Completion Date: 2023-02-17
Completion Date: 2023-02-02
Time Spent (Hrs): 100

Manager	Author	Created By
Herrera, Paulina	CAREY, Ryan	

Facility: NO
Alert Group / Department: (193) ENGINEERING
Plan Type: INDUSTRY BEST PRACTICES

Revision Date	Rationale for Extension or Status Change
2023-02-17	

TCD Extension Approver:

PO & C* (at least one)

OR.3 -- MANAGEMENT SYSTEMS (Inactive)

References

SCR	A/R Number	Other Ref#
	28257390	

Title/ Activity*

Title

[redacted]

Applicable Locations

Location/ Contact Description

Objective/ Scope/ Benefit

Purpose
The Purpose of this Benchmark was to compare and contrast the current DNNP processes and functions against [redacted] executing a similar mega-project. The goal was to identify key areas where there are gaps and/or opportunities for improvement so that actions can be taken to enhance the delivery of project. This will allow the OPG team to adapt industry best practices which is especially important for the First of a kind (FOAK) BWRX-300 project.

Topic Areas
The following were the main topics areas for the benchmark

• Engineering Oversight in Design
• Engineering Oversight in Construction

Scope
Items/areas that were assessed:
• Design process overview and implications to oversight
• Application of Quality Assurance
• Oversight program objectives, requirements, and application
• Frequency and format of formal design reviews (e.g., technical review meetings)
• Graded-approach methodology
• Contractor Owner Interface Requirements (COIR) and documentation of accountabilities
• Oversight performance tracking and applicable metrics
• Lessons Learned and Objectives
• Risk Identification and Mitigation processes
The intent was to evaluate the oversight processes and activities being implemented on the [redacted] mega-project to identify opportunities for improving efficiency and effectiveness in oversight on the Darlington New Nuclear Project 1 (DNNP1).

Details/ Discussion/ Best Practices/ Findings

Findings -- click here to open PDF

Recommendations

Mandatory - Document Justification or alternate tracking of actions to be taken

☐ No Action/ Action Tracking Required

Recommendations

1) See actions.
...

Actions

1. Updates to Documentation/Governance (28257390-01):
a. Review Supply Chain QA audit plans and scope to identify potential overlap with currently planned engineering oversight activities. Where duplicates are identified, revise affected documents to eliminate duplicates and drive efficient use of resources.
b. Update applicable documentation to clearly identify formal reviews to be completed prior to receiving final signed and sealed engineering deliverables. Consider identifying this as a "Hold Point".
c. Revise OPG Oversight Plan to remove reviews at 50% of each phase and hold reviews at the end of each phase.
d. Assess with partners, feasibility of incorporating submittal of QA certification statements as part of phase design package formal submittals. If feasible, revise applicable documentation to reflect this requirement.

2. Identify and communicate to applicable SPOC, key aspects of E-Builder that would be beneficial if implemented in Aconex (28257390-02). Items to consider:
a. Comment classification built into Aconex.
b. Review Plans to be captured in the system including type of review (sufficiency, detailed, quality, etc), lead OE, stakeholders required by name, etc.
c. Explore possibility of automated notifications and reminders for identified individuals supporting stakeholder reviews.
d. Common Issues Tracking for all partners on Aconex.

3. Establish internal guidance & training for OEs and applicable stakeholders including (28257390-03):
a. Provide further clarity on roles and responsibilities of OEs including guidelines for scope of technical reviews
b. Develop and communicate guidelines for comment classification
c. Identify critical GEH/SNC programmatic documents that OEs need to be familiar with to effectively conduct their role
d. Awareness of contractual model and commercial bounds OE roles.
e. Rollout of Owners Requirements to Engineering team, including how to identify where/how Owner Requirements have been addressed for individual systems.
f. Consider implementation of more focused identification of risks, with smaller groups, potentially leveraging existing touchpoints. Communicate any identified improvements to appropriate stakeholders for implementation.

...

Actions - AR

A/R #	AS #	SCR	Due Date	Details

Actions - SCR

SCR: Details

A/R #:

AS #:

Due Date:

Team Members

Full Name
CAREY, Ryan
Herrera, Paulina
Tenjak, Jonathan
Rahman, Shahzaib
Huffman, Lucas

Team Members (External)

Name

Attachment (50 MB max)	Added On	By

Post Comments

NO23-000064-BM

Findings

1.0 OVERVIEW

1.1 Objective/Purpose

The Purpose of this Benchmark was to compare and contrast the current DNNP processes and functions against [redacted], executing a similar mega-project. The goal was to identify key areas where there are gaps and/or opportunities for improvement so that actions can be taken to enhance the delivery of project. This will allow the OPG team to adapt industry best practices which is especially important for the First of a kind (FOAK) BWRX-300 project.

1.2 Topic Areas

The following were the main topics areas for the benchmark

- Engineering Oversight in Design
- Engineering Oversight in Construction

1.3 Scope

Items/areas that were assessed:

- Design process overview and implications to oversight
- Application of Quality Assurance
- Oversight program objectives, requirements, and application
- Frequency and format of formal design reviews (e.g., technical review meetings)
- Graded-approach methodology
- Contractor Owner Interface Requirements (COIR) and documentation of accountabilities
- Oversight performance tracking and applicable metrics
- Lessons Learned and Objectives
- Risk Identification and Mitigation processes

The intent was to evaluate the oversight processes and activities being implemented on the [redacted] to identify opportunities for improving efficiency and effectiveness in oversight on the Darlington New Nuclear Project 1 (DNNP1).

2.0 BENCHMARK PARTNER JUSTIFICATION

The [redacted] is another mega project that would have faced similar obstacles with respect to Oversight that DNNP1 is facing. The DNNP1 and [redacted] projects are similar in the sense that they both have a large scope that would require application of a graded approach to oversight based on safety significance of the various aspects of design. Both projects also involve multiple partners with their own respective QA programs that could impact how oversight is applied, design outputs, and management of interfaces.

Benchmarking of how Engineering Oversight is being executed on the [redacted] project will allow DNNP (Darlington New Nuclear Project) Owners Engineers to understand how oversight is applied on a project that is not a nuclear project but have a high safety significance and involvement of a regulatory party. The intent of the benchmarking session was to identify alternative approaches to performing oversight in other regulated industries to improve effectiveness and efficiency in oversight.

3.0 STRATEGY

3.1 Progress Measures

Due to the nature of engineering oversight activities, distinct measures are difficult to quantify. Directly measurable effects on downstream design and execution activities are difficult to identify. Therefore, the success criteria and quality metrics will be based on improvements to OPGs (Ontario Power Generation) processes following the benchmarking activities. Benchmarking is successful in two situations: 1) findings and feedback confirm that DNNP approach to oversight is consistent with industry best practice and methods applied on [redacted] project, or 2) Significant improvements are found which are then incorporated into engineering oversight plans and improve quality of engineering oversight for DNNP. A list of outputs and activities from the benchmarking is included below:

- Revisions to engineering oversight plans/ confirmation of appropriate oversight applied on a mega-project.
- Preparation of a project execution plan for engineering interfaces and handoffs.
- Documentation of benchmarking results in OCRSA database.
- Rollout of key benchmarking findings to the engineering and projects organizations.

3.2 Methodology

Information regarding benchmarking was extracted in several different ways.

Namely:

- Question and answer sessions with knowledgeable staff (split between oversight of design and construction)
- Review of oversight plans and documentation (as provided by [redacted]).
- Field walk-down of construction site and recording of observations.

This list is not exhaustive and additional opportunities to improve the methodology or add specific activities arose from discussions with [redacted].

3.3 Detailed Benchmark Topics

The following is a list of preliminary questions prepared by OPG to facilitate discussion and gather information (additional questions arose during the visit):

1. High level overview of the design process and implementation of oversight on that process, to help understand what, if any, parallels we can draw to implementation of oversight on the DNNP project?
2. How does the oversight organization determine what level of change in the field requires a re-sealing of a design document and re-review by the owner prior to proceeding?
3. How has the oversight organization decided on what deliverables to review as part of the oversight program?
4. How is “acceptance” of design deliverables documented prior to final turnover to the Owner?
5. Is a graded approach to oversight being applied (e.g., in design reviews, through strategic oversight, or otherwise)? How are high priority items vs low priority items for review determined?
6. Are additional elements of rigor being applied through oversight (e.g., third party reviews, etc.)? If so, how is it determined where to apply those additional elements?
7. What, if any, are the strategic oversight activities being implemented, other than document reviews only? Is there a focus on adherence to QA programs and processes?
8. What frequency are oversight engineers engaging with designers in a formal/informal capacity? How does that tie to the design process?
9. How is feedback captured and communicated to the vendor? How are interfaces and accountabilities between the [redacted] and various project partners documented and managed?
10. With multiple design agencies, whose QA program is being followed? If multiple QA programs are being applied, how is integration of the programs managed? What, if

any, are the implications to oversight?

11. Any additional information or lessons learned related to Engineering Oversight?

12. How is risk managed and coordinated for multiple parties?

13. How are interfaces between design agencies managed and tracked for changes to the interface point?

4.0 DISCUSSION & FINDINGS

4.1 Project Overview

4.1.1 Key project details and stakeholders

[redacted]

4.1.2 Project Delivery Models

[redacted] utilized the “Public-Private Partnership” or “P3” model. The BWRX-300 project will utilize the “Integrated Project Delivery” (IPD) model. It is important to understand the similarities and difference to determine what information is applicable and useful for the Benchmark.

4.1.3 Public Private Partnerships (“P3”)

Public-private projects — also known as P3 projects — get to reap the benefits of both public and private projects. As their name suggests, the project is the result of a partnership between a private and a public entity.

Projects like affordable housing and infrastructure are often the result of these types of agreements. Like private projects, they are controlled by a private company which helps create efficiency and add expertise. Like public projects, there’s a steady project owner, decreased payment risks, and a project that will greatly benefit the general public.

Depending on who plays what role in the project, there are two facets of these partnerships that contractors and suppliers need to be aware of – whether it’s subject to prevailing wage provisions and how to protect their payment rights. Publicly funded

projects are subject to federal or state prevailing wage regulations. Privately funded projects are usually not.

4.1.4 Integrated Project Delivery ("IPD")

Integrated project delivery (IPD) is the most recent addition to the project delivery palette. In these projects, all the project team members are contractually connected with only one contract. All team members are selected before design begins, and they each play a role in the whole process, from design to construction.

IPD is gaining popularity because everyone shares the risk on the project equally. Also, this method creates the most innovative and collaborative approaches to projects. When combined with other construction methods, such as lean construction, they can greatly improve the efficiency of construction methods and shorten project timelines significantly.

4.1.5 Traditional Design-Bid-Build ("DBB")

Design-bid-build (DBB), also called traditional project delivery, is the most common project delivery method, which involves a design team and general contractor working directly for the owner under separate contracts.

The design team works with the owner to develop the contract documents: drawings, specifications, and other exhibits. Once the design is finished, it is sent out for general contractors to provide a bid on the project.

Then, the design team and owner evaluate the proposals from the general contractors and select one to enter into contract with. Once the contract is signed, materials and equipment are ordered so that construction can begin.

4.2 Engineering Oversight in Design

4.2.1 Design Development Process & Owner's Oversight Roles & Responsibilities

[redacted], contracted the Owner Engineer role to [redacted]. The OE's contractual responsibility is to provide reasonable assurance that all vendors are following their contractual requirements. The contract specifies how design and oversight is to be executed. Stage 1 design is 30% complete, Stage 2 60-70% complete, and then final Stage is delivery of the construction package (not signed and sealed yet, final opportunity to review, to address comments on final design package).

The OEs in their review utilized a strategy of audits (which would be performed by the Supply Chain group within OPG) and spot checks (which would be performed by Owners Engineers within New Nuclear Design Engineering) on all document required by their contract. The contractual agreement defines what is the expectation of each package. For non-technical documents, the review was limited only to document control checks. For technical submissions, OE leads would review based on a risk-based approach. The OE would review each page of the document however only spot-checked certain calculations. The Engineering Service Provider on the [redacted] was also required to submit a Certification Statement with design package submission attesting to adherence to their internal QA program. The OEs only had the ability to review to provide comments or reject packages, not approve. The Engineering Design team were required to complete a full review of OE comments and provide resolution. The comments were provided in accordance with the agreed upon commenting guidelines created in an all-team workshop. The comment classification included "Non-conformance". "Missing", "Technical Concern" and "For consideration". In accordance with the commenting guidelines the OEs are only able to provide non-directorial comments. In cases where the document is rejected, the

contractor then must resubmit the entire package at their own cost.

[redacted] also developed and delivered a training program for the engineers performing design reviews on behalf of the Owner. The training program was focused on behaviors of Owners Engineers during reviews and the approach that should be used to be most effective in their reviews. Training also addressed comment classification, expectations on best practices, and how to ensure the intent of the contract has been met.

Key Takeaways and Good Practices

- A combination of Owner Engineering audits as well as document spot checks were an effective and efficient oversight which assisted in identifying any errors, gaps or process inefficiencies and failures. Reference Section 5.0, Action (1a)

- Reviews undertaken only at end of each phase, at 30%, 70% and 100% complete design packages. Reference Section 5.0, Action (1c).

- Incorporated submittal of QA certification statements as part of phase design package formal submittals. Reference Section 5.0, Action (1d).

- Roles and Responsibilities for all teams and parties were well defined in Project documentation. This included communication guidelines, interface requirements, and assimilation of existing processes. This resulted in a greater integrated team with clear scope and role definition which lead to teams working efficiently in collaboration and fewer commercial hurdles. Reference Section 5.0, Action (3)

-

4.2.2 Handling of signed and sealed documents

The project utilized the document management system E-Builder. This system enabled the OEs to receive any and all submissions from contractors giving them full visibility on who had viewed and reviewed the documents, as well as provide notifications and track review status as it progressed through the workflow. E-Builder also enabled tracking of the number of various types of comments such that metrics could be pulled to evaluate service provider performance. The OE's had set a review period of 15 days in which they were to review and provide any comments. However, it was a common practice for the OEs to be engaged by the Engineer of Record (EOR) throughout the development of the package to raise any issues or concerns. It is important to note the onus is on the EOR to engage the OE. All issue management start in E-Builder, there is a comment matrix stored, and can track issues in an internal log. Weekly meetings were held to discuss, and resolve issues raised in E-Builder.

Key Takeaways and Good Practices

- Formal reviews were completed prior to receiving final signed and sealed design packages. This was due to active collaboration between the Design team and the OE. As a result, formal reviews could be completed in a timely manner. Reference Section 5.0, Action (1b)

- E-Builder was an effective and efficient tool that assisted in maintaining a document workflow management process. Reference Section 5.0, Action (2)

4.3 Engineering Oversight in Construction

4.3.1 Owner's Oversight Roles & Responsibilities – Observe, Verify, Audit, Inform

The OEs oversight role in construction was like that of design which consisted of observing, verifying, auditing and informing. The OEs used a Graded (Risk-based) approach in their oversight, focusing on complex, high-risk, or new activities and areas of known performance issues/concerns. The OEs provided their own third-party verification testing on materials and equipment so they did not solely rely on the constructor and its sub-contractors. The Constructor is responsible for all QA requirements, but the OEs provided reasonable oversight of processes to ensure they were following there QA process. There is also an audit team that is created to perform oversight reviews of certain activities.

4.3.2 Performance Monitoring, Tracking, and Reporting

The OEs completed Owner Verification Reports (OVR) on certain activities, this consisted of a review of the construction documents, trend analysis, vendor performance and oversight. The outcome of the OVR was to prescribe whether the vendor was "Compliant", "Deficient" or "Non-Compliant". The OE also completed Oversight Verification Test (OVT). The test were only executed on 10% of the material/activities.

4.4 Risk Management Framework & Processes

The Risk Management process was separate for all the Vendors. [redacted] maintained their risk registrar in "ARM" online tool. [redacted] did have access to any of the vendor risks, but they still worked with the vendors to identify new risks, create mitigation action plans, and closeout risks. They also had the power to approve [redacted] risk management plan to ensure it aligned with their expectations, however they did not have access to their risk register under the P3 model. The High scoring risks were reviewed on a monthly frequency by the internal team. Lower risks were reviewed at a 2-month frequency. Additionally, [redacted] held Risk Identification focused sessions, where the entire team would brainstorm and identify any new possible risks.

4.5 Key Takeaways and Good Practices Identified

This section will highlight areas of good practices observed that would be of value to DNNP Engineering to implement.

- A combination of Owner Engineering audits as well as document spot checks were an effective and efficient oversight which assisted in identifying any errors, gaps or process inefficiencies and failures. Reference Section 5.0, Action (1a)
-
- Reviews undertaken only at end of each phase, at 30%, 70% and 100% complete design packages. Reference Section 5.0, Action (1c).
- Incorporated submittal of QA certification statements as part of phase design package formal submittals. Reference Section 5.0, Action (1d). Formal reviews were completed prior to receiving final signed and sealed design packages. This was due to active collaboration between the Design team and the OE. As a result, formal reviews could be completed in a timely manner. Reference Section 5.0, Action (1b)
- E-Builder was an effective and efficient tool that assisted in maintaining a document workflow management process. Reference Section 5.0, Action (2)

- Roles and Responsibilities for all teams and parties were well defined in Project documentation. This included communication guidelines, interface requirements, and assimilation of existing processes. This resulted in a greater integrated team with clear scope and role definition which lead to teams working efficiently in collaboration and fewer commercial hurdles. Reference Section 5.0, Action (3)

4.6 Existing/Reassured Good Practises

In this section, areas of good practices will be highlighted that have previously been implemented or similar activities have been conducted by DNNP Engineering.

- The DNNP risk Review process is similar to that of [redacted]. This includes a similar tool to manage the registrar and similar frequency of meetings.

- [redacted] coordinated technical working group meetings for the purpose of engaging the OEs. This is equivalent to the touchpoint meetings between DNNP Engineering and GEH, where the OE is engaged.

- The OEs at [redacted] completed spot checking of engineering calculations to their discretion. Similarly, DNNP Engineering OEs apply the graded approach to their oversight, leaving the depth and breadth of the review to OE discretion.

- The [redacted] OEs documented both conformances and non-conformances in their reviews. Similarly, DNNP Engineering document oversight activities and results for sharing with Partners.

- [redacted] utilized specialized consultants for key aspects of the design which contributed to there success. Similarly, DNNP Engineering has and will continue to leverage specialized expertise for key aspects of the design.

5.0 RECOMMENDED ACTIONS

1. Updates to Documentation/Governance (28257390-01):

    a. Review Supply Chain QA audit plans and scope to identify potential overlap with currently planned engineering oversight activities. Where duplicates are identified, revise affected documents to eliminate duplicates and drive efficient use of resources.

    b. Update applicable documentation to clearly identify formal reviews to be completed prior to receiving final signed and sealed engineering deliverables. Consider identifying this as a “Hold Point”.

    c. Revise OPG Oversight Plan to remove reviews at 50% of each phase and hold reviews at the end of each phase.

    d. Assess with partners, feasibility of incorporating submittal of QA certification statements as part of phase design package formal submittals. If feasible, revise applicable documentation to reflect this requirement.

2. Identify and communicate to applicable SPOC, key aspects of E-Builder that would

be beneficial if implemented in Aconex (28257390-02). Items to consider:

a. Comment classification built into Aconex.

b. Review Plans to be captured in the system including type of review (sufficiency, detailed, quality, etc), lead OE, stakeholders required by name, etc.

c. Explore possibility of automated notifications and reminders for identified individuals supporting stakeholder reviews.

d. Common Issues Tracking for all partners on Aconex.

2. Establish internal guidance & training for OEs and applicable stakeholders including (28257390-03):

a. Provide further clarity on roles and responsibilities of OEs including guidelines for scope of technical reviews

b. Develop and communicate guidelines for comment classification

c. Identify critical GEH/SNC programmatic documents that OEs need to be familiar with to effectively conduct their role

d. Awareness of contractual model and commercial bounds OE roles.

e. Rollout of Owners Requirements to Engineering team, including how to identify where/how Owner Requirements have been addressed for individual systems.

f. Consider implementation of more focused identification of risks, with smaller groups, potentially leveraging existing touchpoints. Communicate any identified improvements to appropriate stakeholders for implementation.

--EOR-- NO23-000064-BM

Benchmarking

Report No	Report#	Status	Last Updated
EP25-039311-BM	Facility: EP	Approved and Closed	Chase, Joshua (2025-02-24)

Period From	Period To
2025-01-22	2025-01-29

☐ Benchmark has been shared with Site Communications team for possible review in DOM Note

Year:
2025

Entry Date:
2025-01-24

Start Date:
2025-01-22

Target Completion Date:
2025-02-25

Completion Date:
2025-02-24

Time Spent (Hrs):

Manager	Author	Created By
Chase, Joshua	Duhig, John	

Facility:	Alert Group / Department
N	(DNNPSMROM) DARLINGTON NEW NUCLEAR SMR OPS & MTCE

Plan Type
CONFERENCE CALL

Revision Date	Rationale for Extension or Status Change
2025-02-25	Manager was out of office for BWROG Conference

TCD Extension Approver
Chase, Joshua

PO & C* (at least one)

RS.1 -- RADIOLOGICAL SAFETY

PM.1 -- PROJECT MANAGEMENT

References

SCR	A/R Number	Other Ref#

Title/ Activity*

Title

Radiation Protection Lessons Learned from [redacted]

Applicable Locations

Location/ Contact Description

Objective/ Scope/ Benefit

[redacted]

Details/ Discussion/ Best Practices/ Findings

[redacted]

[redacted]

Recommendations

Mandatory - Document Justification or alternate tracking of actions to be taken

☐ No Action/ Action Tracking Required

Recommendations

Identify the radioactive sources that will be received at the DNNP site prior to operations and the associated plans for managing them (e.g. when will they be received, where will they be stored, what RP controls are required?). Reference P6 87427RP110 and 87427RP290

Develop RP Commissioning Plan. Reference P6 87427RP290

Actions

These recommendations are being tracked as P6 scheduled activities as noted above.

Actions - AR

A/R #	AS #	SCR	Due Date	Details

Actions - SCR

SCR: Details

A/R #:

AS #:

Due Date:

Team Members

Full Name
Chase, Joshua
Kalafatis, Aris
Lee, Ryan

Team Members (External)

Name

Attachment (50 MB max)	Added On	By

Post Comments

Benchmarking

Report No	Report#	Status	Last Updated
RF18-001377-BM	Facility: RF	Approved and Closed	

Period From: 2018-09-30
Period To: 2018-10-03

☐ Benchmark has been shared with Site Communications team for possible review in DOM Note

Year: 2018
Entry Date: 2018-10-19
Start Date: 2018-10-01
Target Completion Date: 2018-11-30
Completion Date: 2018-11-30
Time Spent (Hrs): 100

Manager: OWENS, Bill
Author: Maunder, Ashley
Created By:
Facility: RF
Alert Group / Department: (3181) Projects Office
Plan Type: INDUSTRY BEST PRACTICES
Revision Date: 2018-11-30
Rationale for Extension or Status Change:
TCD Extension Approver:

PO & C* (at least one)

LF.1 -- LEADERSHIP (Inactive)

References

SCR	A/R Number	Other Ref#

Title/ Activity*

Title

Benchmarking trip to [redacted] from Sept 30, 2018 to Oct 03, 2018.

Applicable Locations

[redacted]

Location/ Contact Description

[redacted]

Objective/ Scope/ Benefit

[redacted]

Details/ Discussion/ Best Practices/ Findings

Findings -- click here to open PDF

Recommendations

Mandatory - Document Justification or alternate tracking of actions to be taken

☑ No Action/ Action Tracking Required

Recommendations

Ike's recommendations for refurb/RTS:
1. Perform component level testing as soon as possible

2. If it moves the utility owns it
3. Utility controls the schedule
4. Utility can direct the contractor
5. Capture the RTS lessons learned from unit 2 for unit 3
6. Grab the house from unit 2 early and move to unit 3

Actions

1) Findings were shared at U3 teamwork meeting with the U3 team by Bill Owens, October 2018.

Actions - AR

A/R #	AS #	SCR	Due Date	Details

Actions - SCR

SCR:	Details
A/R #:	
AS #:	
Due Date:	

Team Members

Full Name
OWENS, Bill
Richardson, Jeff
Ross, Paul
Guin, Joshua
Sansom, Ian

Team Members (External)

Name

Attachment (50 MB max)	Added On	By

Post Comments

[redacted]

RF18-001377-BM

Findings

Bill Owens:

1. Significant trade shortage particularly Electricians and Pipefitters (welders). [redacted] has gone to Canada trying to secure electrical resources from the IBEW, if a resolution is not found the project schedule will push critical path. Fibre Optics is a unique skill and with miles of fibre optic cables needed for this project this single point of vulnerability is significant. Need to check if our Turbine Controls upgrade has any unique trade requirements.
2. The method used to determine the duration target for the second unit was a 10% reduction in schedule (spoofy) across the entire project. [redacted] The current duration for Darlington U3 is 1013 days which represents a 5% reduction for the second unit however considering the Turbine controls will be a FOAK evolution for Refurb 5% seems reasonable at this time.
3. The contractual Terms and Conditions in place for the completion of [redacted] does not allow the owner [redacted] to direct the Vendor [redacted] on schedule or execution methodology, this has created a tension between the two and does not allow the owner to have control on what resources work on what activities. The Vendor also owns the schedule which does not allow the owner to direct work activities or hours of work for the project execution.

Josh Guin:

- [redacted] is primarily reliant on the corrective action process to drive changes into subsequent Units. [redacted] process is limited to an individual gathering information from calls and area managers and documenting lessons into a database (~130 lessons). [redacted] has kicked off a new process, independent from [redacted], for System Turnovers in which they plan on having groups document their top 2 focus areas and develop an action plan with due dates. Review of the [redacted] lessons learned program reinforces the need to have a lessons learned program that covers collection, documentation, prioritization, communication and implementation to ensure productivity targets are driven to.
- [redacted] organizational structure is largely independent with separate teams managing work areas [redacted]. The separation does not permit effective knowledge management which has been identified as a challenge. Having a single organization line (project, field area, etc.) is needed across all units to ensure experience, tacit knowledge, is driven into next unit execution. Project and functional organizations need to develop specific resourcing strategies for [redacted] to ensure the same individuals and teams execute work.
- [redacted]. Much of the early earned value [redacted] was obtain through completion of easier tasks and now that more challenging work is being completed. As such work on [redacted] is coming ahead posing resource constraints. [redacted]. It is important to have contingency strategies should one Unit be delayed or pull ahead. In addition contracts need to be reviewed in detail to examine potential contractual impacts and incentives that can be used to support work direction in [redacted].

Jeff Richardson:

1. 120k mnhrs behind on [redacted] bulk work
2. [redacted] on track
3. Currently 500 elecs - need 1400
4. Shifting forces from [redacted] to catch up
5. 700-800 package output /month; [redacted] now owns planning
6. Similar contract structure to OPG/SNC - target price, quarterly fee, reimbursable cost/price based on mechanical completion
7. Utility must own the schedule & direct the work & control engineering scope
8. Contractor & utility incentives/motivation must align tightly
9. Distinct teams for [redacted] - [redacted]

[redacted]

10. PMO is common layer to pass lessons learned
11. [redacted] ...
12. [redacted]
13. T-30w RTS system scoping done target
14. T-24w RTS system scoping done to allow construction to plan effectively to complete to RTS start date
15. T-12 to T-8 planners to plan; T-8 to T-4 final constructibility walk downs; T-4 to T-0 work in enabled
16. Safety had been improving but now increasing; 0.6 current rate
17. Need to organize work & personnel by work package & function - not by geography (room/vault/TG/etc.)
18. 3-4 owners' reps in morning meetings (plus some on call); 6 auditor schedulers auditing schedules; monthly XER files to [redacted]
19. Integrated RCS flush will be [redacted] critical path
20. Match ITS output to drive SAF
21. [redacted]
22. [redacted] had very, very few [redacted] personnel; here [redacted] had hundreds who essentially did no construction work - all oversight; had to make transition to [redacted] becoming "doers" not just oversight
23. Comparison of utility oversight: 25 quality people here; 4 at [redacted]; 7 safety personnel here, none at [redacted]
24. NEI construction CAP program used - but all play in the same CAP system - [redacted]
25. Need to look for eliminating redundant systems - CAP, LL, Risk, Action Tracking, etc.
26. QA aligned to RTS process re:CAP expectations (i.e., not writing CRs for typical field corrections/discovery that don't have forward or backward implications)
27. Build a procedure for RTS for opening up requirements for SCR v. Troubleshooting protocols/practices
28. Lots of re-training required to built RTS/ITP capability - most of the personnel were operating plant personnel who didn't appreciate or understand testing - the planning curve, the complexity, the discovery, the recovery/troubleshooting
29. Eliminated morning break in favor of longer lunch break to increase productivity
30. Work a series of staggered shifts to manage traffic for driving, parking, security gate clearance
31. Weekly schedule updates; turnover systems issue daily updates
32. Productivity lowest with Electricians then Pipefitters - made improvements in location of break areas, etc. to improve productivity
33. POD meetings are combined [redacted]; majority of others are by-unit

Paul Ross:

1 Refurbishment integrated schedule development needs to be detailed/planned with Return to Service milestones documented prior to start of the project. This includes tying all key/required maintenance and project work to the appropriate RT3, System Available for Service (SAFS) and RCHP. This will allow for an

integrated RTS schedule with clear/key priorities (i.e. SAFS critical path). Help will be required from Engineering to detail what key components, SSCs are required for each RT3 and SAFS MS. (Prior to Rev 0 schedule, a SAFS/RTS waterfall must be in place)

2 As part of bullet #1, a documented process should be in place with P6 scheduled paperwork closeout activities. This will help with the implementation of clear/automated reporting.

3 Similarly, for SAFS testing, there needs to be a "deficiency program" built into the RTS procedures to allow the commissioning/RTS team flexibility within their approved procedures/workplans. This will minimize any delays encountered when marginal results are found. As part of this, a commissioning/test engineering group should be developed and incorporated into the RTS team.

--EOR-- RF18-001377-BM

Benchmarking

Report No	Report#	Status	Last Updated
RF22-000664-BM	Facility: RF	Approved and Closed	

Period From	Period To
2022-06-13	2022-06-15

☐ Benchmark has been shared with Site Communications team for possible review in DOM Note

Year: 2022
Entry Date: 2022-06-07
Start Date: 2022-06-13
Target Completion Date: 2022-08-31
Completion Date: 2022-07-27
Time Spent (Hrs): 80

Manager	Author	Created By
Popovic, Dragan	Brown, Jim	

Facility:	Alert Group / Department
RF	(3145) Project Assurance & Commercial Strategy

Plan Type: INDUSTRY BEST PRACTICES

Revision Date	Rationale for Extension or Status Change
2022-08-31	

TCD Extension Approver

PO & C* (at least one)

LF.1 -- LEADERSHIP (Inactive)

References

SCR	A/R Number	Other Ref#

Title/ Activity*

Title

[redacted] Benchmarking Visit - DNNP Project Best Practices

Applicable Locations

Location/ Contact Description

OPG Participants - Jim Brown, Karim Osman, Dragan Popovic
GE Hitachi Participants - Glen Watford, Mark Kazanas, Brian Johnson

Monday June 13th at [redacted]

Tuesday June 14th at [redacted]

Objective/ Scope/ Benefit

The purpose of the [redacted]enchmarking trip was to gain an understanding of OPEX, industry best practices and lessons learned to apply to the Darlington New Nuclear Project (DNNP). In addition the DNNP team looked to establish networking contacts to support future design, planning, engineering and construction execution. The following areas were reviewed by the team.

1/ General presentation of [redacted]

2/ Design
• Engineering
• [redacted]Design Process including Civil and MEH sequences
• Lessons Learnt
• Configuration management / Design Stability

3/ Quality and Lessons Learned
• Overview of lessons learned process and integration
• Overview of any differences in QA process for Nuclear vs non-nuclear
• Overall lessons learned and pitfalls to avoid during planning and construction
• Budgeting overview or priority for Quality
• Training aspect for future operators

4/ Contract Strategies
• Contract strategy model and structure, breakdown of interface model between owner, constructor, and integration with vendors
• Breakdown of alliances and partners structure, principle clients, principle contracts, supply chain integration

5/ Planning and Construction
• Overview of work site controls and logistics, how construction process is managed
• Overview of integrated project controls, vertical integration of schedule, key milestones/journeys
• Overview of challenges during planning and construction, stakeholder engagement, schedule and integration with vendors, technical integration
• Overview of Area Integration, area lens, vertical lens, how technology and tools are used to resolve engineering conflicts during construction
• Overview of 3D and 4D tools used on-site to help with design complexity

6/ Organizational Design

7/ Project Delivery methodology
• Overview of project structure from planning to construction, project life-cycle, milestones
• Clarity surrounding schedule drivers vs cost drivers for project execution and success

8/ Digital Strategy
• End-to-end digital strategy for efficiency and effectiveness
• What pitfalls to avoid when developing digital strategy
• Configuration management, details surrounding how records are stored, documentation tools, etc.
• Overview of digital strategy team and integration with the project
• Demo of key Digital tools (if possible)

9/ [redacted]

Details/ Discussion/ Best Practices/ Findings

Findings -- click here to open PDF

Recommendations

Mandatory - Document Justification or alternate tracking of actions to be taken

☐ No Action/ Action Tracking Required

Recommendations

1) Integrated Project Delivery Model - Consider embedding a few IPD team members in the [redacted]org (maybe one from OPG Design and one from SNC into their Delivery team, one from AECON with their [redacted]

2) Digital Strategy - Establish a digital strategy early in the process that all IPD partners will use as a common platform

3) Design to Execution - Engineering transition, consider organization that transitions from Design to Field Construction support. Benefit for transition into SMR 2 to 4.

Actions

Based on the learning from the [redacted]Benchmarking Trip, the following recommendations are documented for DNNP project:

1) Implement an Integrated Project Delivery Model to support DNNP organization

2) Implement one digital platform for all stakeholders on the DNNP project

3) Provide a transition plan from Engineering and Project Planning to construction execution

Action above owned by Jim Brown and Kaela Esseghaier tracked in ePMX 57566.

Actions - AR

A/R #	AS #	SCR	Due Date	Details

Actions - SCR

SCR:	Details
A/R #:	
AS #:	
Due Date:	

Team Members

Full Name
Osman, Karim
Brown, Jim
Popovic, Dragan
Sivekumar, Dan

Team Members (External)

Name

Attachment (50 MB max)	Added On	By

Post Comments

RF22-000664-BM

Findings

Engineering

Define what design complete means to ensure the design is as close to 'ready' as possible before construction begins
Design to Execution - Engineering transition, consider organization that transitions from Design to Field Construction support
'Modular' by definition, puts more importance on the need to ensure design is complete in advance. "Watch making on an industrial scale".
Constructablity very important and integrated – upfront, part of gated process – Constructor invited to gate
Intelligent Customer - Eng is org'd by area and 50 Design authorities (technical customer – DA)

Schedule

Utilize a 4D model to broadly communicate project progress. 4D schedule was used to interferences and conflicts with different trades and work packages.

Building the Team

Diverse organization with the bias to acquire talent – Ensure best athlete for the role within team regardless of background and skillset

Integrated Project Delivery Model

Consider embedding a few IPD team members in the [redacted] org (maybe one from OPG Design and one from SNC into their Delivery team, one from AECON with their [redacted]
From a contracting strategy, going to a joint IPD model does seem the right approach, don't get too caught up on the legalese and instead focus on building and nourishing the relationship (co-location to the extent possible should be part of this strategy)

Culture

Don't get too caught up on contract negotiation, once the terms are agreed to, you rarely look back on them….build on success.

Don't be arrogant, thinking we know how to do this, we don't. It's been 3 decades since plants were built, the world has moved on in those 3 decades

Construction

Use as much modular construction as possible - [redacted] formed and poured modular concrete rooms to avoid interferences and improve efficiencies
Consider the design of construction site plan and layout to maximize efficiencies for execution include harsh weather in Ontario climate
How will we consider fabrication and construction of steel bricks?
Over 70 tower cranes used on site to support modular construction

Security

Complicated for entry into construction island potentially leading to significant and significant resulting for protesters and political pressure. Not required for OPG, avoid turnstiles, however what is our accounting strategy.

Digital Strategy

Establish a digital strategy early in the process that all IPD partners will use as a common platform

Regulatory Affairs

Manage the regulator (this goes without saying but need to ensure what's deemed as safety related is bounded in order to protect the business case, both cost and schedule)

Operations

Bring ops in early, Simulator is already up and running [redacted] (recommended to have 2 full scale simulators for DNNP [redacted])

Involve Ops in commissioning as part of training

Supply Chain/QA

Educate suppliers early, work with them to drive the right behaviours…..look after your suppliers. The more time spent up front with them, the less re-work we'll have.

Put the appropriate planning up front and how to ensure records are stored for the lifetime of the facility and that suppliers need to submit those records early and progressively, not all at the end. Include dates for submission.

--EOR-- RF22-000664-BM

Lessons Learned Report

Project No:	N/A
Project Name / Work Series:	Benchmarking Report: [redacted]
Program:	SMR-X 1 NN-Program Management
Project Director:	Scott Ritzie
Date:	Feb 24-27, 2025
Attendees:	Scott Ritzie, Ebraheem Waraich, Mike Zdero

REQUIRED INFORMATION FOR LESSONS LEARNED DATABASE	
Workgroups Involved: Design Engineering, Execution	**Unit(s):** SMR-X Unit 1
Project Phase: Definition	**CWP #:** N/A
EBX #: 18096	**Work Order:** N/A
SCI #:	**Equipment #:** N/A
☒ **Share Lesson for Future Project Planning**	
Priority 1 – Immediate Impact or Risk to Safe Operations *Priority 2 – Pending Impact or Risk to Safe Operations*	*Priority 3 – Operational Impact – Work in Next Window* *Priority 4 – Normal Work Process*

SCOPE

Executive Summary:

This report provides an in-depth analysis of the [redacted] project, benchmarked against industry standards and best practices, and incorporates lessons learned from [redacted]. The focus is on enhancing project management, contracts and procurement, construction, storage and material handling, security, and engineering. Key observations, recommendations, and insights from regulatory oversight are presented to improve project efficiency and effectiveness.

Introduction:

[redacted]. This benchmarking report evaluates the project's processes and practices, identifying areas for improvement and opportunities to incorporate industry best practices. It also integrates lessons learned from the NRC's regulatory oversight to provide a comprehensive view of the project's strengths and challenges.

Follow-up Actions:

1. Explore access to [redacted] construction review board findings to gain deeper insights into decision-making processes.
2. Engage a [redacted] expert to audit and review current DPSC practices, offering valuable external perspectives.
3. Request a copy of [redacted] weekly execution package to understand their operational cadence and project tracking methodologies.

Lessons Learned Report

4. Obtain [redacted] NCR/Quality Dashboard to benchmark quality management practices.
5. Acquire [redacted] readiness check sheet to enhance our preparation protocols.
6. Review [redacted] field engineering procedure for potential improvements in our own practices.
7. Organize visits for operations teams to observe [redacted] training, self-guiding procedures, and Control Room setup for best practice adoption.
8. Organize a deep dive for configuration management with a focus on documentation with [redacted].

Good Practices Already in Place:

a) The current meeting setup and run stream is effective, ensuring consistent communication and alignment.
b) The weekly execution package provides detailed insights, facilitating informed decision-making.
c) CWP package size is well-calibrated, balancing detail with manageability.
d) The resource-loaded, logic-linked schedule is robust, supporting efficient project planning and execution.
e) The Integrated Project Delivery (IPD) approach minimizes administrative burdens compared to traditional EPC models, enhancing project agility.

Conclusion:

The [redacted] project exemplifies both the achievements and challenges inherent in large-scale nuclear construction. By addressing identified areas for improvement and leveraging existing strengths, future projects can achieve greater efficiency and success. The insights gained from this benchmarking exercise provide a valuable foundation for driving continuous performance improvement and operational excellence in nuclear construction projects.

Associated Risks (Opportunities/Threats)/Issues: N/A

SCR Associations: N/A

Lesson 1	
Topic: Project Management	**Category:** Project Administration

Lesson Learned Description:

The [redacted] project exemplifies a structured approach to project management, underscored by the establishment of a Daily Site Oversight Committee. This committee played a pivotal role in reviewing engineering changes and prioritizing decisions, ensuring that the owner's strategic objectives were consistently aligned with project execution. The importance of colocation was evident, as it significantly reduced engineering disposition response times from 72 hours to a mere 6 hours, demonstrating the value of proximity in facilitating swift decision-making. The Construction Control Center emerged as a critical hub for coordinating construction activities, procurement, design, and materials management, and its immediate establishment is recommended to streamline operations and enhance visibility across project components. The importance of flexibility in inspection processes and the need for agile and risk-informed approaches to inspection planning, which can be integrated into project management practices.

Recommended Solutions:

1. Establish a centralized Construction Control Center for real-time oversight and coordination of project activities.
2. Implement a robust change management system to track and manage project changes effectively, ensuring alignment with strategic objectives under our IPA model.

Lessons Learned Report

Plan for Application/Mitigation on Subsequent Unit/Value: Risk-informed approaches to inspection planning	
Potential Cost Impact: N/A	**Potential Schedule Impact:** N/A
Tier: 2	**Action Owner (if applicable):** 1. David Hubbard/ Damarak Madhar 2. Hark Mander
EBX Lesson#: 18097	**Action ID# (if applicable):** 72356**,** 72249

Lesson 2	
Topic: Contracts and Procurement	**Category:** Procurement
Lesson Learned Description: Strategic engagement with consultants and key vendors was a hallmark of the [redacted]. Collaborations with firms like [redacted], underscored the importance of expertise and external validation. [redacted] were integral to project success, while the decision to [redacted] highlighted lessons learned from past experiences. The development of a long-term spare strategy at the purchase order award stage was emphasized, ensuring future markups and negotiated overhead for IEEE replacement parts were addressed proactively. Development of realistic schedules to avoid overstaffing and resource inefficiencies, which aligns with the need for robust procurement strategies.	
Recommended Solutions: 1. Strengthen vendor management and procurement strategies to ensure quality and reliability, leveraging lessons learned and best practices from industry leaders.	
Plan for Application/Mitigation on Subsequent Unit/Value: Enhanced procurement strategies	
Potential Cost Impact: N/A	**Potential Schedule Impact:** N/A
Tier: 2	**Action Owner (if applicable):** Rob Grainger
EBX Lesson#: 18098	**Action ID# (if applicable):** 72308

Lesson 3	
Topic: Construction	**Category:** Construction
Lesson Learned Description: Construction efficiency was a focal point, with studies indicating 30-40% wrench time efficiency. Ten-hour shifts were identified as the most effective, maximizing productivity and minimizing downtime. On-site capabilities for bending rebar and conduits were deemed essential, ensuring flexibility and responsiveness to project demands. Cable management practices, including field verification of lengths before cutting, were crucial in	

Lessons Learned Report

avoiding costly errors and delays. The project wisely anticipated additional cabling needs, ensuring ductus were adequately provisioned. Crane utilization strategies favored tower cranes over crawler cranes, offering increased productivity and reduced susceptibility to wind impact. Quality control measures, such as addressing [redacted] and ensuring fire door installations met settlement and squareness standards, were integral to maintaining construction integrity. The emphasis on optimizing resource use and cross-training inspectors to enhance flexibility and efficiency can further inform construction practices.
Recommended Solutions: 1. Incorporate the learnings above to improve execution efficiency and quality control measures.
Plan for Application/Mitigation on Subsequent Unit/Value: Enhanced construction practices.

Potential Cost Impact: N/A	**Potential Schedule Impact:** N/A
Tier: 2	**Action Owner (if applicable):** Harpreet Grewal
EBX Lesson#: 18099	**Action ID# (if applicable):** 72352

Lesson 4	
Topic: Storage and Material Handling	**Category:** Procurement
Lesson Learned Description: A robust program management approach for long-term equipment and materials was essential, supported by a dedicated staff of 100 for material management. Traceability and inventory management systems were critical, ensuring accountability and efficiency in material handling. The project's emphasis on traceability, including Material Test Reports (MTRs) and Canadian Registration Numbers (CRNs), reflects a commitment to maintaining high standards of quality and compliance. The implementation of a comprehensive system for material handling, inventory, and field-issued inventory further underscores the importance of efficient logistics and supply chain management in supporting project execution.	
Recommended Solutions: 1. Implement a comprehensive system for material handling, inventory, and field-issued inventory.	
Plan for Application/Mitigation on Subsequent Unit/Value: Maintaining high standards of quality and compliance.	
Potential Cost Impact: N/A	**Potential Schedule Impact:** N/A
Tier: 2	**Action Owner (if applicable):** Andrew Clayton
EBX Lesson#: 18100	**Action ID# (if applicable):** 72323

Lesson 5	
Topic: Security	**Category:** Environment, Health and Safety
[redacted]	

Lessons Learned Report

[redacted]

EBX Lesson#: 18101	**Action ID# (if applicable):** 72353

Lesson 6	
Topic: Engineering	**Category:** Scope Management/Engineering
Lesson Learned Description: Site engineering coordination was pivotal, with construction managing field engineering for non-safety systems. A focus on common naming and numbering consistency was essential, streamlining communication and documentation processes. Challenges with final documentation and revisions were acknowledged, highlighting the need for comprehensive as-built packages. Lessons learned from NCR reviews emphasized the importance of incorporating insights from previous units, avoiding the pitfalls of bypassing the learning process. The engineering team's commitment to continuous improvement and innovation was evident in their approach to addressing obsolescence, field routing, and conductor cable issues. The use of modular E-Houses and the standardization of embed plates further exemplified the project's forward-thinking approach to engineering design and execution. The NRC's report highlights the success of the [redacted] Project Office [redacted] and the [redacted] Readiness Group [redacted] in facilitating effective communication and coordination, which can inform engineering practices.	
Recommended Solutions: The key takeaways from this exercise are intended for informational purposes only. The LL has been documented for future reference/OPEX only.	
Plan for Application/Mitigation on Subsequent Unit/Value: Continuous improvement and innovation.	
Potential Cost Impact: N/A	**Potential Schedule Impact:** N/A
Tier: 2	**Action Owner (if applicable):** N/A
EBX Lesson#: 18102	**Action ID # (if applicable):** N/A

SEC Interrogatory #111

Interrogatory

Reference:
D2-4-7

Question(s):

With respect to the development of the contingency amount:

a) Please explain how the development of the contingency amount differs from what was included in the DRP and proposed to be included in the PRP.

b) [p.4-7] Please provide the document results of the Monte Carlo simulation.

c) [p.8] Please explain why the total Unit 1 contingency amounts included in Chart 1 differ from that included in the RQE Budget (D2-4-8, p.8, Chart 2).

d) [p.9] The evidence states: "Recognizing the FOAK nature of the technology, higher uncertainty, and limited relevant historical data to inform the risk profiles, OPG has allocated $193M to the contingency pool."
   i. Please explain how OPG determined the specific amount of incremental Non-IPA contingency, which should be included in the budget ($59M = $193M – $134M).
   ii. Does the Monte Carlo simulation not include risks related to each of the FOAK nature of the technology, higher uncertainty, and limited relevant historical data to inform the risk profile?
   iii. Including the incremental $59M of contingency, what is the total confidence level calculated at?

Response

a) The contingency development for the Darlington New Nuclear Program ("DNNP") is largely consistent with the approach used for Darlington Refurbishment Project ("DRP") and the Pickering Refurbishment Project ("PRP").

   The DNNP Total Contingency is comprised of four components.
   i. OPG (Non-Integrated Project Agreement ("IPA")) Scope Contingency
   ii. IPA Scope Contingency
   iii. IPA Execution Profit at Risk Pool
   iv. IPA Warranty and Unplanned Capacity Loss Factor Risk and Reward Pool

Details on these four components are provided in Ex. D2-4-7, Section 3.0.

The first two components reflect traditional contingency pools, and the development of these contingency components is consistent with the approach used for the DRP and the PRP. Specifically, contingency is developed using a Monte Carlo simulation, incorporating discrete risks, cost uncertainty, schedule uncertainty, and critical path schedule risks to determine a probabilistic contingency output. Additional details on this industry's best practice to contingency development have been provided in Ex. D2-4-7, Section 3.1.

The remaining two components represent additional funds that are available under the IPA established to incentivize the Non-Owner Parties ("NOPs") to achieve execution and operational objectives and performance measures. These two pools are funded largely from NOP Fixed Fees, representing their profit and a share of their overheads. While these components are unique to the IPA and therefore the DNNP, they are similar to traditional disincentives found in target-based EPC agreements. Further details on this structure are provided in Ex. D2-4-7 Section 3.0 and Ex. D2-4-3 Section 4.4.

b) The results of the DNNP Unit 1 Monte Carlo simulation have been provided in Chart 1 below. The highest probability factor performed within the Monte Carlo analysis was 95%.

Chart 1: Darlington New Nuclear Unit 1 Probabilistic Analysis Results

Probability	Contingency ($K)	Schedule
50%	$505,255.50	4/11/2030
75%	$592,896.60	6/27/2030
80%	$616,887.50	7/18/2030
85%	$646,859.20	8/12/2030
90%[1]	$684,195.80	9/15/2030
95%	$736,118.90	10/31/2030

[1] Per management review incorporating best practice, lesson learned, and experience; the DNNP Contingency differs in comparison to the Qualitative Risk Analysis ("QRA") P90 results noted above. Details on the contingency amounts and an explanation of variance between these amounts and the QRA P90 results are provided in Ex. D2-4-7 p.9.

c) The total Unit 1 contingency amounts provided in Ex. D2-4-8, p. 8, Chart 2, includes escalation on contingency as stated in footnote 2, while Ex. D2-4-7, p. 8, Chart 1, does not.

d)

i. The incremental non-IPA contingency of $59M was determined based on management judgment, to account for potential unknown risks in this FOAK project.

ii. The Monte Carlo simulation includes the known risks and uncertainties associated with the FOAK nature of the SMR technology. However, because of lack of historical data, there remains a degree of uncertainty and unknown unknowns that cannot be fully identified and reflected in the model. To address this, the contingency is not based solely on the raw Monte Carlo data and percentile. It reflects a calibrated view that combines the Quantitative Risk Analysis ("QRA") results with experience, benchmarking against comparable complex projects and allowances for scope maturity and integration risk.

iii. Including the $59M contingency, the total confidence level is calculated at P95.6.

SEC Interrogatory #112

Interrogatory

Reference:
D2-4-8, p. 10-18

Question(s):

Charts 3-10 provide a summary breakdown of each work bundle/scope in the RQE budget. For each, please provide a significantly more detailed budget.

Response

Refer to Attachment 1.

D2-SEC-112 Attachment 1

Darlington New Nuclear Project Major Work Bundles - Budget Annualized ($M)											
Bundle	**#**	**Category**	**Total[3]**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Owner Program and IPD Project Management	1	Project Management[1]	829	64	90	112	184	118	103	89	56	13
	2	Inspections	-	-	-	-	-	-	-	-	-	-
	3	Engineering	160	14	14	14	69	17	15	9	7	2
	4	Procurement	16	1	(0)	1	7	7	-	0	0	-
	5	Construction	15	-	-	-	15	-	-	-	-	-
	6	Commissioning	5	-	-	-	-	1	1	1	1	0
	7	**Sub-Total**	**1,026**	**79**	**104**	**127**	**275**	**142**	**119**	**100**	**64**	**15**
	8	Escalation[2]	15	-	-	-	2	3	3	4	3	1
	9	**Total**	**1,041**	**79**	**104**	**127**	**277**	**145**	**123**	**104**	**67**	**16**
Site Preparation	1	Project Management[1]	7	2	4	1	0	-	-	-	-	-
	2	Inspections	-	-	-	-	-	-	-	-	-	-
	3	Engineering	8	4	3	0	0	-	-	-	-	-
	4	Procurement	4	-	3	1	0	-	-	-	-	-
	5	Construction	45	12	29	5	-	-	-	-	-	-
	6	Commissioning	-	-	-	-	-	-	-	-	-	-
	7	**Sub-Total**	**63**	**17**	**39**	**7**	**0**	**-**	**-**	**-**	**-**	**-**
	8	Escalation	-	-	-	-	-	-	-	-	-	-
	9	**Total**	**63**	**17**	**39**	**7**	**0**	**-**	**-**	**-**	**-**	**-**
Design Engineering	1	Project Management[1]	-	-	-	-	-	-	-	-	-	-
	2	Inspections	-	-	-	-	-	-	-	-	-	-
	3	Engineering	431	61	68	110	108	40	30	13	0	0
	4	Procurement	-	-	-	-	-	-	-	-	-	-
	5	Construction	-	-	-	-	-	-	-	-	-	-
	6	Commissioning	6	-	-	-	-	-	1	3	2	-
	7	**Sub-Total**	**437**	**61**	**68**	**110**	**108**	**40**	**31**	**17**	**3**	**0**
	8	Escalation	11	-	-	-	4	3	3	2	0	0
	9	**Total**	**449**	**61**	**68**	**110**	**112**	**43**	**33**	**18**	**3**	**0**
Nuclear Island	1	Project Management[1]	150	-	3	7	52	38	31	20	0	-
	2	Inspections	-	-	-	-	-	-	-	-	-	-
	3	Engineering	-	-	-	-	-	-	-	-	-	-
	4	Procurement	658	3	9	73	113	171	192	88	10	-
	5	Construction	337	-	-	-	39	62	139	86	11	-
	6	Commissioning	-	-	-	-	-	-	-	-	-	-
	7	**Sub-Total**	**1,146**	**3**	**11**	**80**	**203**	**271**	**362**	**194**	**21**	**-**
	8	Escalation	110	-	-	-	8	22	45	31	4	-
	9	**Total**	**1,257**	**3**	**11**	**80**	**211**	**293**	**407**	**226**	**25**	**-**
Conventional Island	1	Project Management[1]	47	-	2	3	10	12	11	9	-	-
	2	Inspections	-	-	-	-	-	-	-	-	-	-
	3	Engineering	7	1	1	-	4	0	-	-	-	-
	4	Procurement	481	-	0	32	120	154	111	56	8	-
	5	Construction	388	-	-	-	32	81	165	91	19	-
	6	Commissioning	3	-	-	-	1	2	-	-	-	-
	7	**Sub-Total**	**926**	**1**	**3**	**36**	**167**	**250**	**287**	**155**	**27**	**-**
	8	Escalation	90	-	-	-	7	21	33	24	5	-
	9	**Total**	**1,016**	**1**	**3**	**36**	**174**	**271**	**320**	**179**	**32**	**-**
Balance of Plant	1	Project Management[1]	97	-	3	17	20	26	23	8	1	-
	2	Inspections	-	-	-	-	-	-	-	-	-	-
	3	Engineering	-	-	-	-	-	-	-	-	-	-
	4	Procurement	136	-	-	34	39	34	25	4	-	-
	5	Construction	771	-	1	95	247	295	112	21	-	-
	6	Commissioning	19	-	-	-	-	9	9	-	-	-
	7	**Sub-Total**	**1,023**	**-**	**3**	**147**	**306**	**365**	**169**	**33**	**1**	**-**
	8	Escalation	59	-	-	-	10	26	18	4	0	-
	9	**Total**	**1,082**	**-**	**3**	**147**	**316**	**391**	**187**	**37**	**1**	**-**
Digital Strategy	1	Project Management[1]	27	0	3	5	4	4	5	4	1	0
	2	Inspections	-	-	-	-	-	-	-	-	-	-
	3	Engineering	2	-	-	-	-	-	1	1	-	-
	4	Procurement	6	-	-	-	1	1	2	1	0	-
	5	Construction	5	-	-	-	-	-	3	2	0	-
	6	Commissioning	-	-	-	-	-	-	-	-	-	-
	7	**Sub-Total**	**40**	**0**	**3**	**5**	**6**	**5**	**11**	**8**	**2**	**0**
	8	Escalation	3	-	-	-	0	0	1	1	0	0
	9	**Total**	**43**	**0**	**3**	**5**	**6**	**5**	**13**	**9**	**2**	**0**
Commissioning and Start-up	1	Project Management[1]	13	-	-	7	2	1	1	1	1	0
	2	Inspections	-	-	-	-	-	-	-	-	-	-
	3	Engineering	-	-	-	-	-	-	-	-	-	-
	4	Procurement	42	-	-	-	10	2	5	26	-	-
	5	Construction	18	-	-	-	-	-	-	5	9	3
	6	Commissioning	72	-	-	-	1	3	13	25	22	7
	7	**Sub-Total**	**145**	**-**	**-**	**7**	**13**	**7**	**19**	**57**	**33**	**11**
	8	Escalation[2]	-	-	-	-	-	-	-	-	-	-
	9	**Total**	**145**	**-**	**-**	**7**	**13**	**7**	**19**	**57**	**33**	**11**

[1] Project Management includes OPG Project Management Team ("PMT"), Vendor PMT, Overhead, Expenses (Travel, Training, Other)

[2] Escalation on NOP costs only. Escalation on OPG costs is embedded within individual lines above.

[3] Totals may not match due to rounding

SEC Interrogatory #113

Interrogatory

Reference:
D2-4-8, Attachment 2

Question(s):

With respect to the BTTC *Third Party Assurance Report*:

a) [p.11] The Report finds certain sub-areas with a maturity level of 2, which is below a level 3 (Effective). Has OPG brought those sub-areas to at least a level 3, and if so, were the changes incorporated into the RQE budget?

b) [p.12] The Report finds partial compliance with 4 sub-areas of the Estimate Plan. Has OPG brought those sub-areas into compliance, and if so, were the changes incorporated into the RQE budget?

c) [p.13-16] For each of the key recommendations, has OPG implemented the recommendations, and if so, were they incorporated into the RQE budget?

Response

a-c)

Within Assurance Workstream 1, “the BTTC assurance review found that OPG and DNNP have established a strong suite of governance, processes and procedures that are generally aligned with industry-recommended practices across all Control areas related to the development of the Release Quality Estimate.” Four sub-areas were classified to have a maturity rating of 2, indicating “Minor Improvements Required”. These ratings were driven by the Key Recommendations provided in Ex. D2-4-8, Attachment 2, pp. 13-14. Overall, OPG has taken action to address all recommendations. OPG’s response to all the Category B “Important” recommendations is provided in Attachment 1. No changes to the RQE were required as a result of the recommendations.

Within Assurance Workstream 2, “the compliance checks conducted across the selected areas indicate that OPG and DNNP have generally adhered to the governance frameworks, processes, and procedures under review. In some cases, the requirements were not fully complied with, while in others, OPG exceeded the expected standards. For the small number of requirements where full compliance was not achieved, it was typically found that OPG had implemented alternative

controls and governance processes. Although these differed from the prescribed requirements, they still demonstrated strong control environments." Four sub-areas were classified to have a maturity rating of 2, indicating "Partial Compliance". These ratings were driven by the Key Recommendations provided in Ex. D2-4-8, Attachment 2, pp. 15-16. Overall, OPG has taken action to address all recommendations. OPG's response to all the Category B "Important" recommendations is provided in Attachment 1. No changes to the RQE were required as a result of the recommendations.

Assurance Workstream 1

ID	Control Area	Category	Finding / Observation	Recommendation	Benefit / Impact	Disposition
CA2.2	Development of Cost Estimate (CA2)	B	**Process Equipment:** – AACE contains a detailed requirement that the estimated value of expected equipment should be based on budgetary / firm quotes, in-house pricing or another stated basis. Where quotes have been obtained, a summary of the bidding process should be provided including details on the minimum number of bidders and how bids are to be normalized for evaluation. **EST-DTG-001** Estimating Desk Top Guide Section 6.4 requires the Estimator to capture the cost of long lead materials as well as non-long lead materials. **NK054-PLAN-01210-00108** and **DA1-IPD-NN-NN-TPLN-CE-0001** requires the equipment to be listed, however none of the plans and procedures request bidding information and details of the procurement process.	The AACE guideline 36R-08 'Development of Estimate Plans' is prescriptive on the requirement for a summary of the bidding process used to obtain market pricing. OPG and DNNP Estimate plan requirements are generic and therefore subject to estimating judgement. On a nuclear project, safety case analysis, equipment validation and qualification requirement criteria greatly affect the cost accuracy of the bids received and should be well documented. It is recommended that a summary of budgetary / firm cost information obtained from the market and used in the estimate is included as part of the estimate substantiation. The Scalable Project Delivery Criteria could have an added level of detail for information on required number of bidders, bid analysis and review depending on the size and complexity of the project.	Ensuring the procurement process is well planned and documented is essential in ensuring that the estimate pricing is based on the latest information and any gaps, or budgetary pricing can be identified. Analysis of received bids can assess the level of competition encountered in obtaining rates and prices from the marketplace and also the amount of normalisation necessary to compare bids which can be an indicator of scope certainty. The aforementioned points will aid in evaluating the accuracy of the estimates	Although the procurement process was not summarized within the estimate plans as recommended by BTTC, the information was considered and did exist when preparing the estimate. No additional update to the RQE was required. **EST-DTG-001** Estimating Desk Top Guide has been updated to reflect BTTC's recommendations. The EPMO Estimating group has taken an action to update the Estimate Plan template to include documentation of procurement processes (bid comparison/analysis). The IPD Estimating Team will follow this template when creating an Estimate Plan for future estimates.
CA2.4	Development of Cost Estimate (CA2)	B	**Risk Analysis and Contingency:** Requires the estimate to identify the method of risk analysis and contingency determination including software to be used. A summary of the risk analysis results should be included in a separate section of the basis of estimate with a cost risk profile chart **OPG-MAN-00120-0015-005** Project Risk management Sections 2.4.1 and 2.4.2 describe the methodology to be used depending on the project level, Monte Carlo (A and B) and EMV (C). and state the type of risks that will be included in the QRA, Section 3.0 outline types of contingency assessment that can be used on the project, but it is not specific on what will be used on the project. **OPG-MAN-00120-0012** - Project Estimating management lists risk register as an input (App A item 3)	Recommend **NK054-PLAN-01210-00108** DNNP Estimate Plan and **DA1-IDP-NN-NN-TPLN-CE-00001** DNNP Estimate Plan be updated to include specific references to **OPG-MAN-00120-0015-005** Project Risk management and **OPG-MAN-00120-0012** Estimating Manuals. Estimate plans should inform where the risk information and contingency is held, how it's been treated, and its relationship to the main estimate.	While there are plans and procedures for managing risk and contingency, they aren't detailed or referenced in the Developing the Basis of Estimate section. The estimate plans offer limited information on risk and contingency. It's important to consider how the development of the estimate will influence risk and contingency, as it helps address any missing information or assumptions needed to fill design gaps.	Although the OPG Risk Management and Estimating Manuals were not referenced within the estimate plans, they were considered, and processes used when preparing the update. No additional update to the RQE was required. The EPMO Estimating group has taken an action to update the Estimate Plan template to include a reference to the Risk Management governance documents. The IPD Estimating Team will follow this template when creating an Estimate Plan for future estimates.
CA3.1	Cost Estimate Classification (CA3)	B	**General Process:** **OPG-MAN-00120-0012** Project Estimating Section 2 and **EST DTG-001** Estimating Desk top guide Section 4. Both documents refer to AACE RP 18R-97 'Cost Estimate Classification for the Process Industry'.	These documents should be updated to incorporate AACE 115R-21 specifically for the Nuclear Industries as expected accuracy ranges differ and contains a more detailed estimate input checklist and maturity matrix. Further, OPG plans and procedures should reference the following AACE RP's where appropriate: • **56R-08 Cost Estimate Classification - Building and General Construction** for OPG Non-Nuclear (Normal Civils) • **18R-97 Cost Estimate Classification - EPC / Process** for OPG Non-Nuclear Complex Projects	AACE RP's ensures consistency in approach and that engineering deliverables stated within the RP's are in line with those likely to be encountered for the project at hand. Measures which flow from the engineering inputs such as estimating accuracy and range of outcomes will attract a higher level of confidence than would otherwise be the case.	Although AACE 115R-21 was not referenced wihin the OPG Project Estimating Manual and desk top guide, the DNNP met the more stringent estimate maturity requirements within this AACE recommended practice. More details are provided in Ex. D2-4-8 p. 2. No additional update to the RQE was required. **OPG-MAN-00120-0012** Project Estimating and **EST DTG-001** Estimating Desktop Guide have been updated to incorporate AACE 115R-21, 18R-97, and 56R-08 where applicable.
CA5.2	Developing a Project Risk Management Plan (CA5)	B	**Quantitative Risk Assessment:** Define escalation, including the types of risks and how budget values are derived. **DA1-IPD**_**NN-NN-TPLN-PM-0004** DNNP Functional Plan Project Controls: Section 6.1 describes that budget values will be derived using the project schedule and estimate values.	This requirement is partially covered in the project controls plan, however, cost escalation on contingency is not clearly described across the suite of documents provided. It is recommended to make it clear how escalation is dealt with.	It is important that the project team, namely the risk and estimating teams, understand how escalation will be managed concerning risk. This will avoid under or over estimation of risk impacts on the project	Although the treatment of cost escalation on contingency was not specified within the DNNP estimating plans, **OPG-MAN-00120-0012** Project Estimating describes how escalation and interest are being calculated by the Investment Management Team. This processes was followed when preparing the estimate. No additional update to the RQE was required. The EPMO Estimating group has taken an action to update the Estimate Plan template to include a clear definition of escalation, specifically cost escalation on contingency. The IPD Estimating Team will follow this template when creating an Estimate Plan for future estimates.

Assurance Workstream 2

ID	DNNP Management Plan	Category	Finding / Observation	Recommendation	Benefit / Impact	Disposition
AW2.1	DNNP Estimate Plan	B	**DA1-IPD-NN-NN-TPLN-CE-0001** Estimate Plan **Section 2.5** requires the source pricing will be identified, including supplier quotes, database pricing etc. 1. Equipment 2. Piping, speciality piping, cable, cable tray conduit 3. Structural steel, rebar, plate etc. 4. Control system components (control valves, I/O, transmitters, gauges etc.) The BOE/RQE does not detail/record what materials are the subject of supplier quotations and to what level (budget, firm, historical data etc.) - the RQE estimate does provide embedded information however it is limited in the flat extract of the estimate used in this study. A Summary table detailing information such as supplier name, firm quote/budget/database/number of bidders/sole source etc. would have been expected in the BOE. We have also been issued (29/04/25) with 3 summary files for equipment which record the maturity of the pricing/quotation but has limited vendor/supplier information, number of bidders, RFQ status etc. The vendor status description differs between DNNP partner information. As of 30/04/25 we have not received any information on Bulk materials	Equipment and bulk materials summary tables should be attachments to the BOE document. This would formally record and capture all the detailed requirements of the estimate plan, and the information used for pricing within the RQE. Recording and capturing this exact data within the BOE will allow greater audit and traceability of cost information contained within the RQE. Whilst reviewing work stream 2 with the DNNP team it is evident that a substantial amount of the information required by the DNNP estimate plan is available, however it is not centrally stored within a designated Class 3 records folder and has been difficult to retrieve easily and quickly.	Auditability and traceability of key pricing information. Ease of finding key information used within the class 3 estimate. Detailed records of vendors, number of bidders, quotes received, quotes status is important information as it captures the level of maturity, missing information, plug numbers etc for reporting movements from the estimate as pricing becomes firmer. Further, recording the source of cost information is an activity that is used when assessing the accuracy of cost data and facilitates the appropriate inclusion of design development and estimating uncertainty allowances.	Equipment and bulk materials pricing information was available but was not summarized in a table within the BOE. Capturing the source of pricing information would facililtate estimate reviews, however it would not have an impact to the final cost estimate. No additional update to the RQE was required. The EPMO Estimating group has taken an action to create a new Basis of Pricing template which will include a section on documenting and consolidating key sources of pricing information. The IPD Estimating Team will follow this template when creating a BOE for future estimates.
AW2.2	DNNP Estimate Plan	B	**DA1-IPD-NN-NN-TPLN-CE-0001** Estimate Plan **Section 2.9** Freight. Freight is generally included with material and equipment pricing. Separate shipments will be included as required. Special Loads will be identified and included as required. There is limited information captured within the BOE document and RQE estimate to identify what has been included in respect of freight. Our assessment of “Special loads” meaning within the estimate plan would be for the very large, specialist equipment and high value bulk materials. Also, due to size of the project many bulk materials will require a high number of separate shipments.	It is recommended that handling, shipping, transportation and storage of large equipment / modules warrants being captured in detail, with freight provisions further detailed and recorded by the project as a separate item within the RQE. Further, Incoterm requirements including duties/import tax, shipping options (factory to site, factory to port, port to site etc., and by which partner/vendor etc.), roles and responsibilities and transportation methods should all be detailed in the estimate reflecting the associated high cost and risk.	Detailing freight provisions separately allows auditability and traceability of included/excluded ownership, responsibility and cost provisions. It allows analysis of the full logistics trail for equipment and records the responsible party and facilitates accurate tracking and reporting the cost for the logistics and freight. For this type of project with its complexity and scale, freight will be a large cost outlay which covers a wide range of logistical operations under one heading. Therefore, separately recording in detail exactly what is covered by vendor quotes/prices will allow the full logistics process to be appropriately priced reflecting multiple part inputs during equipment/materials transportation to the site.	Freight costs were not explicitly documented in the BOE as they were included in the overall equipment pricing. Separating out the freight costs would increase visibility into the cost details but not have an impact to the estimate itself. No additional update to the RQE was required. The EPMO Estimating group has taken an action to create a new Basis of Pricing template which will document freight provisions and logistics assumptions. The IPD Estimating Team will follow this template when creating a BOE for future estimates.
AW2.3	DNNP Estimate Plan	B	**DA1-IPD-NN-NN-TPLN-CE-0001** Estimate Plan **Section 2.12** requires the labour wage rates be based on craft mix and crew compositions. The BOE does detail shift, rate source, productivity factors. We also recognise the BOE details the factor uplift for non□working foreman (FM and GM) which covers the element not included in the hourly rate, and the labour factors for productivity/complexity factors used to uplift the man hours. These are added within Hard Dollar and not visible on the RQE flat extract. The BOE has no section on crew mix and crew composition detailed. From our assessment of the RQE labour rates on Mechanical and Electrical sections have no crew mix and composition adjustment. These rates are based 100% of Journeyman level.	Recommend assessment of craft mix and crew composition to ensure an appropriate blended hourly rate. For example, tray, trunking, conduit, hangers, de-scaling pipe and preparation, bevelling, cutting etc. would not be undertaken solely by Journeyman labour and would use a higher percentage of apprentices and general labour for these types of works. This hourly rate should be calculated and used directly against the labour hours embedded into the estimate workbook/software and detailed within the BOE document. Note: It is recognised that within the RQE (CBS 29 - Below the line adjustment) there are items for “adjusting labour cost for Apprentice composition”.	Inclusion of craft and crew mix assessment embedded into the estimate file/software will improve accuracy of labour cost/trade and removes the requirement for a manual adjustment. Including a craft and crew mix assessment allows tracking of estimated crew composition to actual as work progresses for reporting and tracking, records union requirements for Apprenticeship levels and is generally considered to be estimating good practice.	Although not documented within the BOE, craft mix and crew composition were assessed and taken into account when determining labour costs. No additional update to the RQE was required. The EPMO Estimating group has taken an action to create a new Basis of Pricing template which will document crew mix and composition. The IPD Estimating Team will follow this template when creating a BOE for future estimates.

SEC Interrogatory #114

Interrogatory

Reference:
D2-4-9, p. 7-8

Question(s):

With respect to cost and schedule performance, please provide the most recent DNNP, a) Schedule Performance Index (SPI), b) Cost Performance Index (CPI), c) Cost Variance (CV) and Schedule Variance (SV), d) Estimate at Completion (EAC), and e) Variance at Completion (VAC) scores/values, as well as the inputs (e.g. for CPI, the Earned Value and Actual Cost).

Response

Refer to Ex. L-D2-AMPCO-085.

SEC Interrogatory #115

Interrogatory

Reference:
D2-4-9, p. 16

Question(s):

With respect to DNNP Oversight and Assurance Model:

a) Please detail the regular reporting that is provided to the Chief Projects Officer, and the OPG Executive Leadership Team regarding the DNNP. For each regular reporting mechanism (weekly, monthly, and annual reporting), please provide the latest copy.

b) Please provide all reports to date provided by OPG management, and the Nuclear Oversight function, with the Major Projects Committee of OPG's Board of Directors related to the DNNP regarding DNNP progress, and any issues that have arisen to date.

c) With respect to the DNNP Board of Directors,
   i. Has the DNNP Board of Directors been established yet? If so, please provide details of the membership.
   ii. Please provide all materials provided to the DNNP Board of Directors to date.

Response

a) Currently, DNNP reporting is provided monthly to OPG's Chief Projects Officer and quarterly to the OPG Executive Leadership Team. The reporting includes updates regarding safety, quality, cost and schedule as well as other items of interest. The latest copy of each of these reports are provided as Attachment 1 (confidential) and Attachment 2 (confidential).

b) DNNP Information Reports have been provided to the Major Projects Committee ("MPC") of OPG's Board of Directors on a monthly basis since 2023, and prior to that, on a quarterly basis since 2021. Due to the significant number and lack of relevance of prior reports, OPG has only provided its most recent DNNP Information Report to the MPC as Attachment 3 (confidential).

   A table summarizing all Nuclear Oversight Reports associated findings, and corrective actions can be found in Attachment 4. All corrective actions associated

with findings identified by OPGs Nuclear Oversight function are tracked to completion through OPGs robust Corrective Action Process.

c)

i. Yes. The DNNP LP Board of Directors consists of five directors:
   - Jon Franke (OPG)(Chair);
   - Chris Cunningham (OPG);
   - Omar Masud (OPG);
   - Patrick Chabot (Canada Growth Fund Inc.); and
   - Anca Drexler (Building Ontario Fund).

ii. DNNP LP declines to respond since the request for all materials provided to the board of directors is overly broad and nonspecific and as such does not provide any basis of relevance.

DARLINGTON NEW NUCLEAR PROGRAM

SMR Program Update

OPG Proprietary

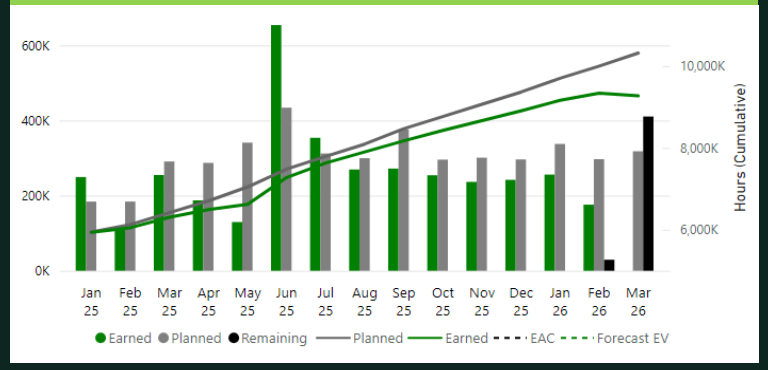
Social License

SMR1 Program Total Value
Total: **36 Projects**
Value: **$7.698** Billion (includes interest, escalation, & contingency)

Indigenous Spend
Actuals: $2.74M YE Target: $40M
Forecast: **41.8M**

Diverse Supplier Contracts Spend
Actuals: $0.034M YE Target: $2.0M
Forecast: **2.0M**

Program Labour Hour Distribution



Commercial Operation Date
Baseline Date: 21-Apr-30
Forecast Date: 19-Nov-30

Critical Path
87 days behind plan (Basemat)

Project Excellence

SPI: 0.94

DNNP SMR 1 Overall % Complete
Actual: 41% YE Target: 56%
LTD Plan: 44%

DNNP SMR 1 Construction Progress
Actual: 16% YE Target: 38%
LTD Plan: 20%

SCHEDULE Variance
Feb ME -631k (Jan ME -604k)

Submission of License to Operate Small Modular Reactor (SMR 1)
Actual: 26-Mar-26 Target: Jun 30, 2026

Look-Ahead Milestones (Critical Path)

Milestone	Baseline Date	Current Forecast	Forecast Status
Finish DEC Simulator Installation	25-Nov-25	31-Mar-27	Missed
RB Shaft Ready to Use	24-Dec-25	13-Mar-26	Complete
Basemat Ready for First DPSC Module Lift	30-Jan-26	27-Apr-26	Missed
LTO Application Submitted	31-Mar-26	26-Mar-26	Complete
RB Level 1 Complete	13-Jul-26	31-Dec-26	Behind

Financial Strength

CPI: 0.89

Contingency Health
Total: 1240M
Remaining: $1175M

DNNP SMR1 LTD Cost Target $3.41B
Actual: $2.08B Plan: $2.35B
YE Forecast: $3.34B

Top Program Risks

ID	Title	Owner	Current Score	Post Score	Response Type
62293	Delayed delivery of critical items could impact project schedule and cost.	JONES, Mel	15	6	Mitigate
73704	Incomplete or Misaligned Information Turnover	Wang, Michael	15	4	Mitigate
69881	Additional procurement costs may need to be incurred if projected savings are not realized.	Zhang, Kevin	12	12	Accept
69885	Due to potential threats of new and increased tariffs applied to import and exports between Canada and USA, there is a risk of higher procurement costs. (Excluded from contingency calculation due to the high degree of uncertainty and changing conditions).	Zhang, Kevin	12	6	Mitigate

SMR-X Team

- Basemat fabrication is 12 weeks behind the internal schedule, with basemat installation forecasted on April 27, 2026. DPSC welding has progressed ahead of revised forecast and thus, the critical path is transitioning to the Reactor Building shaft in-pit work, in preparation for basemat lift.
- OPG has submitted the License to Operate (LTO) application to the CNSC ahead of plan in March 2026.
- All three shaft excavation work is now complete, marking a significant milestone in site construction.
- The Heavy Lift Crane, biggest crawler crane in Canada has been assembled for the 905 tonnes, 36-meter diameter basemat lift.

- **Finish DEC Simulator Installation** - The third-party reviewed recovery plan for the simulator, will deliver a standard (emulation) simulator by Q4 2026 and a full-scope simulator by Q4 2027 to support the Initial Certification class.
- Basemat fabrication is 12 weeks behind the internal schedule, with basemat installation forecasted on April 27, 2026.

- **Nuclear Island:** Underspend of $155.7M driven primarily by: $96M due to delays in equipment: (Procurement Oversight, B21 Nuclear Boiler, C10, C20, C30 I&C System,). $32M behind planned due to DPSC weld failures and the subsequent repairs and $15M underspend due to delay in radwaste building (RWB)/Procurement:). Recovery for the basemat lift is being assessed. $7M behind planned due to delay in procurement: (U31- RB Crane, K10 Offgas System& Cooling Systems) and $5.7M in others.
- **Conventional Island:** Underspend of $88.8M driven primarily by: $14M the delays in procurement for Instrumentations & Piping, $12M delays Piling & Caissons, $9M in Condensate & Feedwater Heating System (Equipment), $5.2M in Security Building (Instrumentation), $8M delays in Non-Safety Electrical Distribution, and $40M for other condensers & auxiliaries' equipment.

- **Design Engineering:** The schedule variance backlog increased from 193K hours to 247K hours within the period. The primary drivers of the additional variance are electrical, Instrumentation & Control (I&C) design.
- **Nuclear Island:** Overall schedule variance backlog decreased from 168K hours at January month end to 118K at February month end. Primary drivers include DPSC offsite drafting/technical support for levels 1-4 and basemat on-site
- **Conventional Island:** Overall schedule variance backlog increased from 135K hours at January month end to 144K at February month end. Primary drivers include N31 (Main Turbine & Generator), U43 (Fire Protection), U72 (Pile and Slab Construction), and R41 (Grounding and Lightning Protection System)

(Issue) Fabrication of the Reactor Pressure Vessel (RPV) continues at BWXT, currently forecasting a 220-day delay to the delivery of the RPV (April 2028 vs. October 2027). The delays are due to a combination of design changes as well as fabrication issues and a managed decision to move the shipping window after the St. Lawrence winter waterway closure. This currently puts the RPV very near critical path and any additional delays will negatively impact the completion of the Reactor Building.

(Risk) Incomplete or misalignment of data turnover for Operations - Incomplete or misaligned information turnover to OPG during the turnover phase may lead to insufficient documentation to support operational readiness and critical path delays. Additional work to perform data integration and acceptance could also be required.

[redacted]

Darlington New Nuclear Project (DNNP)
Q4 2025 ELT Update

SMR-X OPG Leadership Team | Feb 27, 2026

OPG Proprietary

Agenda

1. Land Acknowledgment – Mike Zdero
2. Safety Moment – Adriana Chang
3. Program Performance – Ryan Howard, Chris Cunningham
4. Operations – Bob Jackowski
5. Execution – Mike Zdero, Carol Lam, Ebraheem Waraich
6. Engineering – Blake Ruelens
7. Licensing – Kristina Bramma
8. Supply Chain and Procurement – Kevin Zhang
9. Appendices

Land Acknowledgement

Land Acknowledgement

OPG | Electrifying life

The lands and waters on which the Darlington New Nuclear Project (DNNP) is situated are the traditional and treaty territory of the Williams Treaties First Nations, which includes Curve Lake First Nation, Hiawatha First Nation, Alderville First Nation, Chippewas of Beausoleil First Nation, Chippewas of Georgina Island First Nation, Chippewas of Rama First Nation, and the Mississaugas of Scugog Island First Nation.

The DNNP is within the territory of the Johnson-Butler Purchase/Gunshot Treaty (1787-88) and the Williams Treaties of 1923. These Treaty Rights were reaffirmed in 2018 in a settlement with Canada and the Province of Ontario.

To acknowledge the treaty and traditional territory, is to recognize the rights of the First Nations. It is to recognize the history of the land, predating the establishment of the earliest European colonies. It is also to acknowledge the significance for the Indigenous peoples who lived and continue to live upon it, to acknowledge the people whose practices and spiritualties are tied to the land and water and continue to develop in relation to the territory and its other inhabitants today.

ALDERVILLE FIRST NATION | BEAUSOLEIL FIRST NATION | CURVE LAKE FIRST NATION | GEORGINA ISLAND FIRST NATION | HIAWATHA FIRST NATION | SCUGOG ISLAND FIRST NATION | RAMA FIRST NATION

Journey To Excellent Safety Performance

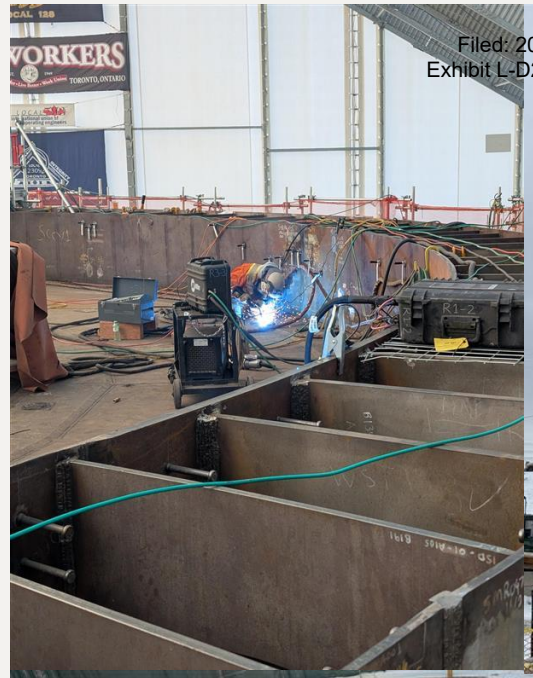
Since our last critical injury in July 2025

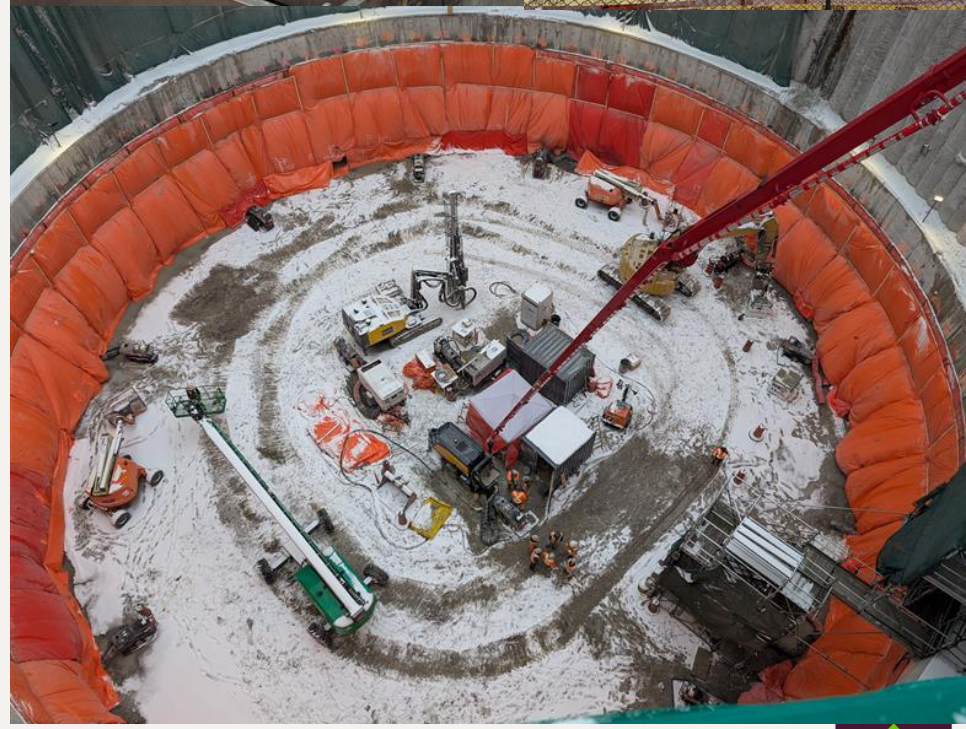
IMPROVED PERFORMANCE

- ☑ **Safety – EHS Committee Field Engagement**
- ☑ **Supervisory Engagement**
- ☑ **Enhanced Construction Oversight Training**

CRITICAL FOCUS AREAS

- **Hoisting and Rigging – Basemat lift, lift plan reviews**
- **Hot Work and Combustibles**
- **Struck By (industry's top cause of fatalities) – Spotters**





Areas for Improvement

1. Procedural integrity and completeness
    - Version control
2. Effective implementation of safety related corrective actions from CLBs
3. Subcontractor oversight
    - Utilities
    - Administrative Building

Program Performance

SMR 2-4 Executive Summary

Key Project Highlights

[redacted]

Look-Ahead SMR 2-4 Milestones (3-6 months)

[redacted]

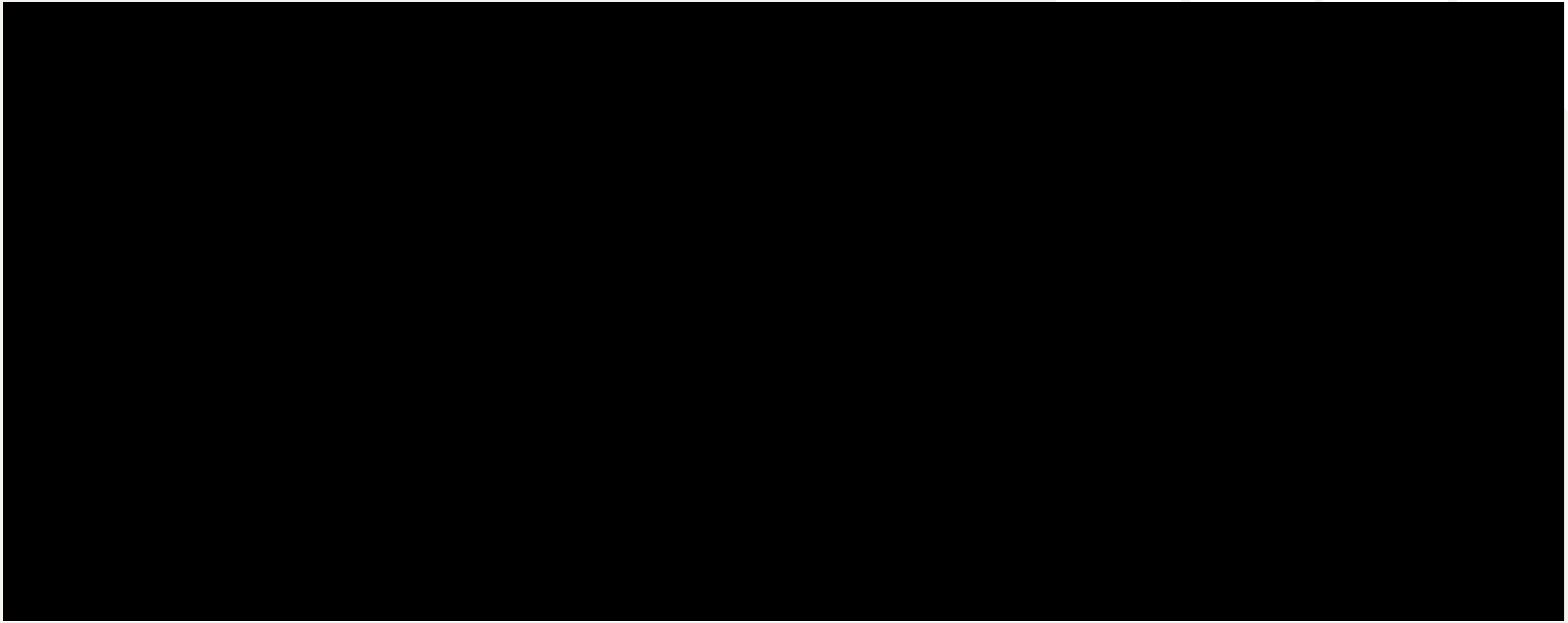
Risks, Issues and Opportunities

[redacted]

Cost and Schedule Variance

[redacted]

Optimization Update



Modularization Animation – Unconstrained Vision

Modularization Status

Commercial Agreements Roadmap

Key objectives driving the commercial strategy:

[redacted]

[redacted]

[redacted]

Activity

[redacted]

Procurement Cost Mitigation Opportunities

[redacted]

4 Unit Procurement Release Plan

[redacted]

Unit 2-4 DPSCs Roadmap

SMR1 Dashboard

Social License

Health Safety & Environment

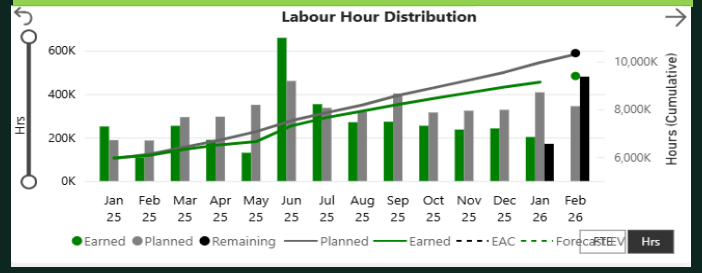
DATA FREQUENCIES	YTD	12 MTH ROLLING
Hours Worked	168,472	1,465,094
TRIR	0	1.09

Quality Performance
L1 / L2 ACERs: 0 L3 / L4 ACERs: 29
Overdue Actions: 9
IPD Observation trends: -

[redacted]

Culture (Collaboration) - 3-month rolling
# of Recognitions (NOPs): 66
Cross company Recognitions (NOPs): 35

Construction Labour Hours Distribution



Project Excellence

SPI: 0.94
SPI (IPD): 0.89
Overall % Complete Actual: 41% Plan: 44%

Schedule Variance
Jan ME -604k (Dec ME -523k)

Construction Progress Target
Actual: 16% YTD Plan: 20%

Design Progress Target
(Including I&C and Execution Design Deliverables)
Actual: 86% YTD Plan: 90%

Look-Ahead Milestones (Critical Path)

Milestone	Baseline Date	Current Forecast	Forecast Status
Finish DEC Simulator Installation	25-Nov-25	26-Oct-26	Missed
RB Shaft Ready to Use	24-Dec-25	18-Mar-26	Missed
BL3 Design Complete	31-Dec-25	31-Dec-25	Complete
Basemat Ready for First DPSC Module Lift	30-Jan-26	27-Apr-26	Missed
RB Level 1 Complete	13-Jul-26	31-Dec-26	Behind

Commercial Operation Date
Baseline Date: 21-Apr-30
Forecast Date: 19-Nov-30

Financial Strength

CPI: 0.91
FAF: 0.98
Lifecycle BAC (excluding contingency): 6,517M
Actual: $2,002M Plan: $2,259M
EAC: $6,923M

CPI (IPD): 0.89
Lifecycle BAC (excluding interest and contingency): 3,914M
Actual: $1,488M Plan: $1,754M
EAC (pAOC): $4,333M

Contingency Health
Total: $1240M
Remaining: $1180M

Top Issues

- DPSC Onsite Fabrication
- Engineering IFC Completion

[redacted]

House Load

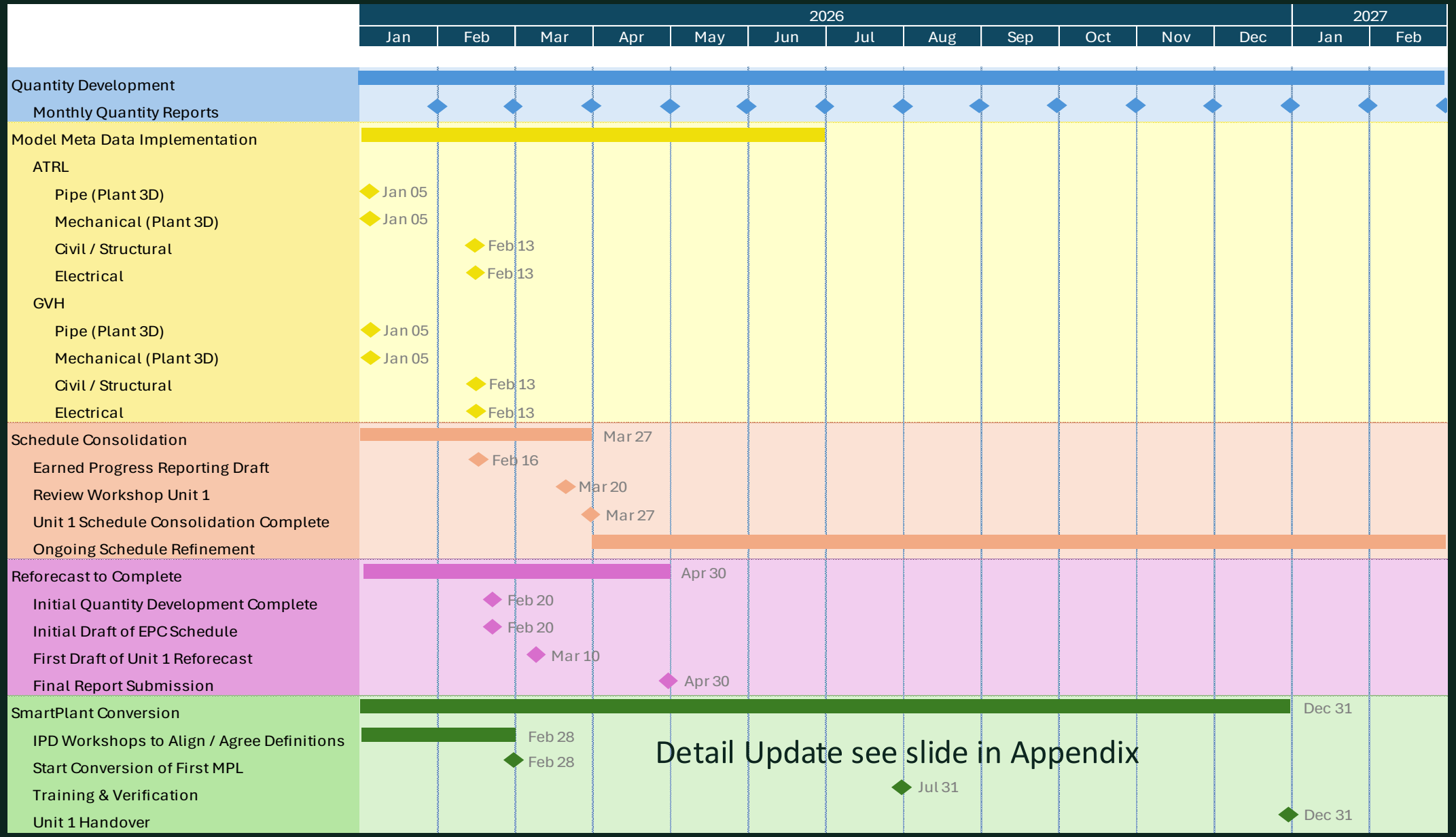
Baseline: 18MW
Forecast: 17.891MW

Readiness

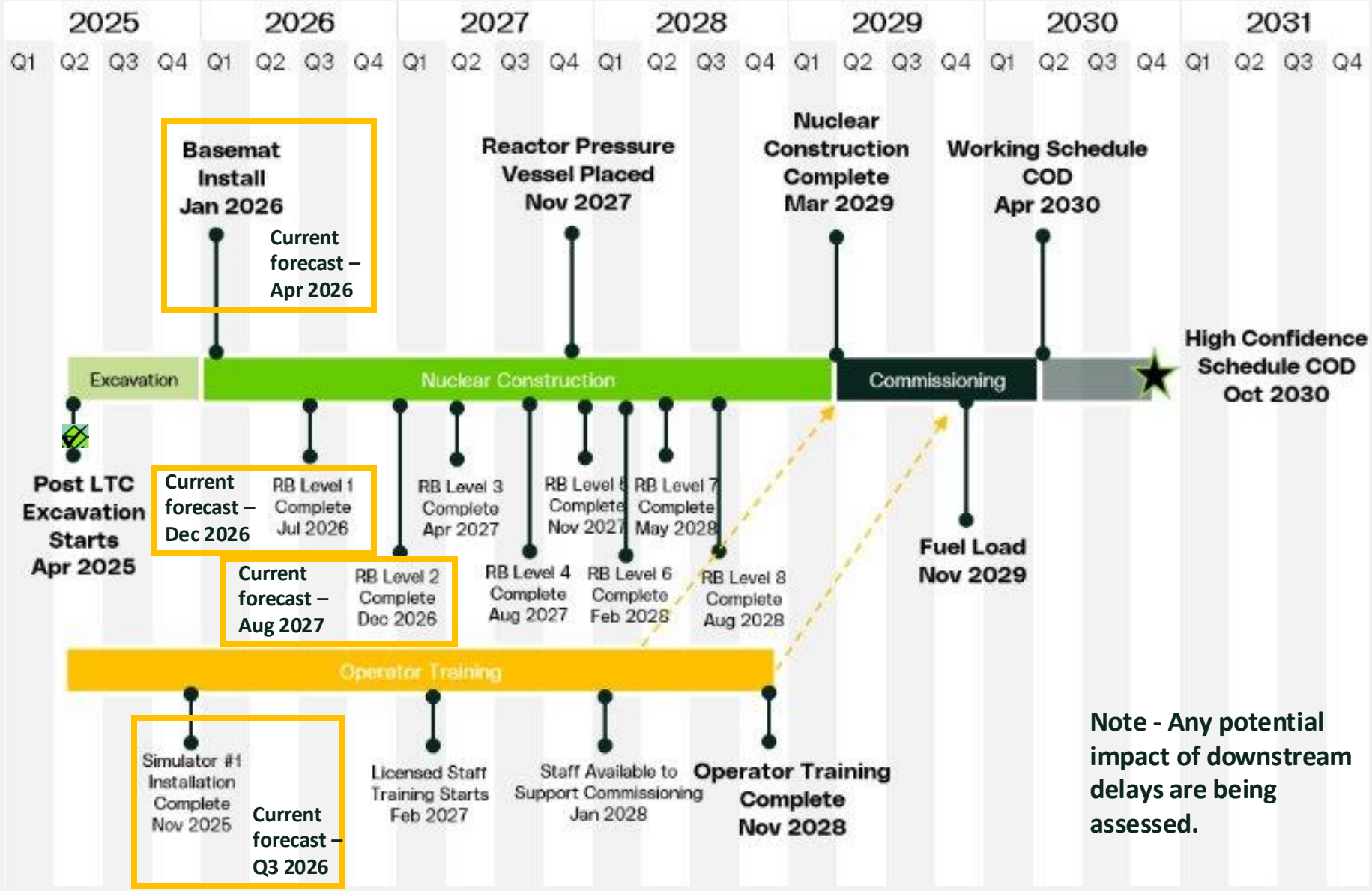
Readiness: 92%

T-19 Milestone Adherence: 37%

Key Programmatic Priorities



Unit 1 Key Milestones | Working Schedule



Unit 1 Cost Contingency Status

Operations

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Operational Readiness Performance & Status

CPI: 1.01 SPI : 0.97

Major Milestones

- **WANO TSM OR**

Q1

- **LTO application Submission**
- **WANO TSM for training**

Q2

Q3

- **Management System Teir 3 Doc**
- **Simulator ready for training and procedure validation**

Q4

Status / Highlights

- Initial Certified Training (ICT) mitigation plan developed and presented to PLT
  - Commissioning and Train the Trainer (TtT) in same training classes
  - Approval for additional class in coming months
- New management system documents ready for LTO submission
- Digital tools all on track per schedule and proving assumed capabilities
- Independent review of Commissioning plans

Challenges

- Training Execution Readiness
  - Design delivery remains critical for ICT recovery plan
  - No remaining margin in schedule to recover if ICT failure rate higher than assumed
  - Admin Building Simulator required for ICT
  - Procurement information required to develop Maintenance procedures and Field Tech Training
- Data Transition Plans
  - Owner's requirements, data mapping, and detailed information turnover schedule in development to support transition to operations systems

Opportunities

- Collaborative Training development and delivery using OPG Training staff to augment GVH Training development team

Construction Lookahead

No.	Activity	Planned % Complete	Actual % Complete	Delta % Complete	Baseline	Forecast Completion Date	Duration Variance (months)
1	DPSC Offsite Fab (Basemat)	100%	91%	-9%	25-July-2025	13-Feb-2026	-7
2	DPSC Onsite Fab (Basemat)	100%	40%	60%	30-Jan-2026	27-Apr-2026	-3
3	Reactor Building Excavation Shaft	100%	80%	-20%	24-Dec-2025	18-Mar-2026	-3
4	Turbine Building Piling	100%	80%	-20%	12-Dec-2025	03-Apr-2026	-3.5
5	Forebay Shaft (Soil Excavation)	100 %	100 %	0%	12-Sep-2025	23 Dec 2025	-3
6	Launch Shaft Excavation(Soil & Rock)	100%	89%	-11%	2-Jan-2026	28-Mar 2026	-3
7	Fabrication Shop Building	100%	99%	-1%	15-Sep-2025	28-Feb-2026	-6
8	Warehouse	100%	99%	-1%	31-Aug-2025	28-Feb-2026	-6
9	Admin Building	46%	21%	-25%	31-Oct-2026	27-Jan-2027	-3
10	Marine Works	70%	70%	0%	30-Oct-2027	9-Oct-2027	+1

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Construction Lookahead

- **Nuclear Island**
  - Reactor building shaft excavation is progressing with rock anchor installation, shotcrete and rock break/mucking. Completion is on track to support the basemat lift in April 2026.
  - RCSB concrete slab placement is 3 months behind baseline however a recovery plan is in place to mitigate downstream impacts. Slab concrete will be placed in Q1 2026.
  - Completion of the simulator (hardware), revised plan for training and simulator presented to PLT that supports training needs.
  - Constraints/concerns : RPV and RIN design evolution driving cost and schedule overrun (impact to be presented to PLT this month)
- **Conventional Island**
  - Piling work is behind plan with 98/122 piles complete. Forecast completion date is trending to April 2026. Managed decision made to remove evening / weekend shifts to minimize cost impacts as piling can be conducted in parallel with slab works. Slab mud mat SOI achieved 3rd week of February.
  - Constraints/Concerns: TB slab IFC holds and continued design issues – delaying the completion of rebar shop drawings and affecting the concrete pours. Start of rebar is now planned for beginning of April, which will impact FOI. In addition, thermal stress/core temperature concerns have not been fully resolved, affecting downstream pours.
  - Constraints/Concerns: Structural Steel IFCs on hold, pending equipment design input. IFC issuance is trending to September 2026 (due at the end of 2025) with a current need date of March 2026 (working with vendor to confirm a potential later date).
- **Balance of Plant**
  - Key hours variance expected to be recovered by Q1 2026 for Launch shaft excavation, Forebay base slab, and buildings.
  - Team is implementing an updated execution strategy for the start/commissioning of the tunnel boring machine. This will allow for schedule impact avoidance (maintain Q3 2026 start), and cost savings.
  - Warehouses and Fabrication construction complete and now commissioning.
  - Constraints/Concerns: Admin Building forecast of Jan 2027 at risk, with key handover dates to support simulator area on track.

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Engineering

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Engineering

CPI: 0.95 SPI : 0.95

Major Milestones

- **BL3 (Mech/Elec/Civil) Acceptance**
- **POSAR Rev 0 issued**
- **LTO Submitted**
- **RHP-1 Removal**
- **LTO Package #2 Submission**
- **BL2B I&C Complete**

Status / Highlights

- Overall Unit 1 Design Progress: Actual 85%, Plan: 89%
  - Execution (EXE) phase schedule integration workshops underway to perform logic tying across engineering, procurement and execution.
  - Baselining efforts ongoing is expected to reduce design completion (Estimated ~10%).
- BL3 milestone completed – Shifting to execution phase readiness. Review cycle underway for BL3 Acceptance milestone.
  - Early results show good quality, but many open items. Risk to March 31 given LTO/POSAR.
- POSAR page turns completed in support of Rev 000 as key input to LTO (on track)
- CNSC LTO early engagements underway for critical areas (Design, Nuclear Safety)
- Design optimization ideas reviewed for DNNP 2-4

Challenges

- Safety Strategy, DPSC, and Design Extension conditions (DECs) have a few remaining open items for RHP-1 closure.
  - Significant progress has been made in closing and linking to an appropriate
  - Additional oversight is put in place along with licensing and technical meetings with CNSC management.
- I&C Plan for standard plant design (BL2B) matured and progressing to new target date of Q4 2026.
- Site Specific I&C completion (BL3-1) impacted by EXE phase and Engineering Changes from mechanical/electrical. Plan continues to mature.

Opportunities

- Supporting Procurement through progressing engineering standards to simplify number of unique parts and standardized monitoring.
- Partnering with Reg Affairs to increase joint technical-regulatory touchpoints to avoid surprises
- Engineering Staffing survey initiated for future unit and operational staffing.
- Engaged with Modernization Hub to collectively support the operational engineering tool suite.
- Supporting transition to SmartPlant® for project execution and ensuring owner's requirements are clear.

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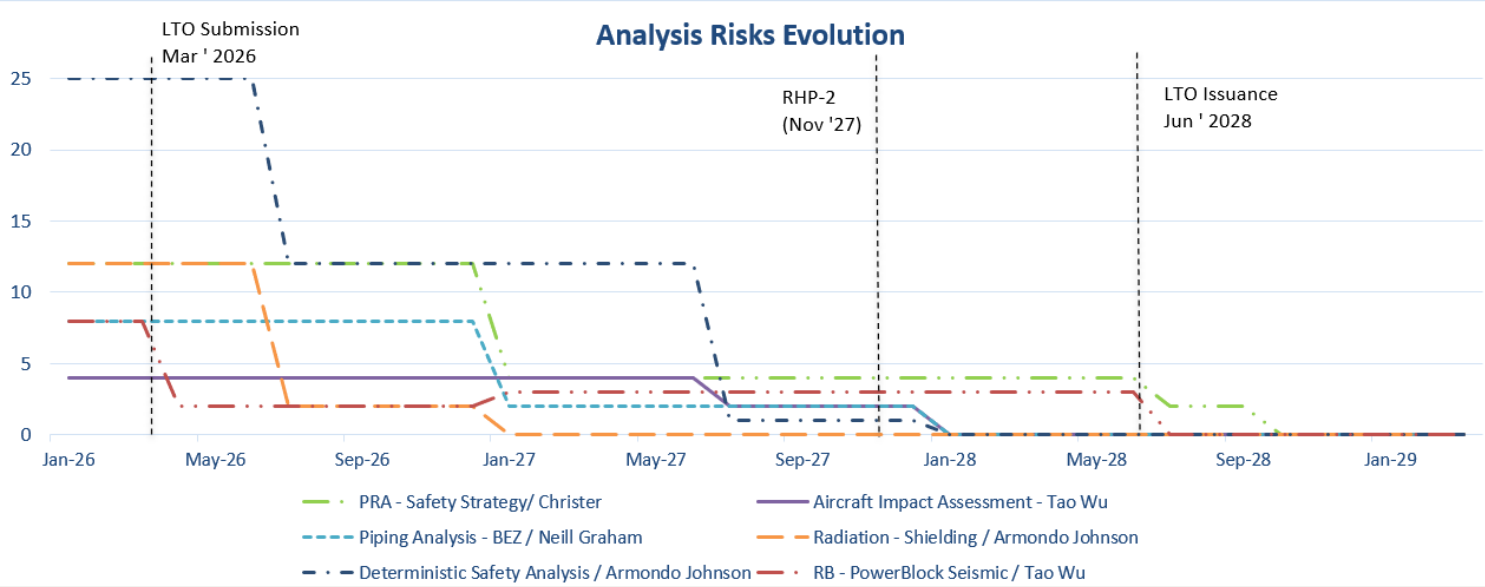
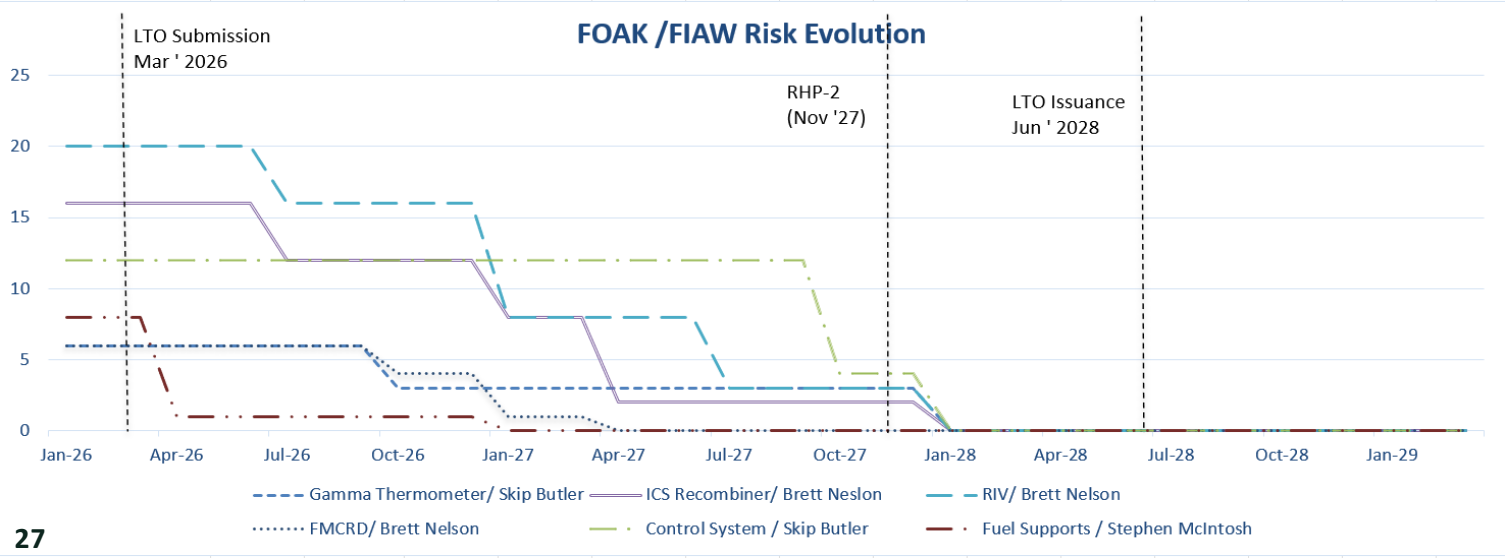
Key Technical Risks

Analysis Risk Evolution



FOAK / FIAW Risk Evolution



Updates:
Risk management and oversight has continued to mature and continues to reduce FOAK/Technical Risks in general.

Key technical risk items are:

- Control System (I&C) Maturity: Hardware de-risking activities progressing to plan. Many NUMAC hardware risks resolved. Item added for integrated platform testing. Readiness for training and simulator risk managed separately.
- Safety Strategy: Progressing to plan. Leak detection strategy presentation to CNSC in 2026Q2.
- Piping Analysis – Remains on track. No threats.
- Safety Analysis (Deterministic/Severe Accident): Early Release strategy progressing to resolve in 2026Q2. Potential risk to minor design changes – Team in-progress.
- Reactor Isolation Valve (RIV): Design and prototyping activities are progressing to plan.
- Isolation Condenser System (ICS): Testing POs are all in place, and tracking to plan.
- Shielding: Tracking to plan. Concrete testing results expected imminently.

Heightened oversight is being put in place to ensure focus isn't lost due to DPSC issues and some delays in risk mitigation action completion

- Monthly Technical Issues Review Meetings enable cross-functional teams to prioritize and resolve challenges effectively.
- Executive Board and Monthly CEO Briefings focus on top issues to ensure leadership is informed and facilitates timely decisions

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Licensing

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Licensing Performance and Status

CPI: 1.24 SPI : 0.99

Major Milestones

- **LTO Application Package 2 Submitted**

Q1 — Q2 — Q3 — Q4

- **RHP-1 Released Request to CNSC**
- **LTO Application Package 1 Submitted**
- **L&ILW LTC Amendment Application Submitted**

Status / Highlights

- LTO Application - On track - 25MAR26
  - Submitted to Indigenous communities for review
  - Final comment resolution 13FEB26
  - SVP Final Page Turn - 10MAR26
- Low and Intermediate Level Waste (L&ILW) LTC application drafted and in review – At Risk
- RHP 2&3 Deliverable Identification - 30MAR26
  - With CNSC for comment and acceptance

RHP Status

- RHP-1 Deliverables tracker (39 total) - Forecast 26MAR26
  - ❑ Submissions Remaining: 0
  - ❑ Deliverables with CNSC for Review: 4
  - ❑ CNSC Responses with OPG for Disposition: 7
  - ❑ Commitments pending Closure: 6
  - ❑ Accepted by CNSC: 17

Challenges/Opportunities

Risks

- RHP-1 Deliverable Acceptance
  - Licensing and Technical meetings established twice a week with experts to resolve lingering comments
- L&ILW Waste LTC Amendment
  - Design maturity and completeness of supporting deliverables presents a risk for CNSC decision timeline

Opportunity

- Streamlined submission approval process for deliverables that overlap LTC and LTO

Supply Chain (Procurement)

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Supply Chain

Major Milestones

Q1 Q2 Q3 Q4

Status / Highlights

[redacted]

- SMRRB Visit – procurement progress and strategic positioning
  - Implemented end-to-end procurement visibility tool to enable better operational control
  - Formalized bulk procurement strategy leveraging economies of scale across 4 units for cost efficiency
  - Enhanced governance with Procurement Work Package coding, updated approval processes and Material ID alignment with ERP requirements

Challenges

- Cost Escalation
  - First-of-A-Kind designs cause uncertainty, engineering rework and contract changes
- Supplier Capacity Constraints
  - Limited nuclear-qualified suppliers lead to premium pricing and long lead time
- Quality Standards Impact
  - Nuclear-grade standards add overhead through inspection and qualification testing
- Schedule Risks and Governance
  - Design immaturity and evolving specs extend timelines
  - Governance models and lookahead schedule help control delays

Opportunities

- Fleet procurement initiative with GEVH
  - Kick off meeting planned with GEVH to outline detailed plan for the two teams to define the opportunities, jointly negotiate with the vendors and provide regular report of progress
- Bulk procurement strategy has been developed to ensure cost efficiency and schedule reliability
  - Focus on aggregated demand for high-volume commodities (valves, HVAC, structural steel, concrete, rebar, piping, insulation etc)
  - Further develop piping suppliers in Sarnia, capitalizing on current local capacity

[redacted]

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ELT Support Required

Area of Support Required	Description
Security Clearances	Continued support with security clearances to support North American/international contractors. Implement MOU for CCW and Admin Building scope.
Site Name	Site name is impacting progress of deliverables (e.g. LTO application, digital tool configuration, culture plan)
[redacted]	

Appendices

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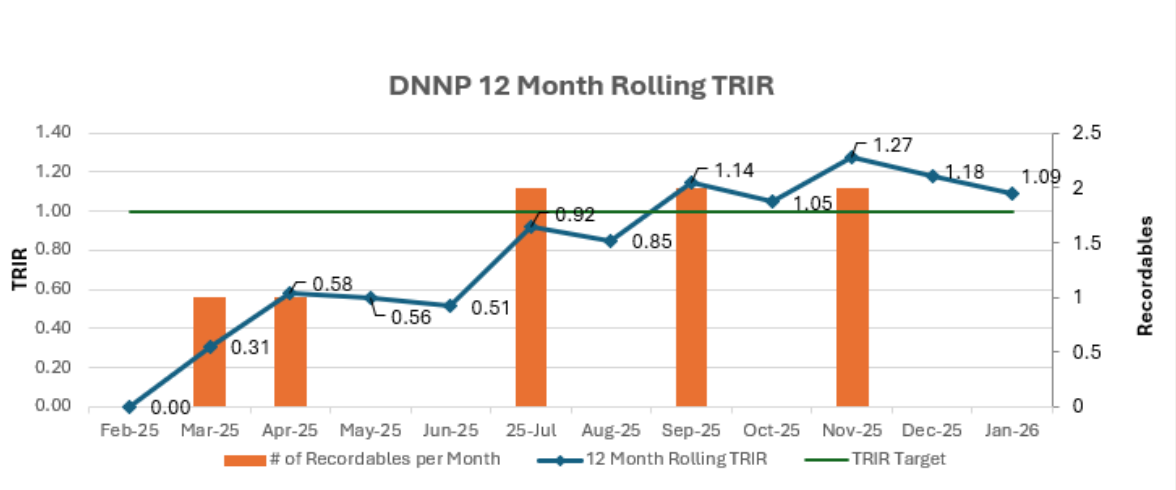
Safety



DATA FREQUENCIES	YTD	12 MTH ROLLING
Hours Worked	168,472	1,465,094
TRIR	0.0	1.09

LEADING INDICATORS	TARGET	TOTAL	CUR MTH Completion %	PRE MTH Completion %	CUR MTH Criticality %
Critical Control Verifications (CCV)	184	229	124%	137%	16%
Observations & Coaching (O&Cs)	297	443	149%	138%	24%
Workplace Inspections	282	367	130%	123%	25%

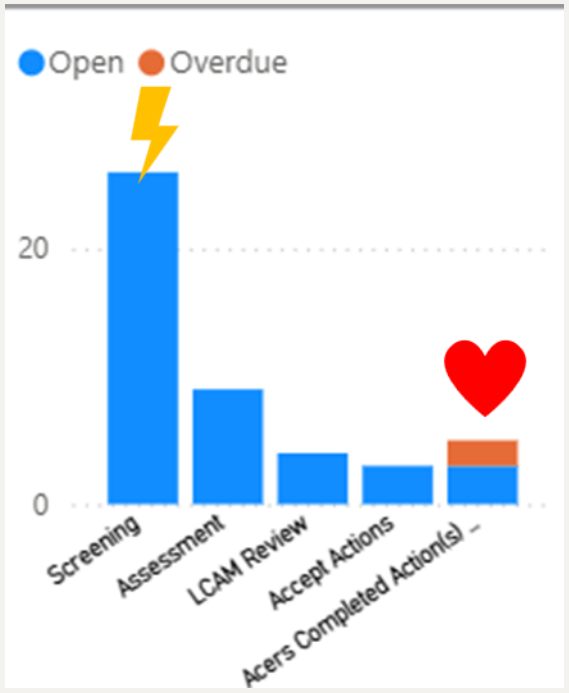
Key Messages

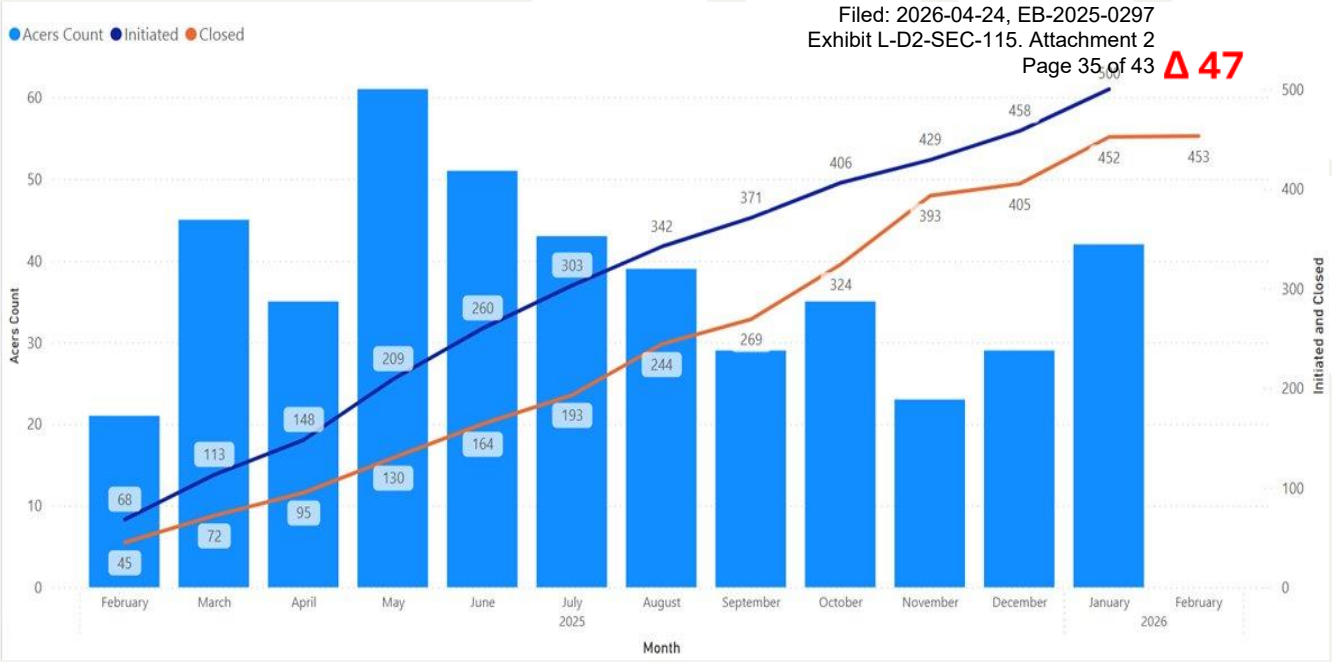
1. Perception survey and engagement survey actions TCD- March 31/2026
2. PAPR's pilot underway.
3. Diesel spill remediation TCD- end of February
4. Internal EHS audits completed for Subcontractor Management, Document Control & Record Retention, and Hoisting, Rigging and Material Handling completed, supporting continual improvement.
5. Learning Teams session continues supporting lessons learned.
6. Solid improvements with Observations numbers, turning attention to improving quality.

Δ 47

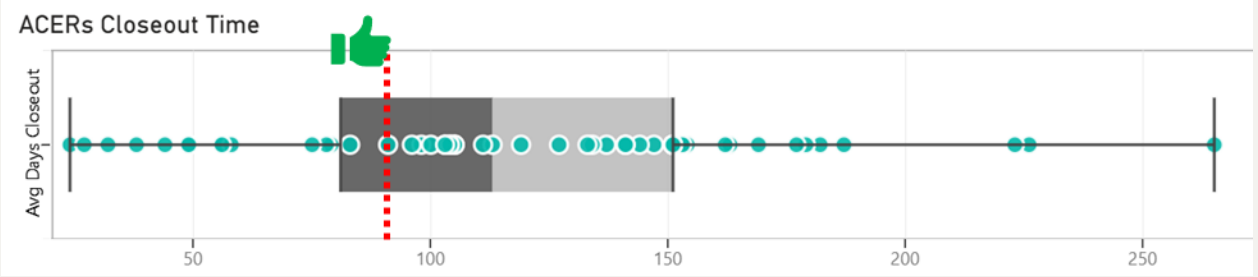
Quality

	Green-Good	Yellow-Medium	Red-Worst
SL-2 Open in Period	<=3	>3, <=10	>10
SL-1 Open in Period	0	<=3	>3
Overdue ACER Actions*	<=5	>5, <=10	>10

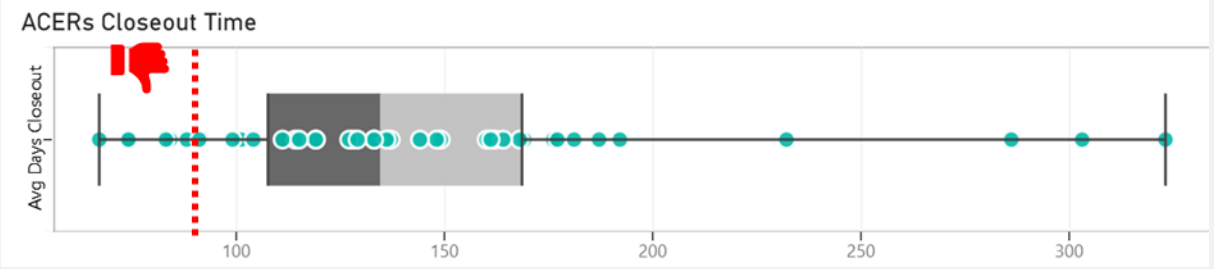




Bundle Related SL3 – **Median: 113**, Q1: 81, Q3: 151

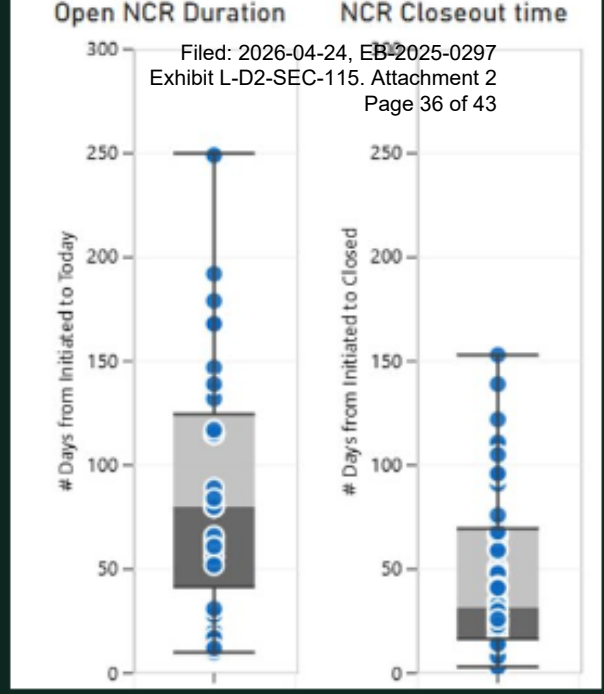


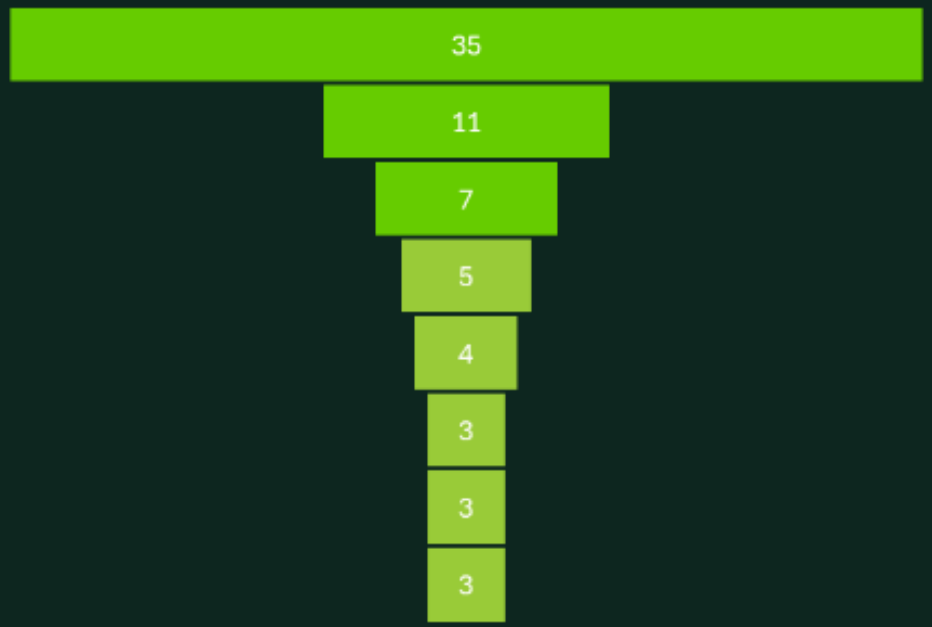
Non-Bundle Related SL3 – **Median: 134**, Q1: 107, Q3: 168



Non-Conformance Report

Type	Total	Open	Closed
Non Conformance Report	130	46	84
Nuclear Corrective Action Report	20	5	14
Overage, Shortage & Damage Report	4	2	2
Supplier Corrective Action Request	19	4	15





RB Structure Basemat: Pre-Assemble/OnSite Fabrication

Outfall Shaft Stage-3, Rock Excavation & Blasting -WMS

Rad Waste Building - Caissons

RB Shaft Rock Blasting - Excavation Stage -3

Forebay Shaft Excavation - Stage 1 (88masl-63masl)

No CWP associated

Service Building - Caissons

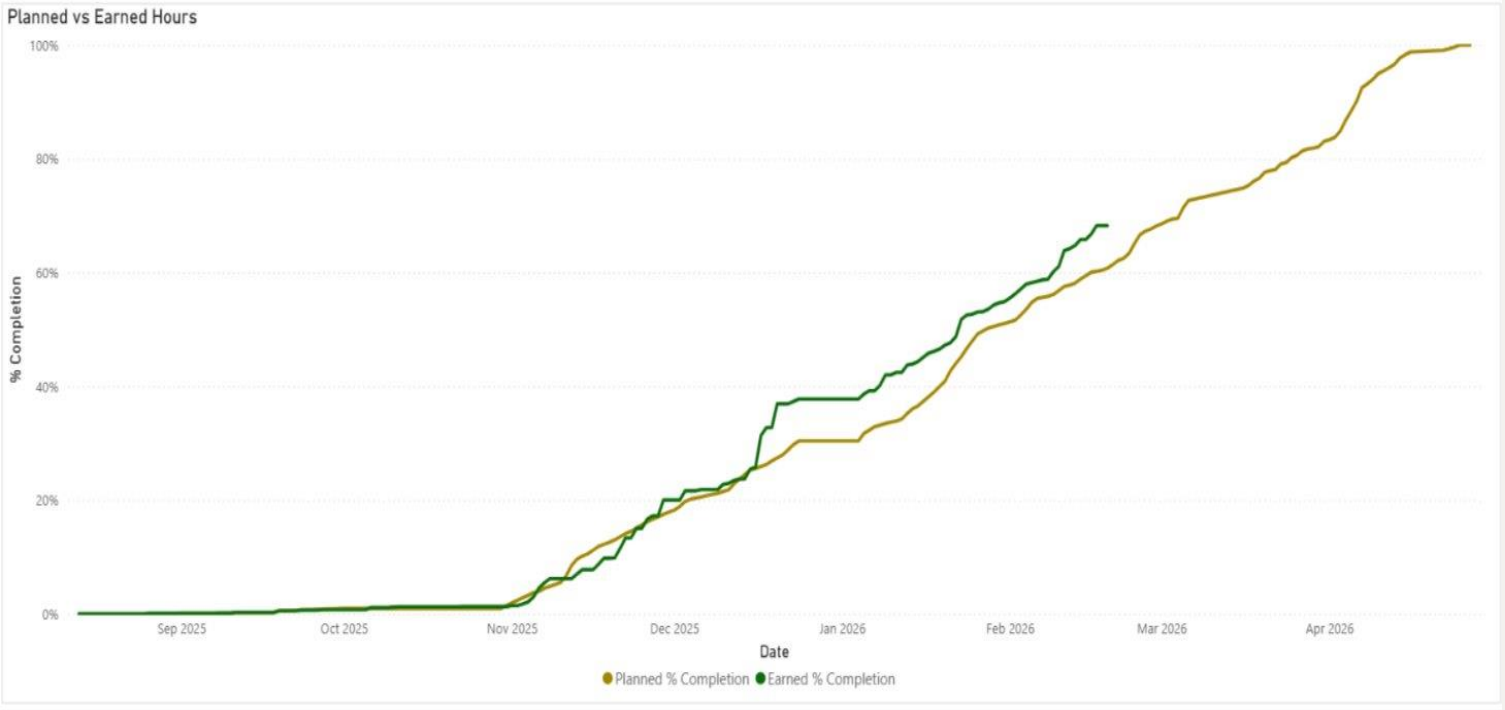
All CWPs

DPSC Fabrication

Click for detailed view

Click for printable report

60.4%	68.3%	27-Apr-2026
Planned Hours	Earned Hours	Basemat Lift Date



Indigenous Relations Quarterly Overview

Status / Highlights

- Stage 1 & 2 archaeology completed for shoreline protection with MSFN. Pending Stage 3 for Lynde Shores Conservation Area.
- Shared Lynde Shores Maintenance and Monitoring Report and Habitat Creation Plan
- Site tours with MSFN reps: beneficial action areas, Lynde Shores Conservation Area, lakebed dredging/disposal, boreholes, water quality, winter mammal survey
- Early engagement Units 2--4
- 6 permits pending (four submitted and 2 awaiting regulator review)
- Engagement on License to Operate
- Engagement on amendment to License to Construct (Waste Storage)
- Annual Indigenous Engagement Report for CNSC

OPG-Wide Challenges

- Lakebed jurisdiction will continue to be a contentious issue for all nuclear projects
- Maintaining trust/confidence in relationships in face of provincial and federal de-regulation on environment for economic development (DTC, Section 35 Rights)
- MSFN capacity for OPG and other proponent engagement/consultation
- Working at the pace/capacity of MSFNs

DNNP Specific Challenges

- Alignment on licencing LTO duration

Opportunities

- OPG-wide offsetting alignment and Indigenous collaboration on design
- Indigenous business opportunities
- ION program placements 74 achieved in 2025 with a goal of 70 for 2026 with a stretch goal of 90.
- Continued in-person IR training for key DNNP staff
- Planned meeting with OPG CEO and Chiefs in Q1 2026.
- Continued outreach to Chippewa Nations
- Annual review of CFA and IEPs

Radioactive Waste Management

Major Milestones: Completion of documentation to support licence application submissions

- L&ILW LTC Amendment Application Submission
- G1/G2 L&ILW SS
- L&ILW SS Design in progress
- Continued Development of Procedures

Status / Highlights

- LTC Amendment in final reviews for March 6th submission dates
- L&ILWSS PSAR issued
- Solid Radioactive Waste Management Plan in final reviews for submission with LTO

Challenges

- Site orientation for the building may need to rotate 90 degrees. In progress to determine impact and path forward
- FSAR required prior to commissioning and use of L&ILWSS. Engaging vendors for support required to meet in-service dates

Opportunities

- Managing commissioning wastes from Unit 1 can minimize impact to in service date for L&ILWSS

Commercial Management

Major Milestones

Highlights

Challenges

Opportunities

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Schedule Variance by Bundle

	Dec ME	Jan ME	Variation (Dec-Nov)	Variation (Jan-Dec)	Variation Drivers (Jan ME)
Design Engineering	(218k)	(200k)	(69k)	18k	➢ Electrical design (modeling and supports) - no impact to execution schedule ➢ U72 TB ➢ SCCV penetration design ➢ Instrumentation and Control design ➢ Commissioning scope
Nuclear Island	(144k)	(168k)	(23k)	(24k)	➢ DPSC Offsite Engineering and On-site Fabrication ➢ RCSB Slabs ➢ RB Shaft
BOP & Site Prep	(90k)	(61k)	6k	29k	➢ Launching Shaft Excavation ➢ Admin Building ➢ N71 (CCW) Piping ➢ Fabrication Building ➢ Warehouse ➢ Y99 & Y53- Storage tanks and Yards Misc
Conventional Island	(112k)	(135k)	(23k)	(23k)	➢ Y15- Power Supply ➢ U43 - Fire Protection ➢ U72 - Pile and Slab Construction ➢ N31 – Main Turbine and Generator (Engineering)
Other (PMO, CS, DS)	(19k)	(40k)	(5k)	(21k)	➢ Managed Systems
Total	**(583k)**	**(604k)**	**(114k)**	**(21k)**	

Supply Chain (Procurement)

[redacted]

Key Messages

[redacted]

NoP	Original RQE (CAD)	Best (CAD)	% Overrun vs. RQE	Most Likely (CAD)	% Overrun vs. RQE	Worst (CAD)	% Overrun vs. RQE
[redacted]							

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FOR INFORMATION to the Major Projects Committee

March 30, 2026

DARLINGTON NEW NUCLEAR PROGRAM

REASON FOR REPORT

This report provides a summary of the Darlington New Nuclear Program (DNNP) status, progress and performance for the period ending February 28th, 2026, as well as current updates of interest.

CONCLUSIONS

Key program highlights over the period are as follows:

- There were no significant safety events in the period.
- There were no significant quality events in the period.
- Small Modular Reactor (SMR) Unit 1 is **41%** complete, against a plan of **44%.** The variance is primarily due to delays in Diaphragm Plate Steel Composite (DPSC) fabrication and delays in the design of the Reactor Building civil structural scope.
- Construction is **16%** complete compared to a project-to-date plan of **20%** primarily due the previously reported safety standdowns in 2025 and delays due to onsite fabrication.
- Basemat fabrication is 12 weeks behind the internal schedule, with basemat installation forecasted on April 27, 2026. DPSC welding has progressed ahead of revised forecast and thus, the critical path is transitioning to the Reactor Building shaft in-pit work, in preparation for basemat lift.
- All three shaft excavation work are now complete, marking a significant milestone in site construction.
- Overall engineering progress is **87%** complete, compared to a plan of **92%** at the end of the reporting period.
- As of February 28th, the total SMR Program is 13% underspent with **$2,142.6M** spent compared to a plan of **$2,450M.**
- A Unit 1 cost and schedule forecast to complete exercise is in progress and is targeted to be completed by late Q4 2026.

HIGHLIGHTS

Darlington New Nuclear SMR Unit 1 Project Performance

SMR Unit 1 lifecycle progress is 41% complete versus 44% planned. DPSC welding has progressed ahead of revised forecast and thus, the critical path is transitioning to the Reactor Building shaft in-pit work, in preparation for basemat lift. The project team continues to focus on the constructability and design improvements of the different levels of the reactor building. Further detail on SMR Unit 1 milestones and construction progress are provided in **Appendix 1: Program Roadmap**, **Appendix 2: Unit 1 Key Milestones**, **Appendix 3: 2026 DNNP Major Program Milestones** and **Appendix 4: Construction Progress**.

Engineering

Overall engineering is 87% complete, compared to a plan of 92%. The schedule variance backlog increased from 193K hours to 247K hours within the period. The primary drivers of the additional variance are electrical, Instrumentation & Control (I&C) design. I&C design maturity remains behind plan due to delayed inputs from mechanical design. Downstream impacts to operations training and the simulator are being mitigated. An I&C recovery plan has been developed and is being executed, while electrical delays are largely attributable to cable routing design impacts resulting from I&C changes. Details are provided in **Appendix 5: Design Engineering Earned Hours**. The remaining engineering scope is being assessed through the overall execution cost and schedule forecast to complete, expected to be completed in Q4 2026.

Licensing

Regulatory Hold Point 1 (RHP1) release is forecasted for April 1, 2026. OPG has submitted the License to Operate (LTO) application to the CNSC ahead of plan in March 2026. The LTC amendment application for the Low & Intermediate Level Waste (L&ILW) storage structure is being deferred from March 2026 to May 2027 to improve design maturity and further engagement activities, with no expected impacts to operations.

Nuclear Island

Reactor building shaft excavation work is now complete. The Heavy Lift Crane, biggest crawler crane in Canada has been assembled for the 905 tons, 36-meter diameter basemat lift. [redacted] This currently puts the RPV near critical path and any additional delays will negatively impact the completion of the Reactor Building. The team will be working with BWXT to monitor an integrated schedule with deep dives to exploit opportunities for schedule improvements.

Conventional Island

Turbine building piling continues to progress behind plan and near critical path with 105 of 122 piles complete and forecasting completion of all piling in Q2 2026. Shop drawings for the turbine building slab have commenced with the first rebar targeted to be onsite in mid-April. [redacted]

Balance of Plant

Fabrication Building and Warehouse turnover is complete, delivering over 40,000 sq ft of indoor storage. The Administration Building will be completed in April 2027, 6 months behind plan with no impact to critical path. Launch Shaft excavation is now complete, and excavation of the Tunnel Boring Machine (TBM) starter tunnel is in progress. The scope retains approximately five months of float to the critical path, and the tunnelling start remains on track for Q3 2026. Forebay Shaft soil excavation is complete. Forebay base slab work is underway, with completion targeted for May 2026.

Indigenous Relations

OPG continues to engage with the four Michi Saagiig Nations and the rights holding Chippewa Nations to support the overall consultation processes for the DNNP project. An assessment of shoreline protection work was shared with the Nations for review. Concerns on the protection of bank swallows during construction were dispositioned. The proposed Lynde Shores habitat creation plan for the offsite beneficial action area related to DNNP was reviewed by representatives of the Michi Saagiig Nations.

[redacted]

Operations

Operational Readiness is on track, with milestones achieved in the management system, digital tools and change management with the transition from construction to operations. An intrusive oversight plan is in place which leverages both internal and external (WANO, Vogtle) experience to perform deep dives in management systems, commissioning, and training to assess issues early. WANO conducted a Member Support Mission as part of the oversight plan. They have identified a strength in the use of technology and learning methods. They have provided an insight to continue monitoring support organization readiness. Training remains a top Operations risk due to delays in I&C engineering deliverables impacting simulator delivery. The third-party reviewed recovery plan for the simulator, will deliver a standard (emulation) simulator by Q4 2026 and a full-scope simulator by Q4 2027 to support the Initial Certification class. The training strategy separates commissioning resources from the Initial Certification program to maintain schedule and regulatory objectives, improve certification success, and ensure certified staff are available for integrated testing, procedure approval, and fuel-load readiness.

Commissioning

Commissioning program is on track, and the administrative procedures have been developed. The next phase is the development of test specifications and procedure development. An integrated change management plan has been developed which transitions the organization from the project phase all the way to commercial operations, including end state culture, management system transition and major plant evolutions. The “construction to operations” team is in place to streamline the transition between construction and plant turnover, ensuring that work is not duplicated and process are aligned.

Darlington New Nuclear SMR 2-4 Project Performance

[redacted]

Darlington New Nuclear Cost Performance

SMR1 continues to forecast within the $7.7B estimate, with life to date underspends of $269.9M. The main drivers for this variance are $155.7M for Nuclear Island, $88.8M for Conventional Island, and $26.8M for Balance of Plant and $1.4M overspends for others. A Unit 1 cost and schedule forecast to complete exercise is in progress and is targeted to be completed by late Q4 2026. The overall program contingency remaining is $1,175M.

Cost variance for the full program is depicted in the table below.

Unit	Life-to-Date Performance ($M)			Released Forecast ($M)		
	Planned To Date	Actuals	Variance	Budget	Forecast	Variance
SMR 1	2,344.9	2,074.9	(269.9)	7,697.6	7,697.6	0.0
SMR 2-4	105.1	67.7	(37.4)	520.7	520.7	0.0
Total	**2,450.0**	**2,142.6**	**(307.3)**	**8,218.3**	**8,218.3**	**0.0**

Submitted by:

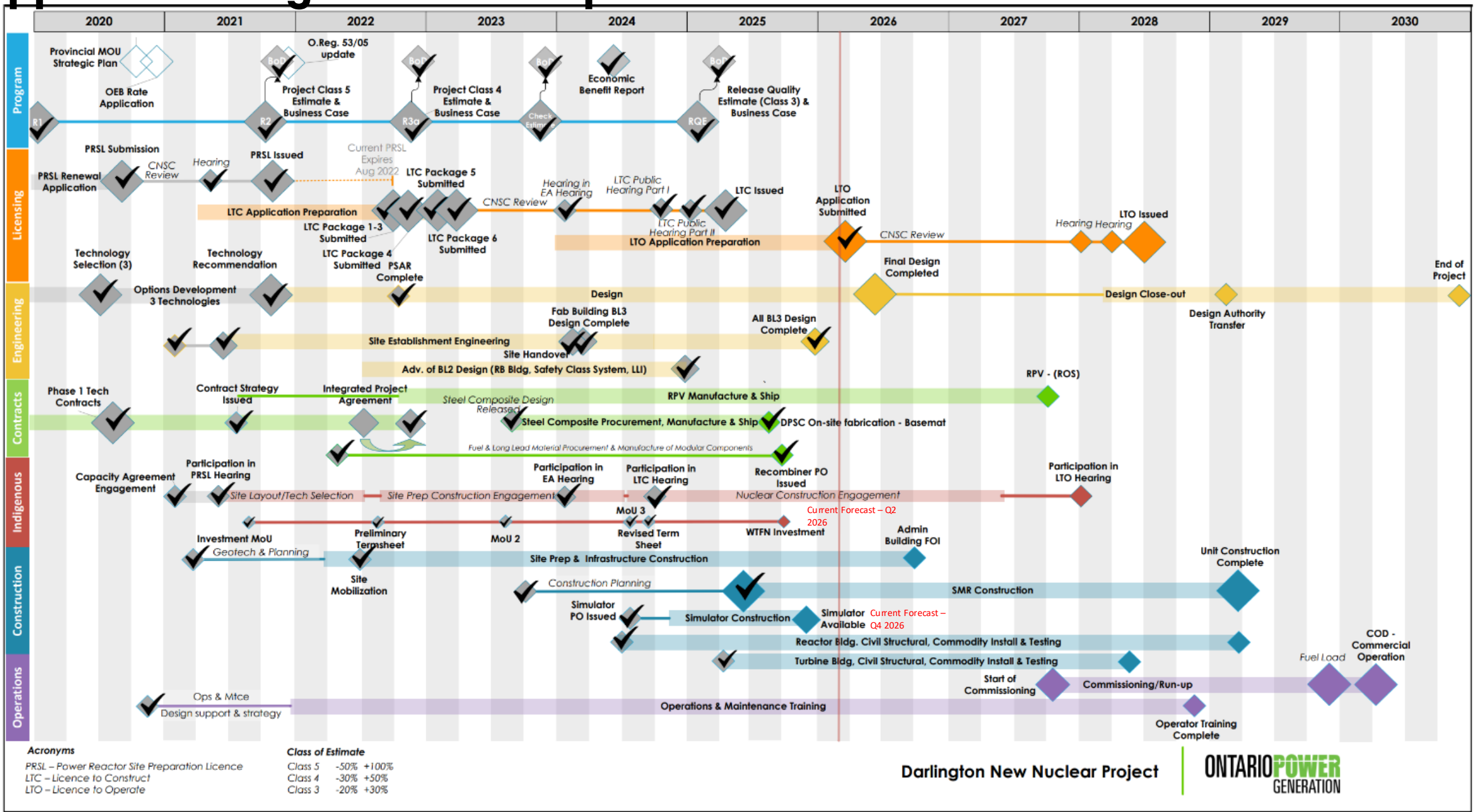
Subo Sinnathamby
Chief Projects Officer

The information contained in this memo is current as of **March 30, 2026**.

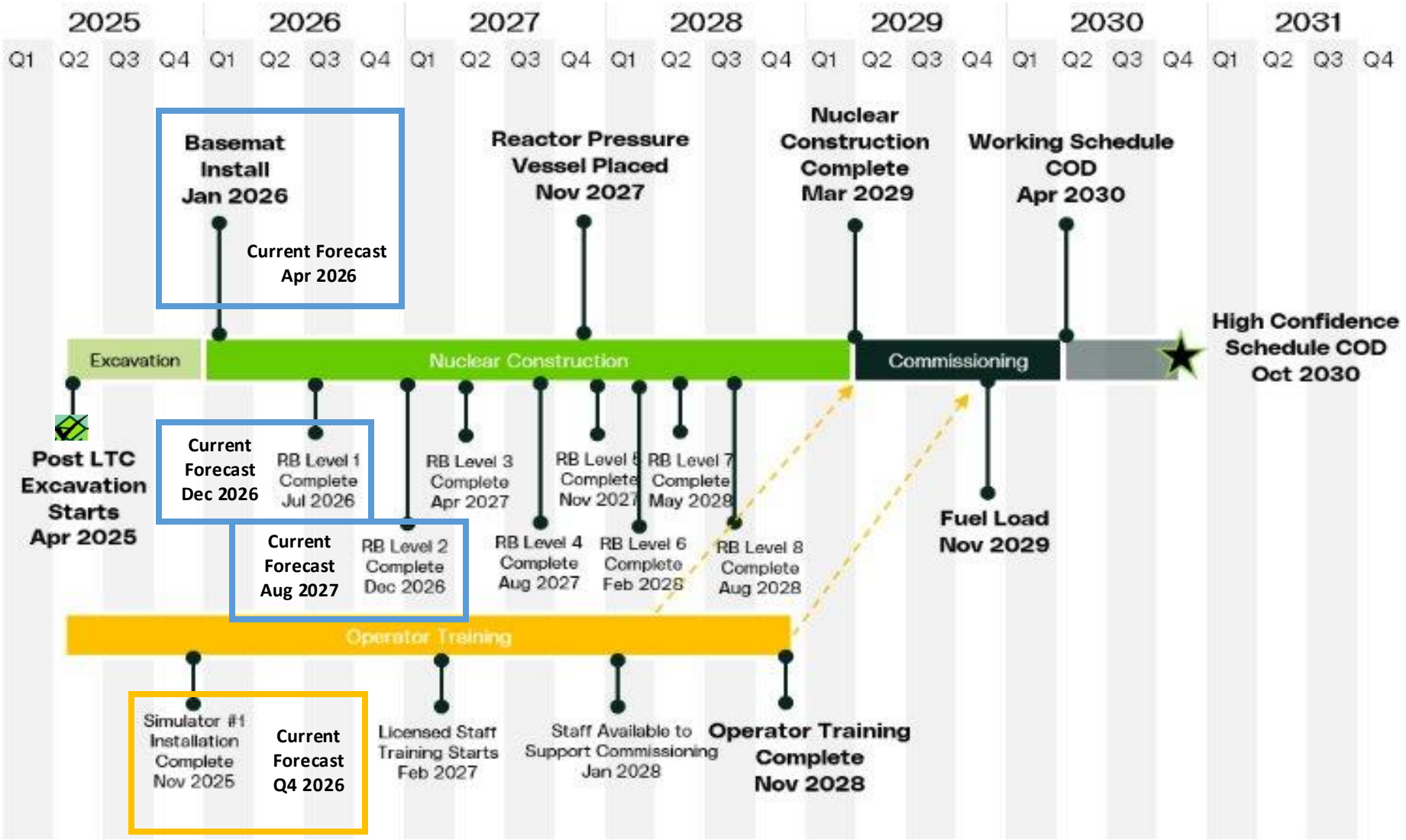
APPENDICES

1. Program Roadmap
2. Unit 1 Key Milestones
3. 2026 DNNP Major Program Milestones
4. Construction Progress
5. Design Engineering Earned Hours
6. DPSC Onsite Fabrication for Basemat (Working Schedule)
7. Contingency Waterfall
8. Key Program Risks
9. Procurement and Field Progress

Appendix 1: Program Roadmap



Appendix 2: Unit 1 Key Milestones



Appendix 3: 2026 DNNP Major Program Milestones

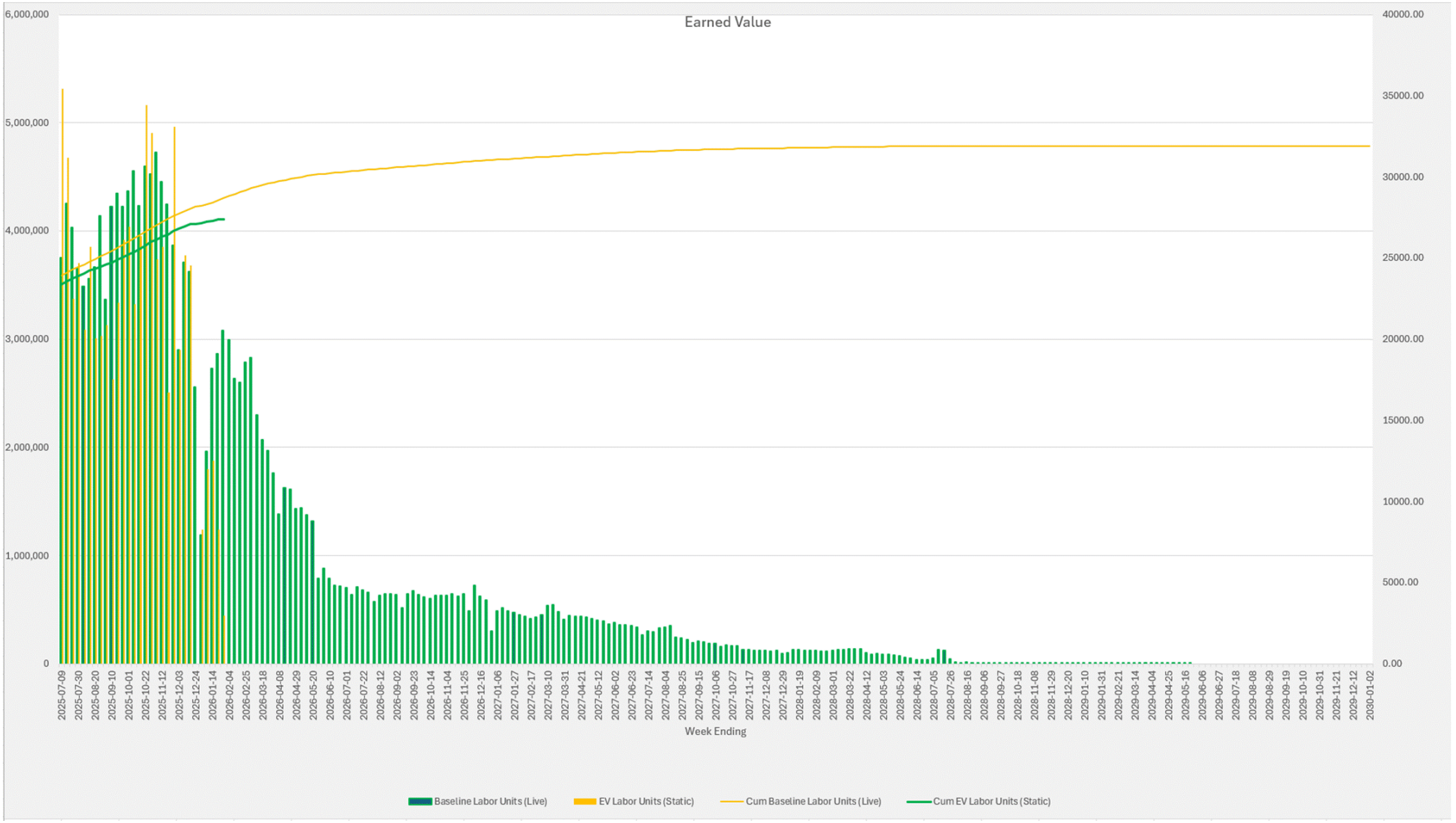
Project Name	Program Milestone Name	Baseline	Forecast	Status
Power Block Design	Milestone 4 - U71 and T10 DPSC Plate Design Released for Installation - Issued For Construction for Basemat	15-Dec-25	24-Mar-26	Missed
Nuclear Island Construction & Procurement	Reactor Building Shaft Ready to Use	24-Dec-25	13-Mar-26	Complete
Nuclear Island Construction & Procurement	Reactor Building Basemat Ready For First DPSC Module Lift (RHP1)	30-Jan-26	27-Apr-26	Missed
CCW	SOI - TBM Assembly	04-Mar-26	2-Jul-26	Missed
EA Licensing & Support	LTO Application Submitted	30-Mar-26	30-Mar-26	Complete
Nuclear Island Construction & Procurement	RB Level 1 Complete	13-Jul-26	31-Dec-26	Behind
CI/BOP Procurement (GEH)	N35 - ROS Moisture Separator Reheator (MSR)	30-Nov-26	13-Sep-27	Behind

Appendix 4: Construction Progress

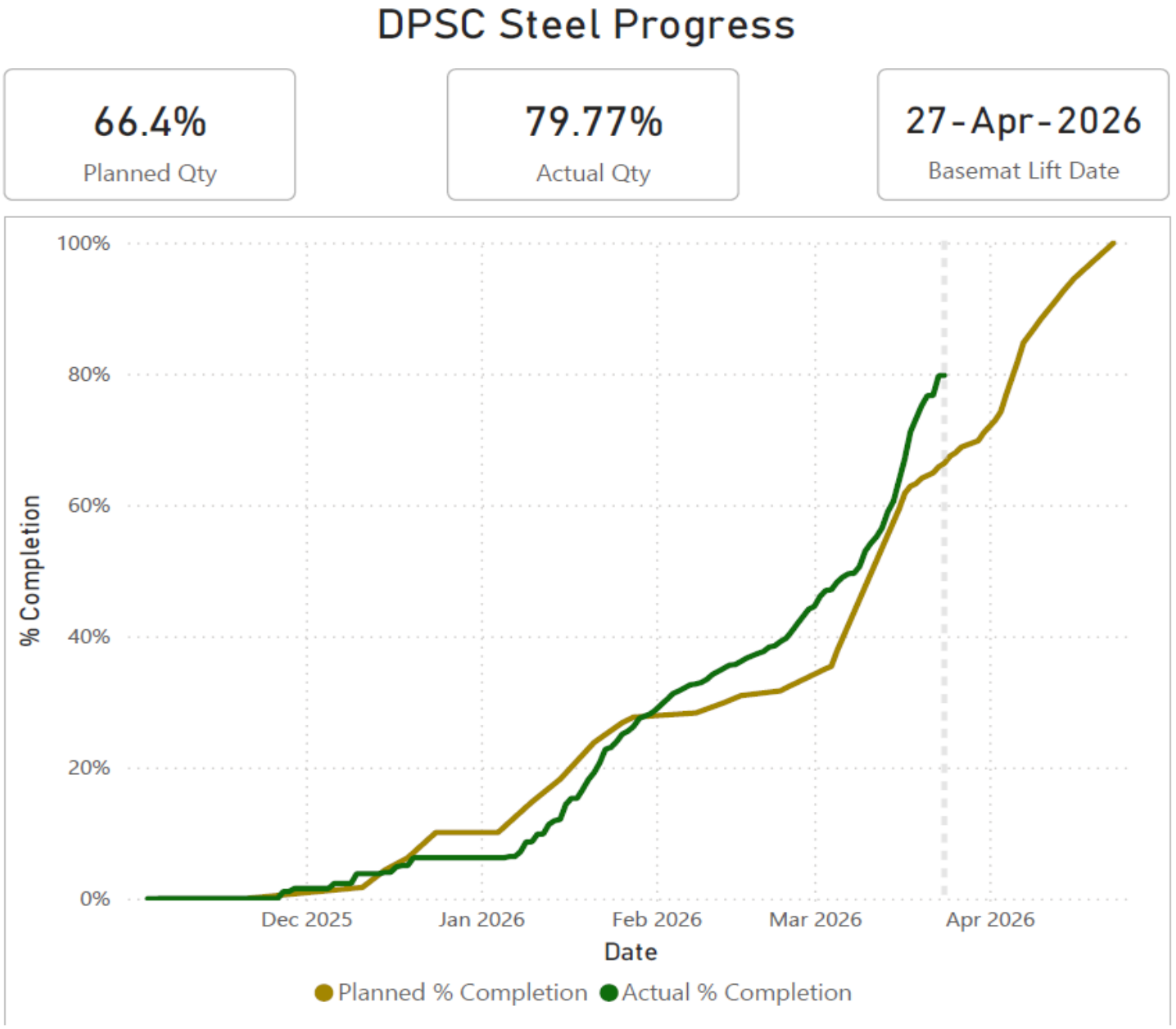
No.	Activity	Planned % Complete	Actual % Complete	Delta % Complete	Baseline	Forecast Completion Date	Duration Variance (months)
1	DPSC Offsite Fab (Basemat)	100%	100%	-	25-July-2025	13-Feb-2026	-
2	DPSC Onsite Fab (Basemat)	100%	77%	33%	30-Jan-2026	27-Apr-2026	-3
3	Reactor Building Excavation Shaft	100%	100%	-	24-Dec-2025	13-Mar-2026	-
4	Turbine Building Piling	100%	84%	-16%	12-Dec-2025	03-Apr-2026	-4
5	Forebay Shaft (Soil Excavation)	100%	100%	-	12-Sep-2025	23 Dec 2025	-
6	Launch Shaft Excavation(Soil & Rock)	100%	97%*	-3%	2-Jan-2026	4-Apr 2026	-3
7	Fabrication Shop Building	100%	100%	-	15-Sep-2025	6-Mar-2026	-
8	Warehouse	100%	100%	-	31-Aug-2025	6-Mar-2026	-
9	Admin Building	50%	22%	-28%	31-Oct-2026	13-Apr-2027	-6
10	Marine Works	70%	70%	-	30-Oct-2027	9-Oct-2027	+1

Note:
*The launch shaft excavation progress includes the starter tunnel work

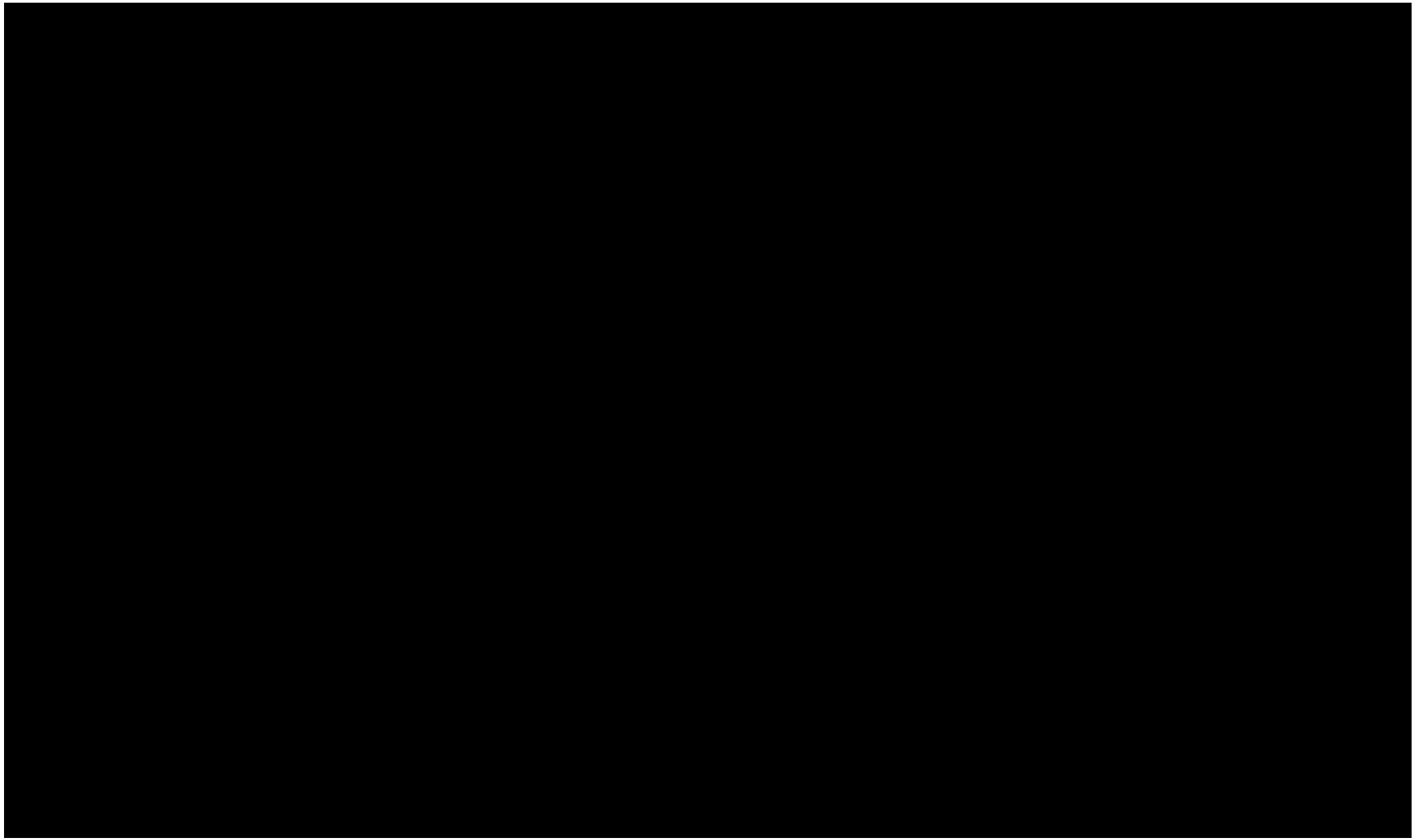
Appendix 5: Design Engineering Earned Hours



Appendix 6: DPSC Onsite Fabrication for Basemat (Working Schedule)



Appendix 7: Contingency Waterfall



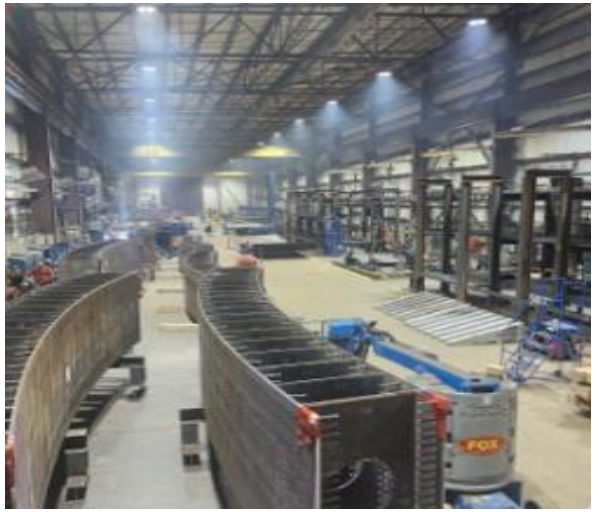
Appendix 8: Key Program Risks

	Risks	Status and Mitigation
FOAK (First of a Kind) and Analysis Timing Impacts	Significant cost or schedule increases due to FOAK components would impact the economics of the project.	• Diaphragm-Plate Steel-Composite - Prototypes and mock-ups will be used to decrease risks on fabrication, assembly and installation to ensure safety and quality of assembly and installation activities. This risk has been partially realized for the basemat modules. • Key FOAK, First-in-a-While, or significantly modified nuclear safety related components will undergo prototype testing and confirmation of the design before the final installation. • Analysis risks pertain to their maturity and timing for delivery in support of licensing milestones to ensure sufficiency and support of Regulatory Hold Point clearance.
Delayed delivery of long lead items could impact project schedule and cost.	Delay in delivery of long lead Item (LLI) at site may have schedule and cost impacts on the project.	• Detailed schedule has been developed for each long lead item required to be issued in validation phase. • Lessons learned from early purchase orders being implemented to subsequent procurement • Majority of long lead items purchased.
Incomplete or misalignment of data turnover for Operations	Incomplete or misaligned information turnover to OPG during the turnover phase may lead to insufficient documentation to support operational readiness and critical path delays. Additional work to perform data integration and acceptance could also be required.	• Define scope of key business requirements and deliverables required for operational readiness – Initial requirements complete • IPD partners to standardize templates for turnover data in required structure for migration - TCD of Q2 2026 • Data definitions mapped against key business requirements and deliverables for defined target operational tools with 3rd party support (EAM, NxM, ESM, PLM, etc) - TCD 28-AUG-2026 • Revise Information Turnover Plan – 30-SEP-2026 • Constructors' data turnover activities and Master Information Delivery Plan (MIDP) included in Schedule – 30-SEP-2026 • Phased information turnover and data cleansing transformation by MPL / system with Ops / Eng acceptance – Issue commissioning and handover procedures (Q1 2026) – monitor for the project lifecycle 11-JUN-2030
Indigenous Opposition impacting Permits and LTC	Indigenous Opposition may cause delays in perimetry impacting the project schedule or negative impacts during the LTC hearings if external, political and environment changes occur.	• OPG will store Low-Level Waste and Intermediate-Level Waste at the DNNP site on an interim basis, until a long-term solution has been planned and developed. • Permitry is on schedule and discussed routinely with rights-holding Nations. • No opposition was encountered leading up to the LTC hearing and the licence was granted by CNSC in April 2025. • [redacted]

Appendix 9: Procurement and Field Progress

Reactor Pressure Vessel

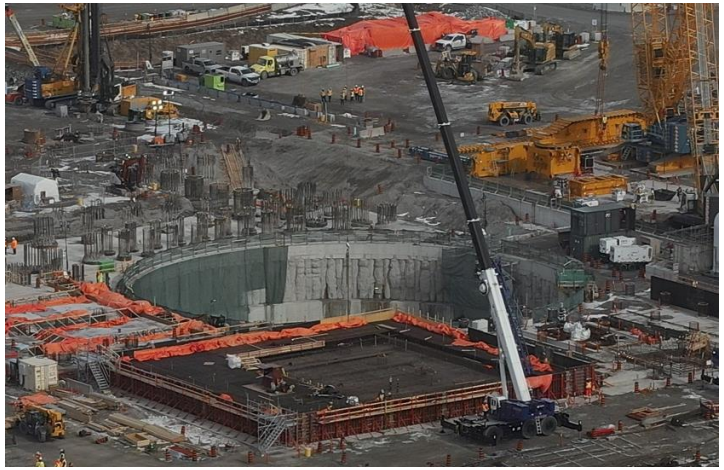
View From Inside the Launch Shaft



Level 1 Module Offsite Fabrication

Heavy Lift Crane Assembly

Admin Building



Reactor Shaft

L-D2-SEC-115

Attachment 4

Ontario Power Generation

Darlington New Nuclear Project (DNNP)

Findings Nuclear Oversight

Table 1 — Nuclear Oversight Fleet-Wide Programmatic Audits with DNNP in Scope

Audit #	Audit Title	DNNP Related Findings?
NO-2023-011	Darlington New Nuclear Project (Small Modular Reactors)	No
NO-2025-001	Performance Improvement	Yes
NO-2025-017	Darlington New Nuclear Project	Yes

Table 2 – Nuclear Oversight Assessments with DNNP in Scope

Assessment #	Assessment Title	DNNP Related Findings?
2024 Task ID # 225	Management System and Cyber Security Plans for the Small Modular Reactor Project	No
2025 Task ID 257	Construction Management	Yes

Table 3 — DNNP-Relevant Audit/Assessment Findings

Audit / Assessment #, Title	Audit Finding	Finding Significance Level (SL)	Action Response
NO-2025-001, Performance Improvement Audit	At EPO, some gaps were identified in the use and oversight of contractor Corrective Action Program (CAP), particularly regarding timely and effective resolution of low performing indicators as demonstrated by recurring red and yellow indicators on contractor CAP Scorecard.	SL3	Action is Complete. Governance was revised to add clarity and OPG oversight expectations for contractors using their own corrective action process, including escalation/follow-up when vendor performance indicators are not addressed in a timely manner or when negative trends are identified.
NO-2025-017, Darlington New Nuclear Project Audit	1. Some gaps were identified in the DNNP Program Management Plans PgMPs and associated documentation in demonstrating implementation of CSA N286-12 requirements through the integration of OPG and Contract Partners management systems.	1. SL3	Action in Progress. A systematic review is being conducted of OPG applicable programs and DNNP documentation to ensure the relationship between the programs and PgMPs is clearly defined.
	2. The DNNP Document Management PgMP does not provide a detailed definition of the activities and oversight requirements for an effective document management program during the construction phases.	2. SL3	Action is in Progress. A document change request has been submitted to update the DNNP Document Management PgMP. The update will define document management activities and establish oversight requirements specific to the construction phases.
2025 - Task ID 257, Construction Management	Construction and Field Engineering Oversight plans are not consistently prepared to address project-specific risks and issues at DN, DNR, PN, PNR, and DNNP as required by	SL3	Action is in Progress. Applicable governance, OPG-PROC-0231, will be reviewed and revised as needed to clarify oversight plan requirements, including scope, ownership, and

Assessment	OPG-PROC-0231 R001 'Construction Management Oversight'.		implementation, and to ensure supporting tools are available to execute these requirements.

Significance Level classification per N-LIST-01966-10000, Section 11.0 Audit Findings.

Significance Level	Definition as per N-LIST-01966-10000 Section 11.0 Audit Finding
General	Audit / Assessment finding SCRs shall be at least as high in significance level (SL) as the adverse condition described elsewhere in this N-LIST as if the line organization had identified the issue. Other sections of Table 3 should be referenced for the specific events and corresponding significance levels. The significance level for repeat findings should be determined using the criteria in this Section based on the impact of the finding. Repeat findings include the following two types: -Related finding: The audit / assessment team identifies that the actions taken to correct a previous finding were not effective and cause it to reappear as a finding which contains the most fundamental aspects of the previous finding. -Continued finding: Mitigating actions are in place and considerable progress is being made in resolving the problem(s); Long term plan established, and appropriate actions are in progress on a reasonable schedule for completion; Some improvement in performance is evident.
SL1	A highly significant event or adverse condition or programmatic implementation deficiency that causes a major reduction in the margin of safety to the public or to station personnel and/or which has a major impact on the environment or on production or on other business deliverables.
SL2	A significant organizational adverse condition and/or programmatic implementation deficiency that causes some reduction in the margin of safety to the public or to station personnel and/or has some impact on the environment or production or on other business deliverables. (Table 2 and other sections of Table 3 in this N-LIST should be referenced for specific events that may relate and would support SL2 rating). In addition to the identified impact, the finding should reveal one or more of the following: • A program is not fully or effectively implemented, including high impact or chronic performance problems that exist with the execution of the program. • There is a risk of a breakthrough event. Note that this means that breakthrough events may not have occurred yet. • Evidence of lack of management oversight of key program areas; (i.e. the line organization was reliant on Nuclear Oversight to identify program deficiencies or oversight efforts have been ineffective at identifying and/or correcting performance concerns). • A significant issue that supports escalation of the audit/assessment (i.e. a program deficiency that is cross-functional in nature or has substantially reduced the effective execution of a program or element of a program).
SL3	All other findings not meeting the criteria above. (Table 2 and other sections of Table 3 in this N-LIST should be referenced for specific events that may relate and would support SL3 rating).
	Programmatic implementation deficiencies or performance problems, which have the potential to be more significant or may be the precursor for more significant events, are identified by the finding.
	Ineffective application of Learning Behaviours that results in a programmatic implementation deficiency or performance problem: • Deficiencies in use of the Corrective Action Program to self-identify and resolve adverse conditions. • Self-assessments are not timely, not self-critical, and/or recommendations are not dispositioned. • OPEX not used effectively (i.e. internal and external).

SEC Interrogatory #116

Interrogatory

Reference:
D2-4-9, p. 17

Question(s):

With respect to the Small Modular Reactor Review Board (SMRRB):

a) Please provide all reports (either formal or informal) produced by the SMRRB to-date.

b) Please provide the SMRRB terms of reference, and all other governing documents, including any contract, retainer agreements, or other agreements.

c) Please provide a list of SMRRB members and their biographies.

Response

a) The SMRRB conducted twelve independent assessments of the DNNP. These assessments are provided as Attachments 1-12, respectively.

b) Refer to Attachment 13 for the SMRRB terms of reference, which is the governing document. The contract is OPG's standard form contract for general services.

c) Refer to Attachment 14.

Small Modular Reactor Review Board
Independent Oversight Report on the Darlington New Nuclear Program

(June 20-23, 2022)

Submitted to:
Major Project Committee of the Board of Directors for Ontario Power Generation

Executive Summary

The Small Modular Reactor Review Board (SMRRB) conducted its introductory review of the Darlington New Nuclear Program (DNNP) from June 20 through June 23rd, 2022. The objective of this review was to educate the SMRRB members on the key elements of the DNNP program, provide an initial assessment of its progress, and set the foundation for the SMRRB review in October 2022.

The SMRRB observed that many of the staffing, process, and management tools expected for a project of this complexity and magnitude at this stage are in place. In particular, OPG has developed a dedicated SMR Execution organization to ensure the proper organizational focus and alignment. The project team is proactively collaborating with vendor partners to plan site preparation work, progress design engineering, prepare the Licence to Construct (LTC) application submittals, and negotiate commercial arrangements that facilitate an Integrated Project Delivery (IPD) model. The Canadian Nuclear Safety Commission (CNSC) is being proactively engaged to prepare for the review and hearing process to support the issuance of a LTC. The risks associated with delivering to the ambitious schedule are being identified, including mitigating actions, and are being managed through a formal process that is beginning to take shape. Stakeholder and indigenous relation consultation requirements are being identified and processes to manage this are being put in place. In summary, these are all necessary and appropriate steps.

The SMRRB recommends the following further enhancements and that additional management emphasis be placed on the following key areas:

- Constructively managing the tension between business case requirements and the challenges of project execution.
- Understanding how program implementation and behaviors will be different to what was done on unsuccessful mega-projects.
- Developing the culture of trust, transparency, and teamwork required for the IPD model to reach its full potential.
- Implementing metrics that provide an unambiguous and transparent understanding of engineering design completion progress.
- Ensuring the duty to consult with indigenous communities is diligently executed.

These are proposed areas of emphasis for the SMRRB when it returns for its 2nd review in October 2022.

Detailed Report

Background

The SMRRB was commissioned by the OPG Board of Directors to independently monitor the new Small Modular Reactor (SMR) project to be built at the Darlington site. This is the first review for the SMRRB and it is expected that the SMRRB will conduct approximately three reviews per year.

The objective of this report is to support the Major Project Committee's (MPC) oversight of the DNNP project and provide recommendations to the MPC to assist in the monitoring of the project.

For this review, the SMRRB comprised the following members:

1. Sandy Rupprecht (Chair)
2. Virginia Greiman
3. Emily Whetung
4. David Christian
5. Dietmar Reiner (OPG internal member)

OPG Support: Cory Bruder

POSITIVE OBSERVATIONS

1. The regulatory plan for submission of the LTC application to the CNSC is very detailed, well laid out, and well understood by the OPG Nuclear Regulatory team. Measures have been taken to reach alignment with the CNSC on approach, structure, and content of the LTC, and a protocol with the CNSC for pre-construction and construction activities is in place. In the SMRRB's view, this proactive approach will help to mitigate uncertainty in this "first in a while" LTC application process.

2. It is recognized that there are critical areas where OPG requires additional knowledge and guidance. To address this OPG has engaged in a series of reviews of operational experience of mega-projects, including site visits, both internal and external to OPG (Hinckley Point C) to understand key lessons learned, and has engaged with third party consultants to help guide the development of the IPD commercial negotiations and model development.

Scope Item 1 – OPG's Business Case for SMR Program

Introduction

The SMRRB reviewed OPG's business case for the DNNP which outlines OPG's basis for proceeding with the current phase of the project.

Observations

1. **Strategic Plan for SMRs** - The need for SMR technology is clearly described as initiating a path towards zero emissions, environmental sustainability, and increased capacity. However, the vision and approach for construction of four SMRs, and the path to reach this goal, is not clearly communicated in OPG's current business case and requires clarification. For example, it was mentioned during interviews that a decision was needed on whether to construct an administration building for one or four units on the site. Also, the distinction between the first unit which has been described by the project team as "stick built", and the remaining units which has been described as "modular", should be explained. SMRs achieve their economic advantages based on economies of scale, modularity and standardization for commercial deployment. This advantage will be best secured through a clear strategy and timeline.

2. **DNNP Timeline** - OPG's release strategy overview describes obtaining the LTC by end of 2024, and completing all requirements for commercial operations by late 2028/early 2029. These milestones are highly ambitious in light of the current state of preparedness of the regulatory process and the uncertainties surrounding the first-of-a-kind (FOAK) technology that adds additional risk. The tension between the strategic goals and the realities of execution must be achievable from both an investment and cost perspective.

Recommendations

1. Develop a clear communication of the vision and timeline for development of all four units including the requirements for common costs associated with the first unit. A determination should be made as early as possible with respect to the reality of the forecasted completion dates for the LTC and the Licence to Operate (LTO).

Scope Item 2 – Organization/Accountability/Culture

Introduction

The SMR Execution organization was put in place at the beginning of 2022 to provide a single point of accountability for the initial phases of program development. The SMRRB reviewed the structure of the current organization with key execution team members and received their feedback on evolving the structure as the project matures.

Observations

1. The organization appropriately designates the Vice-President, SMR Execution as the single point of accountability for the programmatic aspects of developing a new nuclear plant program. The organization comprises the requisite technical and programmatic roles one would expect for a new nuclear plant development organization. Matrix reporting relationships are identified and are deemed to be appropriate.

2. Accountability for commercial strategy and the development of associated contracts resides with a separate organization called New Growth & Commercial Management. Integration and coordination between the organizations will be essential to ensure that commercial contracts align with the proposed delivery model.

3. It's envisioned that, as the project matures into the detailed planning and design phase, IPD model will be adopted that creates a single integrated team to include OPG, GE-Hitatchi (GEH), AECON, and SNC-Lavalin. This will require that the SMR Execution organization evolves into a different structure in the future. Part of the organization will likely integrate into the IPD and another part will remain separate to facilitate the Owner's Engineering oversight roles and responsibilities.

Recommendations

1. A vision of how the SMR Execution organization will evolve to support the IPD and the Owner's Engineering concept should be developed to facilitate staffing and execution planning.

Scope Item 3 – Regulatory Requirements

Introduction

The LTC and LTO are two of the most critical licences required in order to de-risk and progress the project. The LTC is currently forecasted for November 2024, whereas the LTO is currently forecasted for Q3 2027. The SMRRB reviewed the high level timeline, key deliverables, and risks associated with these activities, but focused primarily on the near term activities associated with LTC submittal and subsequent approval.

Observations

1. The LTC plan has an ambitious schedule requiring a significant amount of work to be performed in a short period of time to meet the October 31, 2022 Licence Application milestone. The subsequent supporting technical packages are scheduled for delivery between October 31, 2022 and March 31, 2023. The risk in delivering on these early submittals is largely tied to sufficiently progressing the design and developing the associated safety case.

2. The risk associated with the CNSC review, approval, and issuance of the LTC adds schedule uncertainty. This is due to FOAK technology features, the likelihood of the CNSC being the first regulatory body in the world to formally licence the BWRX-300, and the attendant need for the CNSC to develop a BWR knowledge-base and regulatory framework.

3. The CNSC is cognizant of the concurrent, though longer-term, review process being performed by the U.S. Nuclear Regulatory Commission (USNRC). While the CNSC will exercise their sovereign responsibility to arrive at their own conclusion, they will likely do so in consultation with the USNRC to increase the probability of alignment between the two regulatory organizations. Understanding the USNRC's perspectives will be critical to anticipating CNSC perspectives.

4. The risks are now being identified and OPG/GEH are collectively and proactively engaging with the regulator upfront to ensure alignment on acceptance standards, design maturity expectations, and review timing. The SMRRB deems these actions to be appropriate, but cautions that they may require further enhancement. The regulator's insights and approach is likely to mature as reviews of the submittals progress. It will be important that OPG/GEH develop a protocol with the CNSC to drive these views to the forefront so that any barriers can be expeditiously addressed.

Recommendations

1. Work with GEH, and potentially other key stakeholders, to develop a process to proactively assess and manage the "tension" that's likely to occur between the long-term desire to maintain a standard plant design and the near-term pressure to compromise to expeditiously resolve regulatory issues.

Scope Item 4 – Stakeholder Management and Indigenous Relations

Introduction

Stakeholder management is important in securing public support for a new nuclear project. Developing a social licence for the project will allow political support to build momentum

behind the project. Additionally, new nuclear projects will require social licence from Indigenous communities.

The most critical issue is ensuring that the Duty to Consult with First Nations leadership has been satisfied. For the Williams Treaty First Nations, there are constitutionally protected rights that must be considered. For other communities, there are issues triggered at common law. More recently, First Nations have been able to leverage the Duty to Consult to prevent the Federal Government from cancelling projects or revoking licences that would otherwise bring economic benefit to First Nations. This was the case for Ermineskin Cree Nation (ECN) as a partner with the Vista Coal Mine in Alberta. When the Federal Ministry for the Environment and Climate Change ordered the mine to be a designated project under the Impact Assessment Act, it significantly harmed the economic benefit to ECN. Therefore, Indigenous rights can impact the critical pathways required to meet the aggressive LTC and LTO – both as positive supporters and potentially contributing delays if not assessed appropriately.

Observations

1. To date, the Stakeholder Relations plan seems to be well designed and well executed. Updated plans anticipated in the coming months should provide a better understanding of the community needs to create the required social licence.

2. The Indigenous Relations team has clear understanding of the constitutional and legal framework.

3. Indigenous Rights appear to only be a consideration at the nuclear regulator level. However, at every licencing and permitting application, Indigenous Rights are to be considered by the government acting as a representative of the Crown.

4. Stakeholder Relations has a team of four full-time staff dedicated to the project. Indigenous Relations has one full-time staff. As a result, resourcing appears to disproportionately reflect in the risk level. If the regulator is not satisfied that Indigenous engagement has taken place to satisfy both the constitutionally protected rights and the common law requirements, then the licences will be delayed.

Recommendations

1. Increase resources for Indigenous Engagement to ensure there is no delay in the licencing process.

2. To address concerns raised in the observations above, track the changes made to all plans. This will ensure that should constitutional challenges be brought to any licencing or permitting application, OPG is able to demonstrate:
   a) Consultation occurred (or was attempted);
   b) Indigenous concerns raised during consultations were examined; and

c) Accommodations were made throughout the project.

Should any regulator question the consultation and any derivative accommodations that resulted, answers will be readily available and documented ensuring the project continues.

Scope Item 5 – Commercial Strategy

Introduction

The SMRRB reviewed OPG's commercial strategy, and the progress and status of negotiations underway with the key project partners - GEH, SNC Lavalin, and Aecon.

Observations

1. It was evident that considerable thought has gone into selecting the contracting model. The complex nature and FOAK aspects of the project influenced the decision to use an IPD approach instead of the traditional Engineer, Procure, Construct (EPC) or Design, Bid, Build models. At present, quadripartite negotiations are ongoing with and between OPG (owner), and GEH (designer), SNC Lavalin (architect engineer) and AECON (constructor). The SMRRB was advised that project participants, although having varying degrees of experience with the IPD approach to projects, appreciate the potential benefits in terms of incentive alignment and risk allocation.

2. The near-term goal of having an agreement in principle among the four parties by late July 2022, is a prelude to having a finalized contractual agreement in place by November 2022. OPG understands the various issues to be worked through in the coming months such as governance, decision-making and escalation processes. It is encouraging to note that two independent consultants with experience in IPD agreements have been engaged to facilitate progress. The SMRRB agreed with the concept of running table-top exercises or simulated scenarios to test the IPD process.

Recommendations

None

Scope Item 6 – Design Engineering

Introduction

The first phase of the DNNP project, to be completed by end of 2022, includes completion of DNNP conceptual design and initiation of detailed design. The SMRRB reviewed the approach being taken to progress design engineering, monitor risks and status, and ensure the readiness of key design engineering information needed to support the LTC application and execution of the second phase of the project.

Observations

1. The design process incorporates an iterative approach where maturity of requirements and design documents increases through four phases, or baseline. The SMRRB sees this as an innovative approach given the tight timelines required for progression of design and engineering deliverables. Management should= monitor, however, to ensure that the level of design detail needed at the phase where construction planning and procurement are to commence does not lack important information, which could erode the anticipated schedule benefits.

2. A strategy to "standardize" the design is being implemented on the design of the first unit of SMR at DNNP, with an objective to obtain design efficiencies on future SMRs. The SMRRB cautions OPG to monitor for additional risks and costs this may create (e.g., OPG incurs costs that should be borne by GEH or future SMR projects).

3. Measures to track the progress of design engineering have not yet been finalized. A great deal of thought and rigor has been involved in developing appropriate measures that allow for accurate tracking of design engineering progress. It is critical; however, that these are finalized given the tight timelines and critical upcoming milestones that are dependent on progression of design engineering.

4. GEH is the Design Authority for the Power Block and related interfacing systems during the design, construction, and commissioning phases of the project after which Design Authority will be turned over to the OPG Engineering Design Authority. An Owner's Engineering Department that monitors and oversees the GEH design process has been established by OPG. The Owner's Engineer model is common in industry; however, it has not been used on OPG's nuclear projects and will require a mindset/culture shift.

Recommendations

1. Place urgent priority on finalizing the measures that will be used to track progression of design engineering.

2. Ensure that roles, accountabilities, and authorities of OPG's Owner's Engineering Department are documented and communicated to staff involved in Design Engineering.

Scope Item 7 – Site Preparation

Introduction:

Planning and execution of site preparation work has commenced. The scope of work covers three general areas: (i) geotechnical investigations/surveys including onshore and offshore drilling required to complete design of the SMR; (ii) early works which include roads, domestic and fire water, construction power, and parking; and (iii) main site preparation including excavation, construction of an administration building, and tie-in of utilities installed as part of the early works. The SMRRB reviewed OPG's plans related to this work.

Observations

1. A significant amount of up-front planning is required prior to the commencement of construction activities. This includes obtaining CNSC approvals on closeout of open items stemming from the licence to prepare the site, obtaining all required permits (e.g. building/environmental), engaging with indigenous communities, and completing design engineering. Rapid identification, escalation, and resolution of issues in the up-front planning efforts is critical in mitigating potential schedule risks that may impact the start of DNNP construction. This, in turn, requires appropriate decision forums and authorities to be in place and clearly laid out and communicated.

2. OPG has elected to utilize existing contracts with EPC vendors to facilitate the site preparation work. This removes a potential complexity and will be helpful in meeting the tight timelines for completing the site preparation work.

3. OPG made the decision to retain Design Authority accountability for site preparation work. In the SMRRB's view, this has the potential to add complexity to work that can be largely executed under commercial engineering standards.

Recommendations

1. The SMRRB encourages OPG to review the standards being used and the decision made to retain Design Authority for site preparation work. OPG Engineering oversight and support is required, but there may be a potential for efficiencies by using commercial standards and delegating the Design Authority accountability to the appropriate EPC vendors executing the site preparation work.

Small Modular Reactor Board
Independent Oversight Report on the Darlington New Nuclear Program

(Visit #2 - Oct 18-20, 2022)

Submitted to:
Major Project Committee of the Board of Directors for Ontario Power Generation

Executive Summary

The Small Modular Reactor Review Board (SMRRB) conducted its 2nd review of the Darlington New Nuclear Program (DNNP) via a series of remote reviews on September 23, and an onsite review from October 18-20, 2022. This review was a follow-up of the introductory review that was conducted June 20-23, 2022.

The SMRRB observed continued progress in the development of the Class 4 Basis of Estimate (BoE), the licensing submittals to support the request to the Canadian Nuclear Safety Commission (CNSC) for the License to Construct (LTC), the conceptual Integrated Project Delivery (IPD) team, front-end engineering design, site preparations, indigenous relations and planning for a future digital engineering platform. These accomplishments were underpinned by the continued maturing of the OPG SMR Execution organization and their evolving integration and coordination efforts with GEH. While these are important accomplishments to date, the DNNP project is rapidly approaching an inflection point where the current mode of operating is unlikely to be adequate to respond to the CNSC LTC inquiries and the simultaneous demands to aggressively progress the project design and planning. An accelerated transition from the current "alliance" model to an effective IPD model that seamlessly integrates OPG, GEH, SNC, and AECON into "One Team" will be required. This should be a primary focus of the project management team following the conclusion of the Definitive Agreement between the 4 parties.

Detailed Report

Background

The SMRRB was commissioned for the OPG Board of Directors to independently monitor the DNNP. This is the second review and it is expected that the SMRRB will conduct approximately three reviews per year.

The SMRRB comprised the following members:

1. Sandy Rupprecht (Chair)
2. Virginia Greiman
3. Emily Whetung
4. David Christian
5. Dietmar Reiner (OPG internal member)

OPG Support:

1. Cory Bruder
2. Ryan Pinto

OPG's Business Case for DNNP

Introduction

The Class 4 Estimate is planned for Board approval in November 2022, and an updated Class 3 Estimate is planned for November 2024. The SMRRB reviewed presentations by the OPG Project Team on the Class 4 Estimate with the focus primarily on the "process" of establishing the estimate and how uncertainty is being identified and managed. The review did not focus on the quantitative outcome of the process.

Observations

1. The Estimate will be a range and not a point estimate. This is appropriate given the unknowns and risks that remain to be understood. The estimation process is rigorous and incorporates best practice from the Association for the Advancement of Cost Engineering (AACE) and industry OPEX. Risks are integrated and incorporated into the process. However, given the maturity of the project and the uncertainties associated with its First of A Kind (FOAK) nature, the AACE estimating process alone may not provide adequate guidance. Judgement will also be an important component of the estimating process.
2. A Definitive Agreement by November 2022 between the 4 parties (OPG, GEH, SNC, and AECON) is aggressive but possible. Some areas of uncertainty associated with the definitive agreement may not be included in the Class 4 risk estimate or contingency at this point and would may require disclosure.
3. OPG has confidence that regulatory impacts associated with technical licensing are manageable but concern over public stakeholder consultation being undertaken by the CNSC remains a major unknown at this point in the project.
4. OPG has hired an independent cost reviewer which the SMRRB judges to be a positive approach. Independence of any reviewer will be critical throughout the project's life cycle and will require continuous evaluation.

5. In a project of this size and complexity, all options and alternatives to the DNNP need to be considered in the event the regulatory process is delayed or disrupted.
6. The SMRRB judges the Class 4 estimate process being employed by OPG to be appropriate.

Recommendations

1. Judgement will likely be required to account for uncertainties associated with the regulatory process, engineering maturity, labor and overall execution of the project. The use of judgement should be clearly identified and its basis provided in the Class 4 basis of estimate.

Investment in Execution Certainty and Organizational Accountability, Integration & Alignment

Introduction

Execution certainty is central to the success of the DNNP. The delivery of this FOAK must produce technical excellence as well as support the business case through on time delivery within budget. This will require an upfront investment in people, organization, culture, process and management tools. The Integrated Project Delivery (IPD) model is a critical element for how OPG and its partner vendors will make this investment and deliver execution certainty. As such, the bulk of the SMRRB's review was on the IPD concept and its future implementation.

Observations

1. Substantial progress has been made toward reaching a definitive multi-party agreement for the DNNP. An IPD approach was selected for this project because of its FOAK and complex nature. The SMRRB concurs with the selection of the IPD approach. The SMRRB noted that effective implementation is highly dependent upon the details of how the IPD is implemented and the behaviors of the participants. These elements will be the subject of future SMRRB reviews.
2. The main objectives of the IPD are to achieve alignment of incentives among participating partners, agreed upon proportional sharing of risks and rewards, consensus decision making, minimize scope creep, and to take a "best athlete" approach for staffing and scope assignment. With respect to the "best athlete" approach, the SMMRB was satisfied with the approach taken in the IPD agreement relating to Key Person provisions.
3. The SMRRB considers the execution of the decision-making structure to be critical to project success. The SMRRB cautioned OPG regarding several perceived shortcomings in the IPD model, most notably, the requirement for unanimity, which may cause sub-optimal compromises and potential delays. The SMRRB agreed that the already included "safety valve" override authority at the Executive Board (EB) level is an essential risk mitigant and

element of the model. Considerable thought needs to be given to how the Project Management Team (PMT) and Project Leadership Team (PLT) efficiently deal with issues where there is not unanimity, and the expedient escalation to the EB as required. This can be accomplished by stress-testing the model via table-top exercises.

4. The SMRRB emphasized, that, despite the structural intent to limit scope changes, it is important for the team to acknowledge and plan for changes that *will occur* owing to the FOAK and complex nature of the project. It is critical that the incentive structure does not inadvertently suppress identification, communication, and resolution of issues that will likely result in changes.

5. OPG recognized some inherent challenges to implementing the IPD model and offered high level mitigation plans which included participant training, a Project Charter, and metrics to capture performance relative to requisite behaviours. The SMRRB will review the more detailed mitigation plans as they are designed and implemented.

6. Some aspects of planning are in place to train and facilitate participants so as to build and sustain a culture of trust, transparency and teamwork. Progress has been tempered by not having a definitive agreement in place. For example, valuable Team Operating System information, including purpose and mission, values, roles and relationships, priorities, etc. was presented in August at a Leadership Alliance meeting. These have the potential to be adapted to the IPD. Due to ongoing negotiations, however, all parties were not invited to participate in the Alliance meeting. Until the IPD definitive agreement is in place, it will be difficult to meaningfully evaluate this area.

7. The SMRRB recognizes that the IPD is a work in progress and that it will be a journey to implement. Bringing together four different cultures is a complex challenge with much uncertainty. The mission, vision, and plan for the IPD currently exists informally with senior OPG management and has not yet been developed into an institutional view shared by all IPD participants throughout the organization. OPG management acknowledged the challenge and cited its intent to bring in dedicated expertise to further develop and nurture the IPD model over an extended period of time.

Recommendations

1. The organization should add a dedicated resource for an extended period of time to plan, develop, and institutionalize the IPD model into a functional and effective project execution culture across all participants.

2. Between Gate 4 and Gate 3 OPG should perform an independent “execution readiness” evaluation to validate the readiness of the IPD implementation plans and to potentially expose additional gaps.

Indigenous Relations

Introduction

Stakeholder Management is an important step in getting public support for a new nuclear project. Creating a social licence for the project will allow political support to build momentum behind the project. Additionally, new nuclear projects will require social licence from Indigenous people to pre-empt grassroots level action.

The most critical Indigenous Relations issue to be aware of is ensuring that the Duty to Consult with First Nations leadership has been satisfied. For the Williams Treaty First Nations, there are constitutionally protected rights involved. Additional Indigenous Rights will be triggered in the long run with waste disposal in the Saugeen Ojibway Nation territory. For other communities, there are issues that may be triggered at common law.

Observations

1. OPG's Indigenous Relations group has clearly taken and actioned the recommendations from SMRRB Visit 1. Appropriate recognition of the critical role that Indigenous inclusion from the early stages and respect for constitutionally protected rights has been demonstrated.

2. OPG's Indigenous Relations group has been engaged to support the strategy of the DNNP project. In addition, plans are in place to add a full time employee to the DNNP team to manage and document the progression of the relationship with appropriate First Nations groups.

3. The creation of a logging tool integrated into the ePMx system to track communications, engagement, and Consultation activities will be invaluable during the licencing process. The Indigenous Engagement tool will track treaty, geographical, and political data. It will include contact information.

4. The continued development of an Indigenous Relations working group across all aspects of OPG's operation will support uniformity of messaging, better coordination of engagement opportunities, and consistency of touch points.

5. Clearly the inclusion of Indigenous perspectives is beginning to permeate the work taking place to develop the first SMR. There were multiple references to participation in Indigenous ceremonies from a variety of teams. There was a reference to starting the site preparation off in a meaningful way. Information was also shared regarding a meeting with

the contractor on site that included an archeologist to ensure recognition and appropriate respect of Indigenous artifacts. This is a positive indicator of an ongoing and meaningful relationship being developed.

Recommendations

1. None

Site Preparation

Introduction

A number of pre-requisite site preparation projects and activities need to be executed to enable construction of an SMR at OPG's Darlington new build site. These include (i) Onshore and offshore geotechnical investigations and surveys to obtain data required for the design of the SMR and related systems; (ii) Execution of "early works" infrastructure projects such as roads, domestic and fire water, sanitary sewer lines, construction power, temporary parking, lay down areas, etc.; (iii) Site preparation work including excavation, grubbing, leveling, construction of support facilities, tie-in of utilities installed as part of the "early works". The SMRRB reviewed the progress of this work.

Observations

1. In its prior visit, the SMRRB commented on the potential complexities created by OPG's decision to retain Engineering Design Authority responsibilities for site preparation work. The SMRRB has reviewed the basis for this decision, and in conjunction with a new commercial engineering modification (CMOD) process that OPG has implemented, concurs that this decision results in efficiencies for the DNNP.
2. Site preparation work is currently not fully integrated with other SMR project work that will be managed by the IPD, nor is it being executed by the IPD partners. This creates some risks for the SMR project. OPG management have recognized these risks and are taking steps to facilitate integration of this work with the IPD. The SMRRB concurs with this decision.
3. Commitments made when the DNNP site license was initially obtained have added risks to the timely acquisition of permits needed to commence site preparation work. This in turn is creating schedule risks for execution of site preparation work that are being monitored.
4. Key risks to schedule are not always being expeditiously surfaced and addressed. For example, the construction blackout window of March to September for bird nesting and fledging in some areas of the Darlington site has the potential to extend the entire SMR construction schedule by six months if the required Endangered Species permits are not

obtained on a timely basis. There may be underlying personnel, organizational, or cultural issues that are inhibiting the rapid identification, escalation, and resolution of issues.

Recommendations

1. The underlying issues inhibiting key project risks from being expeditiously surfaced and addressed need to be understood and rectified.

Front End Engineering Design Progress

Introduction

The progression of front end design Engineering is typically a key leading indicator for project execution performance. The metrics and reports that are used to track design Engineering thus become a key project management tool. In its June 2022 review, the SMRRB recommended that urgent priority gets placed on implementing metrics that provide an unambiguous and transparent understanding of design engineering progress. In this visit, the SMRRB reviewed the associated methodology and metrics, as well as the overall progress being made on completion of design Engineering.

Observations

1. Metrics have been developed and are being put in place to track design engineering progress. These include both hours expended relative to plan as well as timelines for completing specific engineering deliverables. The granularity of these metrics spans plant systems and components. In the SMRRB's view, the methodology, metrics, and controls that are being put in place to track design engineering are extremely robust.
2. The planned "go live" date for issuance of design engineering progress reports by the Project Controls organization is end of November. Some "burn in" period to deal with any data integrity issues and to "tune" the reports is expected. The SMRRB will review the implementation of the metrics and associated reports and controls in its next visit.
3. Maintaining an accurate connection between what is reflected in design engineering progress reports and what is actually happening in work execution, prioritization, resource allocation, and identification/mitigation/resolution of risks and issues is critical. Using the performance tracking tool as a management tool will help to maintain this connection, especially as the demands on the engineering organization increase through the SMR licensing process.
4. The Engineering efforts being executed by the various entities involved in the SMR project are well integrated. The integration extends to other OPG partners, e.g. TVA, and both the

CNSC and NRC. The SMRRB views this level of integration as necessary to bridge knowledge gaps given boiling water reactor technology is new to OPG.

5. Overall, progress of design engineering is behind schedule. This is recognized by the integrated engineering team. Downstream impacts on the licensing process are being mitigated through the flow of information to the CNSC. Sequencing the closure of gaps where further design details are required will be important to ensure there is no impact to the CNSC's ability to conduct reviews.
6. Project Controls for the integrated SMR project are centralized in and managed by OPG. Vendor data is fed into OPG's systems and the associated metrics and reports that are generated will be used by the integrated project team to drive decision making processes. The SMRRB views this as a good practice.

Recommendations

1. Use the system/metrics being put in place by the Project Controls organization to track progress of design Engineering not just as a reporting tool but also as a management tool.

Design Engineering Integrated Digital Engineering Platform

Introduction

The development and implementation of an integrated digital engineering platform is a critical tool for capturing, integrating, and managing plant information over the life-cycle of the DNNP. The platform is currently in the planning phase.

Observations

1. The SMMRB reviewed activities underway and plans to support a Digital Strategy. The SMRRB had the opportunity to ask probing questions about the vision, the progress, and the challenges. At this juncture, the SMRRB judged that the CIO integration staff understands the tasks and architecture requirements for facilitation of the SMR project implementation.

2. Engineering confirmed that a 3D digital model of Reactor Building and Power Block will be used to identify and minimize construction interferences.

3. Further, the end state requirements to achieve assumed staffing efficiencies in the Levelized Cost of Electricity (LCOE) targets are being specifically identified. Additional details of the implementation schedule will be incorporated following the establishment of the definitive agreement.

4. The SMRRB will revisit progress in a future session to verify proper integration and functioning among all project participants.

Recommendations

1. None

Regulatory

Introduction:

License to Construct (LTC) and License to Operate (LTO) are two of the most critical licenses required in order to de-risk and progress the project. The LTC is currently forecasted for November 2024, whereas the LTO is currently forecasted for Q3 2027. The SMRRB reviewed the high level timeline, key deliverables, and risks associated with these activities in general, but primarily focused on the nearer term activities associated with LTC submittal and subsequent approval.

Observations:

1. The submission of the LTC has been delayed from the original September 30, 2022 anticipated date. However, it appears the revised submission date of October 31, 2022 will be met and still meets the overall requirements of the project.

2. Once the LTC submission is made, it is anticipated there will be a large volume of requests from the CNSC regarding the technical aspects. With the ambitious timeline for a hearing in mid-2024, OPG has identified anticipated areas of concern and questions that the CNSC will likely pose.

3. Through experience with the Darlington refurbishment licencing process, OPG has anticipated the need for a responsive system with the CNSC. OPG has detailed a process and relationship that will ensure rapid and timely exchange of information moving forward. There is a signed LTC protocol that is in the process of being updated to cover several key items including timelines and process for receipt / response to information requests.

4. The highest risk areas to the LTC licence approval and timelines are the use of steel bricks in the containment system and the safety control systems. It is anticipated by the team that this will be the focus of requests coming from the CNSC. The OPG and GEH team continue to perform confirmatory tests and include CNSC participation to allow for early information exchange and to assist the CNSC in narrowing the scope and focus of future questions.

5. Given the ambitious timeline and phased application approach, it may be beneficial for OPG and GEH to review the regulatory sections of the risk register more often than the current monthly timeline. The need for this approach will be reviewed in a future meeting.

Recommendation

1. None

Visit #1 - 8 Recommendations Status:

1. ePMx 57340 - Business Case clear vision to include all 4 units – Closed
2. ePMx 57364 - Vision of how Owners Engineer concept will be staffed – Closed
3. ePMx 57365 – OPG to manage CNSC and standard design – Closed
4. ePMx 57366 - Increase OPG's Indigenous resources – Closed
5. ePMx 57367 - Process to demonstrate Indigenous Consultation – Closed
6. ePMx 57368 - Develop measures to track design progress – Open
7. ePMx 57369 - Roles of Owners Engineering are communicated to Design – Closed
8. ePMx 57370 - Site Preparation decision on OPG Design Authority - Closed

Small Modular Reactor Review Board
Independent Oversight Report on the Darlington New Nuclear Program

(Visit #3 – Feb 13-16, 2023)

Submitted to:
Major Project Committee of the Board of Directors for Ontario Power Generation

EXECUTIVE SUMMARY

The Small Modular Reactor Review Board (SMRRB) conducted its 3rd review of the Darlington New Nuclear Program (DNNP) via an onsite review from February 13-16, 2023. It was noted in the October 2022 review that the DNNP project was approaching an inflection point in which the volume, pace, and complexity of the work would increase dramatically in 2023 as it transitioned into the validation phase. Successful implementation would require an accelerated transition to an effective Integrated Project Delivery (IPD) team that seamlessly integrates OPG, GEH, SNC, and AECON into "one team".

The SMRRB focused this review on the organization's transition into this new phase. Of particular note is the progress in establishing the IPD framework via the Integrated Project Agreement (IPA), setup of the Project Leadership Team (PLT), the identification and initial staffing of the Project Management Team (PMT) structure, the engagement of BTTC to assist with the introduction of the IPD concept into the multiparty organizations, and the continued progress of the License to Construct (LTC) and Indigenous Relations activities.

While the progress to date is significant, given the ambitious timeline for developing and delivering the DNNP the SMRRB has concerns regarding whether this progress to date is sufficient. Various areas for improvement are outlined in the body of the report with the most notable being those associated with cross-cutting project management fundamentals and the design and implementation of the IPD team. It is the judgement of the SMRRB that if management attention is given to improve performance in these areas that the project can successfully position itself to develop and deliver the DNNP.

DETAILED REPORT

Background

The SMRRB was commissioned for the OPG Board of Directors to independently monitor the DNNP. This is the first review of 2023 and it is expected that the SMRRB will conduct further reviews in July and October 2023.

For this review, the SMRRB comprised the following members:

1. Sandy Rupprecht (Chair)
2. Virginia Greiman
3. Emily Whetung
4. David Christian
5. Mike Skaggs (remote)
6. Dietmar Reiner (OPG internal member)

OPG Support: Cory Bruder

Project Management Fundamentals

Introduction

The SMRRB reviewed 8 different functional areas and identified concerns of varying degrees regarding the implementation of project management fundamentals across many of the areas reviewed. In the judgement of the SMRRB, these need to be corrected in order to assure the project's ability to achieve its cost and schedule objectives.

Observations

1. Limited Identification and Understanding of Validation Phase Goals and Objectives – During the reviews the SMRRB noted that many of the areas had limited understanding of what they needed to deliver at the end of the validation phase. The License To Construct (LTC) regulatory organization provided the fullest understanding. The concern is that if organizations do not establish a common vision and understand "what good looks like" at the end of the validation phase, they may not be focusing their activities appropriately.
2. Project Schedule Not Yet Integrated – All organizations reviewed had activities that were interdependent on other functional organizations within the IPD team. They assumed that the requisite support would be available when required. An integrated project plan to ensure understanding, availability, and to identify/resolve resource conflicts and project priorities is currently under development. However, the plans to complete its development were not known.
3. Poor Accountability Behaviors – During the course of multiple reviews, project personnel exhibited behaviors that did not reflect accountability to key project outcomes. Discussion of plans and/or completion dates were often caveated with the words "draft, target, hope, try, etc." There was limited understanding of what would be required for those activities to transition from their current uncertain state to becoming project commitments. These behaviors are at odds with the strong commitment culture that is required for success of the project.
4. Lack of Integrated And Synchronized Performance Management Framework -- There are a variety of weekly and/or monthly touchpoint discussions between various levels of the organization. While these are judged to be necessary and appropriate it is unclear how these are integrated, synchronized, and employ common performance data from the working level to the PMTs, and in turn to the PLT. No plan was identified to develop such a framework.

Recommendations

1. Develop detailed validation phase objectives that will ensure a successful transition to execution. These should then cascade throughout the IPD team and drive local objectives. These objectives need to possess sufficient detail to ensure that each organization knows "what good looks like" for their scope of work at the end of the validation phase.
2. Based on the detailed validation phase objectives, expeditiously develop a detailed and integrated project schedule for the validation phase that is understood by all organizations, is used to drive accountability, and enables integration between organizations. It should drive a clear understanding of "what, when, and by whom".
3. Identify and implement IPD wide Accountability/Ownership behaviors. This should mirror what was done to develop and roll out the OPG-wide accountability model and behaviours.
4. Outline a formal, rigorous, and disciplined monthly performance review cycle that starts at the working level and cascades up to the PMT and PLT levels of the IPD team. The objective of the reviews is to understand performance, ensure integration, alignment, and commitment to project objectives, identify and resolve risk, and to adjust resource deployment as appropriate.

Integrated Project Delivery Team

Introduction

An Integrated Project Delivery (IPD) model was chosen by OPG to execute the DNNP project with its key vendors to enhance project performance via better collaboration, early engagement, interface management, and commercial alignment to the DNNP project goals. However, it is a new way of operating for OPG and many of the IPD organizations and will require continuous investment and development over time. The SMRRB review focused on the implementation of the IPD model to date, and the plans for its future development and implementation.

Observations

1. The Integrated Project Agreement (IPA) is a significant accomplishment that created the framework and commercial underpinning to achieve the projects objectives. While the IPA agreement is a necessary underpinning, it will not be sufficient to assure that IPD full potential is realized.
2. The IPD team has begun building understanding of the IPD concept with the multi-party management team via a kick-off meeting, identification of the PMT structure, and the initiation of PMT meetings. The organization is in the early phases of the "forming and storming" development cycle.
3. It is recognized by the PLT that the formation of PMTs will not be sufficient for the IPD team to adapt a new way of operating. The PLT has contracted with BTTC to assist in the development and implementation of a formal organizational development program. A review of the early development program indicates that the primary focus of the program is building the team's understanding and acceptance of the principles, behaviors, and cultural elements of the IPD. The SMRRB views this assistance favorably. However, the accountability for the continuous development of the IPD should reside within the IPD organization in order to assure long-term ownership and alignment with the needs of the DNNP.
4. The formation of PMTs alone will not deliver the full benefits of the IPD concept. At this stage of development, it is unclear to the SMRRB how the IPD will systematically ensure:
    a. Cross-functional integration and collaboration – a major source of value creation for the IPD team.
    b. Seamless flow of information and products across interface boundaries – incomplete, misunderstood, and/or inefficient flow of information across organizational or functional boundaries can be a major cause of delay, rework, and project disruption.
    c. Timely issue identification, decision making, and resolution – given the First-of-a-Kind (FOAK) nature, scale, and complexity of the DNNP project, emergent issues will be an everyday occurrence. Inability to address issues in an expedited fashion can be a major source of cost and schedule under-performance.

    Ensuring these performance enhancements actually occur requires the formal design and implementation of cross-functional teams, processes, delegation of authority, and ways of operating. Examples are co-location of personnel, "war" rooms, HIT teams, graded delegation of authority to field engineering, etc. These methods typically are only implemented with the proactive, and purposeful action by IPD leadership. Implementation as a reaction to an emergent issue is too late and undercuts the IPD team potential.

Recommendations

1. Development of the IPD should be assigned a senior management "owner" from within the IPD organization.

2. The adoption of behavioral and cultural elements of the IPD being facilitated by BTTC should be complimented by practical activities that require substantial cross-functional integration and collaboration. This would enable the IPD team to practice and experiment with the new way of working in a manner that yields key deliverables for the validation phase. Such suggestions have already been identified in the Construction Planning review as a means to reduce risk during the execution phase of the project.
3. The IPD model design and implementation needs to explicitly address how it will manage the functional interface boundaries to ensure seamless delivery and to ensure ultra-fast decision making to address emergent issues.

Indigenous Relations

Introduction

Aboriginal[1] people in Canada have constitutionally protected rights that OPG must consider in the development of any energy project. These rights are elevated to the highest level where there is a Treaty. The requirements of recognizing and addressing the rights of Aboriginal people in Canada (the Duty to Consult and Accommodate) rests entirely with the Crown. In 2018 the Williams Treaty was recognized both provincially and federally having an impact on the development of any projects at the Darlington location.

For a variety of reasons, First Nations rights have notably come in conflict with major projects in recent history. OPG has taken many steps to ensure that the DNNP avoids the types of delays that have been seen across Canada. Initially, Indigenous Relations was a section of Stakeholder engagement but has undergone a significant growth and development since the SMRRB first met with the DNNP. As an independent pillar in the functions of the organization, Indigenous Relations is now actively participating in all aspects of the project development.

Observations

1. The Indigenous Relations team has recognized the risk of relying on the provincial crown to satisfy the Constitutionally protected rights. OPG's team articulated the clear mandate from the provincial Crown to satisfy the procedural aspects of the constitutional obligations thereby allowing OPG to control management of the risks.
2. The DNNP Indigenous Relations team has developed and implemented an organization-wide tracking system to ensure that all engagements with, and commitments to, First Nations are documented. This program will allow for easy access to reports as permitting and licensing move forward.
3. The Indigenous Relations team have identified a risk in the federal Crown discharging their constitutional and common law obligations through the CNSC. Efforts to integrate reporting, share information, and support the CNSC are being made to manage the risk.
4. The constitutional and common law obligations are satisfied at a First Nation leadership level. However, many of the protests causing delays for other major projects across Canada have been undertaken by the citizens of the First Nation without support from elected leadership. The SMRRB has seen clear evidence that the efforts of the Indigenous Relations team go well beyond the bare minimum satisfaction of Constitutional requirements and extends into building a meaningful

[1] The term "Aboriginal" is used in this case as a direct reference to s.35 of the Constitution Act.

relationship. The Indigenous Relations team clearly understands this aspect of risk and has begun to consider how to build a plan to get in front of First Nations communities in order to understand their concerns, and address them to avoid escalation.

5. The IPA requires the development and delivery of an Indigenous Participation Plan within 180 days of the Effective Date. The Indigenous Relations team have clear line of sight to the elements this plan and how they will be developed. The SMRRB look forward to receiving it once it is prepared.

Recommendations

None

Procurement

Introduction

The purpose of the procurement review was to assess the structure and effectiveness of DNNP's procurement program and processes and to determine whether the program is adequately positioned to meet all sustainability, policy, and regulatory supply chain and procurement requirements for a FOAK project.

Observations

1. The Procurement Management Team (ProcMT) understands the necessity of establishing a supply chain strategy and framework that supports a robust procurement process, promotes collaboration, and provides best value including supplier innovation.
2. The ProcMT is in the process of developing a tactical, strategic and OM&A supply chain strategy and Master Agreement that includes parts and services post execution.
3. The Team's current areas of focus include integration with the IPA and its working structures and establishing targets for Canadian, ED&I and RAP awards.
4. The Team is working on long lead items from a Supply Chain and procurement perspective to include audits and qualifications for Non-Owners Parties (NOP's) and issuing Performance Work Statement's for IPA.
5. The team has developed an Indigenous participation scorecard and is focused on the importance of developing partnerships to create business opportunity in the Indigenous and local communities.
6. Progress has been made on the development of one common database across all procurement activities and packages.

Recommendations

1. The team is focused on establishing integration with the QA/QC teams. The integration needs to be cross-organizational with well-defined integration and coordination processes and execution processes to meet the demands of the integrated project schedule and ensure timely approvals from the PMT's. Roles, responsibilities, and accountabilities of the procurement team need to be clearly defined.

Site Preparation

Introduction

The SMRRB investigated progress in relation to Site Early Works and Site Main works required to support the Project Schedule.

Observations

1. Site Prep activities have not proceeded according to plan and a recovery plan is necessary to minimize impacts to the overall schedule. Contributing to this shortfall are:
   - Contractor Performance issues,
   - Failure to anticipate the timeline for obtaining an Endangered Species Assessment (ESA) permit, and
   - Requisite Long Lead Material (LLMs) not procured in a timely manner.
2. The ultimate impact is the potential loss of the 2023 spring construction season for planned site prep activities. In order to allow limited progress in site preparations:
   - Engineering is changing the layout of the site. Administration Building moved because of construction interfaces.
   - Engineering is evaluating elimination of the planned permanent Site Warehouse and utilizing the Construction Warehouse.
   - Simulator training will be relocated to the Pickering Learning Center until such time as an on-site Simulator Building can be constructed.
   - The Project is transitioning to a different contractor.
3. The responsible parties understand the importance of Site Preparation to the construction schedule. Citing the dependency upon Engineering (building relocations) and permitting, the Site Prep Team could not answer questions as to when Site Early Works would be complete nor when Site Main Works would be complete. This situation has potentially resulted in decisions which have increased Engineering workload and to some degree have potentially created a schedule cost and risk bow wave.
4. The decision to tie into the Darlington Demin Water plant, the development of engineering packages to do so, the subsequent decision (4-5 months later) to not tie into the Darlington Demin Water plant, and the resulting engineering effort all warrant further investigation. There are likely important lessons to be learned from this situation. At this early stage of the project, value can be derived from assessing performance so that the issues and drivers can be understood and communicated to the broader team as an illustration of how poor alignment and schedule commitment can have compounding effects.

Recommendations

1. It is recommended that the organization undertake a review to extract and derive value from the lessons that have been learned. The review should focus on, but not necessarily be limited to, understanding the schedule requirements, anticipation and attention to detail, timeliness of decision making and rapid escalation of issues for resolution when appropriate.

Engineering

Introduction

The SMRRB assessed the organization's progress in achieving planned engineering objectives and goals for the validation phase (2023 - 2024). This included a review of the organizational infrastructure, resourcing, tools and processes for tracking and monitoring performance, and overall progress on completion of design and development of the associated engineering products and deliverables relative to the plan and milestones that have been set out for the SMR project.

Observations

1. Comprehensive metrics and dashboards have been developed to track engineering progress against scheduled milestones. Forums have also been set up to facilitate structured progress reviews, albeit these are in early stages of maturation. To date, OPG has driven implementation of the infrastructure needed to monitor and manage performance. The SMRRB encourages GEH and other vendor partners performing engineering work to take ownership of metrics and performance monitoring/reporting for their work.
2. To date, design engineering priorities and efforts have been driven in large part by information needed to support OPG's License to Construct (LTC) application to the CNSC. With the LTC submissions nearing completion, the team has begun to shift its focus to strengthening integration with procurement and construction. Cross functional forums have been established to facilitate constructability reviews and ensure design plans and the associated engineering baselines are adjusted pending outcome.
3. The plan for completing design engineering and the associated deliverables has been re-baselined to reflect current status and a better understanding of the design work that needs to be completed. This has indicated that progression of design engineering is behind plan. Steps are being taken to mitigate downstream schedule impacts.
4. Engineering resource requirements are being developed and are indicating shortfalls in resources across all IPD partners. In some cases, advance hiring was done in anticipation of the increasing engineering workload. Each of the IPD partners, including OPG, has initiated hiring efforts and are putting agreements in place with external agencies that can provide additional engineering support. The SMRRB is concerned that the full extent of engineering demands and associated resourcing risks over the life of the project are not yet completely understood and do not yet reflect all of the engineering demands the project will face.

Recommendations

5. The SMRB recommends that an integrated engineering resourcing demand/supply plan spanning the validation phase and execution/construction phase of the project be developed. This needs to include anticipated demands from the LTC process, preparation of License To Operate (LTO) submissions to the CNSC, accommodation of validation phase goals to de-risk the execution/construction phase of the project, compressed timelines for execution of site preparation work, and field engineering requirements.

Construction Planning

Introduction

The SMRRB assessed the readiness of the project team to successfully construct the first SMR unit in accordance with established cost and schedule goals. This included a review of key milestones and goals in the validation phase, incorporation of lessons learned and Operating Experience (OPEX) from other major projects into the construction plans, and the organizational infrastructure being put in place to manage and execute the project.

Observations

1. AECON's PLT level construction leadership appears to be extremely strong with significant and relevant experience in construction, project, and engineering management. This experience needs to be leveraged broadly across the project by the PLT and PMTs.
2. The SMRRB saw evidence of the Constructor providing specialized project and construction management expertise, e.g. civil engineering leadership from AECON's Infrastructure group, to the project. This is consistent with benefits that are anticipated through implementation of an IPD team.
3. The construction organization is very clearly focused on utilizing the time available during the validation phase to best position the project for a successful outcome. For example, there is a clear objective to de-risk construction of the project by pursuing opportunities to build margin into the execution schedule. This example should be used as a "pilot" by BTTC and the PLT in development of the IPD. This is discussed in more detail in the IPD Team section of this report as an observation and recommendation.

Recommendations

None

Regulatory – License to Construct

Introduction

The SMRRB examined the License to Construct (LTC) initiative. The timelines, scope and work progress were reviewed, insights were obtained regarding the working relationship between OPG and GEH licensing counterparts as well as the nature of the interface with the CNSC. Insight was gained with respect to the Duty to Consult with Williams Treaty First Nations (WTFN) Indigenous Rights holders.

Observations

1. The LTC initiative is being well managed. Tasks, relationships, roles and accountabilities are well established and functioning within the Licensing organization. At this time risks to schedule and cost still remain.
2. The lead individual exhibited significant evidence of competence, ownership and accountability for results. The LTC initiative is adequately resourced and future activities, especially the License To Operate (LTO), are being considered and incorporated into planning by the Licensing Group. The LTC and LTO initiatives however rely heavily on resources from other functions and organizations.
3. In responding to CNSC reference requests and requests for information (RFIs), the Licensing Group acts, in many cases, as intermediary in directing RFIs to the Engineering Group and others for disposition. This creates engineering workload during the time in which design development and

review are required, LTC RFI responses must be provided, preparations for the January 2024 LTC hearing, and the beginning of compiling of information for the LTO application. This is further addressed in the section on Engineering.

4. The OPG Duty to Consult with WTFN is being well managed.

Recommendations

None

Permitting

Introduction

Permitting was identified during the SMRRB Visit 2 as being on the critical path. Of particular significance was the Endangered Species Assessment (ESA) permit needed for site preparation early works. The SMRRB objective for this visit 3 was to assess the readiness of the permitting function going forward.

Observations

1. While the ESA permit was submitted in December 2022, the permit has not yet been issued and as a result some aspects of site preparation early works cannot be started until fall 2023.
2. Mitigation of delays caused by the absence of the ESA permit have included reworking the site design, for example relocating the admin building outside of the permit area. There are aspects of the delay that cannot be recovered.
3. A list of necessary permits and associated lead times has been developed, along with the necessary logic functions to tie the dates permits are required to the overall project schedule. This list includes allocation of lead times, Indigenous engagement time frame estimates, and required inputs to obtain the permit for the requisite date.
4. Storm water management permits are now also on a critical path. Mitigation has included development of a phased approach instead of attempting to obtain all necessary aspects under a single permit. This issue also faces complications from transferring ownership between ES Fox and IPD Team.
5. A monthly call has been initiated for Area Leads to review schedule, permitting requirements, and the necessary information to support permit applications. However, there is an outstanding issue with the creation of an integrated schedule of permitting work required to support the project, and communication within the team to create awareness of schedule risks and mitigation measure.
6. The Indigenous Relations team appears to be fully integrated at this point in permitting, though this was clearly a new integration. Lead times for First Nations Consultation activities are an area of concern and there is a risk regarding the First Nations' ability to be responsive in a timely manner. The Indigenous Relations team prioritized the list of necessary permits and reviewed them with First Nations to ensure that efforts and resources were allocated according to First Nation priorities.
7. The Permitting team recognizes the need to increase personnel. They are currently relying on one full time permitting individual, one contractor, and one intern.

Recommendations

None

Visit #1 - 8 Recommendations Status:

1. ePMx 57340 - Business Case clear vision to include all 4 units – Closed
2. ePMx 57364 - Vision of how Owners Engineer concept will be staffed – Closed
3. ePMx 57365 – OPG to manage CNSC and standard design – Closed
4. ePMx 57366 - Increase OPG's Indigenous resources – Closed
5. ePMx 57367 - Process to demonstrate Indigenous Consultation – Closed
6. ePMx 57368 - Develop measures to track design progress – Closed
7. ePMx 57369 - Roles of Owners Engineering are communicated to Design – Closed
8. ePMx 57370 - Site Preparation decision on OPG Design Authority - Closed

Visit #2 – 5 Recommendations Status:

1. ePMx 58212 – underlying issues inhibiting key project risks from being expeditiously surfaced and addressed – Open
2. ePMx 58209 – between Gate 3 and 4 OPG to perform an independent "execution readiness" – Open
3. ePMx 58206 – Judgement applied to the Class 4 Estimate – Closed
4. ePMx 58218 – use the system/metrics of design engineering as a management tool - Closed
5. ePMx 58208 – dedicated resource to institutionalize IPD model – Closed

Small Modular Reactor Review Board
Independent Oversight Report on the Darlington New Nuclear Program

(Visit #4 – July 17-20, 2023)

Submitted to:
Major Project Committee of the Board of Directors for Ontario Power Generation

EXECUTIVE SUMMARY

The Small Modular Reactor Review Board (SMRRB) conducted its 4th review of the Darlington New Nuclear Program (DNNP) via an onsite review from July 17-20, 2023 and site visits to the Aecon, SNC Lavalin, and GEH vendor partner facilities prior to the onsite review. It was noted in the October 2022, and February 2023 review that the DNNP project was approaching an inflection point in which the volume, pace, and complexity of the work would increase dramatically in 2023 as it transitioned into the Validation phase. Consistent with industry operating experience, successful implementation will require a transition to an effective Integrated Project Delivery (IPD) team that seamlessly integrates OPG, GEH, SNC, and AECON into "one team".

The SMRRB focused this review on the organization's progress in transitioning to this phase of the project, as well as positioning the organization for the follow-on construction phase. The reviews demonstrated that there has been considerable progress made in advancing the project with respect to licensing, engineering, procurement and construction planning activities. Additional focus is required to ensure the organization is "ready for construction" in December of 2024.

It is the judgement of the SMRRB that progress is lagging in advancing the SMR-X organization into a single integrated team that is underpinned by a strong project management culture and an understanding of Lessons Learned from other nuclear new build projects. The SMRRB concern is that the project's rate of progress to date may not be sustainable without accelerating the organization's development in these areas. A formal plan along with strong leadership and sponsorship is recommended.

Specific areas for improvement are outlined in the body of the report.

DETAILED REPORT

Background

The SMRRB was commissioned for the OPG Board of Directors to independently monitor the DNNP. This is the second review of 2023, and it is expected that the SMRRB will conduct a further review in October 2023.

For this review, the SMRRB comprised the following members:

1. Sandy Rupprecht (Chair)
2. David Christian
3. Saga Williams

4. Mike Skaggs
5. Dietmar Reiner (OPG internal member)

OPG Support: Cory Bruder

Validation Phase Success Criteria

Introduction

The DNNP project is currently in the Validation phase where the focus is largely on refining the cost, schedule, and risks associated with executing the DNNP, obtaining the required approvals for execution of the first SMR unit, and ensuring the project is fully ready to successfully transition to the Execution phase at the end of 2024. The SMRRB assessed how the team will determine if the project is on a trajectory for achieving the Validation phase goals and for being fully ready to transition to the Execution phase.

Observations

1. The DNNP organization has identified seven (7) critical goals/objectives that are intended to ensure that the Validation phase objectives are achieved and that the project is positioned for transition to the Execution phase. This was identified by the SMRRB as a critical requirement in the February 2023 visit.
2. In the SMRRB's view, there is not yet sufficient detail on how these goals cascade across the various project delivery and support teams and how they cascade down into each organization to the level of detail that is needed to validate the project cost, schedule, and risk, and to ensure there is a good understanding of "who needs to do what by when" to ensure that the DNNP is fully ready to transition to the Execution phase at the end of the Validation phase.
3. This is recognized by the Project Leadership Team (PLT) and also by some of the project delivery and project support teams. For example, the Site Prep Project Management Team (PMT) and the Engineering PMT are taking proactive steps to address this, albeit in isolation of other PMTs and only for their specific scopes of work and deliverables.
4. The PLT has stood up a Project Integration Team (PIT). The PIT is developing a phased "roadmap" focused on building the foundation for "how" the DNNP will deliver its Validation phase goals/objectives and what needs to be done to be fully ready for the transition to the Execution phase. This includes ensuring there is alignment and understanding across the DNNP.
5. As previously recommended by the SMRRB, success criteria/objectives with sufficient detail need to be developed that define "what good looks like" and these need to then be used to measure if the DNNP is on the right trajectory for achieving its Validation phase goals and for getting all of the things done that need to get done to be fully ready for the transition to the Execution phase.
6. There is urgency in getting this done, to not only facilitate the project needs, but to also "catch up" with work already being done by some of the PMTs.

Recommendations

No additional recommendations. Recommendation ePMx 59214 from Visit #3 is still considered open.

Integrated Project Delivery Team Development

Introduction

An Integrated Project Delivery (IPD) model was chosen by OPG to execute the DNNP project with its key vendors to enhance project performance via better collaboration, early engagement, interface management, and commercial alignment to the DNNP project goals. This is a new way of operating for OPG and the vendor partners, and will require continuous commitment and development over time. The SMRRB review focused on the implementation of the IPD model to date, and the plans for its future development and implementation.

Observations

1. Members of the Project Integration Team (PIT) outlined the efforts to date that had been made in advancing the development of the IPD team. These included the staffing of Project Management Teams (PMT), staffing of the Area Leads to support the PMTs, a leadership meeting at the GE facility in Crotonville, NY to socialize and internalize the roles and responsibilities of the Area Leads, the branding of the delivery team as SMR-X, and the development of the draft cultural charter of the SMR-X team.
2. An evolving draft document was provided to the SMRRB that was a “plan for a plan”. It provided a phased road map for the Validation Phase. The “plan for the plan” targeted 7 different project phases that included Validation Phase Readiness, Early Construction Readiness, Nuclear Construction Readiness, Rolling Wave Construction, Pre-Operational Testing, Commissioning and Turnover, and Closeout.
3. It is the judgement of the SMRRB that the IPD Team development effort is lagging to meet the demands of project execution. This has the potential to result in degraded project performance. Examples that the SMRRB observed were:
    - Many of the project team members do not understand the project model, interfaces and organizational objectives.
    - Poor meeting conduct, inefficient meeting conduct and overuse of the staff’s time.
    - Inadequate means to track and trend organizational performance to sustain and improve project alignment and collaboration.
    - Insufficient attention to construction readiness.
    - Inconsistent project performance reviews.
    - Weak accountability behaviors in organizational pockets with respect to ownership, resolution of issues and drive to excellence.
    - Missing or poor guidance for personnel on-boarding, indoctrination and training.
    - Slow or ineffective resolution of critical issues.
    - Weak application of lessons learned from other nuclear construction projects
4. The SMRRB challenged that the team consider the following topics as part of the plan development:
    - Verify industry lessons learned have been applied.
    - Identify and include the project transitional phases into the plan approach.

- Evaluate, identify, and address any risks that currently exist while the IPD Development plan is being developed and approved.
- Address staffing, onboarding, training and qualifications of project personnel needs.
- Address updates to IPD Development plan through project completion.
- Industry norms like meeting conduct, schedule reporting conduct, action item management, etc. need to be resolved immediately through management direction.
- Paper management (e.g., design documentation, inspection reports, work completion documentation, ASME certification documentation, system, and area turnover certification, etc.) should be addressed as part of the plan.

Recommendations

In addition to the open recommendation ePMx 59920 from Visit #3, the SMRRB has the following additional recommendations:

1. The SMRRB recommends the expedited completion of the vision and objective for the conduct of the Integrated Project Delivery (IPD) team and the supporting IPD Integrated Development Plan.
2. The SMRRB found insufficient evidence of capturing, valuing and applying lessons learned. The SMRRB recommends that the IPD address this shortfall.

Vendor Site Visits

Introduction

The SMRRB has largely judged the effectiveness of the SMR-X IPD implementation from the perspective of observed PMT activities and reviews with PMT members. In order to gain greater clarity on the effectiveness of the implementation, several SMRRB members visited individual vendor partner sites in order to gain a perspective on how those "home" organizations are supporting the greater SMR-X IPD organization. Individual visits were made to AECON's Toronto, ON head office, AECON's Cambridge, ON fabrication facility, SNC-Lavalin's Mississauga, ON facility, and GEH's Wilmington, NC facility. The reviews afforded the SMRRB the opportunity to gain insights into the operational support approach, organizational structure, staffing plans, priority management, issue identification and escalation, personnel reward structure, and observations of workstream meetings.

Observations

1. Consistent with other PMT observations, these visits revealed a significant amount of initiative and a substantial amount of on-going work focused on making the SMR-X project successful.
2. In all visits the vendor partner leadership expressed strong commitment to the one-team SMR-X IPD team approach and acknowledged that there were gaps between the current operating approach and the future IPD team approach. No formal plans exist to systematically close those gaps.
3. All organizations have dedicated personnel assigned to the SMR-X project, with supplemental Subject Matter Experts (SMEs) matrixed to the project on an as needed basis. Where staffing shortfalls exist, 3rd party organizations are being on-boarded to provided supplemental staffing.
4. Alignment of 3rd party organizations to the SMR-X project goals and objectives is acknowledged. No formal plans exist to assess and address that risk.
5. Co-location is acknowledged as a critical strategy to accelerate the IPD development and implementation. Each vendor articulated visions that had varying degrees of co-location (core team, frequency and duration). A formal integrated plan was not yet available for review but

the SMRRB understand that a plan is in place to co-locate a core project team at OPG's new Oshawa head office in early 2024.

6. Complacency in meeting and owning commitments was observed to varying degrees in all site visits. The gaps with these behaviors were acknowledged by leadership, but no formal plan for addressing existed.
7. Observed operations were to varying degrees predominantly focused on a "vendor centric" approach as opposed to a broader IPD "project centric" approach. Observed touch-point or run-stream performance review meetings were predominantly focused on informing and engaging "local" vendor leadership. This is likely a necessity at this point in the project given that the broader IPD team development and implementation that is still in its early phases.
8. There are opportunities for the Project Integration Team (PIT) to set standards and expectations for both individual behavior, and organizational execution in order to gain the benefits expected of the IPD. In many cases the PIT can leverage best practices that may already be in place within the vendor partners organizations.

Recommendations

See Integrated Project Development (IPD) team Recommendations.

Project Management Teams (PMTs)

Introduction

The organizational structure that has been implemented for the DNNP IPD includes a number of integrated Project Management Teams (PMTs). Some PMTs are accountable for delivery of the various project scopes of work, organized into project bundles (e.g., Nuclear Island, Conventional Island, Balance of Plant), and other PMTs provide functional support to the delivery PMTs (e.g., Engineering, Supply Chain, Project Controls). The SMRRB undertook discussions with the leadership of various PMTs, including the Nuclear Island, Conventional Island, Balance of Plant, Site Prep, Engineering, and Project Controls PMTs to discuss progress, performance, issues and risks.

Observations

1. The SMRRB observed, across all PMTs, a lot of people doing a lot of good work and taking initiative to progress the project. The SMRRB also saw pockets of very strong leadership and strong project management skills and capabilities. There however appear to be some resource gaps and workload issues that are hindering progress. This is likely the result of some key roles (e.g. Area Leads) not yet being filled and not having sufficient skill/capability in specific areas. Risk identification, rating, and mitigation and the assessment and application of lessons learned are examples of areas where additional skill and capability is warranted. Given the large amount of work that needs to be executed in a very short period of time, the DNNP would benefit significantly by adding some additional experienced resources in key areas of the project.
2. The SMRRB has also observed inconsistent levels of ownership, commitment, accountability, and urgency amongst the PMTs. The PMT leadership that took part in the review discussions displayed the right attributes and behaviours. Based on observations from various PMT meetings that the SMRRB had an opportunity to listen in on leading up to this review, there is a tolerance for critical staff not attending key meetings, delegates not being sent, milestones being missed, and lack of formality and rigor in meeting conduct.

3. The Engineering PMT and Site Prep PMT appear to be the most mature in terms of their understanding of what "good" needs to look like, relative to their scopes of work, in order for the DNNP to successfully achieve its Validation phase objectives and transition to the Execution phase. This understanding has not been documented. In the SMRRB's view, having a documented articulation of what "good" looks like would serve as a very powerful alignment and communications tool.
4. The advanced level of maturity seen by the SMRRB in the Engineering PMT and Site Prep PMT is in part driven by urgency needed to meet specific schedule milestones and goals. In the case of the Engineering PMT, this urgency stems from the design and analysis deliverables required to support the License to Construct, and in the case of the Site Preparation PMT, the urgency stems from a project objective to be ready to execute early site preparation work by the end of 2023. This has resulted in the development of processes and tools, and a level of rigor and discipline in tracking progress and managing project performance within these PMTs that should be fully leveraged by all PMTs across the DNNP.

Recommendations

1. The SMRRB recommends that some additional experienced resources, both at a leadership and working level, and ideally with new-build experience, be brought onto the project.
2. The PIT should leverage the work that has already been done by the PMTs to establish a consistent approach and model for managing performance and tracking progress across the DNNP.

Project Management Office

Introduction

The Project Management Office (PMO) is a critical organization that is being put in place for developing, implementing and maintaining the project control functions, as well as the continuous reporting, trending and performance management of the SMR-X project. The SMRRB reviewed its progress to date, as well as its future development plans.

Observations

1. The SMRRB conducted a review session on Project Controls, Project schedule and other similar topics. Project Controls provided background on:
    - Roles and responsibilities
    - Organizational structure – utilization of a common and combined project team
    - Work Breakdown Structure
    - Architectural layout of the project schedule
    - Reporting, trending and performance management – tools and use of best practices
    - Schedule to completion of the Project validation milestone
2. Project Controls has developed instructions for the conduct of scheduling, so alignment of performance is maintained within the organization.
3. Estimating is performed within the Project Controls organization. The interface between Project Controls and Accounting appears to be appropriate.
4. The reports that Project Controls issues include:

- Weekly schedule
- 3 month lookahead
- Next week lookahead
- Master milestone list
- Monthly cost forecast
- Monthly Report
- Board Report
- CEO Report
- Design progress Tool
- Risk Register

5. The SMRRB reviewed some sample schedules and had no comments. Project Controls is maintaining schedule fidelity through the end of calendar year 2024. This approach is challenging and should be carefully monitored. Some current risks to the schedules include permitting. Work is ongoing to mitigate this risk. Work is also ongoing to improve schedule the readiness to construct.
6. In summary, the SMRRB found significant progress since the prior discussions. As a result the SMRRB is closing the previous recommendation regarding the development of an integrated project schedule.
7. The SMRRB suggested that Project Controls employ compression analysis for building space, and organizational capabilities in future activities.

Recommendations

None

Indigenous Relations

Introduction

Aboriginal[1] people in Canada have constitutionally protected rights that OPG must consider in the development of any energy project. These rights are elevated to the highest level where there is a Treaty. The requirements of recognizing and addressing the rights of Aboriginal people in Canada (the Duty to Consult and Accommodate) rests entirely with the Crown. In 2018 the Williams Treaty was recognized both provincially and federally having an impact on the development of any projects at the Darlington location. For a variety of reasons, First Nations rights have notably come in conflict with major projects in recent history. OPG has taken many steps to ensure that the DNNP avoids the types of delays that have been seen across Canada.

Observations

1. Initially, Indigenous Relations was a section of Stakeholder engagement but has undergone a significant growth and development since the SMRRB first met with the DNNP, now branded as the SMR-X. As an independent pillar in the functions of the organization, Indigenous Relations is now actively participating in all aspects of the project development.

[1] The term “Aboriginal” is used in this case as a direct reference to s.35 of the Constitution Act. .

2. The SMR-X planning activities have not adequately planned for the seamless integration of Indigenous Relations communication and engagement processes into the various delivery workstreams schedules and milestones.
3. The new branding (which was not shared with the Indigenous Relations team), is a great opportunity to refresh internally and externally in terms of a fulsome IR inclusion. It allows for a distinct approach for a revision of the Indigenous Engagement Plan specific to the SMR build. There are new members of the IR team that bring specific interests and expertise that can be utilized to create a fulsome deployment of the Indigenous Engagement Implementation Plan. Targets need to be set and measured (creation of an Action Plan) that includes permitting (environmental inclusion), employment and training, business development and relationship building.
4. SMR-X cannot afford to be impacted by other proposals/projects/processes that the four partners of the SMR-X engage on with the SMR-X identified Indigenous communities.
5. There needs to be SMR-X team Indigenous cultural intelligence training across the organization.
6. All aspects of Indigenous engagement need to focus on the constituents within communities. This includes leadership, technical staff, consultants and community members.

Recommendations

1. Proactively integrate Indigenous Relation communication and engagement activities into the planning of delivery workstreams. Ensure associated risks are identified and captured in the risk register and that accountabilities are appropriately assigned to those best in the position to avoid, prevent, and/or mitigate the risks.
2. A training program should be developed that educates the broader SMR-X team on the benefits of proactively planning these IR activities, and on the risks to the project of reactively including them as an afterthought.
3. Review the DNNP (transitioning to SMR-X) Indigenous Engagement Implementation Plan ("Plan") and create an associated Action Plan to engage leadership, technical staff and members within the Indigenous communities identified in (a revised) Table 1.

License to Construct

Introduction

The SMRRB examined the progress and planning for the License to Construct (LTC) required at the end of the validation phase, the preparations for hearings on the Technology Selection and Environmental Assessment (EA) Validity, as well as the organization's preparations for the transition to the License to Operate (LTO) scope of work during the Construction phase of the project.

Observations

1. Consistent with prior SMRRB reviews, the LTC organization demonstrated that they had a clear understanding of what has to be accomplished to prepare for and support the public hearings for both the Technology Selection & EA Validity in January of 2024 and the License to Construct (LTC) in October of 2024.
2. Through a variety of regularly scheduled touchpoint meetings and use of the Integrated Schedule process the LTC organization maintains the focus, alignment, and engagement of the SMR-X project organization Subject Matter Experts (SME) to respond to information requests,

preparation for upcoming public hearings, and direct engagement in support the licensing requirements.

3. In an effort to continuously de-risk the licensing scope of the project, contact is proactively maintained with the regulatory agencies through formal and informal contacts in order to stay abreast of the resolution of identified issues and to understand what issues may be forthcoming.
4. An effort has already begun to position the organization to transition to the LTO scope of work at the conclusion of the Validation phase. The person previously responsible for the LTC submittal has already been re-assigned to lead the LTO effort. Work is already underway to formally catalogue the additional information that will be required for the LTO and preliminary plans for obtaining that information have begun.

Recommendations

None

Steel Bricks to DPSC

Introduction

The SMRRB became aware of the project's re-direction away from Steel Brick construction methodology to Diaphragm Plate Steel Composite (DPSC) methodology and requested a meeting to review the basis for the change and to understand the associated risk profile. Both Steel Brick and DPSC methodologies represent First of A Kind (FOAK) use for nuclear plant construction.

Observations

1. A multi-disciplined "tiger" team was assembled to evaluate alternatives to Steel Brick methodologies. A systematic approach was used and various alternatives were studied.
2. Cost comparisons along with impacts to construction were considered.
3. New and different risks are involved with the selection of DPSC.

Recommendations

1. Update the risk register to a) remove references to Steel Bricks and b) capture the new and different risks associated with DPSC construction methods, (e.g., automated welding, robotic software, structural characteristic validation, tolerance stack-up concerns, NDT requirements, and ASME or other standard certification).

Digital Strategy PMT

Introduction

Deployment and collaborative application of digital tools holds substantial potential to facilitate best in class construction outcomes. Additionally, digital tools can enable new management models to allow long-term operations with substantially reduced staffing levels.

Observations

1. The Digital Strategy PMT has taken a thoughtful and deliberate approach to meeting project and long-term owner requirements. Substantial progress has been made since the last review.
2. The Digital Strategy PMT has developed and is rolling out for use digital tools for Common Data Environment, Construction IT tools (CMIS), document management, etc. The scope of work for IPD and non-IPD aspects are well understood.
3. Test cases have been table topped or practically exercised to validate the efficacy of the tool set.
4. Training is ongoing in support of tool set roll out.
5. Cybersecurity, non-proliferation considerations and other requirements have been integrated programmatically.
6. The PMT has a high level of confidence from a Digital Strategy perspective in being ready to support project construction goals beyond January 2025.
7. Remaining items in the Risk Register relating to Digital Strategy are understood and are being addressed.

Suggestion

1. Share good practices and experiences with other PMT leads.

Visit #1 - 8 Recommendations Status:

1. ePMx 57340 - Business Case clear vision to include all 4 units – Closed
2. ePMx 57364 - Vision of how Owners Engineer concept will be staffed – Closed
3. ePMx 57365 – OPG to manage CNSC and standard design – Closed
4. ePMx 57366 - Increase OPG's Indigenous resources – Closed
5. ePMx 57367 - Process to demonstrate Indigenous Consultation – Closed
6. ePMx 57368 - Develop measures to track design progress – Closed
7. ePMx 57369 - Roles of Owners Engineering are communicated to Design – Closed
8. ePMx 57370 - Site Preparation decision on OPG Design Authority - Closed

Visit #2 – 5 Recommendations Status:

1. ePMx 58212 – underlying issues inhibiting key project risks from being expeditiously surfaced and addressed – Open
2. ePMx 58209 – between Gate 3 and 4 OPG to perform an independent "execution readiness" – Open
3. ePMx 58206 – Judgement applied to the Class 4 Estimate – Closed
4. ePMx 58218 – use the system/metrics of design engineering as a management tool - Closed
5. ePMx 58208 – dedicated resource to institutionalize IPD model – Closed

Visit #3 – 10 Recommendations Status:

1. ePMx 59214 - develop detailed validation phase objectives that will ensure a successful transition to execution, cascaded throughout the IPD Team – Open
2. ePMx 59215 – develop a detailed and integrated project schedule for validation phase - Closed
3. ePMx 59216 - identify and implement IPD wide Accountability/Ownership behaviors – Open
4. ePMx 59217 - Outline a formal, rigorous, and disciplined monthly performance review cycle that starts at the working level and cascades up to the PMT and PLT levels of the IPD team - Closed
5. ePMx 59218 - development of the IPD should be assigned a senior management "owner" from within the IPD organization – Closed
6. ePMx 59219 - the adoption of behavioral and cultural elements of the IPD being facilitated by BTTC should be complimented by practical activities that require substantial cross-functional integration and collaboration – Closed
7. ePMx 59220 - the IPD model design and implementation needs to explicitly address how it will manage the functional interface boundaries to ensure seamless delivery and to ensure ultra-fast decision making to address emergent issues – Open
8. ePMx 59221 – ProcMT roles, responsibilities, and accountabilities of the procurement team need to be clearly defined - Closed
9. ePMx 59222 – Site Preparation is recommended that the organization undertake a review to extract and derive value from the lessons that have been learned – Closed
10. ePMx 59223 - the SMRRB recommends that an integrated engineering resourcing demand/supply plan spanning the validation phase and execution/construction phase of the project be developed – Closed

Small Modular Reactor Review Board
Independent Oversight Report on the Darlington New Nuclear Program

(Visit #5 – Oct 16-19, 2023)

Submitted to:
Major Project Committee of the Board of Directors for Ontario Power Generation

EXECUTIVE SUMMARY

Prior Small Modular Reactor Review Board (SMRRB) reviews have concluded that while there has been substantial progress in licensing, engineering, procurement, and construction planning, the progress in advancing the SMR-X organization into an Integrated Project Delivery (IPD) team and to ensure the project is "ready for construction" in January 2025 was lagging. This review was primarily focused on assessing progress in these previously cited areas for improvement.

The review revealed that since July 2023, there has been significant progress. Of particular note is the progress in developing and implementing an IPD development plan, execution readiness process, Validation Phase success criteria, and lessons learned program. While some planned activities and actions have been completed in these areas, many are still in progress with completion commitments for October through December 2023. Successful completion is expected to form a solid platform from which to continue to accelerate progress. This will require leadership reinforcement from all levels of the organization to achieve consistent progress across the SMR-X organization. Particular areas of focus are implementation of accountability behaviors, conduct of Project Management Team (PMT) meetings, integration of Indigenous Relations, and ensuring effective responses and mitigation actions exist for key execution risks.

Given the First-Of-A-Kind (FOAK) nature of the project, the SMRRB believes it would be beneficial for additional organizational attention to be focused on proactively developing "margin" to anticipate and counter the likely FOAK issues and disruptions that may emerge. In addition to the measures that are already in place (e.g. project contingencies, risk mitigation plans, etc.), this can be achieved through the proactive pursuit of cost and schedule improvement opportunities, as well as through the deliberate design of resiliency into the IPD team (i.e., staff surge capability, emergent issue protocol and processes, issue response teams, "war rooms", etc.). Examination of the SMR-X organization's performance in response to the Reactor Building (RB) Seismic issue presents an opportunity to examine where additional "margin" can help to mitigate the potential impacts that a significant disruption can have on overall project performance.

DETAILED REPORT

Background

The SMRRB was commissioned for the OPG Board of Directors to independently monitor the DNNP. This is the third review of 2023, and it is expected that the SMRRB will conduct 3 further reviews in 2024.

For this review, the SMRRB comprised the following members:

1. Sandy Rupprecht (Chair)

2. David Christian
3. Saga Williams
4. Mike Skaggs
5. Dietmar Reiner (OPG internal member)

OPG Support: Cory Bruder

Validation Phase Success Criteria

Introduction

In its February 2023 review, the SMRRB recommended that detailed Validation Phase objectives should be developed to ensure a successful transition to execution, and that these objectives should be cascaded across the various project delivery and support teams and down into each organization to a level of detail needed to successfully achieve these objectives. In the July 2023 review, the DNNP organization presented seven (7) critical Validation Phase goals and objectives that have been established and communicated across the DNNP. These goals and objectives are intended to ensure that the Validation phase objectives are achieved and that the project is well positioned for transition to the Execution phase. In this review, the SMRRB assessed the progress being made in implementing the SMRRB's recommendation.

Observations

1. A significant amount of work has been done by the Project Integration Team (PIT) in the development of a comprehensive Ready To Execute strategy that includes processes, procedures, metrics, etc. needed to guide and monitor progress of the Validation Phase goals, and to ensure the DNNP is ready for execution at the end of the Validation Phase. It also includes the elements needed to address the SMRRB's recommendation on cascading the Validation Phase goals across and down the entire DNNP and support organizations to a level of detail needed to successfully achieve these goals.
2. Many of the associated deliverables are still in an early development stage. Owners and due dates have been established by the PIT, and the PIT is overseeing, guiding, and monitoring progress.
3. The PIT has also established additional actions and dates by when the SMRRB's recommendation regarding the Validation Phase goals will be completed. Provided these actions, as well as the underlying processes, procedures, metrics, etc. are completed by the dates indicated, the SMRRB's recommendation on Validation Phase goals and success criteria will be closed. Recommendation ePMx 59214 from Visit #3 is still considered open.

Recommendations

None

Integrated Project Delivery Team Development

Introduction

An Integrated Project Delivery (IPD) model was chosen by OPG to execute the DNNP project with its key vendors to enhance project performance via better collaboration, early engagement, interface management, and commercial alignment to the DNNP project goals. The SMRRB's July 2023 review concluded that progress was lagging in advancing the IPD team. The SMRRB recommended the development of a formal plan along with strong leadership and sponsorship. This review focused on the progress of the IPD development in order that the SMR-X organization is "ready to execute" in January of 2025.

Observations

1. A detailed plan focused on IPD Development was created that focused on Area Lead Development, Job Familiarization Guidelines, IPD Future State, Accountability Behaviors, and Process Structure,with actions and owners assigned. Completion dates range from October 2023 through February 2024.
2. The IPD Development plans are complemented by detailed plans associated with Lessons-Learned, Validation Phase Success Criteria, and Execution Readiness Process.
3. The Execution Readiness Process is an integral part of how the organization will ensure that it is prepared to execute. The adoption and rigorous implementation of this plan is expected to prepare the organization to execute at Start of Installation (SOI) dates. Piloting of the process for the Reactor Building (RB) Shoring readiness activities is expected to yield feedback that will improve the process.
4. Effort is still required to address the recommendation of how functional interfaces will be managed to ensure seamless delivery, as well as how the IPD will ensure ultra-fast decision making to address emergent issues. (EPMX 59220). It is suggested that the SMRRB Recommendation in the Seismic Root Cause review section of this report be employed to inform the organization how to implement these features into the IPD.
5. Ownership & Accountability behaviors have been established and communicated to the SMR-X team. SMRRB observations of various meetings have shown that while progress has been made in implementing these behaviors, there are often situations where the behaviors are not being fully implemented. It is the judgement of the SMRRB that further leadership reinforcement is required to complete the implementation of these behaviors. As discussed in the PMT Meeting Observation section, the PLT has already taken action to attend a range of meetings to ensure that standards and expectations are being met and to provide coaching on achieving those standards where appropriate. ePMx 5926 remains open pending future SMRRB observations.
6. The collective implementation of the plans outlined above are expected to provide a strong platform from which to continue to build the IPD capability.
7. It is judged by the SMRRB that there has been considerable progress in the development of a detailed IPD plan and the organization is currently in the process of implementing that plan. Continued management focus and reinforcement is required to ensure continued progress. Future SMRRB reviews will monitor the progress and effectiveness of the implementation of the plan.

Recommendations

None

Operations and Maintenance

Introduction

The SMRRB conducted their first discussion and review of the Operations and Maintenance (O&M) functions. The DNNP created this group to develop and implement plans to ensure that:

- Plant procedures are developed, approved and ready for use,
- Plant staffing is onboard, trained, qualified and proficient to safely operate and maintain the plant,
- A management system is in place and meets the needs for plant operation,
- The plant digital strategy and WANO Plant Startup Review (PSUR) is successfully implemented and
- Equipment, tools and supplies are available for safe plant operation and maintenance

Observations

1. All O&M related work activities will be integrated into the master P6 project schedule by year end.
2. The O&M team appeared to have performed a broad and thorough review of OPEX and has plans to incorporate the results of their review into their strategic plans.
3. GEH is responsible for the drafting and writing of the plant procedures and instructions – except for the operation of the switchyard - the O&M team has individuals from their organization integrated with GEH.
4. The O&M staffing strategy relies on the SMR design and implementation of digital strategy to simplify operations and maintenance and in turn reduce staffing requirements - there is potentially an element of risk here, which is captured in the risk register.
5. Some of the O&M team overused non-committal language when describing their responsibilities and tasks. This behavior could result in a lower sense of urgency.
6. The SMRRB intends to review the following topics at the next meeting:
    a. The schedule to define the plant headcount requirements by function (i.e, maintenance technician, operator, security officer, etc.), timing for developing the job function, posting the position, conducting the interviews, selecting, hiring and onboarding the candidates, training for the candidates, the class sizes, timing and conduct of OJT/TPE, the assumed attrition rates, training failure rates and target staff versus the hiring target.
    b. The strategic plan to foster, engage and develop the new hires before the plant is commissioned.
    c. The details of how the multiskilled process will work including the review of industry lessons learned.

d. The details of what is included in the WANO Pre-Startup Review (PSUR) department notebooks, including the benchmark utilized and the schedule details to populate these notebooks

Recommendations

O&M should develop metrics to track the progress in completing the development of plant procedures and simulator hardware/software. Tracking the completion of the development, draft, review and final approval stages would be one possible method of tracking the progress.

Risk Management Process

Introduction

Risk resides and inheres in every project. In mega-projects and especially in FOAK mega-projects, it is essential for project participants to maintain a sharp focus on risks by establishing a means of identifying, evaluating and tracking identified risks and by having countermeasures to avoid, mitigate, or otherwise minimize the individual and cumulative impact of risks known to exist.

Observations

1. A systematic approach is being applied to identification and characterization of project and program risks. Based on the progress of the project, the SMRRB finds the number of risks presently captured in the risk register to be comparatively low based on other mega project OPEX and may indicate a gap in the surfacing and evaluation of meaningful risks.
2. A risk oversight process is in place to ensure the risk management process is functioning and providing reliable information to the PLT. Leadership recognizes their role in reinforcing the importance of risk management emphasizing ownership and follow through on countermeasures.
3. During the course of this review, the SMRRB did not perform a detailed review of risks which have been submitted and are in process, but not yet active. Current practice is to review “draft” risks which have an age older than 60 days at each Risk Oversight Committee meeting.
4. The SMRRB will monitor one or more Risk Oversight Committee (ROC) meetings in the near future to assess the effectiveness of risk oversight.

Recommendations

Action is required to ensure inactive, or “draft” risks receive visibility, or are activated or deleted more quickly.

Indigenous Relations

Introduction

Aboriginal people in Canada have constitutionally protected rights that OPG must consider and accommodate in the development of any energy project they initiate, including the DNNP. These constitutionally protected rights are elevated to the highest standard of engagement, consultation and accommodation thresholds where the project site is located on a Treaty. The requirements of recognizing and addressing the rights of Aboriginal people in Canada (the Duty to Consult and Accommodate) rests entirely with the Crown, with procedural aspects delegated to the proponent as the expert in the scope and specifications of the project, the DNNP in this case with the oversight body being the CNSC.

In 2018, the Williams Treaty Settlement Agreement was ratified and recognized by four Michi Saagig and three Chippewa First Nations, as well as the provincial and federal governments. This Settlement Agreement had the effect of elevating the Treaty and Aboriginal rights of the Williams Treaties First Nations, including those Treaties that were signed prior to confederation and enveloped by s.35 of the Constitution Act, 1982. having an impact on the development of any projects at the Darlington location. For a variety of reasons, the exercise of First Nations rights has notably been impacted by the historic and recent development of major projects in Ontario. OPG has taken many steps to ensure that the DNNP avoids the types of delays that have been seen across Canada.

Observations

1. Initially, the Indigenous Relations (IR) Team was located within the Stakeholder Engagement area. It has undergone significant growth and development within the OPG IR Team and the SMR-X Team since the SMRRB first met with the DNNP over a year ago.
2. As an independent pillar in the functions of the DNNP organization, IR is now participating in all aspects of the project development and is seen as a centralized business area. It is notable that the SMR-X IR Team is working well with the PMT organizations.
3. The planned deployment of training across the SMR-X Team over the next two months will assist in the practical incorporation of IR into regulatory, permitting and required engagement activities in the various workstreams. These are key to the deployment of the IR consultation and engagement requirements to mitigate risks.

Recommendations

1. Ensure that the risks associated with the IR communication and engagement activities are identified and captured in the risk register and that accountabilities are appropriately assigned to those best in the position to avoid, prevent, and/or mitigate the risks.

2. A comprehensive training plan has been developed that includes an education program for OPG, and the broader SMR-X team on the history of Indigenous peoples. Over the next four months, ensure that the SMR-X team members participate in the training to emphasize the need for effective IR engagement and consultation, to support the team in planning of IR accommodation activities, and to respond to the concerns and issues of Indigenous rights holders.

License to Construct

Introduction

The SMRRB examined the progress and planning for the readiness of the SMR-X team to meet the CNSC hearing requirements for the License to Construct (LTC) required at the end of the validation phase, the preparations for hearings on the Technology Selection and Environmental Assessment (EA) Validity, as well as the organization's preparations for the transition to the License to Operate (LTO) scope of work during the Construction phase of the project.

Observations

1. Consistent with prior SMRRB reviews, the LTC organization demonstrated that they have a clear understanding of what has to be accomplished to prepare for and support the public hearings for both the Technology Selection & EA Validity in January of 2024 and the License to Construct (LTC) in October of 2024.
2. Through a variety of regularly scheduled touchpoint meetings and use of the Integrated Schedule process the LTC organization maintains the focus, alignment, and engagement of the SMR-X project organization Subject Matter Experts (SME) to respond to information requests, preparation for upcoming public hearings, and direct engagement in support the licensing requirements.
2. In addition to the LTC hearing preparation, the SMR-X team has a formal plan in place that is linked to the DNNP Risk Registry in preparation for the LTO process.

Recommendations

None

Stage Gate 3 Review Plan

Introduction

The Stage Gate (SG) process is cited as a best practice in assessing the progress and readiness of a project to move into the next phase of development. To date it has been applied to the DNNP project to assess the maturity of the various project bundles and to provide a basis for releasing funding for the Validation Phase of the project (Stage Gates 1 and 2). It will continue to be employed with the Stage Gate 3 (SG3) process to assess the maturity of the various project bundles to transition from the Validation Phase to the Execution Phase in November of 2024. This review was focused on assessing the plan for ensuring that the implementation of the SG3 process will provide sufficient rigor, integration, and coordination to ensure an effective owner review for ultimate approval by the OPG Board.

Observations

1. While the formal SG3 reviews are planned to take place in Q4 2024, the planning and preparation for the reviews have already begun one year in advance. Deep dive reviews, including schedule, Construction Work Packages (CWPs) and Execution Readiness reviews, are part of this advanced preparation to ensure that the Review Board is sufficiently familiar with and has had adequate opportunity to digest and challenge the adequacy of the bundle strategy, safety, cost, schedule, and quality plans.

2. The general makeup of the Gate Review Board Members has been outlined per procedure. There is clear representation on the Review Board with respect to Project Management, Project Controls, Engineering, Construction, and Finance. There is no explicit Supply Chain representation as a voting member of the Review Board, though there is nothing that precludes Supply Chain participation in the review. In February 2024, the SMRRB intends to gain a better understanding of how the Supply Chain readiness will be assessed as part of the SG3 review.

3. It is important that the actual members assigned to fulfill these roles have the appropriate qualifications, and time to engage to ensure that their knowledge and subsequent interrogation provides a meaningful assessment for the owner to approve moving forward into execution. In February of 2024, the SMRRB will review these aspects of the review board to gain confidence in the implementation of the SG3 process.

Recommendations

None

Suggestion: Emphasis has been placed on SG Review Board members having sufficient time available to accomplish a thorough and meaningful review and validation. This will be a challenge as the volume and pace of activities increases in the coming months. Consider adding to the review an ex-officio independent external participant.

Lessons Learned Process

Introduction

In the July 2023 review, the SMRRB noted that there was insufficient evidence that lessons learned by other mega projects were being adequately captured, valued, and applied to the DNNP and the SMRRB recommended that the project team address this shortfall. In this review, the SMRRB assessed the Lessons Learned process and its implementation.

Observations

1. Since July 2023, the project organization has documented and implemented a formal Lessons Learned program. The program is resourced to meet the DNNP's needs. Procedures and expectations have been communicated across the DNNP. Tools have been developed that allow for capturing new lessons, searching the lessons learned database, tracking actions that have been taken to incorporate the lessons in the DNNP, and reporting on key performance metrics to monitor the overall "health" of the Lessons Learned program.

2. Specific examples on the identification, categorization, and application of lessons learned on other projects to the DNNP were demonstrated and discussed with the SMRRB. This included the SMR intake and discharge tunnel boring.

3. The SMRRB's overall conclusion is that the lessons learned program and associated process and tools are robust, well implemented, and well managed. The value of leveraging lessons learned recognized by the DNNP team.

4. In the SMRRB's view, the project team has taken appropriate action to address the shortfall that was previously observed, and as such, the SMRRB is closing the recommendation from its February 2023 review.

Recommendations

None

Suggestions: Consider using the management of the Lessons Learned program as a development opportunity for project staff, e.g., development of Area Leads.

Seismic Root Cause

Introduction

The seismic analysis and modeling conducted by the DNNP design team has uncovered some deficiencies in the Reactor Building and Reactor Pressure Vessel designs. The rectification of these deficiencies has the potential to impact the overall project cost and schedule. The SMRRB assessed the DNNP team response to this issue and how the lessons learned from the response are being applied across the DNNP to better position the project team to deal with future issues and challenges that have the potential to create disruption for the project. The SMRRB did not assess the technical aspects of the team’s response to the seismic issue.

Observations

1. A team of highly skilled, talented, and engaged people have been assembled and mobilized by the DNNP to resolve the seismic issue. This team is working collaboratively and systematically to understand the issue, evaluate mitigation options, and develop plans and actions to rectify the issue with clear line of sight on minimizing impacts on cost and schedule. In the SMRRB’s view, the response is appropriate and is what should be expected given the significance of this issue.

2. This issue could have been surfaced and escalated more quickly. The project team recognizes that this is an issue that has potentially cost them several weeks of time in developing mitigation plans and actions.

3. The project team has implemented “special purpose reviews” to assess other areas where assumptions needed to be made to progress the detailed design of the SMR, and where there is the potential for cost and/or schedule impacts on the project should these assumptions need to be changed.

4. This issue, and specifically the approaches taken to rectify it, creates a teaching opportunity that can help to better position the DNNP organization to respond to future issues. In the SMRRB's view, this is an opportunity that the DNNP team should not forgo. Given the First-Of-A-Kind (FOAK) nature of the DNNP, there will likely be other issues that have the potential to create disruption for the project.

Recommendations

The SMRRB recommends that an assessment of what the team did well, where there were gaps, and what the team would do differently in response to the seismic issue gets conducted. This assessment should then get utilized to better prepare and position the broader DNNP team to deal with future issues that have the potential to create disruption for the project.

Reactor Building Shoring

Introduction

The SMRRB reviewed the project's preparation efforts associated with Reactor Building (RB) shoring and foundational work. RB shoring is the first critical construction activity for the DNNP project. Turbine building and pedestal shoring is planned to occur prior to the RB shoring and those lessons learned are planned to be utilized to further the preparation and execution of the RB shoring. RB shoring is scheduled to start in June 2024. The current issues with RPV seismic analysis are compressing the shoring schedule and as a result the subject work is essentially on critical path.

Observations

1. The recently developed Execution Readiness Process is being utilized to ensure adequate preparation.
2. The lead for the task is engaged in the planning and preparation details and contingency planning.
3. The lead vendor performing the shoring and foundational work is experienced in the task to be performed.
4. Two independent design reviews are planned for this task.
5. The schedule is being currently revised to include the details being discovered as part of the preparation work and contingency planning.
6. In February 2024, the SMRRB will review RB Shoring's progress in being ready to execute in June of 2024.

Recommendations

None

Nuclear Island (NI) PMT and Major Procurement

Introduction

The SMR X300 is a first of a kind (FOAK) nuclear plant for which an established supply chain does not currently exist. As such, determining appropriate codes and standards and developing a sourcing strategy for large numbers of reactors and related components is essential to project success.

Observations

1. The project alliance members:
   a.) have detailed knowledge of global manufacturing capabilities and have produced sourcing strategies and options for most FOAK components. Final decisions have been made in some cases. In some cases, decisions cannot be finalized pending final determination of seismic loading.
   b.) have identified a number of risks to be addressed and mitigated over the coming weeks and months.
   c.) are working diligently and in real time with design engineering, licensing, and others to mitigate inherent risks without jeopardizing project performance delivery.

2. One new FOAK was captured during discussions. Specifically, the requirement for a 90 foot long refueling mast which has never been built and the task of fuel handling through 60 feet of water.

Recommendations

None

PMT Meeting Observations

Background

A key element of the SMR-X project management fundamentals is the regularly scheduled PMT monthly meetings. These meetings are led by the integrated PMT leadership team and are to be the prelude to "rolling-up" the PMT performance data to the Monthly DNNP Program Performance Review. Prior SMRRB reviews in February and July of 2023 had identified shortcomings in the conduct of these meetings and it was recommended that a consistent approach for managing performance and tracking progress across the DNNP be established for these meetings. In response, the PLT has issued tools and expectations for the meetings (PMT Dashboard Template, PowerPoint Template, Meeting Minute Template, Meeting Expectations), following the September 11-14 Crotonville session. Prior to the October on-site review meetings, the SMRRB remotely observed the Nuclear Island, Balance of Plant (BOP), Conventional Island, and Engineering PMT Meetings.

Observations

1. There was a wide range of inconsistent meeting formats observed between September 25 and 27. In the judgement of the SMRRB, the Engineering PMT represents the best example of

implementing the expectations of the PLT, with the NI PMT providing the next best example. Positive attributes generally found in these meetings were:

a. Structured agenda that was rigorously followed.
b. Safety, EDI, and Accountability moments at the beginning.
c. Standard PMT Dashboard template
d. Emphasis on risk and mitigation actions
e. Attendees came prepared and were engaged throughout the meeting.
f. Coaching was provided when shortcomings in meeting expectations were observed.
g. Constructive challenges came from Areal Leads and PMT leadership.
h. Meeting assessment conducted at the close out of the meeting

2. The BOP and Conventional Island (CI) meetings did not adhere to the PLT meeting standards communicated. Some key areas for improvement are:
    a. While an agenda may have been suggested, it was not rigorously followed
    b. Required attendance was unclear; lack of attendance was tolerated, and meetings were postponed/canceled.
    c. Standard progress templates inconsistently employed
    d. No roll-up of performance into a standard set of project metrics.
    e. Decision making confusion; authority and escalation unclear.
3. Some general areas for improvement:
    a. Suggested that Project Controls representatives should be attending the meetings
    b. Attendance -- Clarity on required attendance; allow delegates to attend and be prepared to represent.
    c. Accountability Behaviors – Lack of ownership or precise communication via phrases “hope”….”if all goes well”….”I will try”…..”expect it soon”. While an improvement over prior observations, these behaviors still exist.
    d. Performance Roll-Up Timing – End of Month performance review employs month-old data. The time frame should be reduced to weeks.
    e. Meeting Focus – Too much time spent on making sure “lists” of activities were up to date and/or accurate; whereas time should be spent on collaborating to ensure commitments are met and/or issues are prevented/mitigated.
4. PLT members are actively engaging in observing PMT roll-up meetings to ensure that they are being conducted to the standards and expectations that the PLT have outlined to the SMR-X organization.
5. The SMRRB will perform additional observations prior to the February review to assess progress.

Recommendations

None

Open Recommendations Status:

Visit #2:

1. ePMx 58212 – underlying issues inhibiting key project risks from being expeditiously surfaced and addressed – Open
2. ePMx 58209 – between Gate 2 and 3 OPG to perform an independent "execution readiness" – Open

Visit #3:

1. ePMx 59214 - develop detailed validation phase objectives that will ensure a successful transition to execution, cascaded throughout the IPD Team – Open
2. ePMx 59216 - identify and implement IPD wide Accountability/Ownership behaviors – Open
3. ePMx 59220 - the IPD model design and implementation needs to explicitly address how it will manage the functional interface boundaries to ensure seamless delivery and to ensure ultra-fast decision making to address emergent issues – Open

Visit #4:

1. ePMx 60964 - expedited completion of the vision and objective for the conduct of the Integrated Project Delivery (IPD) team and the supporting IPD Integrated Development Plan - Open
2. ePMx 60970 – PIT should leverage the work that has already been done by the PMTs to establish a consistent approach and model for managing performance and tracking progress across the DNNP – Open
3. ePMx 60969 - additional experienced resources, both at a leadership and working level, and ideally with new-build experience, be brought onto the project – Open

Small Modular Reactor Review Board
Independent Oversight Report on the Darlington New Nuclear Program

(Visit #6 – Feb 12-15, 2024)

Submitted to:
Major Projects Committee of the Board of Directors for Ontario Power Generation

EXECUTIVE SUMMARY

The October 2023 Small Modular Reactor Review Board (SMRRB) concluded that while satisfactory progress had been made in several areas in developing the project, continued leadership engagement and reinforcement was required to ensure the project was ready to transition to the Execution Phase in January of 2025. In this review the SMRRB assessed continued progress by reviewing licensing, engineering, construction, operational readiness, and indigenous relations functions, along with key Integrated Project Delivery (IPD) team processes and observations of team interactions.

The review concluded that while there was satisfactory progress in many areas, Project risk is continuing to increase. While part of this increase is due to the maturation of the deployment of the risk management process, a key contributor of this adverse trend is also the standard plant design engineering (BL2) delay and the subsequent propagating impact on procurement and construction activities. While detailed plans are now in place to recover and mitigate the BL2 delays, the SMRRB judged that there is uncertainty as to whether the propagating risk is being appropriately identified, incorporated, and proactively mitigated. This uncertainty has the potential to adversely impact the Release Quality Estimate (RQE) cost and schedule that is currently planned to be submitted to the OPG Board of Directors in October 2024.

The First of a Kind (FOAK) nature of the project, as well as the ~53 month Unit 1 execution schedule will likely result in emergent issues and project disruptions that will challenge the IPD team's execution capability. It is the SMRRB's judgement that anticipating and operating in this challenging environment should be an IPD core competency. While there has been progress in developing project management fundamentals, much still needs to be done to anchor and accelerate this progress. Further, operating in a FOAK environment will likely require the IPD team's expectations, processes, and tools to be specifically tailored to rapidly manage parallel, overlapping, interdependent and iterative cross-functional delivery workstreams (licensing, engineering, procurement, construction, and operational readiness). By necessity these workstreams will have to utilize propagating assumptions that must be clearly identified, tracked, and validated. The IPD team's development efforts to date have only begun to explore how to address these project requirements.

DETAILED REPORT

Background

The SMRRB was commissioned for the OPG Board of Directors to independently monitor the Darlington New Nuclear Project (DNNP). This is the first review of 2024, and it is expected that the SMRRB will conduct 2 further reviews in 2024.

For this review, the SMRRB comprised the following members:

1. Sandy Rupprecht (Chair)
2. David Christian
3. Saga Williams
4. Mike Skaggs
5. Dietmar Reiner (OPG internal member)

OPG Support: Cory Bruder

LICENSE TO CONSTRUCT

Introduction

The SMRRB has continued to examine the progress and planning of the SMR-X team leading up to the CNSC hearings for the Licence to Construct (LTC) and the preparations for hearings on the Technology Selection and Environmental Assessment (EA) Validity, as well as the organization's preparations for the transition to the Licence to Operate (LTO) scope of work during the Construction phase of the project.

Observations

1. Consistent with prior SMRRB reviews, the LTC organization demonstrated that they had a clear understanding of what needed to be accomplished to prepare for and support the public hearings for both the Technology Selection & EA Validity in January of 2024 and preparations for the LTC hearings anticipated to occur in October of 2024.
2. Through a variety of regularly scheduled touchpoint meetings and use of the Integrated Schedule process the LTC organization are exemplary in continuing to be accountable to maintain the focus, alignment, and engagement of the SMR-X project organization Subject Matter Experts (SME) to respond to information requests, prepare for the public hearings, and directly engage in supporting the licensing requirements.
3. In addition to the LTC hearing preparation, the SMR-X team has a formal plan in place that is linked to the DNNP Risk Registry in preparation for the LTO process, which is being monitored and communicated by the Licensing area.

Recommendations

None

ENGINEERING BL2 RECOVERY

Introduction

The progress of the standard plant design is a critical pre-requisite of the DNNP project for consideration to transition from the Validation Phase to the Execution Phase. Its progress is measured as the percent complete of the Base Line 2 (BL2) milestone. At the end of 2023, BL2 was reported as 29% complete against a plan of 35%. By the end of the 2nd quarter of 2024, the plan was to have BL2 at 67% complete. Thus, a design complete improvement of ~38% is required over the course of the first 6 months of 2024. The delay of BL2 completion has likely downstream impacts on Licence to Construct (LTC) commitments to the CNSC, procurement, and construction planning and preparation activities, as well as on the

quality of the Release Quality Estimate (RQE) that is scheduled to be submitted to the board in October 2024. Hence, the success of the BL2 recovery effort is a critical element of positioning the DNNP project for transition to the Execution Phase.

Observations

1. The completion of Design Engineering activities to meet the BL2 milestone is currently tracking about 180,000 hours behind plan. The backlog in hours is still growing. A plan has been developed by GEH to recover the backlog and mitigate the risks this presents to the LTC and the downstream procurement and construction activities.
2. The BL2 recovery plan is a refined plan for the development of design engineering deliverables that recognizes the need for design work to progress in parallel and to prioritize its activities to ensure the demands of upcoming licensing, procurement, and construction activities are supported, as well as protecting the overall DNNP cost and schedule. The plan includes:
    a. A detailed Level 5 resource loaded schedule with interim milestones and metrics for tracking performance.
    b. Schedule integration with the development of CWPs, procurement of materials, and construction, which will make downstream impacts of changes in Engineering progression very visible and will help to assess and quantify the associated risks and opportunities.
3. In the SMRRB's view, the BL2 recovery plan is a credible plan that reflects a maturation of approach for effectively progressing detailed design.
4. Parallel execution of design activities will require assumptions to be made and to be effectively communicated, tracked, and closed out within the design engineering community as well as in the procurement and construction elements of the project. Failure to do so not only creates risks within the engineering design functions, but these risks will likely propagate into the licensing, procurement, construction, and operational readiness elements of the project. Effective configuration and risk management systems are essential to ensure that these assumptions are effectively tracked and managed.
5. It was clearly stated in the review that the tracking and communication of these assumptions was an important element of the integration and coordination between GEH and the various 3rd party vendors that make up the design engineering community. However, it was not clear that the same priority and rigor was being applied to how these assumptions and risks were being identified and tracked in the procurement, construction, and operation readiness elements of the project.
6. When the RQE gets established, the state of detailed design needs to be clearly understood so that the related risks can be adequately characterized and quantified, both in time and cost.

Recommendations

1. Confirm that the configuration and risk management systems are proactively and effectively identifying, tracking, and mitigating critical design engineering assumptions and associated risks both within the design engineering function, as well as those that propagate into the licensing, procurement, construction, and operational readiness functions of the project.

PROCUREMENT

Introduction

The Procurement Project Management Team (PMT) is a critical organization for integrating and collaborating with the Engineering and Construction organizations to ensure that that the SMRX project receives the right parts, at the right time, at the right place, and for the right cost. SMRRB observations of various Project progress meetings have highlighted the delays in procurement of Reactor Pressure Vessel (RPV) forgings, lower head, internals, Fine Motion Control Rod Drive (FMCRD) material and other items. This first review by the SMRRB was focused on organization and staffing, manufacturer hesitancy to accept flow-down terms and conditions, long lead material procurement progress and issues, and other challenges, along with corrective actions to improve performance.

Observations

1. The procurement PMT leadership team described, at a high level, the project to date milestone achievements and highlighted present and ongoing challenges. There was not yet a well-defined Lessons Learned nor an integrated strategy for procurement support of project construction activities.
2. From earlier meetings, the SMRRB was aware that suppliers were not responsive to invitations to bid with what were perceived to be onerous and voluminous flow-down requirements. Some progress was reported in this area.
3. The risk register (dated August 27, 2023) was reviewed to determine if procurement risks are adequately captured and characterized and whether actions and ownership seem appropriate. It is suggested that this area have additional oversight from both PMT leadership and the Project Leadership Team (PLT) to ensure that the risk register appropriately captures the risks and mitigating actions.
4. In several cases, important procurement milestones are linked to and/or contingent upon engineering input, highlighting the need for close coupling between those functional groups.
5. Ongoing use and assessment of market intelligence is being employed by the Procurement PMT to inform strategies for minimizing necessary future spend.
6. Appropriate attention is being paid to project goals with respect to indigenous spend and employment.
7. Material receipt, storage, and warehousing considerations appear to have been well addressed. The team is pursuing minor efficiencies by using nearby existing OPG assets.
8. A Lessons Learned assessment from recent long-lead item procurement activities, as well as from general procurement PMT challenges and opportunities was committed to be performed by 8 March, 2024. The SMRRB will perform follow-up reviews of this Lessons Learned activity and the associated action plan.

Recommendations

None

CONSTRUCTION READINESS PROCESS

Introduction

The SMRRB reviewed and challenged the Construction Team on the process to be utilized to ensure they are ready to execute work, the approach and design of Construction Work Packages (CWP), and their plans to sustain and improve Construction performance.

Observations

1. Construction leadership adequately addressed the SMRBB's topics, appeared to be well organized, and demonstrated adequate teamwork, and collaboration.
2. The scheduling methodology of CWPs and the associated ties with Design Engineering and Procurement was discussed. The logic ties being utilized include control account, work package design by phase, issuance of BL2 and BL3 drawings, work package creation and issuance, final issuance of CWP, walkdown readiness, permits available and purchase order issued. This logic is standard for project activities. Project Controls are utilizing several different coding techniques to allow a finer grouping of work for design and construction. The SMRRB found the scheduling methodology and logic ties and use to be satisfactory.
3. The construction team is employing digital strategies to provide finer details of work completion, improved dashboards of field work status, and measures to improve the efficiency of the process like the use of electronic updates for the CWPs. One other objective of the digital strategy is to right size the CWPs.
4. The construction team utilizes several different spreadsheets and methods to track readiness for work. The methods are coupled to the schedule and appear to be appropriate.
5. The approach to completing the Nuclear Island (NI) was provided. The approach included a simple schedule that showed the major activities, in logical order, to complete the subject building, by elevation. The level of detail was appropriate for the status of the project and the integration of the estimate and schedule was as expected. The SMRRB was satisfied with the discussion and the work done to date. This product will need to evolve as the design is finalized and as fabrication details mature.
6. Site Establishment and Balance Of Plant (BOP) and the Conventional Island (CI) project bundles have not progressed like the NI. For example, the simple schedule with major activities in a logical order to complete the subject building does not exist for Site Establishment and BOP and CI project bundles. Construction leadership indicated that this product would be available at the end of the 2nd quarter of 2024. The SMRRB will review these new products as well as the NI product at the next meeting.
7. The DNNP construction window is ~4.5 years. This is an aggressive window for completion for a FOAK project. Construction leadership is cognizant of this challenge. The SMRRB will continue to focus on the Construction window and the efforts of the construction leadership to validate the accuracy of this window. The SMRRB suggests that different techniques be utilized to understand the risks associated with the construction window. For example:
    a. Minimize the use of schedule constraints including those associated with the end date.
    b. Perform additional risk analysis of the construction window to identify mitigation strategies.
    c. Refine the probability of confidence for the construction window schedule.
8. The approach to integrating the quality inspections and organizational positioning as well as reporting responsibilities is appropriate.
9. The approach to utilizing Field Engineers is appropriate.
10. The resource peak is currently projected at approximately 930.
11. An initial compression analysis of resource loading in building spaces has been completed for the Nuclear Island. This analysis allows Construction Leadership to ensure the schedule resource loading is accurate. This analysis will also need to be completed for Site Establishment and BOP and CI project bundles.

12. Labor relations is engaged and working to establish labor agreements for the project. The current labor agreements expire in 2025.
13. Performance management and use is satisfactory.
14. In summary, the SMRRB was satisfied with the approach and the work done to date.

Recommendations
None

REACTOR BUILDING SHORING CONSTRUCTION READINESS

Introduction
The SMRRB examined the progress and readiness of the SMR-X team to perform the Reactor Building (RB) Shoring to meet the Project's milestone for June 2024.

Observations
1. The SMRRB attended and observed the RB Shoring readiness meeting on January 26, 2024. Participants included Aecon, GEH, Atkins Realis, and OPG. The meeting had good participation, discussion and a focus on safety. There was appropriate use of the schedule, challenging and coaching to ensure readiness. The PLT was not represented. It was discovered during the challenge conversation that lift plans were not integrated into the schedule. Actions were taken to address the concern and to evaluate if other important interfaces similar to lift plans should be addressed in the schedule.
2. The SMRRB discussed construction readiness, plans for the piles and excavation, risks and mitigation plans, contingency plans and plans for Field Change Requests.
3. The RB Shoring task is utilizing the Readiness Process Procedures. The SMRRB challenged the use of the readiness procedures and the adequacy of the checklists. The SMRRB team found the use of the procedures and checklists to be satisfactory.
4. The spreadsheets that are being utilized to gauge readiness are created through live schedule data so the risk of working outside the schedule is minimized.
5. The construction organization has done an adequate job of identifying the risks and mitigation plans associated with their task. The top three risks associated with RB Shoring were discussed:
    a. Performance of equipment.
    b. Equipment reliability.
    c. Maintaining verticality of shoring hole.
6. The use of and readiness for Field Change Requests (FCRs) was discussed. An interim process for the issuance and use of FCRs has been developed with the final version of the process expected to be issued in the 2nd quarter of this calendar year. The SMRRB has no concerns with the process being employed by the team.
7. The SMRRB found the approach and the readiness for the RB shoring to be satisfactory.

Recommendations
None

OPERATIONS AND MAINTENANCE

Introduction

The SMRRB conducted their second discussion and review of the Operations & Maintenance (O&M) functions. This organization was created to develop and implement plans to manage and provide oversight of the activities associated with commissioning of the unit, facility readiness, O&M workforce readiness including training and verification of employee proficiency, process and procedure readiness, digital operations support, operational organizational readiness, change management that leads to effective plant operation and maintenance, conduct of the pre-startup readiness checklist to support the WANO review, support and conduct of pre-operational testing, startup testing, and performance demonstrations.

Observations

1. A procedure was drafted that describes the scope, the oversight model and approach methodology to be utilized, along with the roles and responsibilities of the Operational Readiness group.
2. A draft Pre Start-up Readiness (PSUR) checklist was provided that illustrates the backbone of the work required to be completed to support a successful WANO PSUR visit.
3. No process or approach was utilized to ensure that the defined Operational Readiness scope is accurate.
4. The development of an estimate and subsequently the schedule for the activities for Operational Readiness has not started in earnest.
5. The process for developing the procedures for System and Area Turnover, including the possible use of partial turnovers, needs to be developed.
6. An initial count of procedures and instructions has been performed.
7. Documentation detailing the work to date for Training was provided, including:
    a. A one-page DNNP Training Scope and Structure that addressed current governance, development of structure, and integration of the program.
    b. Overall training program structure.
    c. A 5-year training plan.
    d. A simple roadmap to completion of the simulator.
8. A copy of the milestone schedule for DNNP commissioning was provided.
9. The terms of reference for the conduct of an Operational Readiness Oversight Forum should be revisited once the overall Operational Readiness program is developed to ensure that it appropriately reflects its many elements.

Recommendations

The Visit #5 recommendation for Operational Readiness (ePMx 62310) will be closed. A new set of recommendations has been created to account for the observations from this review.

1. Refine the procedure that defines the role of Operational Readiness and distinguish between oversight functions versus scopes of work that are required to be performed by the group.
2. Draft and issue the System and Area Turnover procedures including the possible use of partial turnovers and incorporate that strategy into Construction’s approach to work completion.

3. Develop performance metrics to track progress of Operational Readiness tasks.
4. Perform an independent check of the scope of Operational Readiness to ensure the scope is accurate.
5. Develop estimates for Operational Readiness work and the development of an integrated project schedule for the scope of Operational Readiness, including PSUR notebooks, and procedure development and approval, testing, training, etc.

IPD TEAM DEVELOPMENT

Introduction

An IPD model was chosen by OPG to execute the DNNP project with its key vendors to enhance project performance via better collaboration, early engagement, interface management, and commercial alignment to the DNNP project goals. Prior SMRRB reviews judged that progress was lagging in advancing the SMR-X organization into a single integrated team that is underpinned by a strong project management culture and an understanding of Lessons Learned from other nuclear new build projects. A detailed plan was reviewed during the October 2023 review. This plan focused on Area Lead Development, Job Familiarization Guidelines, IPD Future State, Accountability Behaviors, and Process Structure. It was complemented by plans associated with Lessons Learned, Validation Phase Success Criteria, and the Execution Readiness process. Completion dates ranged from October 2023 through February 2024. This review focused on the progress of that plan such that the SMR-X organization is "ready to execute" in January of 2025 along with observations of PMT Execution, PMT Functional, and PMT/PLT Huddle meetings during January-February 2024.

Observations

1. It was judged by the SMRRB in October of 2023 that the collective implementation of the "Ready To Execute" (RTE) plans would provide a strong platform from which to continue to build IPD capability. Tracking and management of the deliverables are now being performed through a dedicated Project Integration Team (PIT) Action Tracker. During this review it was reported by the PIT that the majority of plan deliverables are complete, with the remaining items trending to completeness in the near term. A few key areas of note are:
    a. The Execution Readiness Process is being piloted and in the process of being implemented across the project bundles. The effectiveness of this process will be initially reviewed and judged by the SMRRB in the review of RB Shoring execution.
    b. Area Lead development has continued with the identification and roll-out of key roles and responsibilities during the February SMR-X leadership meeting. It has been made clear in that roll-out that the Area Lead is responsible and accountable for leading the engineering, procurement, construction, and commissioning activities with their assigned scope of work within a project bundle.
    c. Validation Phase goals have been further elaborated and cascaded throughout the IPD to ensure a successful transition to execution. A further articulation of specific things that are being done differently by the SMR-X team to make execution of the DNNP a success relative to other nuclear new build projects would be beneficial.
    d. Accountability behaviors have been observed in general to improve, with examples of "victim" behaviors becoming fewer and farther between observations. Continued vigilance by management is warranted to ensure continued progress.

2. In order to assess the impact of these activities on the effectiveness of the IPD team such that they will be "ready to execute" by January of 2025, the SMRRB observed several project meetings and interviewed a cross section of IPD staff working on the DNNP. The objective was to gain insights into the functioning of the IPD team, and to identify gaps that have a potential to create risk for the DNNP and impede the continued development of the IPD. The key takeaway from these observations is that while there is a sense of progress at the program level, those actions have not translated into significant change in the conduct of the PMT's. Key observations are as follows:
    a. There is significant variability in the functioning of the PMT's. This is likely the result of significant variability in the PMT leadership's vision of the purpose and conduct of the PMT meetings. This is likely further exacerbated by the existing "leadership by committee" structure of each PMT, which the IPD plans to eliminate in the coming months by assigning single points of accountability in each PMT.
    b. The transition from "cooperation" to "collaboration" has been slow. The inability to fully co-locate integral members of the SMR-X team is a contributing cause. The availability of OPG's new Oshawa office is expected to accelerate this transition. It is the SMRRB's perception that many SMR-X staff will not relocate to the new Oshawa office, which has the potential to continue creating impediments to efficient execution of project work, expeditious decision making, and rapid resolution of issues.
    c. Although the PMTs include representation from each of the IPD partners, the integration of Design Engineering, Construction, and Procurement with the Project Management functions, at a working level, is not evident. Project execution plans being developed by the PMTs may thus not reflect all project execution risks, e.g., impacts related to delays in completion of design engineering, poor quality of construction labour and cost estimates, delays in procurement of materials and components.
    d. Project performance monitoring and reporting for the DNNP is driven largely by the Project Controls function. Project Controls staff are often the ones that will answer questions related to specific project issues, risks, actions, etc., at project performance review meetings. This could inadvertently be abdicating Area Leads and Project Managers of their responsibilities and accountabilities.
    e. There appears to be a sentiment at the project working level that it is unacceptable to DNNP leadership that key project milestones, such as the completion of BL2 Detailed Design, are missed. This has the potential to negatively impact the identification, characterization, and actions taken to effectively manage project risks and issues. The DNNP leadership need to be cautious that a culture where bad news goes "underground", because it is deemed to be unacceptable for the project leadership to hear, does not emerge.
    f. In summary, it is the judgement of the SMRRB that there has been continued progress in the development of the IPD operating model. There are still concerns regarding whether that progress will be sufficient to ensure that the IPD operating model can transition to the Execution Phase and have the required resiliency to address the challenges of operating in a FOAK environment. This concern is addressed in more detail in the section associated with Seismic Issue Organizational Lessons Learned.

Recommendations

1. The SMRRB recommends that the following be implemented to accelerate improvements in the conduct of meetings:

a. Make consistent use of dashboards with objective metrics to report project performance.
b. Report progress by exception.
c. Make Area Leads and PMT Leads report on the performance of their projects.

2. Measures should be put in place to strengthen the integration and ownership of all project outcomes at the Area Lead and PMT levels. This needs to include design engineering, procurement, development of construction plans, readiness for project execution, as well as integration with other projects/project bundles.
3. The potential reluctance of the organization to raise issues to DNNP leadership that challenge cost, schedule and quality should be validated rapidly, and associated corrective actions taken immediately.

IPD TEAM DEVELOPMENT – LESSONS LEARNED FROM THE SMR-X ORG RESPONSE TO SEISMIC ISSUE

Introduction

The seismic analysis and modeling conducted by the DNNP design team has uncovered deficiencies in the Reactor Building and Reactor Pressure Vessel designs. The correction of these deficiencies has the potential to significantly impact the overall project cost and schedule. A review of the organization's identification, escalation, response, and recovery to this issue provides an opportunity to assess the IPD Team's current performance to an emergent issue and to make subsequent organizational improvements in order to improve future performance. The SMRRB reviewed the findings documented in OPG Incident Investigation Report N-2023-17876, as well as a summary presentation and discussion during the on-site review.

Observations

1. An investigation was conducted utilizing methodologies to identify direct, root and contributing causes. The key findings were summarized as follows:
    a. The root cause was identified as being a lack of collaborative behaviors and processes associated with identification, escalation, and resolution of issues; with an associated set of corrective actions around developing and implementing:
        - A guide to assist the organization in understanding the key principles.
        - A cross-functional integrated problem identification, escalation, and resolution process.
        - IPD 101 training for the organization.
    b. A contributing cause was identified as being a prioritization by leadership of schedule demands; with an associated set of corrective actions around developing and implementing:
        - Clarification of Owners oversight responsibilities.
        - A Nuclear Safety Culture in the IPD.
2. It was unclear to the SMRRB how these corrective actions would collectively result in an IPD operating model that was better and faster in dealing with the multitude of emergent issues that are anticipated to continue to arise in the Unit 1 First of A Kind (FOAK) environment. Schedule pressures will be a feature of the FOAK environment. Developing a nuclear safety culture will likely enable the organization to more effectively dialogue and appropriately address the often-competing

demands of safety, quality, cost, and schedule. However, it is unlikely to address how to effectively and efficiently manage these demands.

3. It is the SMRRB's judgement that the FOAK environment will require the organization to identify, escalate, and resolve emergent issues in an expedited fashion in order to minimize overall schedule and cost impacts. The corrective actions outlined above may assist in this requirement, however, these processes will likely also require parallel and iterative activities in licensing, engineering, procurement, construction, and operations. This will likely require the use of design engineering assumptions that will need to be clearly identified, tracked, validated, and dispositioned in a configuration management system in order to control their propagation through the downstream work streams. In addition, the use of the Risk Management System is essential to identify and proactively prevent/mitigate the attendant risks that will also propagate through the work streams. It is unclear if the corrective actions outlined above will address all of these dimensions.
4. Further, it is the SMRRB's judgement that for the organization to quickly address emergent issues, so as minimize the impact on the overall cost and schedule, the IPD will also require the careful consideration of how the organization is empowered to execute. Have Levels of Authority (LoA) been appropriately moved to the lowest level within the organization to promote rapid issue resolution? The organizational response to the Seismic issue may offer important Lessons Learned as to the effectiveness of the current levels of authority within the organization. These were not considered in the assessment that was reviewed.
5. In summary, the analysis reviewed did not evaluate the timeliness or effectiveness of the organizational response to the Seismic issue nor postulate how it could have been ideally performed in a significantly expedited fashion. Completion of such Lesson's Learned evaluations will form the basis for improving the IPD operating model to enable it to perform more effectively in the FOAK environment. This was an essential theme embodied within Visit #5 recommendation ePMx 62316. This recommendation remains open.

Recommendations
None

RISK MANAGEMENT PROCESS

Introduction
Risk resides and is inherent in every project. In mega-projects and especially in FOAK mega-projects, it is essential for project participants to maintain a sharp focus on risks by establishing a means of identifying, evaluating, quantifying, and tracking identified risks and by having countermeasures to avoid, mitigate, or otherwise minimize the individual and cumulative impact of risks known to exist.

Observations
1. As a follow up to the October 2023 SMRRB, a remote risk management review meeting was held on January 11, 2024. Information on actions which had been taken to address a prior recommendation regarding the treatment of "draft" risks was provided. In summary, the SMR-X risk team promptly established guidelines and criteria for processing draft risks. By the end of 2023, most of the 77 draft risks in existence at the time the recommendation was made had been appropriately dispositioned.
2. During the present February 2024 visit, additional time was spent reviewing risk register items relating to long lead material and other items. In some cases, Action Ownership is unclear, and the actions specified to mitigate the risk do not seem to effectively address the issue. Additionally, in

some cases, “post mitigation” scoring may be unrealistically optimistic. No specific recommendations are offered at this time, but there is a concern as to whether some risks after subjective “post mitigation” assessments are properly characterized. This will continue to be an area of future reviews for the SMRRB.

Recommendations

It should be noted that there is a specific Recommendation associated with the identification, tracking, and mitigation of risk as part of the Engineering BL2 Recovery review contained in an earlier section of this report. It is important to note that prior Recommendation is not focused solely on the engineering design function, but also extends to confirming that any propagating risk into the procurement, construction, and operational readiness areas is correctly identified and characterized. Responses to that particular Recommendation should be sure to address those areas beyond engineering. This notation is not intended to be an additional Recommendation, but to only highlight its extended scope and linkage to the general Risk Management process.

INDIGENOUS RELATIONS

Introduction

Indigenous peoples in Canada have constitutionally protected rights that OPG must consider and accommodate in the development of any energy project they initiate, including the DNNP. The proactive integration and coordination of Indigenous Relations (IR) activities into the daily DNNP project development and execution is critical to ensure that OPG avoids the types of delays that have been seen across Ontario and Canada in other energy-based and resource development projects.

Observations

1. IR continues to participate in all aspects of project development and is integrated as a centralized business area. It is notable that the SMR-X IR Team is working well with the PMT organizations.
2. Progress on IR integration is exemplified in the tracking and reporting on supply chain spend amounts for Indigenous owned businesses, as well as measuring employment numbers and targeted training initiatives. Reporting in these areas needs to continue to progress and be communicated in the monthly meetings with the Williams Treaty First Nations, including those efforts to eliminate barriers facilitating additional onboarding of Indigenous businesses and employees.
3. The successful deployment of Indigenous cultural awareness training across the SMR-X Team over the last four months has also facilitated incorporation of IR into the Area Team Lead decisions including, construction, regulatory and permitting processes. These are key to the deployment of the IR consultation and engagement requirements to mitigate risks, building respectful relationships with Indigenous communities identified in the Indigenous Engagement Plan.
4. A significant positive relationship development is exemplified with the support offered to the Williams Treaties (Mississauga) Communities to lead their own Indigenous Knowledge Study (IKS) within the DNNP footprint. To facilitate the ongoing development of the IKS, it is understood that dedicated capacity is needed at the individual community level, and to this end, the IR Team has identified resources within their Relationship Agreements for the First Nations to dedicate ongoing full-time positions to move the ITK and engagement commitments forward. This was also noted in the LTC Hearings held by the CNSC.

Recommendations

None

STAGE GATE 3 REVIEW PROCESS

Introduction

The Stage Gate (SG) process is cited by OPG as a best practice in assessing the progress and readiness of a project to move into the next phase of development. To date it has been applied to the DNNP project to assess the maturity of the various project bundles and to provide a basis for releasing funding for the Validation Phase of the project. It will continue to be employed with the SG 3 reviews to assess the maturity of the various project bundles to transition from the Validation Phase to the Execution Phase in Q4 of 2024. The October 2023 SMRRB review of the process concurred with the general approach, with a request to gain a better understanding of the interaction of the SG process with the Release Quality Estimate (Class 3) (RQE) used for Board Approval, the independent reviews to be employed in the process, and how Supply Chain readiness will be assessed.

Observations

1. The SMRRB previously had the perception that the SG process was an integral part of informing the board of the readiness at the program level to progress from the Validation to the Execution Phase of the SMRX Program. It is now understood that the RQE process is separate from the SG process, however, both processes employ input from the same sources (Functional and Project Bundles). The RQE process then sets boundary conditions for the SG process. The SG process is not an integral part of the information package that the Board uses to render a decision in Q4 2024.
2. The RQE process gathers data from the PMT Project Bundles, Project Controls, and Risk Management Process. The current schedule shows that it is effectively complete with its collection of input by July of 2024. The RQE is a critical input to the Board of Directors for Program approval in Q4 of 2024. The Board approval forms the basis for subsequently releasing funding to the Project Bundles to manage the actual execution of the project.
3. There are currently 17 SG 3's being planned for Q4 of 2024. Many of these are partial releases of scope of work within a project bundle's portfolio. The SG3 review ensures that the specific scope of work within a project bundle is "ready" to proceed to execution prior to release of the funding.
4. The data used for the RQE and SG processes comes from the same project sources (PMT project bundles, Project Controls, etc.), but will vary in detail and quality due to the differing objectives of the two processes (overall program viability vs. readiness to execute), and the timing of the data collection (Q2 vs. Q4 2024 and beyond).
5. Both the RQE and the SG processes will employ 3rd party independent reviewers, though not the same 3rd party reviewers. The RQE process will employ a 3rd party independent review that is focused on Class 3 cost, schedule, and risk development at the programmatic level. The SG process will employ a 3rd party independent review that will focus on the operational readiness of the project bundles to transition into the execution phase. The SG independent reviewer has specific experience with recent nuclear new build.
6. Prior SMRRB reviews expressed concern regarding representation of Procurement on the SG review board. It is not a required standing function on the SG review board. However, the process does not preclude such representation if it is judged to be critical to the SG review process. Upon further review of this approach, it is judged by the SMRRB to be acceptable.
7. It is the judgement of the SMRRB that these processes will adequately perform their intended functions of providing the board with a RQE estimate upon which to judge the appropriateness of

the project to proceed forward, and to ensure the Project that the specific bundles are ready to transition to the execute phase.

Recommendations
None

PROJECT STAFFING / RESOURCING PLAN

Introduction
Each of the IPD partners continues to experience shortfalls in key resources, at all levels and across all disciplines. Key resources have also left the DNNP to pursue other career opportunities. Hiring efforts to secure resources with the needed skills and experience have proven to be difficult. The SMRRB assessed the DNNP staffing and resourcing plan in light of these challenges, as well as the future state of the IPD model.

Observations
1. The organizational model that will be implemented when the DNNP transitions from the Validation Phase to the Execution Phase has been developed. The PMTs will be modified with single leaders that have accountability for each project bundle, versus the current model where representatives from each IPD partner sit on the PMTs and decisions are made on a consensus basis. The SMRRB sees this change to the PMT structure as very positive. It is suggested that this transition to the future state be made as soon as practical.
2. A plan to transition the DNNP from the Validation Phase to the Execution Phase has not yet been fully developed. This plan needs to consider timing for implementing the Execution Phase organization, communicating changes in roles and responsibilities, rollout of procedural and process changes, establishment of things like a Project Control Centre, etc.
3. Progress has been made on hiring and onboarding individuals with the skills needed to successfully execute the DNNP, however skill and resource gaps still exist across all areas of the organization. Given internal and external demands for skilled resources, the SMR-X leadership team should assume that this is likely to be the case for the duration of the project. As such, emphasis needs to be placed on the development of internal IPD staff and on effective succession planning.

Recommendations
1. The SMR-X leadership team should run tabletop scenarios to stress test governance, levels of authority, decision making, etc. in the Execution Phase organizational model.
2. Develop a strategic plan for transitioning the DNNP from the Validation Phase to the Execution Phase. This should include establishing the end state organization, timing for implementation, communicating changes in roles and responsibilities, rollout of procedural and process changes, setup of a Project Control Centre, etc.

OPEN RECOMMENDATIONS STATUS:

Visit #3:

1. ePMx 59220 – The IPD model design and implementation needs to explicitly address how it will manage the functional interface boundaries to ensure seamless delivery and to ensure ultra-fast decision making to address emergent issues. – **Open**

Visit #5:

1. ePMx 62316 – An assessment of what the team did well, where there were gaps, and what the team would do differently in response to the seismic issue gets conducted. This assessment should then get utilized to better prepare and position the broader DNNP team to deal with future issues that have the potential to create disruption for the project. – **Open**

Small Modular Reactor Review Board
Independent Oversight Report on the Darlington New Nuclear Program

(Visit #7 – June 8-11, 2024)

Submitted to:
Major Projects Committee of the Board of Directors for Ontario Power Generation

EXECUTIVE SUMMARY

During the July 2024 visit the Small Modular Reactor Review Board (SMRRB) performed in-depth reviews in the areas of Licensing, Engineering, Construction, Execution Delivery, Indigenous Relations, and the Release Quality Estimate process. In addition, the SMRRB performed a walkdown of the Darlington New Nuclear Project (DNNP) site to observe the site preparation and Unit 1 Reactor Building shoring installation progress.

The SMRRB has observed evidence of continued progress in preparing the project to be ready to transition from the current validation phase to the execution phase upon receipt of the License to Construct (LTC). Of particular note was the proactive management of identifying and driving closure of open items in the LTC process via "tiger teams" with the Canadian Nuclear Safety Commission (CNSC). This approach is following industry best practices.

The SMR-X project is in the process of pivoting its primary orientation from engineering/licensing to execution/construction. In support of this transition the SMRRB observed evidence of integrated planning and collaboration across the licensing, engineering, procurement, and construction functions in several of the reviews. In addition, progress was observed in the development and implementation of integrated processes to address the future needs of the execution/construction orientation. Continued management vigilance by the SMR-X leadership team will be required to sustain and continue the progress to date, as well as to ensure that the engineering recovery plan remains on track to support the LTC, site preparation, future construction, and the substantial completion of plant specific design by the end of 2025.

It is recommended that additional management attention be applied to the Release Quality Estimate (RQE) process in order to ensure early and timely engagement of the Project Leadership Team (PLT). Complimenting this engagement with more frequent Quantitative Risk Analysis (QRA) will increase the organization's ability to identify and address cost and schedule risks and variances.

DETAILED REPORT

Background

The SMRRB was commissioned for the OPG Board of Directors to independently monitor the DNNP. This is the second review of 2024, and it is expected that the SMRRB will conduct its 3rd review in October 2024.

For this review, the SMRRB comprised the following members:

1. Sandy Rupprecht (Chair)
2. David Christian
3. Saga Williams
4. Dietmar Reiner
5. Boris Vulanovic (OPG internal member)

OPG Support: Cory Bruder

LICENSE TO CONSTRUCT

Introduction

The LTC requires the CNSC to review and approve the SMR-X reactor design that is not only novel to Canada, but one which has not previously received approval outside of Canada. The CNSC and SMR-X team have identified the top 5 key issues requiring resolution and have formed "tiger teams" to identify the outstanding issues and to develop a pathway forward. The SMRRB reviewed the plans for working with the CNSC to bring these items to a satisfactory closure for the pending LTC hearing.

Observations

1. The proactive engagement of the CNSC via "tiger teams" to identify and either close the top 5 issues or to identify a pathway to closure is a good process which is consistent with industry best practices.

2. Due to the fact that this is a First of a Kind (FOAK) deployment of the SMRX-300 it is likely that for some of the issues the CNSC will not adopt 100% of the preferred DNNP position prior to the October hearings. The pathway forward may require a compromise position that involves commitments for additional requirements, analysis, tests, and/or inspections. The development and acceptance of any compromise positions are appropriately being developed by an integrated team of licensing, engineering, procurement, construction, and operations/maintenance in order to ensure an optimal pathway forward. PLT endorsement is required prior to negotiations with the CNSC.

3. The assignment of an Area Lead to the Licensing activities is appropriate to ensure there is proactive planning and integration relative to supporting the Licensing activities for the October hearings with the CNSC, as well as to ensure that the potential licensing risks and impacts are clearly identified and considered by the Execution Bundles (Nuclear Island, Construction Island, and Balance of Plant) PMT's. It should be noted that it took multiple conversations for the SMRRB to gain confidence that this was being accomplished, indicating that there may be some confusion regarding roles and responsibilities. SMR-X management is aware of this observation and will take actions to reinforce/coach as they deem appropriate.

Recommendations

None

ENGINEERING

Introduction

In late 2023/early 2024, it became apparent that the progression of the design engineering deliverables needed to meet the Base Line 2 (BL2) and Base Line 3 (BL3) completion milestones were falling behind schedule. Given the significant impacts on downstream licensing, procurement, and construction readiness activities, as well as on the robustness of the Release Quality Estimate (RQE), a recovery plan was implemented by the project team. The SMRRB reviewed this plan in February 2024, and as part of this review, assessed the progress being made in executing the recovery plan.

Observations

1. A shift in approach has been taken by GEH regarding the division of the "standard plant" design and "site specific" design. The DNNP has been established as the reference plant for development of the "standard plant" design. The SMRRB sees this as a very positive decision. It has the benefit of focusing design efforts on a single design and will help to mitigate design engineering resource constraints. While this creates some risk with respect to transferability of the design for future SMR deployments at other sites, in the SMRRB's view, this is more than offset by the benefits to the DNNP.
2. The engineering team have "put a stake in the ground" to complete the BL3 design deliverables by the end of 2025, to support OPG's submission of the CNSC License to Operate (LTO) application. Some design engineering deliverables will however be completed in 2026, for example those related to Instrumentation & Control (I&C) systems. This is inherent in the sequence of designing the plant and was incorporated in the original design engineering plan.
3. Measures have been put in place to monitor design engineering progress at a very granular level. These include interim milestones that have been incorporated in the recovery plan and tracking progress of specific design deliverables. Significant leadership, support, and oversight efforts are also being applied to ensure the recovery plan is achieved.
4. Although performance has been better than planned in some months, overall progress of design engineering continues to fall behind the recovery plan, albeit to a much lesser degree than previously experienced on the project. The project team is confident that this trend will be turned around.
5. Steps have been taken to mitigate the impacts of delays in design engineering deliverables on downstream procurement and construction activities. These include maintaining schedule linkages between the BL2/BL3 recovery plan and construction execution schedule, prioritizing design deliverables to meet the construction needs (e.g. the Reactor Building (RB) foundation design was accelerated to meet construction needs), and development and implementation of the Design Input Open Items (DIOI) process and tool to track issues, open items, and assumptions to enable downstream activities to proceed with known risks.

Recommendations

None

PROCUREMENT

Introduction

The SMRRB engaged with the SMR-X Procurement personnel to gauge progress in specific areas and to understand how lessons learned from the last visit and subsequent workshops have been applied. The methodology agreed upon in the pre-job briefing was to take a deeper look into Reactor Pressure Vessel (RPV) procurement, fabrication and delivery, and Integral Isolation Valve specification and procurement plans. Issues surrounding Fine Motion Control Rod Drives (FMCRDs) were also explored. The "Received on Site" (ROS) dates for FMCRDs are currently driving the back end of the construction schedule.

Observations

1. There appears to be a good level of integration amongst procurement team members and the greater project team. All questions about the current procurement progress of the RPV were answered readily and satisfactorily. The RPV sub-components are being forged in Morandi Italy and the closure head is being forged at Japan Steel Works (JSW), Hokkaido, Japan. The current design specification is at revision number 9. While additional changes to the RPV design specification document are anticipated, timely issuance of changes during ongoing RPV subcomponent (can) fabrication should provide sufficient time for BWXT to prepare.
2. The team conveyed with clarity the design aspects of the Integral Isolation Valves and the remaining steps which will lead to their procurement. Presently, the design documents for these components are "Rev 0, Unverified". Three potential vendors have been identified as capable of supplying the subject valves. The linkage to the safety analysis needs to be completed before finalizing valve specifications
3. The Procurement team explained the rationale for proposed elimination of the multiport nozzles in favor of an alternative nozzle insert to simplify design and reduce FOAK risks. The SMRRB reviewed the ongoing work to design, manufacture and deliver FMCRDs for the project. At present, FMCRDs remain a significant risk from a design, delivery and performance standpoint. The SMRRB expressed a threshold concern about the linkage between changes in design approach and documents previously submitted to the CNSC for approval. (e.g., PSAR). Assurances were offered that revisions, if any, affecting previous submittals to the CNSC would be communicated as necessary.
4. Process challenges involving the tensions between schedule, costs, Canadian content, Indigenous spend and the implications for rapid decision making were discussed. There is not a simple formulaic approach to addressing these tensions. A "stage gate" approach is being employed to provide early upfront information to decision makers. When RFP responses or tender offers are received, timely decision making is crucial to order placements to sustain schedules. This places a premium on teamwork, judgement, communication within and between team members. It is the intent of the SMRRB to revisit this topic in future reviews.
5. Some discussion focused on safety related Systems, Structures, and Components (SSC) quality requirements and monitoring. The SMRRB will review end to end quality monitoring including subcontractors and second tier subcontractors on a future visit.

Recommendations

None

CONSTRUCTION

Introduction

The SMRRB reviewed construction readiness for Steel Composite Containment Vessel (SCCV) basemat fabrication and placement as well as piling, excavation, and placement plans. Progress on Diaphragm Plate Steel Composite (DPSC) construction methodology, which is key to the modularization plan, was another focus of this review.

Observations

1. The SMRRB reviewed presentation materials and questioned the SMR-X team on numerous aspects of project readiness for basemat installation and DPSC deployment. Specifically reviewed were planning, scheduling, materials of construction, procurement, operating experience, validation mockups and risks. Potential trouble areas of adverse tolerance stack-up and robotic welding were probed. Readiness meeting schedules (T-minus meetings) and objectives were discussed.
2. The presenters were well prepared and comprehensively addressed SMRRB inquiries. Reliable design inputs to support acquisition of robotics and form fixtures are now available. The DPSC plate steel has been ordered and the mockup validation plans are deemed appropriate. While there are still some unknowns and risks which may be encountered such as plate distortion, concrete voids, and the like, the SMRRB is satisfied with the level of preparedness and the competency of team members to meet the challenges which will arise.
3. Engaging Kajima Corporation (Japan) for their expertise in building construction is a positive. Kajima has broad and deep expertise and experience in nuclear building construction including heavy lifts.
4. A brief discussion was held regarding a backup plan of using traditional concrete and rebar in the event of DPSC validation failure.
5. A site tour was undertaken to review the building locations within the project footprint, witness piling works at the containment excavation site and the tunnel boring machine (TBM) entrance location. Safety briefings were suitably thorough. There may be an opportunity to eliminate multiple sign-in sheets to improve productivity.
6. It is suggested that the project consider giving some thought as to how the maximum benefit can be derived from the T-minus challenge and readiness review schedules. Presently, the PLT readiness review of the basemat placement takes place, by procedure template, at T-minus 2 weeks. This may not allow sufficient time to adjust to any meaningful input and could potentially result in delaying a critical evolution. An advance review of activities for which departure from the standard T-minus template may be warranted and could prove valuable. A review of Industry OPEX could be helpful in this regard.

Recommendations

None

EXECUTION DELIVERY

Introduction

A critical activity for the SMR project leadership is to successfully transition the organization from the current Validation phase to the Execution phase of the project. This transition culminates with the CNSC's approval of the License to Construct (LTC) and the OPG Board's approval of the Release Quality Estimate and the start of Unit 1 execution. These are expected to occur in Q1/Q2 2025. The effective transition of the organization to the execution phase is a key focus area for the SMRRB. In this review, the SMRRB assessed the overall progress being made and looked at how lessons learned from the seismic issue have been applied, the plans for expedited emergent issue resolution, and the field engineering readiness plan.

Observations

1. Since the SMRRB's last review, significant progress has been made in defining the Execution Phase end state organization and culture, developing training requirements and training plans, establishing and implementing the procedures and tools needed to effectively execute and monitor project/construction work, and developing a detailed plan to transition the organization from the current Validation Phase to the Execution Phase. Many of the related deliverables are complete and implemented, with the remaining in-progress items planned for completion by the end of 2024. In the SMRRB's view, this will provide many of the elements needed to allow for a successful transition to the Execution phase.
2. Industry lessons learned, as well as lessons learned in the identification and resolution of the recent seismic issue, have been incorporated into the procedures and plans being developed and implemented for the Execution phase of the project. The application of lessons learned needs to be a continual process as the project planning and execution work progresses.
3. A key lesson learned in resolving the seismic issue is the importance of fostering a project culture that emphasizes and encourages the rapid identification, escalation, and resolution of issues that will arise on the project. This is particularity important for the DNNP given the FOAK nature of the project. The project team has taken steps to remove barriers and implement processes and tools that enhance cross-functional integration, improve oversight, provide mechanisms to support rapid responses to issues (e.g. guidelines for High Impact Teams), and have conducted training and tabletop exercises to roll these out to project staff. While the effectiveness of these measures remain to be demonstrated, the SMRRB see the actions taken as appropriate.
4. A model for field engineering support has been established for the project. It includes a site engineering office with design engineering capability, designated "Fix It Now" (FIN) teams at GEH's and Atkins Realis' offices, back shift support from offshore sources, technical support for construction, and a field engineering office with capability to provide rapid resolution of field

issues. A plan to implement the model has been developed with a target of having all elements in place by Q1 2025. The SMRRB sees this as a robust model and plan.

Recommendations
None

Release Quality Estimate (RQE)

Introduction

DNNP is in the process of developing a Class 3 Release Quality Estimate (RQE) for SMR 1 and a Class 4 Estimate for SMR 2-4 which are on-track for Q1 of 2025. The RQE estimate of cost includes contingencies and schedule to execute all approved scope for DNNP. The results of the RQE will be presented to OPG's Board of Directors (BoD) for approval. OPG is planning to go to the Board for approval of the class 3 estimate of DNNP 1 in Q1 2025.

Observations

1. In April 2024 the Project made the decision to move the RQE submission to the Board of Directors (BoD) from Q4 2024 to Q1 2025. This has been done to allow substantial design work to be complete, enabling a stage of maturity that will give the information to have the required overall project cost. This aligns with the BL2/BL3 Engineering design recovery plan which is planned to be rebaselined in July 2024.
2. The project has developed a robust 'Roadmap' schedule for the RQE process with a supporting status review and challenge meeting run-stream that will lead to the submission to the BoD. This includes tracking progress of inputs such as the Design to Cost initiatives, Basis of Estimate updates, Resource Loading, Discrete Risks and Uncertainties and the Quality Risk Assessment (QRA). These inputs are being progressed concurrently with a requirement to have all items complete and updated into the RQE for the data freeze of October 2024.
3. The Design team have developed and are implementing a process to track open items and allow for downstream activities to proceed with known risks. This tool is also expected to inform project risks and assumptions within the RQE. This tool is early in implementation and was acknowledged by the team that it requires runtime to ensure it is capturing all potential issues and risks. The team have implemented interim review sessions to ensure critical issues are represented in both the estimate and the risk database.
4. Through the development of the check estimate and the Class 3 estimate the team has identified potential cost increases to the original Class 4 estimate. In response to these trends the organization is having specific challenge sessions and weekly RQE PLT status reviews to identify Cost Reduction initiatives. New opportunities and initiatives continue to be identified as the team progresses the RQE, however the current U1 Trend Dashboard shows a variance to the target of the Class 4 estimate that does not yet have sufficient initiatives identified to mitigate.

Recommendation

Introduce an additional PLT level RQE challenge session upon completion of the preliminary class 3 estimate updates. This should give the project an aligned snapshot of the RQE status prior to the already planned challenge meetings and finalization of the RQE inputs. Further, an additional PLT level challenge session should be scheduled following the finalization of the estimate to determine if any additional actions should be taken prior to the RQE Data Freeze. To enable this, the frequency of the QRA update should be increased to give a proper picture of the total cost envelope.

INDIGENOUS RELATIONS

Introduction

Indigenous peoples in Canada have constitutionally protected rights that OPG must consider and accommodate in the development of any energy project they initiate, including the DNNP. The proactive integration and coordination of Indigenous Relations (IR) activities into the DNNP project development and execution is critical to ensure that OPG avoids the types of non-technical delays that have been seen across Ontario and Canada in other energy-based and resource development projects.

As per the IR Functional Management Plan (previously the "Indigenous Engagement Plan"), the IR Team has been engaging with the Williams Treaties First Nations communities in a structured and systematic manner, sharing pertinent information on the development of the DNNP, and identifying processes that will accommodate their interests and rights, as well as potential opportunities. The points of intersection with the impacted Indigenous communities are formalized and based on Project milestones. There is proactive information exchanged that aligns with regulatory processes and consultation requirements. This entrenches continued IR integration across the DNNP, and the foundation is being laid to implement a standard roadmap identifying which actions in each project gate create a risk and generate the need to develop a mitigation strategy. Targeted initiatives for identifying Indigenous participation across all SMR-X partners has also been included in the Plan.

Observations

1. The Indigenous Relations Training provided by the SMR-X IR team has been an invaluable mechanism to create Indigenous awareness throughout the Project teams. While 74% of targeted DNNP FTEs have taken the Indigenous 101 training, it would be beneficial for there to be a mandatory on-line Indigenous awareness training program that is a component of the onboarding of all SMR-X FTEs. This is not a replacement or substitute for the (in-person) Indigenous 101 training.
2. The Traditional Knowledge (TK) study, that the Williams Treaty First Nations communities are collectively undertaking in relation to the DNNP site, will be the catalyst for identifying impacts to their Constitutionally protected rights and create a process to identify mitigation measures.

Recommendations

Implement an expanded online Indigenous cultural awareness training program for onboarding new employees and create a database for tracking the number of participants.

OPEN RECOMMENDATIONS STATUS:

Visit #6:

1. ePMx 63800 – Confirm that the configuration and risk management systems are proactively and effectively identifying, tracking, and mitigating critical design engineering assumptions and associated risks both within the design engineering function, as well as those that propagate into the licensing, procurement, construction, and operational readiness functions of the project - **Open**
2. ePMx 63801 – Operation and Maintenance Readiness - **Open**

Small Modular Reactor Review Board
Independent Oversight Report on the Darlington New Nuclear Program

(Visit #8 October 21-24, 2024)

Submitted to:
Major Projects Committee of the Board of Directors for Ontario Power Generation

EXECUTIVE SUMMARY

In the July 2024 Small Modular Reactor Review Board (SMRRB) review it was observed that continued management vigilance by the SMR-X leadership team would be required to ensure the SMR-X organization gains momentum in transitioning from the then licensing/design/planning focus to the future field execution/construction focus that is required upon the anticipated receipt of the License to Construct (LTC) in Spring of 2025. As such, the October 2024 SMRRB review primarily focused on assessing the SMR-X organization's readiness preparations for this transition. This involved reviews of the Integrated Project Delivery (IPD) team's Nuclear Island (NI), Conventional Island (CI), Balance of Plant (BOP), Operations & Maintenance (O&M), Procurement, and Digital Strategy execution bundles. In addition, a review of the Release Quality Estimate (RQE) process was performed along with a site walkdown.

The review found evidence of continued progress with positive observations associated with the development of an integrated schedule that includes engineering deliverable linkages to execution requirements, development and implementation of an execution readiness process, and pockets of excellence associated with the Site Preparation and Reactor Building scopes of work. Across the broader organization, the readiness preparations were not yet observed to be a consistent priority nor a well understood set of requirements. The observed pockets of excellence were judged to be primarily due to individual initiative, knowledge, and prior experience rather than broad organizational focus or competency. In order for the SMR-X organization to be sufficiently prepared to transition to execution, management attention should be given to accelerating the SMR-X's readiness preparations via the establishment of "readiness" as an organizational priority and competency.

In addition, First-Of-A-Kind (FOAK) design maturity risks were highlighted in many of the reviews as having a potential adverse impact on downstream execution. Industry Operating Experience (OPEX) indicates that it should be anticipated that these design maturity risks will likely persist for some time into the execution phase. Hence, the SMR-X organization should anticipate the need to continuously identify and expeditiously respond to these unplanned emergent challenges. During readiness preparations, this should include the proactive development of empowered and appropriately staffed site engineering organizations, along with protocols to expeditiously deploy High Impact Team (HIT) or Fix-It Now (FIN) teams. The ongoing RQE process should ensure that the uncertainty of these design maturity risks are properly identified and incorporated into the analysis.

DETAILED REPORT

Background

The SMRRB was commissioned for the OPG Board of Directors to independently monitor the Darlington New Nuclear Project (DNNP). This is the third review of 2024.

For this review, the SMRRB comprised the following members:

1. Sandy Rupprecht (Chair)
2. David Christian
3. Saga Williams
4. Mark Rauckhorst
5. Dietmar Reiner
6. Boris Vulanovic (OPG internal member)

OPG Support: Cory Bruder

PROJECT BUNDLE EXECUTION READINESS

Industry operating experience indicates that inadequate preparation for projects to transition from the planning phase to the field execution phase results in disruptions to the synchronized flow of site execution. This results in threats to safety, quality, cost, and schedule performance. In this review, the SMRRB assessed the SMR-X project team's approach, progress, and trajectory for ensuring that the NI, CI, and BoP project bundles are ready for field execution when the LTC is issued. The focus is on people, process, material, and tools needed to effectively carry out planned work in accordance with the established schedule and budget. The readiness time horizon was the first year of field execution following issuance of the LTC.

Observations

1. Specific Engineering deliverables required to support field execution are now fully integrated into the execution schedules for each project bundle. This allows for schedule risks related to Engineering deliverables and the mitigation of their impacts on project execution to be identified. The SMRRB sees this as a key step in developing a robust execution schedule.
2. Given the state of design engineering maturity and first-of-a-kind nature of the SMR project, there will be execution and construction challenges that will require a robust, capable, and agile engineering support team at the project site. This team should have the appropriate engineering/design authority to quickly resolve issues and provide solutions to protect the project execution schedule. The SMR-X project team are in process of establishing this site engineering support function. The SMRRB cautions the team to ensure this function is staffed with field-savvy capability, that the structure and makeup are informed by industry lessons learned, and that it is tested and ready to deploy when the LTC is issued.
3. The continued maturation of the SMR design during the execution phase has the potential for field work that has already been completed to require modifications. This emergent rework,

which is to be expected for a FOAK project has the potential to result in significant disruptions and delays. Proactively anticipating and planning for how the project will expeditiously respond to these delays through mechanisms such as HIT and/or FIN teams should be part of the readiness process.

4. The SMRRB reviewed the SMR-X Execution Readiness Guidance & Procedure being used by the project bundles. The procedure articulates what it is intended to achieve. However, the SMRRB's sees an opportunity to make the procedure more clear and precise with respect to its purpose and intended outcomes.
5. The SMRRB also reviewed how the readiness procedure is implemented across project bundles. The procedure rightfully allows for a graded approach regarding its application and implementation. While the graded approach has some clear advantages, it places a premium on the knowledge, skill, capability, and judgement of the Area Leads and project bundle leads. The organization should be mindful of the potential pitfalls associated with this approach and be prepared to capture lessons and learn from field execution failures or shortfalls.
6. As part of its review, the SMRRB asked the project bundle leadership teams how they ascertain whether their project bundles are ready for field execution. It became apparent that there is no common understanding across the project bundles on what being fully prepared for execution looks like and what their readiness efforts need to achieve.
7. The work currently being executed at the SMR site is experiencing some interruptions and stoppages. Such interruptions and stoppages can be avoided with improved readiness efforts. Best efforts are being made to communicate and apply the lessons learned to other project areas and bundles. In the SMRRB's view, the SMR-X project would benefit from implementing a more formal and rigorous approach for capturing lessons learned and feeding these back to the appropriate people, processes, and tools to make continuous improvement.
8. The SMRRB was asked to assess the timeliness and effectiveness of Constructability, Operability, Maintainability, and Safety (COMS) reviews. The process being used is tiered, to allow for issues to get identified and decisions to be made at a working level through various integrated working groups, and to allow for escalation and expeditious decision making through more senior level decision forums should this be required. Several examples were cited where the process resulted in design changes to enable efficiencies in construction, operations, and maintenance activities (e.g., location of isolation valves, installation of drain traps, shielding requirements). Several construction managers also evidenced high levels of experience and a healthy and respectful relationship with Engineering. It should be noted that the SMRRB did not directly observe any COMS reviews.
9. There are many systems and interfaces that integrate across project bundles. These are identified in the project bundle execution schedules. It is not apparent to the SMRRB how the division of responsibility and integration for field work on these systems and interfaces gets managed across project bundles. The SMRRB did not review this potential gap in detail but may do so in future reviews.
10. NI specific observations:
    a. Prior to the on-site project review, the SMRRB observed an NI monthly project meeting and Reactor Building monthly project meeting. The meetings were conducted with rigor and discipline, metrics were used to support the discussion, and the discussion focused appropriately on project issues, risks, and performance.

b. The SMRRB assessed the testing and validation that is in progress for pre-assembly of the Diaphragm Plate Steel Composite (DPSC) bricks at the Aecon and ES Fox fabrication facilities. Design details for the DPSC bricks continue to evolve. This has impacted the timeline for acquiring tools needed to automate the fabrication process and is likely to result in manual welding/fabrication for Unit 1, which may in turn have a cost impact on the project. The project team is well integrated with Engineering and the fabrication teams at Aecon and ES Fox. Regular meetings are held at an appropriate frequency. Progression of design, fabrication testing, lead times for tooling and other materials, schedule and cost impacts, and risks and mitigations are being actively assessed.
c. Simulator delivery is part of NI scope. The SMRRB reviewed the level 1 plan for delivery of the simulator, its associated software and attendant facilities and buildings. The plan appears adequate recognizing that multiple software upgrades will likely be required as design continues to progress.

Recommendations

1. Make readiness for field execution a top project priority for the SMR-X project, ensure that the accountabilities for execution readiness are understood, and develop the competence and knowledge needed for the accountable individuals to succeed. In doing this, leverage pockets of excellence that already exist in the Reactor Building, Site Preparation, and Intake/Discharge Tunnel project areas.
2. Update the readiness procedure to make it clearer and more precise on its purpose, link the purpose to the intended outcomes, and incorporate guidance on how and where the procedure should be applied. Use this as an opportunity to also reinforce leadership accountabilities and behaviours.
3. Implement a formal Lessons Learned program, ideally with dedicated resources embedded and integrated with DNNP. As a learning initiative, choose some early field activities that have been completed (such as Reactor Building excavation below the 78’ depth, installation of Turbine Building piles and caissons adjacent to the Reactor Building, ground grid installation), conduct post-completion reviews to evaluate the effectiveness of field execution planning and readiness activities, and rapidly incorporate lessons learned as necessary.
4. Bundle readiness preparations should include developing plans for rapid mobilization of HIT and/or FIN teams/etc. that may need to be deployed to implement unplanned emergent field changes. These plans should take into consideration protocols for mobilization, processes that will be used to manage and monitor the field work, and advanced identification of resources that would participate on these teams.

Suggestions

1. Consider engaging an external group of experts with direct hands-on new build experience to review and challenge the readiness outcomes for a sample of project execution activities, to ensure these adequately prepare the project bundles for successful field execution of their project plans.

SUPPLIER READINESS

Introduction

Industry OPEX has identified gaps at other projects in the implementation of a rigorous Procurement Delivery Program to ensure the right equipment and material is procured and delivered to the site at the right time to support field execution. These gaps have resulted in significant disruptions and challenges to project schedules. SMR-X must include proper oversight and engagement of the owner to ensure that qualified vendors, and complete documentation and traceability is included in the delivery of the material and equipment necessary to support execution.

Observations

1. It is clearly evidenced that there is integration of the Indigenous Relations Functional Management Plan into the overall supplier plan. It includes not only direct procurement, but also includes Tier 2 and 3 levels, as well as linking opportunities to train and build skill development for increasing the number of Indigenous personnel for this project and for future projects.
2. The team has developed the process and procedure to facilitate delivery of the equipment and material.
3. An oversight matrix has been established which identifies the level of oversight and surveillance that will be performed for specific vendors.
4. The SMRRB observed good integration of the Procurement Team with the DPSC project.
5. The procurement team has done a good job awarding critical/long lead material/equipment contracts to appropriate suppliers. The design completion and the necessary drawings / specifications required to issue comprehensive Purchase Orders (PO's) under those contracts (and therefore mitigate the relevant project risks) requires continued attention in order to not affect project execution.
6. The procurement team is challenged with the timely completion of design and the necessary drawings and specifications required to issue PO’s. This is a project risk and will require continued attention so as to not affect project execution.
7. Industry OPEX indicates that there have been significant issues with the procurement and delivery of bulk commodity purchases. This is a critical issue that should be anticipated for future phases of the project.

Recommendations

The procurement team should ensure lessons learned from industry OPEX is understood and incorporated into their management and oversight of bulk commodity procurement.

OPERATIONS AND MAINTENANCE

Introduction

The SMRRB conducted their third review of the Operations & Maintenance (O&M) functions. The Organization was created to develop and implement plans to execute and provide oversight of the activities associated with commissioning of the Unit, facility readiness and O&M workforce readiness. This includes training and verification of employee proficiency, process and procedural readiness, digital operations support, operational organization readiness and conduct of pre-start-up checklists to support the WANO Pre-Startup Review.

Observations

1. The procedure that defines the role of O&M has been refined to distinguish between oversight functions versus scopes of work that are required to be performed by the group. There is clarity on where the interface is in the responsibility of items such as chemistry, environment, FME, check out and test and commissioning. A third-party review by Cohesive Solutions of the scope of O&M is scheduled for November 2024 to ensure the scope is accurate.
2. The SMRRB sees an opportunity for the O&M team to collaborate with the upstream project execution areas to ensure there is a clear understanding of what and how the project is delivering on key requirements such as quality, chemistry, FME and construction proficiency. This will help to ensure alignment on how the unit will be delivered at points of turnover, minimize the potential impact on commissioning activities and eliminate the duplication of QA reviews in response to poor performance or unknowns.
3. Performance metrics to track progress of Operational Readiness tasks have been developed and are being tracked in an established run stream that does roll up to the appropriate tracking and oversight forums up to the Chief Project Officer and the Chief Nuclear Officer. These cover the development of training, procedures, specifications and mitigation plans that will be required for the execution of commissioning and operation.
4. Estimates for Operational Readiness work and the development of an integrated project schedule for the scope of O&M have been completed and loaded into the master schedule. A review of the key project and design deliverables have also been completed ensuring those tasks have been tied into the operations schedule. This has identified that the final operations delivery of authorization training and qualified staff is currently 5 days off critical path primarily based on the tie to BL2/BL3 design completion.

Recommendations

It is recommended that the SMRX Project determine the required O&M schedule margin to maintain adequate critical path protection and the opportunity to capitalize on any advancement in construction. Specific mitigating actions should be developed to support this that contemplate both Operations action as well as I&C Design advancement.

DIGITAL STRATEGY READINESS

Introduction

The SMR-X project team are developing and implementing a Digital Strategy intended to enable efficiencies in design, construction, commissioning, and on-going operations of the Darlington BWRX-300 SMRs. Key elements of the strategy include Digital Project Delivery integrated across all IPD partners to enable efficiencies in plant design, construction, and commissioning, and SMR Digital Operations to enable efficiencies in plant operations and maintenance. In this review, the SMRRB assessed the current state of Digital Project Delivery, future state of SMR Digital Operations, linkages to critical BWRX-300 operating assumptions, and progress to date in achieving the future state.

Observations

1. Overall, good progress is being made by the Digital Strategy project team in the development and deployment of the Digital Strategy.
2. The IT systems associated with Digital Project Delivery have been selected and implemented. These are largely comprised of existing IT systems that are already in use by the IPD vendor partners. The Digital Strategy project team recognize the need to "freeze" these systems in order to meet project needs and minimize disruptions in SMR-X project execution.
3. The IT systems for SMR Digital Operations have largely been selected. Business requirements for implementation of these systems have been established. Project plans for implementation and change management plans for deployment and rollout are being developed. Project plans are integrated with the SMR project plans for ongoing operations & maintenance. The Digital Strategy project team recognize the complexity and risks associated with the development and deployment of the SMR Digital Operations systems and are managing the project in accordance with the project management discipline, processes, and requirements established by OPG. The SMRRB cautions the SMR-X and O&M project teams to remain connected with progress being made in implementation, to mitigate any risks that might arise should the deployment of systems get delayed.
4. Cyber security and intellectual property protection requirements and concerns are well understood by the Digital Strategy project team. Plans to address risks are aligned with standards implemented for other OPG business systems and are incorporated into the project plans. For the Digital Project Delivery systems, requirements have been provided to the IPD partners where the associated IT systems reside. There may be value in periodically assessing how cyber security and intellectual property requirements are being managed to ensure that this is done in accordance with the requirements specified by OPG.
5. The increased utilization of IT systems to manage and support ongoing SMR operations creates increased business risks related to reliability and availability of the IT systems. The SMRRB encourages the SMR-X and O&M project teams to remain mindful of this.

Recommendations

None

RELEASE QUALITY ESTIMATE (RQE)

Introduction

DNNP is in the process of developing a Class 3 Release Quality Estimate (RQE) for DNNP 1 and a Class 4 Estimate for DNNP 2-4 which is on-track for Q1 of 2025. The RQE estimate of cost includes contingencies and schedule to execute all approved scope for DNNP. The results of the RQE will be incorporated into the Business Case which will be presented to OPG's Board of Directors (BoD) for approval. OPG is planning to go to the Board for approval of the Class 3 RQE of DNNP 1 in Q1 2025.

Observations

1. The Project has completed the preliminary Class 3 RQE updates for each Bundle and Function. They have revised the 'Roadmap to RQE' to include additional PLT level challenge sessions. The challenge sessions include a focus on design input in commodity estimate assumptions in order to provide better cost certainty. This has been supported by the re-baseline of the BL2/BL3 Engineering design recovery plan in July 2024 and the subsequent progress. The SMRRB believes that the 'Roadmap' schedule for the RQE process continues to be robust with additional reviews and challenge meetings having been added prior to the submission to the BoD.
2. The project has implemented a monthly review of the risk log and inputs into the Quality Risk Assessment (QRA). The challenge sessions have worked to identify and eliminate duplication of risks in the database, ensure the right risks are linked to the program schedule (critical path) and to evaluate the schedule uncertainty of each risk. At the time of the SMRRB visit each respective bundle and function have completed an initial review and update of their discrete risks. The design team have implemented the Design Input Open Items (DIOI) tracking process that is being used by the teams and is providing input into the Design risks on the project. There is a PLT level integrated challenge scheduled for November 2024 that will provide an integrated view of the project risks and assessed contingency.
3. The Project Controls team is in the process of developing the Reference Class Estimating Table to support validation of the assumptions within the Class 3 RQE against industry benchmarks. It is the view of the SMRRB that developing this is important to support the validation of the Final Estimate for the end of November 2024.
4. Review of the current contingency distribution and risks by the SMRRB have identified three areas of focus:
    a. The CI Bundle discrete contingency is currently $19M dollars. In comparison to the other bundles, their relative complexity and assessed contingency, the CI contingency is low.
    b. Review of the contingency does not appear to provide a clear list of the commissioning risks or where the ownership lies in mitigating actions and discussion with the team revealed that the link of the risks to the program schedule (critical path) is not yet complete.
    c. Though progress has been made on the design recovery plan, design progress is still trending behind the re-baselined plan. Identified design issues and the characterized

risk appear focused on construction execution readiness. The SMRRB views that the residual risk of design maturity may not be sufficiently represented in all "knock on" impacts such as the design I&C risk to Initial Authorization Training.

5. The project has a PLT level challenge session of the integrated project risk list and contingency planned in preparation for the final estimate. The SMRRB see an opportunity during this session to evaluate and address the potential low contingency of the CI bundle and ensure that the Commissioning risks are properly captured and tied to critical path impact.

Recommendations

A specific PLT level challenge session should be conducted for the specific review of the current residual risk of Design maturity. This should review the estimate, risks and contingency for design completion with a bias to impacts beyond readiness to construct in order to also include impacts to procurement, analysis and commissioning.

INDIGENOUS RELATIONS

Introduction

Indigenous peoples in Canada have constitutionally protected rights that OPG must consider and accommodate in the development of any energy project they initiate, including the DNNP. The proactive integration and coordination of Indigenous Relations (IR) activities into the DNNP project development and execution is critical to ensure that OPG avoids the types of non-technical delays that have been seen across Ontario and Canada in other energy-based and resource development projects.

Observations

1. The Indigenous Relations Training provided by the SMR-X IR team continues to be an invaluable opportunity to create Indigenous awareness throughout the Project bundle teams. Providing the in-person Indigenous 101 training as a tool for onboarding new SMR-X staff should continue with an initial requirement for taking the newly developed on-line SMR-X Indigenous awareness training program. This stresses the need to integrate Indigenous Relations throughout the Project.
2. The commencement of the Traditional Knowledge (TK) study in Q1 2025 that the Williams Treaty communities are collectively undertaking in relation to the DNNP site will provide clarity on impacts to their Constitutionally protected rights and create a process to identify mitigation measures, supporting the ongoing and upcoming Licensing processes.
3. During the on-site BOP tour, it was clear that there was a consistent process to identify, protect and identify any culturally significant Indigenous artifact or human remains. Working with the site supervisor and environment designate, the OPG IR Team will enlist their archeology resource and the local First Nations when items or remains are found. It was also significant that there was an effort to identify a space on-site for Indigenous ceremonies and sacred acknowledgements to take place.
4. It is also noted that the First Nations relationship and interactions with CNSC needs to be consistent and aligned with the DNNP team. Cooperation, support, mentoring and monitoring of

developments in the CNSC and Williams Treaty First Nations relationships by DNNP need to continue.

Recommendations

None

OPEN RECOMMENDATIONS STATUS:

Visit #6:

1. ePMx 63800 – Confirm that the configuration and risk management systems are proactively and effectively identifying, tracking, and mitigating critical design engineering assumptions and associated risks both within the design engineering function, as well as those that propagate into the licensing, procurement, construction, and operational readiness functions of the project - **Closed**
2. ePMx 63801 – Operation and Maintenance Readiness - **Closed**

Visit #7:

1. ePMx 67816 - Implement an expanded online Indigenous cultural awareness training program for onboarding new employees and create a database for tracking the number of participants – **Closed**
2. ePMx 67817 - Introduce an additional PLT level RQE challenge session upon completion of the preliminary class 3 estimate updates and to increase the frequency of the QRA update – **Closed**

Small Modular Reactor Review Board
Independent Oversight Report on the Darlington New Nuclear Program
(Visit #9 February 10th – 13th 2025)
Submitted to:
Major Projects Committee of the Board of Directors for Ontario Power Generation

EXECUTIVE SUMMARY

A key theme of the feedback from the October 2024 Small Modular Reactor Review Board (SMRRB) review was that while continued progress was being made on design, licensing, and planning areas of the project, there needed to be an expanded focus and acceleration of activities associated with preparing the SMR-X organization to execute following the issuance of the License To Construct (LTC) in Q2 2025. This review followed up on that theme and predominantly focused on assessing the organization's readiness to transition to the execution phase.

The review found clear evidence of a continuing SMR-X Integrated Project Delivery (IPD) team making significant strides to work as "one-team", along with a significantly increased organizational focus on readiness activities and behaviours. These were being instilled in the organization via the implementation of a variety of processes, performance tracking mechanisms, leadership meetings and oversight.

While much is being done to ready the organization to execute, industry OPEX indicates that the First-Of-A Kind (FOAK) characteristics of the BWRX-300 design and the developing nature of the SMR-X IPD team will likely result in early workstream performance challenges. In addition to responding to mitigate their immediate technical, cost and schedule impacts, a key to success will be engaging the workforce to rapidly understand and correct the underlying causes. A key recommendation of the SMRRB is that the SMR-X organization embrace these challenges as learning opportunities in order to rapidly improve the IPD teams' execution capabilities. This will require the organization to adopt a rapid learning mindset and develop a capability to rapidly move up the organizational development "learning curve" to prevent repeat events on downstream Unit 1 execution, as well as on future Units 2 through 4 deliveries.

DETAILED REPORT

Background

The SMRRB was commissioned for the OPG Board of Directors to independently monitor the Darlington New Nuclear Project (DNNP). This is the third review of 2024.

For this review, the SMRRB comprised the following members:

1. Sandy Rupprecht (Chair)
2. David Christian
3. Saga Williams
4. Mark Rauckhorst
5. Boris Vulanovic (OPG internal member)

OPG Support: Alex Lopez

Overarching Approach To Readiness

Introduction

It was recommended by the SMRRB during the October 2024 review that the SMR-X team pivot from a primary focus on progressing design and licensing maturity to a focus that included ensuring organizational readiness for execution was a top priority. As a follow-up to that recommendation, the SMRRB reviewed the overall approach and actions that the SMR-X team has taken to ensure that the organization will be ready upon issuance of the LTC.

Observations/Insights

1. The project team has developed and implemented a readiness procedure and process which will be utilized across the project bundles. A graded approach will be implemented based on the quality requirements and complexity of the execution activity. This is a sound application of the process and the SMRRB was able to discuss its implementation with the Nuclear Island and Conventional Island bundle leads and noted good alignment and integration across the bundle leads. The use of the execution readiness dashboard allows for a summary level review of areas which are not meeting requirements and allows for leadership to perform deeper dives into those areas to assess the need for oversight or intervention.

2. In addition, the project leadership at the end of 2024 and into 2025 held team building, alignment, and leadership meetings focused on Readiness to Execute, Importance of Lessons Learned, Support for all IPD members, and On-going Communications Plans. These actions are of high value and will have a positive impact on the entire project team. The SMRRB observed this during our discussions with the various bundles, including the upcoming piling evolution across the various buildings.

3. Bundle readiness activities are underway to develop protocols for rapid mobilization of High Impact Teams (HIT) to address unplanned emergent field issues, processes to manage and monitor the field work (Project Control Center), and advanced identification of resources that would be needed to participate on these teams.

4. The SMRRB judge these overall approaches to be appropriate for preparing and aligning the SMR-X team for the coming execution phase. However, it is anticipated that the FOAK nature of the BWRX-300 design and the developing nature of the SMR-X IPD team will likely result in early workstream performance challenges. The SMR-X organization will need to quickly learn from these performance challenges in order to quickly make technical and organizational behavioral adjustments.

Recommendations

As performance challenges emerge, the SMR-X team should embrace them as learning opportunities and develop a rapid learning capability in order to correct the emergent challenge and to prevent repeat events on the downstream Unit 1 execution, as well as on future Units 2 through 4.

Execution Readiness For DPSC Fabrication And Basemat Install

Introduction

A critical execution milestone of the DNNP project will be the installation of the Reactor Building (RB) basemat, which is currently forecasted to be in January 2026. This evolution will involve the fabrication of Diaphragm Plate Steel Composite (DPSC) modules at dedicated offsite facilities, transport to the DNNP site for assembly and lifting of the basemat modules and ultimate placement into the RB excavation. This will be a critical FOAK evolution for the BWRX-300 modular construction strategy, as well as a critical demonstration of the SMR-X organization's integrated design, procurement, and construction execution capabilities. The SMRRB reviewed the readiness trajectory of this evolution via visits of both the ES Fox and Aecon fabrication facilities, and a high level review of the basemat fabrication, assembly, and placement readiness plan.

Observations/Insights

1. On Friday, February 7th, SMRRB conducted shop visits at both the Aecon and ES Fox offsite fabrication facilities to review the current state and to discuss the initiation of offsite fabrication activities associated with the DPSC basemat and wall sections. Both facilities are in the process of either expanding fabrication space or modifying existing space to accommodate the required platen, fixture and machining required for basemat work. The ES Fox facility is also being renovated for the plate bending machine which is to arrive at the facility in August of this year. Until then, plate material will be rolled prior to shipment to the fab facilities. Aecon started fabrication activities in January and ES Fox anticipates the start of fabrication work by the end of February.

2. The personnel at each facility were knowledgeable and experienced. The fixtures and platens required for welding the sections were in place and the base material was appropriately maintained. The SMRRB was able to view the mockup sections and discussed the lessons learned from the initial welding which had resulted in some warping of the section and diaphragm. These issues had been documented and reviewed by the design authority and changes to the weld process were implemented to avoid future issues. This will be an item that will require continued oversight by both the in-line fabrication and quality organizations.

3. As the mockup is further fabricated, it is expected that additional lessons learned will be identified which need to be captured and shared between the two fab facilities as well as within the site fabrication group. It is essential that these lessons learned be rapidly identified and disseminated in order to minimize disruptions to the schedule.

4. Several initiatives are being pursued for process and execution improvements. Most notable were the use of a tablet system for work package and production/quality records; use of robotics to perform welding; and computer guided stud welding.

5. The preparation activities and mock-ups are providing early insight into the fabrication of the sub-modules. The transition to production fabrication over the next few months and the ability to fabricate and ship these sub-modules to the site will provide an early indication of the project's ability to meet the basemat set date currently targeted for January 2026.

Recommendations

1. The startup of fabrication represents an opportunity to validate the design and actual fabrication of the DPSC. From base material delivery to mockup fabrication, to full scale production, lessons and insights will be identified which must be quickly documented and shared across the project. The project must ensure these lessons are captured and shared in real time so that the rest of the project is able to review and adjust as necessary. Engage the workforce and solicit their feedback on how to improve the procedures, processes and work execution in a timely manner.
2. A significant ramp up in fabrication work in February through April of 2025 will likely require that real time changes and decisions will be required. As a result, the design authority should be onsite in the fab facilities to see ongoing work and rapidly address emergent issues such that the fabrication continues per plan.

The mockup plan that has been developed is an excellent opportunity for the project team to "Practice like you intend to Play". Project leadership should ensure that the mockup fabrication, assembly and concrete placement employs the same procedures, processes and quality programs which will be utilized when fabricating the DPSC basemat. This might include the introduction of challenges which might be seen during actual construction to see how the organization responds to abnormal conditions.

Conventional Island (CI) Constructability Review

Introduction

Constructability reviews during the course of the design development are an essential tool for ensuring collaboration between designers, constructors, and operations & maintenance to ensure that the final design meets functional requirements while also optimally efficient to build in the field and maintain over its service life. The SMRRB reviewed the current revision and the application of the Constructability Readiness Review Process and the SMR-X project team's approach, progress, and supporting runstream for the 30%/60%/90% CI Constructability reviews.

Observations

1. The organization has implemented a comprehensive runstream to support the Integrated Constructability Reviews that includes:
   - Multi-Discipline Design Reviews
   - Engineering Model Reviews
   - 30%/60%/90% Constructability Reviews
   - Weekly Interface Touchpoints covering Civil, Piping & Pumps, Controls, HVAC and Security

2. There is consistent representation from Engineering, Construction, Project Management and Operations and Maintenance in the runstream and the SMRRB observed strong collaboration addressing constructability, operability and maintainability of the design. Comments and actions from all groups are captured in a centralized tool that provides traceability and tracking to ensure timely disposition to support the readiness process. The SMRRB observed strong collaboration

between the groups evidenced by examples of design improvements made to facilitate airlock placement, room layout and shielding requirements to improve constructability and operability of the plant.

3. The SMR Project has implemented a formal Lessons Learned program that requires a lessons learned session to be scheduled 4 weeks after the start of execution of a work package with the product being a lessons learned report with actions to incorporate in future work packages. As a learning initiative the project has also designated early field activities that have been completed (such as Reactor Building excavation below the 78' depth, installation of Turbine Building piles) to conduct post-completion reviews to evaluate the effectiveness of field execution planning and readiness activities, and incorporate lessons learned as necessary.

4. The SMRRB judged the Constructability Review Process to be appropriate and was being properly implemented in activities associated with the CI. The SMR-X project needs to ensure that it is consistently being employed and implemented across the project.

Recommendations

None

Procurement Readiness For Execution

Introduction

2024 was a year of significant accomplishments with contracts and orders for most long lead items secured. The scale and critical nature of the procurement activities will escalate significantly in the coming year as the project transitions into widespread execution. In many cases these procurement activities will be challenged by FOAK design maturity and engineering's schedular performance in progressing the design. In some instances this will make the development of accurate material lists for bulk purchases difficult to generate in order to support the normal procurement process. Effective project execution will be dependent on a procurement team that is dynamic and well integrated into the bundle planning and execution processes. The SMRRB's review was focused on assessing the SMR-X procurements teams readiness activities to manage this challenging situation.

Observations/Insights

1. The communications vehicle "Top 25 for 25" for the 2025 year understates the critical nature and scale of other procurement activities ongoing or upcoming. The organization may find it advantageous to adopt a tag line akin to "The right material, at the right place, at the right time."

1. A review of the level 3 schedule for the next 6 months reveals significant procurement activity. In some cases, the schedule for those procurement activities may be impacted by engineering schedule performance. The plant engineering model is not presently developed to the point that accurate material lists for bulk purchases are generated. One example is the upcoming schedule for bulk

procurement of safety related valves for the ICS. Nonetheless, there is evidence of effective communications between procurement and engineering functions.

2. An individual from the units 2-4 initiative has been tasked with monitoring procurement activities with the intention of optimizing procurements for units 2-4. This forethought is a positive step.

3. The Terms of Reference (TOR) document for the Indigenous/EDI Procurement Teaming arrangement defines a systematic approach to establishing goals, tracking progress, ensuring accountability, and seizing opportunities. Coupled with other Indigenous/EDI initiatives, this teaming arrangement should produce both tangible and intangible benefits to the project and to the community at large.

4. Thorough planning and anticipation of warehouse requirements in large-scale projects is important. Proper storage management can prevent delays, reduce costs, and ensure smoother project execution. The availability of warehouse/storage space has caused problems in the execution of other megaprojects, notably Vogtle 3&4, Sydney Opera House, the Channel Tunnel, and the HS2 High Speed Rail project (UK). A survey of the SMR-X procurement team members reinforced this concern for the DNNP project.

5. Limited insights were gained on this visit in the area of Vendor Surveillance. The procurement organization is focused on a “one team” approach across the IPD participant teams for vendor surveillance. To date, there have been limited lessons learned. This will likely be examined more closely in future SMRRB reviews.

6.

7. While the SMRRB review was limited in scope and duration, it is the judgement of the SMRRB that procurement challenges remain which have the potential to impact the efficient execution following issuance of a LTC. While there are multiple initiatives underway to proactively address many of these risks, it is unlikely that they will be completely eliminated or avoided prior to execution. Hence, it will be incumbent upon the SMR-X procurement team to develop a rapid learning capability in order to correct any material supply issues, but also any underlying management processes that may have enabled the issues.

Recommendations

1. Validate the adequacy and efficiency of the current approach to material storage, especially considering the possibility of receiving some Unit 2 material while Unit 1 is still under construction.

Residual Licensing Risks

Introduction

The FOAK deployment of the BWRX-300 introduces analysis and acceptance methodologies that are novel to historic Canadian regulatory practices. Ideally these novel approaches would be reviewed and accepted by the Canadian Nuclear Safety Commission (CNSC) prior to issuance of the LTC. The SMR-X team has worked proactively with the CNSC via the submission of Licensing Technical Reports, technical meetings, and public forums to ensure there is a thorough understanding of how the design and licensing basis of the BWRX-300 meet Canadian regulatory requirements. While these efforts have

largely been successful, the LTC is anticipated to be issued in April of 2025 with several issues still in the process of being resolved. The final resolution of the open issues could potentially require design and/or operational changes that necessitate rework and/or project delays. The SMRRB reviewed the current state and proposed pathway forward of most risk significant licensing issues.

Observations/Insights

1. The Tiger Team concept put in place by the CNSC and SMR-X team for the Reactor Building (RB) DPSC design, Containment Isolation, and N285 Pressure Boundary topics was successful in reducing the risks associated with these issues to a low level while nuclear construction proceeds. Proactive work with the CNSC will continue to be required in these areas to ensure all commitments are met and are not expected to interfere with the clearing of the first Regulatory Hold Points (RHP) in December of 2025.

2. The Tiger Teams associated with the Safety Strategy and the Break Exclusion Zone (BEZ) issues were successful in defining and reducing the number of gaps for resolution and the associated pathway forward, but they did not fully alleviate the CNSC concerns. These risks will continue to persist at a non-trivial level after the issuance of the LTC. The plan is for additional work to be done in 2025 to demonstrate the feasibility of closing the gaps with and to continue into 2026 to demonstrate gap closure with final design information. Current risk forecasting incrementally diminishes these risks over time into 2026 as it credits the effort in minimizing CNSC concerns.

3. OPEX from other new build projects has shown projected resolution of FOAK regulatory issues can often be optimistic in both technical, schedule, and cost impacts. It is the judgement of the SMRRB that this uncertainty has been adequately incorporated into the Release Quality Estimate (RQE) being prepared for board submission in March via the Qualitative Risk Analysis methodology and multiple challenge sessions.

4. A visual of forecasted risk profiles over time was used as a tool to demonstrate the de-risking of various FOAK/FIAW and analysis risks over time. This tool was judged by the SMRRB to be a best practice for visualizing the risk impact of mitigation and avoidance actions. It is suggested that this tool be employed as a standard method to inform the project and facilitate discussions regarding the efficacy of the forecasted risk reduction activities.

Recommendations

None

Operations and Maintenance Readiness

Introduction

The SMRRB conducted their fourth review of the Operations & Maintenance (O&M) functions. The scope of this visit was to review progress on the previous visits recommendation to determine what the required schedule margin to critical path is for O&M readiness. This included a review of the mitigating actions to support this that contemplate both O&M actions as well as Instrumentation and Control (I&C) Design progress.

The SMRRB also reviewed the progress on plans to execute and provide oversight of the activities associated with construction and commissioning of Unit 1, facility readiness and O&M workforce readiness. This includes training and verification of employee proficiency, process and procedural readiness, digital operations support, operational organization readiness and conduct of pre-start-up checklists to support the WANO Pre-Startup Review.

Observations/Insights

1. The O&M organization has made progress on near term milestone and deliverables. An example being the start of the initial hiring program. A detailed staffing plan has been developed, and postings have been made. Early interviews are in progress to support advancement of the O&M staffing for the SMR-X project. Aptitude testing has been incorporated into the selection process to ensure that individuals hired will support the organizational culture at SMR-X. The SMRRB believes positive progress has been made and continued attention and oversight will be key to managing the release of staff to SMR-X from the other OPG business units.

2. To enable a successful transition from construction to commissioning and operation, a detailed change management plan has been developed for Owners Integration into Construction. This details key activities, objectives and goals to serve as a guide to facilitate change of site ownership, programs and processes. A collaborative framework has been developed that embeds construction personnel with OPG personnel responsible for facilitating change management. There is a monthly Operations and Maintenance Construction Coalition (OMCC) meeting to discuss and provide oversight on progress. The SMRRB believes positive progress has been made and will continue to monitor the development of the OMCC.

3. The O&M Team has ensured consistent representation within the Construction readiness runstream which includes the Engineering Design Reviews, GEH DDT Meetings, Engineering Model Reviews and 30/60/90 Constructability Reviews. The SMRRB saw examples of O&M input into Foreign Material Exclusion (FME) practices during construction and chemistry and cleanliness input into construction that will improve the constructability readiness of the project. The SMRRB views the integration of O&M into construction as improved.

4. The current project working schedule has Unit 1 Commercial Operation Date in April 2030 which provides a schedule margin of 10 months to the scheduled readiness of Operations with Authorized

staff to Operated. Though the O&M team have held the original schedule for Authorization Training readiness there is a HIT team in place managing the transition of design I&C completion and simulator completion. The level 1 schedule also identifies the start of software development of the simulator in July of 2029. It is not yet defined by the HIT team what the specific needs are from Design for Operations to develop the training and meet the current schedule. Actions are in progress from the previous recommendation of the SMRRB to address this topic and will continue to be monitored for progress.

Recommendations

None

Indigenous Relations

Introduction

Indigenous peoples in Canada have constitutionally protected rights that DNNP must consider and accommodate. The proactive integration and coordination of Indigenous Relations (IR) activities into the DNNP project development has been critical to building substantive and meaningful relationships with the local and impacted First Nation communities. The LTC permitting process has exemplified the need to bring the SMR-X team together to ensure collaboration to achieve targets and goals in order to avoid non-technical delays. The effectiveness of their engagement efforts to date was recently exemplified by the First Nations' favorable feedback at the CNSC hearing. While significant progress has been made, collective efforts and outcomes need to continue in order to sustain the positive trajectory and to ensure favorable reports in future check-ins that may be required as part of potential licensing conditions. This SMRRB review was focused on assessing that continued effort.

Observations/Insights

1. Internal employee training commitments, hiring and training practices, procurement awards and spends, as well as integration of Traditional Knowledge are aspects of targets and deliverables all SMR-X partners must commit and adhere to, in order to build upon the relationships established thus far. It is evident that IR continues to be included throughout the DNNP bundles, however further work identified that links to economic opportunities through partnerships and procurement, employment and suppliers' efforts and achievements need to be tracked and measured.
2. The IR team has moved the relationship with the Indigenous rights holders, the WTFNs, into a place where a Project Agreement is to be completed by the end of this year. A SMR-X Project Agreement will indicate First Nation support for the DNNP project, when agreed upon terms are being addressed or met. This is a great accomplishment and will show the CNSC that there is Indigenous consent for this project, thus meeting the threshold for ensuring consultation and accommodation is being met. All SMR-X partners must ensure that they are meeting their commitments outlined in this Agreement.
3. The Indigenous Traditional Knowledge study (ITKs) identified to commence in Q1 2025, will help in continuing the evolution of DNNP and CNSC's relationship with the First Nations. The ITKs will also provide clarity on impacts to constitutionally-protected rights and create a process to identify

mitigation measures, thus supporting the ongoing and upcoming regulatory processes. The creation of an Indigenous Advisory Circle should also support the ongoing interaction and relationship between CNSC and the Williams Treaty communities. This is vital as the CNSC continues to have ownership of the Duty to Consult, ensuring accommodation measures identified for the DNNP adequately address WTFNs' rights and interests.

4. Tracking targets and achievements by SMR-X Partners in the Bundle areas, including employment, and procurement is significant in ensuring Indigenous participation in these areas continue and meet community expectations. For instance, the Procurement Bundle has created a Working Group to assist each SMR-X Partner to identify a potential match of an Indigenous business with a scope of work or contract. The goal of this Working Group is to ensure that procurement spend is allocated to diversity and equity groups, as well as local First Nation, Indigenous and local businesses. These specific processes should be mirrored throughout the SMR-X bundles, including environment and licensing, and employment and training on an ongoing basis ensuring Indigenous inclusion. Not only is this good practice for ongoing relationship building with the WTFNs, it is also a commitment within the Canadian Council for Indigenous Business's PAIR (Partnerships Accreditation in Indigenous Relations Program), of which all SMR-X Partners belong. The SMR-X partners must mirror the PAIR commitments and hold itself to the same auditing standards that are identified by the CCIB through the PAIR Program which include: Leadership Commitments, Employment and Training Programs, Business Development, and Community based programs and investments.

6. It was unclear to the SMRRB whether all SMR-X partners were equally committed to the program objectives, including fulfilling their spend commitments and hiring targets. Management has had discussions with the SMR-X partners on OPG's expectations including the hiring of Indigenous candidates trained through the ION program.

Recommendations

The relationship foundation that the IR Team is currently establishing with the WTFN, including a Project Agreement, requires the continued implementation of the SMR-X IR Framework to track concrete efforts and outcomes. It is a recommendation of the SMRRB that all SMR-X Partners must support these initiatives and efforts with significant attention to creating employment, training, contracting and procurement targets or KPIs, and report on their progress to meet these commitments, including showcasing concrete initiatives. Such initiatives should include a Reconciliation Action Plan (RAP), and commitments identified specifically in the Project Agreement with communities.

DNNP Site Walkdown/Safety

Introduction

Members of the SMRRB conducted a walkdown of the construction site including forebay location, tunnel boring machine launch shaft location, and the Reactor Building excavation. Numerous work activities were in progress including RB piling clean up, rock removal, Units 2-4 grading, etc. In plant operational environments, safety performance is considered a leading indicator of operational performance. Extrapolating to the project environment, safety performance can be viewed as a leading indicator of expected execution performance. All levels of leadership and especially field leadership

must model and reinforce management expectations. The primary focus of the walkdown was to observe safety protocols and behavior.

Observations/Insights

1. The safety briefing, controls, and PPE provided prior to entering the site met expectations. The tour guide showed a genuine interest in our personal safety and conformance to requirements.
2. Field walkdowns, however, revealed numerous examples of workers not complying with current PPE standards. A recent standard change specifying the use of chin straps on hard hats has not achieved any noteworthy degree of compliance. Also observed were an unexpectedly large percentage of workers not donning eye protection as required by posted signage.
3. Use of “exclusion zone” barriers to protect workers from moving equipment and fall hazards were observed. Given the dynamic nature of the work environment, it would be advisable to reinforce the expectations for high standards in the use, markings and visibility of “exclusion zone” barriers.

Recommendation

Leadership, and in particular field leadership, must maintain vigilance in rapidly changing environments to ensure project leadership expectations are being met with respect to basic use of PPE and worker protection by “exclusion zone” barriers.

OPEN RECOMMENDATIONS STATUS:

Visit #8:

1. ePMX: 69960 The procurement team should ensure lessons learned from industry OPEX is understood and incorporated into their management and oversight of bulk commodity procurement. **OPEN**

2. ePMX: 69961 Determine the required O&M schedule margin to maintain adequate critical path protection and the opportunity to capitalize on any advancement in construction. Specific mitigating actions should be developed to support this that contemplate both Operations action as well as I&C Design advancement. **OPEN**

3. ePMX: 69962 A specific PLT level challenge session should be conducted for the specific review of the current residual risk of Design maturity. This should review the estimate, risks and contingency for design completion with a bias to impacts beyond readiness to construct in order to also include impacts to procurement, analysis and commissioning. **CLOSED**

4. ePMX: 69956, 69957, 69963 Make readiness for field execution a top project priority for the SMR-X project, ensure that the accountabilities for execution readiness are understood, and develop the competence and knowledge needed for the accountable individuals to succeed. In doing this, leverage pockets of excellence that already exist in the Reactor Building, Site Preparation, and Intake/Discharge Tunnel project areas. Update the readiness procedure to make it clearer and more precise on its purpose, link the purpose to the intended outcomes, and incorporate guidance on how and where the procedure should be applied. Use this as an opportunity to also reinforce leadership accountabilities and behaviors. **CLOSED**

5. ePMX: 69958 Implement a formal Lessons Learned program, ideally with dedicated resources embedded and integrated with DNNP. As a learning initiative, choose some early field activities that have been completed (such as Reactor Building excavation below the 78’ depth, installation of Turbine Building piles and caissons adjacent to the Reactor Building, ground grid installation), conduct post-completion reviews to evaluate the effectiveness of field execution planning and readiness activities, and rapidly incorporate lessons learned as necessary. **OPEN**

6. ePMX: 69959 Bundle readiness preparations should include developing plans for rapid mobilization of HIT and/or FIN teams/etc. that may need to be deployed to implement unplanned emergent field changes. These plans should take into consideration protocols for mobilization, processes that will be used to manage and monitor the field work, and advanced identification of resources that would participate on these teams. **OPEN**

Small Modular Reactor Review Board
Independent Oversight Report on the Darlington New Nuclear Program

(Visit #10 July 7-10, 2025)

Submitted to:
Major Projects Committee of the Board of Directors for Ontario Power Generation

EXECUTIVE SUMMARY

With the issuance of the License to Construct (LTC) in April of 2025, the Darlington New Nuclear Project (DNNP) formally entered into the execution phase of the project. This review primarily focused on a select group of execution activities critical to achieving Regulatory Hold Point-1 (RHP-1) in January of 2026 and the subsequent placement of the Reactor Building (RB) basemat.

While considerable progress is being made in many areas, issues associated with the completion of design engineering's Baseline 3 (BL3) and the off-site fabrication of Diaphragm Plate Steel Composite (DPSC) modules put the clearance of RHP-1 and the subsequent placement of the RB basemat at risk. Although a credible success path has been identified for the BL3 recovery plan, as the project recovers, the delay continues to hinder progress and introduce error likely situations in the broader execution of licensing, procurement, construction, and operations. Challenges in the offsite fabrication of sub-modules for the DPSC basemat, which were highlighted by the SMRRB in February as highly probable, have not been satisfactorily addressed and resolved to date such that a clear recovery path is evident. Continuing intrusive management oversight and possible further intervention will be necessary on both issues to ensure recovery and mitigation of identified risks/challenges.

As the project continues to expand execution phase work fronts, the SMRRB noted that the Integrated Project Development (IPD) team is continuing to evolve with the introduction of the Project Control Center, Construction Control Center, Site Engineering Office, and the broad adoption of the T-40 Construction Readiness process. Continued monitoring to assess performance and identify areas for improvement are required to prepare the organization to rapidly manage the increasing volume and complexity of future activities. In addition, continued progress was noted in the operations training plan, the procurement warehousing and commodity plans, and the full engagement by all IPD members in the Indigenous Relations activities.

DETAILED REPORT

Background

The SMRRB was commissioned for the OPG Board of Directors to independently monitor the Darlington New Nuclear Project (DNNP). This is the second review of 2025.

For this review, the SMRRB comprised the following members:

1. Sandy Rupprecht (Chair)
2. David Christian
3. Saga Williams
4. Mark Rauckhorst
5. Boris Vulanovic (OPG internal member)

OPG Support: Cory Bruder

DNNP Site Walkdown/Safety

Introduction

Members of the SMRRB conducted a walkdown of the construction site including the forebay location, tunnel boring machine launch shaft location, and the DPSC Mockup building. Numerous work activities were in progress including RB excavation, fabrication building construction, mockup activities, etc. The SMRRB are aware of the significant safety event that occurred since the last visit and the immediate corrective actions that the project team have taken as a result. The team performed observations of the worksite on boarding, site housekeeping, adherence to standards and worker behaviors.

Observations/Insights

1. The safety briefing, controls, and PPE provided prior to entering the site met expectations. The tour guide showed a genuine interest in our personal safety and conformance to requirements. Signage across the site has improved in quality and consistency and visual improvements have been made to the designated walkways for staff. Further improvements to signage and demarcation of crossing areas would reinforce stopping at crossing points and the use of crossing lights.

2. Field walkdowns revealed minor non-compliances to PPE standards such as the use of chin straps on hard hats. Non-compliances were identified and corrected by Construction leadership leading the tour.

3. Use of Spotters and exclusion zone barriers were observed to protect workers from moving equipment. Spotters were observed at each location supporting the movement of large equipment. Given the dynamic nature of the work environment, it would be advisable to reinforce consistent expectations on the use and situations that require spotters, particularly for reverse movement of vehicles. It is important to ensure through the repetitive nature of the current work that consistent control over the movements is maintained.

Recommendation

None

Regulatory Hold Point 1

Introduction

The first Regulatory Hold Point (RHP-1) is scheduled for January of 2026. Successfully passing it is a pre-requisite for initiating the Reactor Building DPSC Basemat Installation. The hold point requirements are a compendium of regulatory topics that have been agreed upon between OPG and the CNSC as being appropriate for regulatory approval before allowing the basemat installation. The objective of this review was to gain insights into whether the trajectory of the regulatory activities and interactions with the CNSC were sufficient to achieve the stated January 2026 milestone.

Insights/Observations

1. The regulatory topics for CNSC approval for RHP-1 are well defined and have a clear Level 1 roadmap for completion to support the January 2026 milestone, and quite possibly a December 2025 milestone completion date.
2. There are well defined internal and external management systems in place to track progress both within the SMR-X organization, and within the CNSC organization. These systems are supported by weekly and monthly interface meetings between SMR-X and CNSC subject matter experts and associated management that are designed to ensure transparent communication of expectations and potential issues, enabling timely identification of pathways forward to support the RHP-1 milestone.
3. A well-defined escalation process is in place to ensure timely and transparent engagement of management in the event of impasses at the subject matter expert level. To date there has been only 1 formal escalation.
4. A key risk for successfully satisfying the CNSC for RHP-1 are centered around the timely completion of key deliverables for radiation shielding and Aircraft Impact Assessment (AIA) in the September and October timeframes. This would enable sufficient time for CNSC review, comment, and ultimate approval. The effort associated with these deliverables is identified and satisfactorily progressing as part of the Engineering Recovery plan. It is anticipated from prior CNSC discussions that if these efforts deliver what was promised, that CNSC approval is likely.
5. It is anticipated that this approach to identification, management, oversight, and escalation is on a favorable trajectory to satisfying the CNSC for passage of RHP-1.

Recommendations

None

Baseline 3 (BL3) Design Completion

Introduction

BL3 design completion has been recognized as a key milestone for this project. The CNSC has mandated BL3 completion as a requirement for RHP-1. Importantly, completion of the BL3 work is required for field construction to proceed, and will trigger more effective procurement activity, as well as unlock more operations training material development. The focus of the SMRRB during this visit was to review the Engineering Recovery Plan, metrics and resource requirements. The SMRRB also reviewed, at a deeper level, a few specific challenging issues including, DCIS (Digital Control and Instrumentation System), Hydrogen Recombiner, and the FMCRDMs (Fine Motion Control Rod Drive Mechanisms).

Insights/Observations

1. The Engineering team has spent considerable effort to define with more precision what BL3 completion means in differing plant design contexts. Certain aspects are needed to support licensing activity while other aspects are necessary to support construction in the field or operator training plans.
2. A focused integrated and co-located team approach was applied to prepare a plan.
3. Examining the BL3 needs and requirements at a granular level has enabled more effective resource allocation and resource requirement decisions. Some additional outsourcing will be required in the short term.
4. Leadership and accountability are evident. Engineering leadership is facilitating more effective communication and collaboration between and within IPD partner organizations. This is resulting in a common mental framework for work prioritization and execution. Engineering teams are realizing significant benefits from colocation of working groups.
5. Frequent leadership engagement has helped to assure continuing alignment around priority tasks.
6. A deep dive into DCIS design engineering, procurement, and construction indicates numerous ongoing challenges to this aspect of the project. Senior leadership focus is evident.
7. Technical issues inherent in the primary approach to hydrogen recombiners remain unresolved. Prototyping work is continuing. Senior leadership focus is evident.
8. A Governance Review and Implementation Team (GRIT) initiative is underway to close recognized gaps in Engineering Governance. The SMRRB will review progress to closure on this issue during a future visit.

Recommendations

None

Commodity Procurement and Delivery

Introduction

Industry Operating Experience has shown that failure to get the right commodities to the right place, at the right time has a significant impact on construction synchronization and productivity. The SMRRB continued to review elements of the procurement function of the DNNP project. Specifically, people, processes and performance were probed. Actions taken on open recommendations were assessed to gage progress and effectiveness.

Observations

1. The Project Director of Procurement position was vacated on June 13, 2025. As of this writing, that vacancy remains and is anticipated to be filled in the near term. Understanding the critical nature of the Procurement Function to project success, PLT leadership is working apace to close this gap.
2. The Procurement team, led by the acting director, has identified and is working towards improving procurement governance to address gaps identified through the lessons learned program. Examples include:
    a. Establishing practices for strategic spares
    b. Creating a post commissioning governance framework
    c. Defining Procurement Document and Records requirements
3. The concept and goal of "end to end" material traceability requires further definition and is not currently well incorporated into routine processes. To date, traceability assurance requires substantial manual efforts. The team is focused on improving this situation.
4. Meaningful actions have been taken by the team regarding the previous SMRRB recommendation to make use of industry OPEX in preparing for bulk commodity procurement. Project personnel have had direct contact with counterparts at the Vogtle project and have incorporated lessons learned elsewhere such as Lungmen, Darlington, and generically as captured in NEI industry documents. The work to date has been fruitful and is deemed sufficient to close the previous SMRRB recommendation (ePMX-69960). The team is encouraged to continue seeking and applying global megaproject lessons learned.
5. In addressing a previous recommendation (ePMX 71536) regarding the adequacy of the warehousing/material laydown space, the team is undertaking a review and is scheduled to have a presentation ready for the PLT by August 29th, 2025. The team was encouraged to continue to review global mega-project experience in this area as material storage issues contributed to construction cost escalation and delays at Flamanville, the Boston Big Dig, and the Berlin Brandenburg Airport and other projects. If a dispersed storage model is implemented, detailed and effective equipment location and tracking system will be required to avoid logistical missteps.
6. Since engineering specifications are a predecessor to procurement of materials, the ongoing communications and relationship between engineering and procurement is key. Industry best practice would dictate consideration of embedding procurement staff into engineering organizations. Equivalent collaborative results would seem achievable virtually if relationships are strong and communication is continuous. One positive example of good collaboration occurred during the SMRRB review week, wherein relevant project engineering

parties and procurement parties met to forge a unified approach to bulk procurement of project valves and piping.

7. Procuring of specialized long lead item materials which has occurred through 2024 and the first half of 2025 was accomplished in large measure by the IPD partner organizations individually, drawing on specific technical knowledge and experience. While successful, there were missed opportunities to build the kind of collaboration and team cohesion which will be required throughout the remainder of the project on these procurements. The example of collaboration cited in the previous bullet, if continued, will contribute to project success.
8. Coordinated efforts by project participants have been successful in achieving targeted indigenous community procurement spending.
9. In summary, procurement challenges exist and may be exacerbated by the present leadership transient combined with the efforts to complete governance documents and processes. Heretofore, owing to the nature of the high-profile specialized acquisition of major components, procurement has appeared to be siloed versus a collaborative team effort. Recent changes signal a positive direction.

Recommendations

Ensure governance and processes are in place and resourced to effectively achieve project goals for “end to end” traceability on material important to safety.

Readiness for Construction

Introduction

Industry Operating Experience has shown that the ability of the IPD team to have the right people, tools, material, work instructions etc. ready to start construction is critical for the planned ramp-up to the required construction productivity. Early project experience has indicated improvement is needed regarding adequacy and timely issuance of engineering deliverables to mitigate the need for further rework, disruption and recovery efforts.

Observations

1. The project continues to be challenged by the delay in the issuance of Issued For Construction (IFC) and Issued For Procurement (IFP) deliverables from engineering. This is requiring the team to pull together Construction Work Packages (CWPs) in an expedited manner, which creates risks for errors. Although the work in the near term is not complex, the impact of delays will be more significant in the future and is therefore not sustainable.
2. Further complicating the situation is the drive for design optimization sometimes at the expense of schedule optimization. There have been several activities which after review were shown to be negatively impacted by this trade-off.

Recommendations

1) Established metrics to track progress towards the IFP and IFC milestones to ensure progression to the procedural requirements.

2) For those deliverables which do not meet the timelines set out in the T-40, the project leadership should review these deliverables to assess potential downstream impacts and take appropriate actions to manage/mitigate them.

DPSC Fabrication Facility Visit and Reactor Building Basemat Installation

Introduction

During the February visit, it was noted that based on recent OPEX, there was a high probability that the Diaphragm Plate Steel Composite (DPSC) fabrication welding was going to experience issues which required prompt actions and decisions from the Design Authority (DA) to keep fabrication efforts going. The recommendation was made that the DA should embed personnel in the fab facilities to quickly resolve issues. This review returned to the two fabrication shops to assess progress, as well as an assessment of the overall basemat installation readiness.

Observations

Fabrication Facility

1) Although the IPD partners did assign additional personnel, the personnel assigned did not have the experience or ability to act and resolve the emerging weld distortion issues, most notably on the D ring submodules. This has delayed the completion and delivery of the D rings. Although a repair scenario has been identified, it could have been identified faster, and there may be an impact on the DPSC basemat installation schedule. The IPD must anticipate and address significant challenges faster.

2) Actual module production has not met the plan which is resulting in adding additional shifts and personnel at both shops and the need to add a third shop to meet project needs. This ramp up in labor will need to be monitored to ensure proper training, oversight and supervision is in place to avoid additional welding issues. In addition, delays in drawing issuance to the shops has further impacted fabrication of the DPSC basemat rings. It is now anticipated that additional personnel and shifts will be required during the onsite assembly of the DPSC basemat to meet the schedule.

DPSC Basemat Installation

With the delays at the fabrication facilities, the site fabrication will be challenged both in schedule and fit up issues as it is assembled and welded. As the DPSC basemat is assembled and welded,

ongoing dimensional verification will be required to ensure the completed module is within design tolerances. This may require the Ring A and Ring B sub modules be fabricated in a manner to allow ultimate fit up at the site. The IPD should plan for and be prepared to address further issues.

Recommendations

1) The DA should staff the Site Engineering Organization with experienced and qualified personnel to address any issues that may arise. This should be done while the mock-up is being welded and during concrete placement to capture learnings in real time.

2) Specific production and quality metrics by person/by shift need to be established and reviewed daily to ensure the recovery efforts are achieving the desired results. These need to be reviewed between the shops to ensure any good performance is learned by the others regardless of organization.

IPD Organizational Resiliency

Introduction

Disruptive design, licensing, procurement, and construction issues will likely persist due to the First-of-A-Kind (FOAK) nature of the BWRX-300 design. Industry Operating Experience indicates that the ability of the Integrated Project Delivery (IPD) team to accommodate these disruptive conditions by rapidly and decisively identifying, managing, and responding will be critical in maintaining the project's forward momentum (often referred to in contemporary Project Management literature as "organizational resiliency"). This was a review of the proactive steps being taken to enable the SMR-X organization to effectively operate in the anticipated disruptive environment.

Observations/Insights

1. Several organizational roles, responsibilities, processes, and tools have been recently put in place with the intent of enabling the IPD to proactively and expeditiously address the anticipated emergent issues. In particular:
    a. PLT dedicated sponsorship roles
    b. Project Control Center (PCC) and Construction Control Center (CCC)
    c. Site Engineering Office (SEO)
    d. Configuration Management (CM) processes and tools
2. These are all in the early phases of implementation and have not been fully implemented nor tested to assess their effectiveness. To date there have been a low volume of emergent conditions requiring Field Change Requests (26 FCRs) and Non-Conformance Reports (39 NCRs), etc. However, this is anticipated to change significantly following the placement of the Reactor Building basemat and the subsequent initiation of more complex vertical construction activities for DPSC assembly and the initiation of commodity systems.
3. Plans are either in place or being developed to further implement the CM and SEO organization, governance, processes, and tools in the coming months to be prepared to

effectively deal with the anticipated increase volume in emergent conditions. The SEO plans require more detail and a formal means of tracking progress.

4. The coming months are an ideal time to proactively test the effectiveness of these measures.
5. The cycle time of identifying and resolving these issues is not visible to the organization and there is no target metric.
6. Recent Design Engineering Baseline 3 (BL3) completion and recovery activities have highlighted the benefit of co-located cross-functional teams to rapidly identify and address engineering issues. This model is planned for the SEO however it is not being executed consistently across all work programs.
7. In assessing the cycle time and effectiveness of the IPD to respond to emergent issues, consideration should be given to how the IPD organization effectively balances the natural tension between optimizing design, cost, and schedule, if the breadth and depth of design authority granted to the SEO is sufficient, influence of optimism/confirmation bias, and if the cultural behaviors associated with transparency, accountability, and courage are being appropriately employed in the process.
8. Recent loss of key personnel has impacted the IPD teams' effectiveness. Steps are being taken by the PLT to develop formal succession planning to anticipate and mitigate the impact of the loss of key personnel. The implementation of this formal program will be the topic of a future SMRRB review.

Recommendations

1. Formalize the SEO deployment plan and track progress and effectiveness metrics at the appropriate forum.
2. Assess the effectiveness of the current IPD's ability to rapidly identify and respond to emergent conditions via a series of tabletop exercises. Based on the results, make improvements and/or adjustments to the organization, governance, processes, and tools.
3. Make emergent issue identification and resolution cycle time a key focus of the IPD organization. Develop and implement a metric that tracks emergent issue cycle time. Periodically assess the effectiveness of the organization's ability to respond to emergent issues.

Indigenous Relations

Introduction

Indigenous peoples in Canada have constitutionally protected rights that DNNP must factor into the development of the project. The proactive integration and coordination of Indigenous Relations (IR) activities into the DNNP project development has been critical to building substantive and meaningful relationships with the local and impacted First Nation communities. While significant progress has been made to date, collective efforts and outcomes need to continue to sustain the positive trajectory. This review was focused on assessing the progress of that continued effort, specifically in the areas of the Traditional Knowledge Study (TKS), employment (and training), and internal Indigenous Knowledge training.

Observations/Insights

1. Although the TKS has not commenced, there are aspects of the TKS that are moving forward and will ultimately feed into the TKS. There have been site visits and participation in the permitting and licensing process that have had the participation of the Williams Treaties First Nations. It is anticipated that the TKS will formally commence in Q3, once the scoping, budget and activities have been identified and agreed to.
2. There has been significant progress made around internal employee training commitments on behalf of all of the SMR-X partners. The uptake of the Indigenous cultural training has been over 90%. The in-person training program is also being deployed as a follow-up to the on-line modular training. This is great progress in building the internal cultural awareness capacity.
3. There has been enhanced efforts put into Indigenous hiring and training practice, as well as procurement awards and spends. Each of the SMR-X team members reported on the extensive activities that they have undertaken throughout their organizations to achieve an increase in hiring, co-op placements and retention program results. The continued efforts in this area, including ensuring employment wrap-around supports are greatly encouraged by the SMRRB. It is understood that the energy put into employment, training and retention programming will lay the groundwork for continued and future employment of an Indigenous workforce. Utilizing external expertise in this area will assist in seeing growth in this area.
4. Procurement has also seen increases in tangible outcomes in the contracting of Indigenous business partners. The identified targets are on track to be met (and exceeded in some instances) in this area. The internal support of the Procurement team has made these achievements possible. This is an example of the SMR-X partners coming together and creating results that are tangible and can be showcased as a benefit for Indigenous businesses.
5. Notably, all SMR-X partners are members of the Canadian Council for Indigenous Business's (CCIB) Partnerships Accreditation in Indigenous Relations Program (PAIR). The DNNP project must mirror the PAIR commitments and hold itself to the same auditing standards that are identified by the CCIB through the PAIR Program. These include Leadership Commitments (ie. participating in community cultural events), Employment and Training Programs, Business Development, and supporting community based investments. The members of the IR team provided an update to their PAIR status and indicated that they were either on the path of continuing to implement their Reconciliation Action Plan (RAP) or discussing internally a process to create and adopt a RAP.
6. The Indigenous Opportunities Network (ION) has been an integral component in seeing the increased Indigenous employment figures. It is recommended that the ION program continue the efforts for outreach, skill development, liaising with the Unions and trades and communities to increase employment opportunities and retention of existing Indigenous staff. All SMR-X partners supporting and utilizing the ION program would see continued benefits within their own companies as well as throughout the DNNP project.

Recommendations

None

Plant Operator Training

Introduction

The SMRRB conducted their fifth review of the Operations & Maintenance (O&M) function. The scope of this visit was to review progress on the detailed planning and preparation for Operator Training to support Plant Operations. This included a review of the key risks and mitigating actions.

Observations

1. The Operations team continues to implement a comprehensive DNNP Culture Change Plan with the purpose of ensuring Nuclear Safety Culture is cultivated throughout the project and identify and manage risks related to people readiness for the operational phase culture of OPG's first SMRs. The SMRRB views the plan as robust and thoughtful and support the continued development and execution of the plan.

2. The SMRRB reviewed the Commissioning Constructions to Commissioning Plan which details the transfer of custody of all systems as they transition from the constructor's quality program and execution procedures to the Owner/Operator. The plan currently outlines the key transition points, requirements for layup and ongoing preventative maintenance if required. Specific layup plans are still to be developed per the prescribed milestones. It is important that the team optimize the transition points to ensure that the turned over systems do not impact blocks of equipment that are still under the control of the constructors perimetry and procedures.

3. The Operations team have advanced the initial Train the Trainer program and have worked to optimize the requirements for the Authorized training core program vs the gap training. Progress has been made in building margin into the training plan by advancing the portions of training prior to the final gap training. The team is at the point of implementing this plan and monitoring the risk.

4. The SMRRB recognize that there are key Engineering deliverables primarily tied to BL3 I&C design completion that will be required to define the final gap training that is the schedule driver for Operations Training Readiness for Operation. Operations have developed a discrete list of design deliverables beyond just I&C completion that are required for final delivery of the training program. The process to identify and track the discrete engineering deliverables along with the aggregate risk to Authorization training will be a future focus area of the SMRRB.

5. Though comprehensive progress has been made on the overall system turnover and care and custody of systems, detailed development of the startup and commissioning requirements are still in progress. It is important that the Operations team decide on key startup and commissioning strategies that will require the development of support systems, tooling and/or equipment. Two key examples that were discussed through the visit were the potential requirement for an auxiliary boiler to facilitate unit warming and the potential requirement for primary circuit filtration to address Foreign Material Exclusion (FME) concerns and prevent fuel failures. These decisions will drive the requirement for new project design and procurement

activities to support unit startup and commissioning. Identification of and progress on these items will be a future focus area of the SMRRB.

Recommendations

None

OPEN RECOMMENDATIONS STATUS:

Visit #8:

1. ePMx 69958 – Implement a formal Lessons Learned program - **Open**
2. ePMx 69960 – Procurement Industry OPEX – **Closed**
3. ePMx 69961 – Operations and Maintenance Margin – **Closed**

Visit #9:

1. ePMx 71534 – Rapid Learning Capability – **Closed**
2. ePMx 71535 – DPSC Lessons Learned – **Open**
3. ePMx 71579 – Design Authority on site – **Open**
4. ePMx 71536 – Materials Stored on Site – **Open**
5. ePMx 71537 – Indigenous Relations all SMR-X supporting initiatives – **Closed**
6. ePMx 71538 – Field Leadership Expectations – **Closed**
7. ePMx 69959 – Execution Bundle Readiness – **Closed**

Small Modular Reactor Review Board
Independent Oversight Report on the Darlington New Nuclear Program

(Visit #11 October 20-23, 2025)

Submitted to:
Major Projects Committee of the Board of Directors for Ontario Power Generation

EXECUTIVE SUMMARY

The Darlington New Nuclear Project (DNNP) has been in the execution phase of the project since April 2025. This review examined project progress in 14 selected areas of licensing, engineering, procurement, construction, and operations. Of the reviewed areas, the SMRRB has highlighted five areas that require continued management vigilance or further recommended actions. The remaining 9 are progressing adequately and summarized in a second section.

While considerable progress continues to be made, design maturity issues associated with timely design completion and First-Of-A-Kind (FOAK) design characteristics continue to introduce cascading risk in the downstream execution of licensing, procurement, construction, and operations activities. While considerable effort is being made to address the design maturity issues, it is anticipated that they will continue to hinder the project for the foreseeable future. As a result, many of the workstreams are currently operating in continuous problem-solving mode with substantial effort being focused on mitigation and recovery activities. Some of these FOAK challenges are to be expected. In spite of this disruptive environment, the Small Modular Reactor Review Board (SMRRB) observed positive behaviours in many workstreams in applying disciplined project management fundamentals.

The need for continued management vigilance and additional Recommended actions was noted with respect to the timely completion of the Baseline 3 Instrument and Control (BL3 I&C) design during 2026; the uncertainty associated with the Diaphragm Plate Steel Composite (DPSC) concrete placement and grout solution paths; the timely expansion of off-site DPSC fabrication capacity; how strategic procurement activities will support project cost and schedule requirements; and Turbine Island high risk evolution/installation.

The SMRRB observed that the Integrated Project Development (IPD) team is continuing to learn and mature as it moves through the “forming, storming, norming and performing” phases of team development. The IPD will need to rapidly ramp-up and sustain required levels of execution for the “performing” phase of team development. It is the judgement of the SMRRB that there is an opportunity for the project to proactively understand the underlying issues in the ramp-up of performance in the DPSC off-site and onsite fabrication efforts and apply any lessons learned to future work for continuous improvement.

DETAILED REPORT

BACKGROUND

The SMRRB was commissioned for the OPG Board of Directors to independently monitor the Darlington New Nuclear Project (DNNP). This is the third review of 2025.

For this review, the SMRRB comprised the following members:

1. Sandy Rupprecht (Chair)
2. David Christian
3. Saga Williams
4. Mark Rauckhorst
5. Samad Kasaai (OPG internal member)

OPG Support: Alex Lopez and Jeff Highet

KEY AREAS OF FOCUS

The SMRRB reviewed 14 areas selected areas of licensing, engineering, procurement, construction, and operations. Five of those areas are being highlighted in this section as key areas of focus that require continued management vigilance and /or additional actions via Recommendations. A sixth area of focus was identified by the SMRRB after stepping back from the individual reviews and reflecting upon common themes across all segments of the project's performance. This is identified in this section as a cross-cutting opportunity for improvement.

BL3 I&C DESIGN COMPLETION

Introduction

During the 2024 visits, the SMRRB expressed concerns about the extended duration to achieve BL3 completion status for I&C design. Completion of this work is a predecessor activity to supporting downstream procurement, operator training requirements, and other critical success factors.

Observations/Insights

1. The CNSC has yet to accept the overall Safety Strategy for the BWRX-300 design, but the remaining differences are being addressed and are expected to be resolved.
2. The SMRRB reviewed plans to achieve BL3 design completion and pathways to accomplish I&C implementation. Considerable management focus has been applied to resource and sequence a dense concentration of critical activities
3. The complexity and interdependencies inherent in this plan are substantial. Performance shortfalls in any one area may affect the ultimate outcome.
4. Some design decisions yet to be made are likely to have bearing on project outcomes. Some decision making has not been timely. For example, the schedule for closure of open Design Engineering Changes (DECs) presented to the SMRRB in July 2025 was not achieved. Continued delays could impact detailed designs, procurement, simulator deployment, operator training, and LTO application preparation. Moreover, the Commercial Operation Date (COD) could also be impacted.

5. Continued management vigilance is required to manage the complexity and risks associated with this critical workstream. The SMRRB will likely follow up in February 2026 to assess progress.

Recommendations

None

PROCUREMENT PLAN TO MEET UNIT 1 RELEASE QUALITY ESTIMATE (RQE) COST GOALS

Introduction

The SMRRB initiated reviews of project procurement beginning in February 2024. During this review, deviations and insufficient ties between design and procurement activities were observed. During the project validation phase, substantial attention was directed to achieving "24 in 24" major equipment long-lead purchases. Subsequent SMRRB visits have continued to evaluate procurement activity following long lead item purchases with an increasingly granular focus on commodity, bulk, and other items. Thematically, since the beginning, design maturity and timing of engineering deliverables have been a limiting factor for procurement. During this visit, the SMRRB received multiple presentations regarding current state, strategies, and activities. Additionally, the SMRRB reviewed results of an OPG Internal Audit concluded in February 2025.

Observations/Insights

1. During the present visit (Oct 2025), the SMRRB was introduced to the successor Project Director for Procurement. Material procurement strategies were presented to the review board. It was generally agreed by the Director and SMRRB members that implementation of such purchasing and contracting strategies would optimally have been implemented substantially earlier in the project. Numerous challenges continue to face the procurement organization.
2. While the procurement strategies and approach are substantially the same at this juncture as they have been in the past, some improvement is evident in the consolidation of information, effective reporting, and upline communication.
3. Incomplete or late design information has continued to stall some purchasing decisions.
4. Delayed material specifications and late engineering deliverables are cited as both cost and schedule risks multiple times in the Risk Registry. The team should consider connecting discrete risks associated with design information and procurement to capture the aggregate risk for this function. The risk registry should also be updated to add actions to address the identified risks.
5. Confidence level in the current project P6 schedule is low given developments so far. Particularly, fidelity with respect to the linkages between engineering and procurement activities can be improved.
6. In some cases, due to schedule compression, Procurement may be forced to operate on a fast-track basis, which can add risk.
7. Regardless of cause (Late engineering or otherwise), delays in procurement can cause strained relationships and stakeholder friction if execution teams become frustrated. Adherence to the T-40 planning cycle should provide project leadership early opportunities to manage through trouble spots.
8. New in-place leadership is focused on improving processes, performance, governance, succession planning, budget tracking and reporting, and managing tariff impacts. All this work is

essential while continuing to procure in support of ongoing execution. Given the amount of spend remaining, even if the foregoing process improvements are effective, it is the judgment of the SMRRB that the likelihood of achieving a total spend in the range of the original RQE is low.
9. To hold project personnel accountable, increased management attention is warranted to ensuring the logic ties within the P6 schedule (as it relates to procurement and associated durations) are credible to the organization.
10. Continued managerial emphasis is necessary to follow through on the plans and strategies set forth by the new Procurement Project Director. The SMRRB will likely review progress in February 2026.

Recommendations

1. By the end of December 2025, produce a realistic Estimate At Completion (EAC) range for Procurement. This estimate should include a high, low, and most likely outcome.

BASEMAT INSTALLATION PROGRESS & ON-SITE FABRICATION

Introduction

During the on-site SMRRB review, the team presented the plan and actions going forward as the submodules are shipped to the site. We did not visit the offsite facilities during this visit.

Observations/Insights

1. The team was well established, aligned, and focused on the upcoming work at the site fabrication area.
2. It was clear that the on-site organization had incorporated lessons learned from the earlier offsite fabrication issues most notably in the training, qualification, and competency of the on-site workforce.
3. The Site Engineering Office continues to increase staff to support the on-site work. The metrology team is staffed and supporting the continuing setting of the submodules on the DOKA for alignment of the overall structure.
4. This team has displayed the attributes of a group that understands the scope, has developed a robust plan, and has been staffed with the necessary resources. They are actively addressing issues as they arise in a timely fashion.
5. The concrete placement testing in the basemat mock-ups has resulted in localized voiding at the top of the Diaphragm Plate Steel Composite (DPSC) structure. The Design Authority is reviewing this and the team is working on plans to address the issue. Further testing of mock-ups will be required to support the current plan to set the DPSC basemat in April 2026.
6. The plan for grouting under the basemat has not been proven successful to date. Ideas are being developed to correct this situation, but these will need to be tested further and validated prior to basemat placement. This will be a critical evolution and must have demonstrated success prior to setting of the basemat. Engaging outside expertise will increase the likelihood of success.
7. It is anticipated that additional offsite fabrication facilities will be required to meet the site construction needs. These facilities must be identified and contracted in the near term to have qualified, staffed, and trained personnel and facilities in place in a timely fashion.

8. Local voids during concrete placement, grouting under the basemat, and capacity expansion at additional offsite fabrication facilities are viewed by the SMRRB as significant challenges that need to be addressed in order to support the setting of the DPSC basemat. The PLT must drive these issues to a prompt resolution.

Recommendations

1. Assess the plans for proactively engaging the CNSC to ensure that there is timely alignment on the solution path forward for localized voiding and grouting challenges.
2. Obtain outside expertise to develop and critique the plan for concrete placement and grouting.

DPSC ADVANCED TEAM PROGRESS (L+1)

Introduction

The Nuclear Island (NI) team has established a separate and distinct Advance Team to review the current design of the DPSC for Levels 2+ and identify opportunities for changes which would improve the constructability of the DPSC.

Observations/Insights

1. The focus and establishment of the team was a good decision by the Bundle Lead and the PLT.
2. The advance team has the appropriate staffing from across the various organizations.
3. In order to achieve the desired goal for each subsequent elevation, the evaluation of the current design, the identification of potential options, the selection of design option, development of detailed design, and issuance of the drawings to support procurement and construction activities must fit within the execution schedule. It was unclear during the review if all of the planned Advance Team activities could be completed within the execution schedule.

Recommendations

1. Develop detailed Advance Team plans to ensure that the planned activities fit within the Reactor Building execution schedule. In the event of conflicts, adjust the plans accordingly.

TURBINE BUILDING PROGRESS

Introduction

Turbine Building construction was initiated in Spring 2025 and is scheduled to continue through May 2028.

Observations/Insights

1. The turbine team appears to be operating as a coherent and aligned team.
2. The team members are aligned around the success of the project rather than objectives of the IPD member companies.

3. The team had a clear picture of the current status, challenges, and execution targets for the upcoming year.
4. This project entails several upcoming high-risk evolutions with potential safety or quality impact. There are currently no formal plans to systematically identify the high hazard evolutions nor to engage in construction-led challenge meetings to ensure safe and productive evolutions. An example is the concrete placement for the 3 meter slab.

Recommendations

1. It is recommended that a review is performed for the high precision installation of the condenser. This includes the placement of the embedments that are to be used as dowels for locating the condenser. Industry OPEX shows that metrology is prone to operator and setup error. Given the high impact of errors, a proactive deep dive in the methodology to be used is warranted to ensure that the assumptions and techniques are error free.
2. It is recommended that a list of upcoming high hazard evolutions is produced and construction-led challenge meetings are conducted on high risk evolutions as part of planning.

CROSS-CUTTING OPPORTUNITY FOR IMPROVEMENT

Introduction

A key contributor to project success is the speed at which the project team is able to stand-up new organizations (people, processes, and tools) and subsequently ramp-up and sustain execution at expected productivity levels. Leveraging prior operating experience, setting the right standards and expectations, ensuring appropriate staffing and training of personnel, and detailed planning/preparation are some of the key components of being able to accelerate the productivity ramp-up. However, it should be anticipated that for complex FOAK projects with new organizations executing together for the first time that there will still be considerable lessons-learned from first-time evolutions in the field. Learning from early challenges is key to a successful project outcome. The SMRRB stepped back from its review of specific execution workstreams to reflect on potential opportunities for the SMRX team to learn from its first-time operations and to subsequently improve its execution ramp-up time.

Observations/Insights

1. The SMRRB observed that in general the Integrated Project Development (IPD) team is continuing to learn and mature as it moves through the “forming, storming, and norming” phases of team development. Required levels of the “performing” phase of development still need to be demonstrated.
2. While this progress is judged to be consistent with that observed in prior mega-projects, it is the SMRRB’s judgement that there are opportunities for improvement that would allow the IPD team to reach the required performance level sooner.
3. The DPSC off-site fabrication activities have had continuing challenges in ramping up to meet productivity expectations. Considerable effort has gone into recovery and improvement activities associated with “people, process, and tools” and the adoption of “lean manufacturing” methodologies.

4. Conversely, the DPSC on-site fabrication performance, while still in its early execution phases, has demonstrated better performance than its off-site counterpart.
5. Comparing and contrasting the underlying causes of the off-site and on-site DPSC performance differences is expected to lead to key learnings that can be applied within the DPSC workstreams and may be applicable to other non-DPSC execution activities, including in the T-40 Construction Readiness process.

Recommendation

1. Perform an evaluation of the DPSC offsite and on-site performance to understand the underlying causes. Assess their applicability to other U1 execution workstreams, particularly non-DPSC execution workstreams. Based on that assessment, proactively take actions as appropriate.

ADDITIONAL AREAS OF REVIEW

An additional 9 areas were reviewed during the SMRRB site visit. The Observations/Insights from those reviews are documented in this section. These areas were not deemed to require additional management attention nor any additional Recommendations. In should be noted that many of these workstreams were observed to be demonstrating positive and disciplined project management fundamentals.

DNNP SITE WALKDOWN/SAFETY

Introduction

Execution Safety is often a leading indicator of execution excellence. A site walkdown was conducted by the SMRRB with a focus on work environment and human behavior.

Observations/Insights

1. General improvements were noted in the areas of signage, housekeeping, and worker behaviours.
2. One instance was noted of a worker not meeting expectations with respect to hard hat chin strap use and some signage where handwriting markers are being used was barely legible.

LICENSE TO OPERATE (LTO)

Introduction

The License To Operate (LTO) for DNNP U1 is currently forecasted to be issued in Q4 2028 in order to support startup and commercial operation in 2029. There are a series of formal submittals and hearings with the Canadian Nuclear Safety Commission (CNSC) that feed into the LTO decision, starting with Package #1 and #2 submittals in March and September 2026 respectively. These packages are followed by additional submittal packages and hearings in 2027, 2028, and 2029. The objective of this review is to assess the adequacy of the planning, preparation, execution to date and the projected trajectory to meet these milestone requirements with a particular emphasis on the 2026 submittals.

Observations/Insights

1. The LTO team has a clear "line of sight" on what has to be done, when it has to be done and who has to do it. This is reflected in a Level 1 Schedule "Roadmap" that outlines the schedule of activities that are required to support the LTO milestones. This includes engagement with the CNSC to ensure proactive alignment as well as more detailed supporting integrated schedules with logic ties to the supporting organizations.
2. The Oversight and Escalation process is an integrated process with the CNSC to ensure alignment and timely response to issues. This process is anticipated to be effective based on similar approaches employed in the LTC and on-going Regulatory Hold Point (RHP-1) engagements.
3. Design Maturity issues, coupled with Design Engineering performance challenges, are likely to create emergent issues that can disrupt the process and place schedule pressure on the LTO plan. There was good awareness of these risks, along with proactive and frequent engagement with Design Engineering in an effort to proactively avoid and mitigate them.

HYDROGEN-RECOMBINER DESIGN & DEVELOPMENT

Introduction

Early in the DNNP Project development plan, several FOAK risks were identified. One such risk was the development of an underwater hydrogen recombiner. During this SMRRB review, plans and progress were reviewed pursuant to this work.

Observations/Insights

1. Engineering plans and contingencies have been developed to address this FOAK issue. The preferred option will be developed under a subcontract and the design validated by 1 of 10 scale model to be conducted in Germany.
2. A back-up plan exists and is being explored as a "just in case" scenario. This back-up plan may require regulatory approvals.

SITE ENGINEERING OFFICE (SEO) DEPLOYMENT

Introduction

The SMRRB met with the SEO lead to discuss the current status of the ramp-up of the onsite organization needed to support construction.

Observations/Insights

1. The SEO team continues to increase staff with personnel in various disciplines necessary to support work in the field.
2. Appropriate metrics have been established and are being tracked.

3. Staffing of night shifts continues to be a challenge and needs to be addressed as site work is ramping up. Although the team is aware of and addressing the issue, the SMRRB would have expected that this would have been resolved by now.

INITIAL CORE FUEL PROCUREMENT

Introduction

The Level 1 SMR Unit 1 schedule currently shows a regulatory hold point for initial fuel load of October 2029. The initial core will be procured, processed, fabricated, delivered, accepted, and stored on site for a period of time prior to initial fuel load. The development and execution of these workstreams will be predominantly led by OPG and is outside of the scope of the IPD. In addition, the procurement of Low Enriched Uranium (LEU) and the subsequent fabrication into BWR fuel assemblies is a FOAK activity for OPG. The focus of this review is to assess the adequacy of the plan, progress, challenges/risks, and any associated risk mitigation plans to fulfill the meet the initial fuel load milestone.

Observations/Insights

1. The review demonstrated that OPG possesses a good conceptual understanding of required activities and requirements of the entire fuel procurement supply chain and associated permitting and licensing. This is supported by contracts already in place for the initial core and to support early reloads. More detailed plans will be developed in the future to ensure timely support of the projects integrated schedule.
2. The transport into Canada from the US of finished fuel assemblies containing LEU and the subsequent receipt, inspection, storage, and security prior to fuel load are all FOAK activities for OPG. While there was acknowledgement of the FOAK nature of these activities for OPG and their associated risk, a risk assessment with associated mitigation strategies had not been developed. Such an assessment should be developed on time scales that are commensurate with project needs.
3. Lessons learned from prior new build initial core procurement activities should be considered in the development of the risk assessment.
4. The identification and management of some of these risks will be the responsibility of a vendor within the supply chain via contract. OPG oversight will be required to ensure that there is adequate identification and preparation. Options for implementation of oversight of the fuel procurement and fabrication process are currently being explored.
5. Future SMRRB reviews will examine the resulting risk assessment and mitigation strategies.

INDIGENOUS RELATIONS

Introduction

Indigenous peoples in Canada have constitutionally protected rights that DNNP must factor into the development of the project. The proactive integration and coordination of Indigenous Relations (IR) activities into the DNNP project development have been critical to building substantive and

meaningful relationships with the local and impacted First Nation communities. This is evident in the formal and informal relationships with impacted First Nation communities that have been evolving over the last three years. The License to Construct (LTC) permitting process has exemplified that the SMR-X team has worked together to ensure collaboration to achieve targets and goals in order to avoid delays. While significant progress has been made, collective efforts and outcomes need to continue in order to sustain the positive trajectory and to ensure favorable reports in future check-ins that may be required as part of the social license to move regulatory and construction activities forward. This SMRRB review was focused on assessing that continued effort, specifically in the areas of the Traditional Knowledge Study (TKS), procurement (spend), employment and training, and the deployment of Indigenous cultural awareness training.

Observations/Insights

1. There are continued efforts to regularly connect with local First Nations including organizing site visits, SMR-X attendance at cultural events, and trade/job fairs. While these have been helpful to build familiarity and relationships, they could be utilized to move formalized Agreements with the First Nations forward including Relationship, Capacity, and Project Agreements.
2. It was acknowledged that the TKS has not commenced despite OPG's efforts to begin the Study. It is suggested that a near term roadmap be created to initiate the TKS and to outline the scope, budget, and associated activities.
3. Significant progress continues to be made to train SMR-X partner employees. The uptake of the Indigenous cultural training has been over 90% in most instances. The in-person training program is also being deployed as a follow-up to the on-line modular training. This is great progress in building the internal cultural awareness capacity of the DNNP teams.
4. Efforts put into Indigenous hiring and training practice, as well as procurement awards and spends, has seen great progress in these areas including ensuring employment wraparound supports and strategic initiatives for building a future qualified Indigenous workforce. It is recommended that the ION (Indigenous Opportunities Network) program continue the efforts for outreach and skill development. Moreover, it is recommended that ION continue liaising with the Unions, Trades, and communities to increase employment opportunities and retention of existing Indigenous staff including receiving support from all SMR-X partners.
5. Procurement has also seen increases in tangible outcomes in the contracting of Indigenous business partners. The identified procurement spend targets are on track to be met (and are exceeded in some instances). The internal support of the Procurement team has made these achievements possible. This is an example of the SMR-X partners coming together and creating results that are tangible and can be showcased as a benefit for Indigenous businesses. There is awareness that controls be established to ensure that legitimate Indigenous businesses are being contracted.
6. Notably, all SMR-X partners are members of the Canadian Council for Indigenous Business's PAIR (Partnerships Accreditation in Indigenous Relations Program), and are moving through the tiered categories incrementally, except for OPG, which has maintained Gold standing - the highest accreditation available.

CCW & SHAFT PROGRESS

Introduction

CCW and Shaft construction has been initiated in various capacities since mid-2024. Tunnel Boring Machine (TBM) assembly is to be completed in April 2026 with "Tunnel Drive" initiation in mid-2026 and completion in mid-2027.

Observations/Insights

1. The team had budgeted a 20% impact on weather delays. However, the actual impact was closer to 50%. Furthermore, this is the area of the project that was most impacted by safety standdowns in late summer 2025. The project was able to identify and execute responsive mitigation and recovery plans to minimize the impact of the safety and weather delays.
2. The success of the next phase of the work relies on ensuring experienced project and construction staff are onboarded. There is heavy competition in the domestic and international markets for these resources. Reduction in the security clearance process where appropriate has been successfully implemented to help reduce barriers for onboarding experienced staff (see Recommendation 1).
3. Contingency operations and off-normal operations are to be expected for this scope. A detailed operation manual has been provided by the vendor with instructions for many scenarios. The CCW project team is planning to extract contingency planning from vendor documentation and incorporate it into the project specific work instructions to ensure there is a safe and efficient methodology to deal with unplanned scenarios. Future SMRRB reviews will follow-up to critique this planned activity.

COMMISSIONING STRATEGIES

Introduction

Detailed planning and preparation for commissioning and startup is a critical development activity. While considerable progress has been made on the conceptual plan for overall system care, custody, turnover, and commissioning/startup, detailed plans are required to be developed. This review was undertaken in the early phases of the detailed strategy and plan development in order to assess the adequacy of trajectory of the effort.

Observations/Insights

1. The five commissioning phases and the respective roles and responsibilities of the owner, constructor, Architectural Engineer, and designer are conceptually defined. Detailed governance, along with roles and responsibilities, are in development.
2. The Commissioning Test Group (CTG) responsible for developing the commissioning startup requirements is comprised of personnel who bring considerable industry experience from recent nuclear new build projects. It is anticipated that they will be able to leverage considerable industry OPEX in the development of the detailed execution plans.
3. There is considerable work to be done to decide on detailed commissioning and startup strategies, risks, and contingency plans as well as their associated support systems, tooling,

and/or equipment requirements. In particular, decisions will need to be made with respect to flushing and cleaning vendor strategies as well as the need for a supplemental boiler and foreign material exclusion. Plans are in place and are being implemented to develop these detailed strategies and execution plans. These efforts are judged to be adequate at this stage of the project. Future SMRRB reviews will focus on the resultant detailed strategies and plans.

TRAIN THE TRAINER RECOVERY PLAN

Introduction

Train the Trainer (TtT) is a key development activity of the DNNP Unit 1 Operations Training Readiness For Operation program. The operations team has advanced the initial TtT program and has optimized the requirements for the Initial Certified Training (ICT) program. While progress has been made in building margin into the training plan, its implementation is challenged by the continuing design completion issues with respect to BL3 I&C workstreams. The focus of this review was to assess the progress of the recovery plan to date and the potential effectiveness of the contingency plans to compensate for the I&C design completion issues.

Observations/Insights

1. Developing OPG expertise, via implementation of the TtT program, is the preferred strategy for subsequently implementing the required Initial Certification Training (ICT) for operators. This approach commences the positive establishment of a BWR competency and culture within OPG. An alternative approach would be to contract GE Vernova Hitachi (GVH) to perform the ICT. This alternate approach would provide additional schedule margin to the BL3 I&C and simulator development and implementation workstreams, but would not allow OPG to develop internal competency.
2. A key risk associated with the TtT approach is that the simulator and/or associated training material will not be available in time to support the TtT timeline as a result of the BL3 I&C design completion issues. Substantial effort has been applied to develop mitigation strategies that preserve the TtT option while accommodating the uncertainties associated with the BL3 I&C delivery. For example, design gaps have been identified and the integrated team is working to utilize Deferred Verification Documents (DVD) as an input to the TtT development program. While all DVDs are forecasted to be completed by the end of 2025, there is considerable uncertainty associated with meeting this commitment.
3. A judgment will be made in December 2025 on whether the likely adequacy and timeliness of the BL3 I&C design completion and simulator readiness will sufficiently support the TtT implementation strategy. This will form the basis for a recommendation to the PLT for continuing with the TtT strategy or switching to the alternate GVH ICT training strategy. This is deemed to be an appropriate approach for assessing and managing this risk.

OPEN RECOMMENDATIONS STATUS

Visit #8:

1. ePMX 69958 – Implement a formal Lessons Learned program – to remain until the pilot program is launched - **Open**

Visit #9:

1. ePMX 71535 – DPSC Lessons Learned – **CLOSED**
2. ePMX 71579 – Design Authority on site – **CLOSED**
3. ePMX 71536 – Materials Stored on Site – to remain open as the strategy is pending approval by PLT - **Open**

Visit #10:

1. ePMX 75360 – Tabletop Workshops **–** Assess the effectiveness of the current IPD's ability to rapidly identify and respond to emergent conditions via a series of tabletop exercises. Based on the results, make improvements and/or adjustments to the organization, governance, processes, and tools. **- CLOSED**
2. ePMX 75356 – Procurement **–** Ensure governance and processes are in place and resourced to effectively achieve project goals for "end to end" traceability on material important to safety. **- Open**
3. ePMX 75357 - Readiness for Construction – 1) Establish metrics to track progress towards the IFP and IFC milestones to ensure progression to the procedural requirements. 2) For those deliverables which do not meet the timelines set out in the T-40, the project leadership should review these deliverables to assess potential downstream impacts and take appropriate actions to manage/mitigate them. **- CLOSED**
4. ePMX 75358 - The DA should staff the Site Engineering Organization with experienced and qualified personnel to address any issues that may arise. This should be done while the mock-up is being welded and during concrete placement to capture learnings in real time. **– CLOSED**
5. ePMX 75359 - Formalize the SEO deployment plan and track progress and effectiveness metrics at the appropriate forum. **– CLOSED**
6. ePMX 75362 - Make emergent issue identification and resolution cycle time a key focus of the IPD organization. Develop and implement a metric that tracks emergent issue cycle time. Periodically assess the effectiveness of the organization's ability to respond to emergent issues. **– CLOSED**

Small Modular Reactor Review Board
Independent Oversight Report on the Darlington New Nuclear Program

(Visit #12 February 9-12, 2026)

Submitted to:
Major Projects Committee of the Board of Directors for Ontario Power Generation

EXECUTIVE SUMMARY

The Small Modular Reactor Review Board (SMRRB) conducted its twelfth independent oversight review of the Darlington New Nuclear Project (DNNP) in February 2026. The review focused on the progress, readiness, and risk of select areas of engineering design, procurement, construction, commissioning, operator training, and engagement with indigenous communities. The project continues to progress and demonstrate growing execution capability.

As noted in prior reviews, there continues to be risk associated with First-Of-A-Kind (FOAK) design maturity issues that introduce cascading risk in the downstream execution. Continued and enhanced attention to detail in managing and retiring these risks is recommended to continue the transition to stable and predictable execution.

A key enabler of project execution is the effective deployment of the Integrated Project Delivery (IPD) model. The SMRRB endorses the activities currently underway focused on realigning the IPD to further emphasize construction execution. It is recommended that a review of the effectiveness of the IPD realignment change management program be performed to ensure it is being successfully implemented.

Review of construction execution activities revealed a mixture of observations. Substantial improvement in the off-site and on-site Reactor Building Diaphragm Plate Steel Composite (DPSC) fabrication activities was observed and is to be commended. Improvement was also observed in the Component Cooling Water (CCW) planning and preparation. Review of the Turbine Building construction effort demonstrated a clear understanding of the challenges and actions required to recover performance. However, there are continued challenges with the Turbine Building integration of engineering and construction activities, resulting in a recommendation for the development and implementation of an improvement plan.

A comprehensive commissioning and operational training strategy is in place and meaningful progress continues to be made. However, the SMRRB remains concerned that commissioning requirements are not yet fully embedded into construction sequencing and prioritization. Absent stronger integration, there is risk that construction decisions could negatively impact commissioning efficiency and ultimately delay startup. It is recommended that actions be taken to ensure construction and commissioning are fulling aligned and to confirm the viability of staffing and recruitment strategies.

DETAILED REPORT

Background

The SMRRB was commissioned by the OPG Board of Directors to independently monitor the DNNP. This is the first Review Board of 2026.

For this review, the SMRRB comprised the following members:

1. Sandy Rupprecht (Chair)
2. David Christian
3. Saga Williams
4. Mark Rauckhorst
5. Bob Franssen
6. Samad Kasaai (OPG internal member)

OPG Support: Cory Bruder, Jerome Arrieta

KEY AREAS OF FOCUS

The SMRRB reviewed 12 selected areas within engineering, procurement, construction, commissioning, and operations. Four of those areas are being highlighted in this section as areas that require additional actions via SMRRB Recommendations.

Commissioning Planning & Preparation

Introduction

Detailed planning and preparation for commissioning, turnover, and startup is a critical development activity. A multitude of planning and preparation activities are required for the project to be ready to execute the 17-month commissioning workstream that is currently scheduled to start in late 2027. Considerable progress has been made, and a detailed concept and strategy are in place. Significant work remains to prepare for the testing and commissioning efforts, and additional strategy alignment with the construction activities will be required for ultimate success.

Observations/Insights

1. It is unclear whether the construction efforts will sufficiently consider input that supports efficient component and system commissioning. Without proper coordination there is risk of the project progressing in a way which conflicts with the most efficient commissioning strategy and may ultimately result in operational delays.
2. A comprehensive commissioning strategy conceptually exists. Several actions remain to move it beyond conceptual. A focused effort will be required to ensure readiness.
   a. Several administrative procedures remain to be developed.
   b. The organizational and tracking database program is new to OPG and further structure and development are necessary prior to use.
   c. Significant effort is required to develop the technical procedures required for testing and turnover of the individual systems and components.

   d. A communication and alignment plan needs to be developed and executed to ensure supporting work groups understand the process requirements.
3. The Commissioning Test Group has done well to identify the personnel resource requirements to support the commissioning plans and have identified the need for 172 cross-trained personnel to support the current plan. Proper planning for selection, on-boarding, and training of personnel will need to be applied to ensure sufficient personnel are in place to support execution.
4. There will be a large variation in level of complexity of the commission testing. Evaluation will be needed to ensure resource requirements are understood and preparation time aligns with the testing complexity.

Recommendations

1. Ensure sufficient personnel resources are in place to support execution of the commissioning and test plan by strengthening plans that support selection, on-boarding, and training of personnel in the timeframe needed to support scheduled activities.
2. Further leadership and team action is required to ensure the commissioning strategy is appropriately incorporated into the construction prioritization and schedule. This should include a mechanism to ensure construction sequencing and prioritization is developed with the appropriate consideration of commissioning efficiency.

Key Technical Risk Retirement

Introduction

Numerous technical risks reside and inhere in any FOAK project. The DNNP project is no exception. Recently, project leadership has instituted a heightened oversight program to ensure a deep understanding of the most significant technical risks and to track their progress. Subject matter experts have convened and by consensus identified the “top 10” technical risks. The oversight process is intended to provide a “deep dive” review and challenge the approach to resolution. Understanding key risks is foundational to resource allocation and management of project costs and schedules.

Observations/Insights

1. A top 10 technical risk list has been developed containing short term, intermediate, and long-term goals for resolution.
2. This oversight process is new and at present only one such meeting has been conducted with time allotted for review of the top three risks. Additional risks on the top ten list are to be reviewed in future meetings.
3. Several of the dates, particularly intermediate term and long term, may not be supportive of construction needs. Each has knock on effects to procurement, procedures, Licence to Operate (LTO), etc.
4. The longer full resolution remains open, the greater the likelihood of rework iterations, delays, and ultimately cost escalation.
5. While it is recognized that the oversight process is new, there is concern that the detail and frequency of reporting to the leadership team may not be sufficient to ensure optimal resource allocation and management to ensure timely resolution.

Recommendation

1. Elevate the level of detail and frequency of upline reporting on key technical risks to ensure accountability, resolution and organizational understanding of potential downstream impacts.

Turbine Building Construction

Introduction

Turbine Building construction was initiated in Spring 2025. To date there have been considerable challenges as the construction effort has progressed. The objective of this SMRRB review was to review the Turbine Building team's progress, understanding of the future challenges, and the plan for improving performance in 2026.

Observations/Insights

1. The team had a clear picture of the current status, challenges, and execution targets for the upcoming year. This was incorporated into the recovery plan that was presented.
2. The SMRRB believes that in order to meet the recovery timelines, stronger steps need to be taken to localize the Engineering team alongside the Execution team. This will foster quicker resolution of technical and constructability issues and overall quicker decision making. While a localized engineering lead has been embedded into the CI Bundle and efforts are being made to increase the design team's presence, the SMRRB believes that stronger measures are needed to further localize key engineering resources, or re-evaluate alternative engineering options.

Recommendation

1. Develop an engineering improvement plan to augment integration with construction.

Integrated Project Delivery (IPD) Team Re-Alignment

Introduction

A critical element of the SMR-X execution organization is the IPD team and its "one-team" approach to integrating, coordinating, and executing engineering, procurement, construction, commissioning and operations scope of work. To date the IPD team has been executing with an operating model that is primarily organized around the Nuclear Island (NI), Conventional Island (CI), and Balance Of Plant (BOP) execution workstreams with matrix support from functional engineering, procurement, construction, licensing, and quality teams. The SMR-X project team has determined the project has reached a phase where the IPD organization needs to be re-aligned with a strong focus on construction in order to enhance execution. The SMRRB reviewed the basis for the change, and the associated change management program.

Observations/Insights

1. Within each IPD bundle (NI, CI, and BOP) to date the execution within that bundle was primarily organized around the scope of work associated with systems. This approach made sense during the early phases of engineering and licensing phases of the project.
2. However, efficient construction execution for structural, mechanical, piping, electrical and commissioning disciplines requires growing integration and coordination both within and across

the NI and CI bundles. A realignment of this organization around the Powerblock (consolidation of NI and CI) and BOP bundles is being implemented, with an enhanced focus on construction execution in each of these bundles. This approach is deemed to be appropriate by the SMRRB.

3. The rollout of this new IPD model was in its early phases during the SMRRB on-site review. The basis for the change and the mechanics of how the new IPD model operated on a day-to-day basis were verbally reviewed at a high level with the SMRRB. There was some concern that the messaging for the change was inconsistent and might be confusing to the SMR-X organization.

Recommendations

1. Evaluate the effectiveness of the Change Management program being implemented.

ADDITIONAL AREAS OF REVIEW

An additional 9 areas were reviewed during the SMRRB site visit, as well as a site walkdown. The Observations/Insights from those reviews are documented in this section. These areas were not deemed to require additional management attention nor any additional Recommendations.

Site Walkdown

Introduction

The SMRRB visited the site toured the DPSC onsite assembly building and the Reactor Building pit.

Observations/Insights

1. Significant progress had been made in assembly of the DPSC basemat and the team expressed confidence in being ready for lift in the April time frame. The work in the pit continues and was also stated as being on track to support the lift.
2. While the SMRRB did not formally review the safety improvement program nor its progress, the team did not observe any safety issues or concerns during its site walkdown.

Recommendation

None

Indigenous Relations (IR): Employment, Procurement, Agreements

Introduction

Indigenous peoples in Canada have constitutionally protected rights that the SMR-X team must factor into the construction at the DNNP site. While significant progress has been made, collective efforts and corresponding outcomes need to continue to meet CNSC requirements and the social license to build and operate DNNP. The SMRRB review continues to be focused on assessing how IR efforts are achieving milestones, specifically in the areas of the Traditional Knowledge Study (TKS), Relationship Agreements, procurement, employment, and deployment of Indigenous cultural awareness training.

Observations/Insights

1. There are continued efforts to regularly connect with local First Nations, including organizing site visits and indigenous attendance at community organized events. While these touch points have been helpful to build familiarity and relationships, they are also being utilized to progress formalized project agreements with the First Nations.
2. Some progress has been made with the Williams Treaties First Nations (WTFN) on the Traditional Knowledge Study development. Currently, the WTFN are organizing themselves and creating a governance structure for oversight of the study. Continuing to articulate the administrative process to support their capacity needs and identifying next steps for moving the TKS forward are efforts that will continue to help progress the Study.
4. Targets set by each of the SMR-X partners to train employees in Indigenous cultural awareness programs have been exceeded. Deployment of the training program both on-line and in person continue. The opportunities to create broader cultural awareness learning and exercising that awareness must be reinforced on a day-to-day basis.
5. The success of increased Indigenous employment numbers is impressive and continue to grow with efforts of strategic initiatives, including ION (Indigenous Opportunities Network). The goal of building a future qualified Indigenous workforce and the ongoing support from Unions and trades, enables communities to support their members in being eligible for employment qualification.
6. Procurement awards and spends have seen great progress over the past year, including exceeding targets for some of the SMR-X partners, bringing the overall Indigenous business spend to above the goal set for the entire SMR-X team. It is suggested that the 2026 procurement targets be evaluated to understand why the targets are not above the 2025 actual spend.
6. All SMR-X partners are members of the Canadian Council for Indigenous Business Indigenous Relations Program and notably, those who previously have not, are also starting to create their own Reconciliation Action Plans.

Recommendation

None

Instrumentation & Control (I&C) Design Completion

Introduction

During 2024, it was noted that the overall design development plan for the BWRX-300 Instrumentation and Control systems demanded additional focus. During this visit, the SMRRB was presented a progress report on plans to complete I&C design. Completion of this work is a predecessor to procurement, construction, operations training, LTO and commercial operations.

Observations/Insights

The SMRRB observed substantial evidence of concentrated focus on I&C design development. Since October 2025 visit:

1. Project leadership visited the GVH Longmont facility to ensure suitable delivery schedules and quality of necessary instrument cabinets.

2. Monitoring and Control System Design Descriptions (M&C SDDs) for 80% of systems are expected to be complete by the end of March with remaining work completed or sufficiently advanced to allow some software development to begin in June 2026.
3. Division of scope responsibilities and attendant interface discussions between GVH and Arabelle STG are progressing. While some issues remain, there appears to be good engagement between the parties and an understanding of how to advance design maturity.
4. A limited notice to proceed (LNTP) has been issued to secure a second set of instrument cabinets as part of a sequencing plan to allow software development and System Functional Acceptance Testing (SFAT) to occur while minimizing impact to project schedules.
5. Risk elements remain, are recognized, and future iterations are a certainty. That said, the organizational focus is deemed to be satisfactory.

Recommendation

None

Engineering Deliverables

Introduction

The engineering team provided a status update on the issuance of design deliverables to meet the project needs in 2026.

Observations/Insights

1. Engineering has recognized that as the project moves into the execution phase the primary focus needs to be the issuance of engineering deliverables to meet construction needs.
2. Structural Steel design completion is acknowledged as being a critical need for the project in the near term.
3. Engineering has recognized and established an integrated team to address piping support deliverables. This effort is also aimed at meeting construction needs.

Recommendation

None

Vendor Quality & Surveillance

Introduction

A critical element of project success is for supply chain vendors to provide products (including documentation) the “first time” that meet project requirements. Discovery of non-conforming products on-site is too late in the process. This review is to assess the adequacy of the prioritization, planning, preparation, implementation, and risk management of vendor quality and surveillance oversight to ensure “first time” delivery of quality products.

Observations/Insights

1. The SMRX team demonstrated that each NOP is following their approved Source Surveillance program (GVH, ATRL, AKNP) for their designated procurement scope.
2. This is supplemented by OPG’s Owner’s Oversight of the NOP Source Surveillance programs and is employing a graded risk informed prioritization process to direct oversight efforts.

3. These activities are being integrated into the P6 schedule to ensure timely planning and implementation of surveillance activities.
4. Based upon the review of the processes and their early implementation, the SMRRB concluded that this approach was appropriate. Future reviews will follow-up to assess effectiveness.

Recommendations

None

Commodity Procurement

Introduction

During the current visit, the SMRRB received a comprehensive briefing on initiatives within the procurement function. As DNNP is a FOAK facility, Procurement has, from the outset, been faced with a number of headwinds that would not be expected for a Nth of a kind project. Some of these challenges include initial estimate quality, reference design basis, design maturity, design changes, planning maturity, missing scope, schedule acceleration, targets for Made in Ontario and Indigenous procurement, limited supplier pool, etc. Following the RQE and the 24 major procurements in 2024, procurement has sought a strategic approach to remaining purchases to control costs to the extent possible.

Insights/Observations

1. Key commodity strategies are being developed and implemented with respect to Rebar, Valves, Consumables, HVAC, Concrete, Steel, Insulation, and Coatings.
2. These strategies include looking at opportunities to leverage Units 2-4 purchasing volumes.
3. The procurement team is employing an End to End Tracking tool and activity linkages to P-6.
4. The SMRRB was satisfied with the scope of the procurement strategy and plan. Less clear is whether there is sufficient resource adequacy to execute the plan as intended. Thus, the SMRRB will follow up in the future by looking at effectiveness and performance metrics.

Recommendation

None

Reactor Building (RB) Construction

Introduction

The SMRRB met with project personnel onsite to review the current progress of the DPSC basemat and discuss the plans for concrete placement and grouting of the module currently scheduled for the end of April. We additionally discussed the progress of the offsite fabrication facilities and the Advance Team activities focused on implementing design changes to accelerate construction.

Observations/Insights

1. The Progress since our last visit was very evident. The team has added skills and expertise to address upcoming critical construction evolutions associated with the basemat lift and set. The teamwork and alignment across all of the IPD organizations was evident. Plans for the next critical activities have been developed and are being proof tested to provide the team with feedback and confidence in executing the actual basemat work in the April/May timeframe.

2. The team stood up a 3rd fabrication facility incorporating the lessons learned from the early experiences at both AECON and ES Fox. They did the necessary training, qualification, early oversight and support to ensure this facility started fabrication without issues. The intent is to stand up a 4th facility and to add additional capacity. The team is evaluating 2 additional facilities that could be utilized should the need arise.
3. The advance team has established a top 6 list of areas where design enhancement could result in construction savings in both material and time. The work required to implement these items has been incorporated into the schedule reforecasting to align with the construction schedule.

Recommendation
None

CCW Construction

Introduction

CCW and Shaft construction has been initiated in various capacities since mid-2024.

Observations/Insights
1. The team had budgeted for a 5-10% weather delay impact for certain scopes (such as the excavation program). However, the actual impacts have been up to 30% (and higher for marine works). The reforecasting should include a more representative assessment of weather delays.
2. Detailed planning for the following 3 months has been incorporated. The project team recognizes the need to expand detailed planning horizon to other critical scope such as pump house/forebay scope. SMRRB will perform a detailed review of these scopes in future visits.
3. The project team had a detailed 3rd party review and report of the tunneling scope by an experienced expert. The project is formally extracting and dispositioning every recommendation and insight from the 3rd party report.

Recommendation
None

Operator Training Planning & Preparation

Introduction

The Operator training and certification team is implementing a planned contingency due to I&C design maturity challenges and subsequent operating procedure and simulator development delays. The SMRRB reviewed the updated training strategy and the adequacy of the associated planning, preparation, and risk management and found that an overall sound plan is in place.

Observations/Insights

1. A solid plan is in place which follows industry standard training program fundamentals.
2. The organization and delivery of the training program will utilize updated technology (CBT Vision).

3. The Standard Plant Simulator and Standard Plant Procedures are being developed by a product line portion of GVH which is not directly tied to the DNNP. Appropriate focus will need to be applied to ensure design and development meets the timeline requirements of the project.
4. Timeliness of the I&C Design and subsequent System Operating Procedure development remain a risk to the training program development and execution.
5. The delay in I&C Design and simulator development has necessitated the implementation of a pre-determined contingency plan which uses vendor training personnel to teach both the initial operator class and the OPG instructors at the same time. This is an acceptable approach, however little margin remains if I&C Design progress does not meet the revised schedule. Further delays have a higher probability of impacting overall Commissioning and possibly COD.

Recommendation

None

Project Controls: Integrated Schedule

Introduction

The SMRRB reviewed the progress associated with the ongoing integrated schedule re-forecasting effort. The team has held several workshops to validate current schedule elements and to add the necessary logic and ties to the schedule. The various trade resources are being loaded to provide a more accurate manpower loading across the project. The effort includes consolidating the approximate 30 individual schedules that currently exist to ~3.

Observations/Insights

1. As the project continues to progress through the construction phase, this effort will allow for the required loading of hours, quantities and unit rates into the level 3 which will provide the necessary metrics to track performance and report status from the schedule.
2. It was noted that in the current schedule hours were loaded in some cases at both level 2 and level 3 resulting in more hours being projected. In addition, the 3 months of component testing had not been scheduled and logic tied which is now being corrected.
3. A discussion of the 2026 milestones identified that some of the early milestones had been missed so this needs some additional attention to ensure accountability across the project.

Recommendation

None

RECOMMENDATION STATUS FROM PAST VISITS:

Visit #8:

1. ePMx 69958 – Implement a formal Lessons Learned Program – CLOSED

Visit #9:

2. ePMX 71536 – Materials Stored on Site – CLOSED

Visit #10:

3. ePMX 75356 – Procurement "End to End Quality" – OPEN

Visit #11:

4. ePMX 77160 – Procurement Plan to meet Unit 1 Release Quality Estimate (RQE) – CLOSED
5. ePMX 77161 – Basemat Installation Progress & On-Site Fabrication – CLOSED
6. ePMX 77162 – Outside Expertise Concrete Placement and Grouting – CLOSED
7. ePMX 77164 – DPSC Advanced Team Progress (L+1) – CLOSED
8. ePMX 77167 – Review is performed for the High-Precision Installation of the Condenser – OPEN
9. ePMX 77168 – List of Upcoming High Hazard Evolutions – CLOSED
10. ePMX 77170 – Cross-Cutting Opportunity for Improvement – OPEN

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OVERSIGHT SERVICES
BY THE
SMR1 REVIEW BOARD

SCOPE OF WORK

ABOUT ONTARIO POWER GENERATION (OPG)

OPG is an Ontario-based electricity generation company whose principal business is the generation and sale of electricity in Ontario. Our focus is on the efficient production and sale of electricity from our generation assets, while operating in a safe, open and environmentally responsible manner. OPG was established under the *Business Corporations Act* (Ontario) and is wholly owned by the Province of Ontario.

OPG's generating portfolio has a total capacity of over 21,000 megawatts (MW) from sources of Nuclear, Hydro, and Thermal stations, making us one of the largest power generators in North America.

OPG owns and operates the Pickering and Darlington Nuclear Power Stations. The two stations have a combined in service generating capacity of about 6,600 MW.

In November 2020, OPG announced resumption of planning activities for future new development at the Darlington site, for the purpose of hosting a Small Modular Reactor (SMR). The Darlington SMR will provide a critical new source of clean nuclear energy for Ontario's future projected energy capacity needs – a demand widely expected to ramp up as transportation and other sectors electrify, using Ontario's clean power to help decarbonize the broader economy. In December 2021, OPG announced the selection of GE Hitachi Nuclear Energy to deploy an SMR at the Darlington New Nuclear site. OPG and GE Hitachi will collaborate on the SMR engineering, design, planning, preparing the licencing and permitting materials, and performing site preparation activities, with the mutual goal of constructing Canada's first commercial, grid-scale SMR, projected to be completed as early as 2028.

The purpose of this scope of services document is to provide an outline of OPG's requirements for conducting periodic independent assessments of aspects of the Darlington New Nuclear Project ("DNNP") for the Major Projects Committee ("MPC" or "Committee") of the OPG Board of Directors (the "Oversight Services"). The Oversight Services will be performed by consulting individuals (each, a "Consultant" or an "SRB member"), collaborating with each other and collectively known as the SMR1 Review Board (SRB).

While acting as independent advisors to the Committee of the OPG Board of Directors, no member of the SRB will perform oversight or assessments of any aspect of the DNNP on behalf of any group other than the Committee of the OPG Board of Directors.

1.0 PURPOSE OF THE MAJOR PROJECTS REVIEW BOARD

The purpose of the SRB is to advise the MPC on the Darlington New Nuclear Project as set out in Section 3.0 further below. The SRB is part of a multi-layer oversight and reporting structure for the DNNP. As an advisory body to the Committee, the primary function of the SRB is to provide an overall assessment and expert opinion of the progress, risks, opportunities, and execution of the DNNP. It is not to validate reports provided by Management to the Board, though the Committee may request independent verification of Management products, if deemed necessary.

For the SRB to effectively perform the Oversight Services, OPG will provide the SRB access to information related to the DNNP and access to any logistical or other support that the SRB may request from time to time. The expectation is that the SRB will not duplicate work that is already being carried out by OPG, whether by OPG's internal resources or by OPG's other contractors.

2.0 MEMBERSHIP ROLES AND RESPONSIBILITIES

2.1 SRB Member General Requirements

The skillset of the SRB members may change as the DNNP progresses through its project lifecycle and the expertise requires changes. SRB members will have experience in senior oversight and/or advisory capacities, preferably with project management related to a "mega-project" (i.e., over one billion dollars). Specific to the initial phases of the DNNP, it is expected that the SRB membership will be comprised of individuals with the following experience and expertise:

- Licensing basis and license to construct
- Front-end project controls for Boiling Water Reactors (BWRs)
- Indigenous relations
- Mega-project estimating
- Engineering design
- Non-nuclear mega project planning and execution

The SRB team should be diverse as much as practical. In keeping with the diverse population of the province, members representing different genders, ethnicities, and races should be sought. Inclusion of members from Indigenous Communities or with significant understanding of local indigenous culture will be valued.

Additionally, the SRB members will have experience with nuclear plant operations (reporting to a Vice President or higher), other extensive nuclear power, regulatory, construction management, major contract management, and project controls experience. It is expected that at least one member will have a strong background in major construction projects while another should have held senior management roles in a nuclear power plant.

The scope might include support to OPG partners review boards in order to help gain lessons learned and provide insights to the SRB team.

2.2 Roles and Responsibilities

2.2.1 SRB Chair

One of the SRB members defined in section 2.1 may be asked to perform the role of Chair of the SRB, either on a permanent or semi-permanent basis. The SRB Chair will interface with the Committee and, as the Committee may request on its behalf for information as needed, also with OPG Executives in the establishment of the scope of assessments, and ensure that the activities of the SRB are aligned with the expectations of the Committee. The SRB Chair will be responsible for advising the Committee of SRB activities and concerns, the overall conduct and performance of the SRB, defining and coordinating their tasks in conjunction with the OPG Executives, and preparing and delivering verbal and/or written reports as requested.

2.2.2 SRB Members

All SRB members are responsible for their attendance at meetings, the review of the material provided to them, and the active contribution of their experience and judgment to SRB deliberations. Attendance at OPG by individual SRB members is dependent upon the scope of each review and attendance will be determined in consultation with the SRB Chair. OPG is looking to retain up to 6 individuals with skills and attributes to most optimally form an effective SRB, with the

ultimate number to be in OPG's sole discretion.

2.2.3 OPG Internal Member

The SRB team will be supported by a designated executive-level individual who will not be an SRB member, to provide additional support including specifically OPG organizational knowledge and insights.

2.2.4 OPG Coordinator

A designated Internal OPG Coordinator will work together with the SRB Chair to facilitate appropriate membership for each visit based on scope and availability of individual members. The OPG Coordinator will be responsible for coordinating and managing all SRB activities including meetings and teleconferences; development of the visit schedule in consultation with the SRB Chair; distribution of review materials; and logistical support to external members as required.

3.0 AUTHORITY, SCOPE AND DELIVERABLES

The SRB is authorized to observe and review any aspect of the DNNP related to:

- Safety
- Cost
- Schedule
- Quality

Periodically, approximately 2-3 times a year, the SRB will conduct independent assessments of project performance, risks and opportunities, identifying "blind spots" that management may not be aware of, and provide recommendations to the MPC that will help to mitigate the project risks and improve overall project performance. The focus of the SRB is to be forward-looking; advising the Committee of any future risks. Specific areas of emphasis for review may be provided to the SRB for different assessments.

The SRB may also comment on the quality and completeness of information provided by the DNNP Team to the Committee regarding whether management is effectively identifying and resolving issues. Reports may provide high-level guidance about what areas the Committee may further inquire.

The SRB will determine how best to achieve the foregoing; however, it may include the following activities:

- Identify emerging trends and/or potential risks with respect to cost, schedules, resourcing, contractor oversight, etc.
- Review DNNP metrics to ensure they are appropriate and to determine accuracy and fidelity.
- Identify whether there are any significant unresolved challenges.
- Test the effectiveness of the DNNP programs.

The SRB members are authorized to communicate directly with all DNNP staff on matters of SRB interest. At any time the SRB sees a major issue that is impacting or will impact the performance of the DNNP, the SRB will communicate it immediately to the DNNP Team or OPG management. The SRB is an oversight body to the MPC and cannot authorize any expenditure or issue any orders that are binding on OPG. For clarity, this does not limit the right of the SRB members to incur travel

expenses to support their activities (which expenses are the direct obligation of the member and will be reimbursed by OPG in accordance with OPG's Business Travel and Expense Policy).

4.0 SITE VISITS, SCHEDULE, AND REVIEW MATERIAL

The SRB will be asked to review the DNNP approximately 2-3 times per year, or at revised frequencies as directed by the Committee. Ad hoc meetings may also be called by the Committee, if required. Dates for the review meetings will be established by OPG.

It is expected that SRB reviews will consist of up to 4-day site visits.

Records and a draft visit schedule will be provided to SRB members by the OPG Coordinator in advance for pre-reading and preparation for each on-site assessment.

5.0 REPORTS

After completing the visits and reviewing the materials and information, the SRB will prepare a draft written report to be reviewed by DNNP management for accuracy approximately 2 weeks prior to the MPC meeting. The SRB will use its judgement to determine which comments from DNNP management should be included. The report will summarize all findings and will include recommendations if requested by MPC. The written report's information will be prepared at an appropriate level for MPC members.

The final written report will be provided to MPC members approximately 10 days in advance of the MPC Meetings. The MPC meetings are usually held in March, June, August and November.

6.0 COMPENSATION

SRB members will be compensated on a Time and Materials basis using fixed hourly rates for time spent completing any OPG or site-specific training courses, preparing for and participating in each site review, and any other work that is requested by the MPC. Estimated hours are shown below:

Nature of Work	Estimated Hours
Preparation	Approx. 30 hours per site review
On-site Visit and Report Preparation	Approx. 40-50 hours per site review
Training	6 to 8 hours per year

7.0 SECURITY CLEARANCES AND TRAINING QUALIFICATIONS

SRB members will be required to complete paperwork and provide documentation to satisfy criteria to hold Site Access CNSC security clearance to access the nuclear facility.

Completion of various computer-based training courses will also be required to maintain OPG facility access qualifications. Completion and maintenance of Radiation Protection training may be required. Most training can be completed remotely through the OPG e-Learning portal.

8.0 TERM OF SRB MEMBERSHIP

It is expected that one of the SRB members will perform the role of SRB Chair, either on a permanent or semi-permanent basis. Each SRB member will commit to a three-year term plus up to two additional (subsequent) one-year extensions at OPG's sole discretion. Members may serve on the SRB for additional periods upon mutual agreement with OPG.

Ex. L-D2-SEC-116 – Attachment 14

The current members of the Small Modular Reactor Review Board ("SMRRB") are:

- Sandy Rupprecht – Sandy Rupprecht is an executive management consultant within the energy sector. [redacted]

  [redacted]

  His current roles include Chairman of Independent Project Oversight Committee in Bruce Power, Executive Advisory Board Member at Kairos Power and an Advisory Committee Member at the Oak Ridge National Laboratory. [redacted]

- David A Christian - [redacted]

[redacted]

- Saga Williams, LL.B. - Saga Williams, LL.B. is the principal and owner of AS Williams Consulting. [redacted] Saga also teaches as an Osgoode Hall Law School Adjunct Professor, introducing first year law students to issues of Indigenous rights and reconciliation, coaches students who are participating in the national Indigenous law moot, [redacted] and currently sits as a Director on a number of publicly traded mining boards.

  Recently, Saga has joined the First Nations Major Project Coalition Team and is working towards membership support and outreach, as well as advising on First Nations involvement in the critical mineral and energy sectors.

- Mark Rauckhorst - Mark is a Senior Executive in the field of Engineering and Construction of large capital projects. [redacted]

[redacted]

[redacted]

[redacted]

- Bob Franssen - [redacted]

[redacted]

[redacted]

[redacted]

- Samad Kasaai - OPG Internal Member, Vice President, Major Projects joined the Pickering Refurbishment Project in May 2023, [redacted]

[redacted]

SEC Interrogatory #117

Interrogatory

Reference:
D2-4-10, Attachment 1

Question(s):

With respect to the Testimony of Joseph Miller (Pegasus-Global) in respect to the DNNP:

a) [p.30] Please provide a copy of the document referenced at ft 36 “Summary of DNNP Integrated Project Agreement (17 Oct 2025)”.

b) [p.32] Pegasus-Global says that “OPG has used certain elements of an IPD model in the DRP as well as the Otto Holden Generating Station refurbishment”. Please provide details regarding the use of the IPD model in those projects.

c) [p.69] Please provide copies of the most recent DNNP generated reports listed.

d) [p.78] Please provide a copy of the evidence filed by Pegasus-Global in the Vogtle 3 & 4 Prudence Review and Rate Adjustment application.

Response

a) Refer to Ex. D2-4-3, Attachment 2 (Confidential).

b) The following IPD elements were used in the DRP (non-exhaustive):

- One Team Approach (refer to EB-2020-0290 Ex. D2-2-4, pp. 3-4 and p. 17);
- Shared risk model;
- Integrated Team principle with integrated leadership between OPG and prime contractor, integrated schedule and streamlined reviews (used in vault restoration);
- Collaboration and common project goals to drive “best for project” behavior, aligning parties around shared outcomes, rather than siloed objectives;
- “Best person for the role” resourcing across organizations, selecting the best-qualified candidate regardless of which organization employs them;
- Transparency / “one set of facts” reporting through joint/standardized reporting using one system; and
- Joint focus on cost control and change discipline.

The following nine IPD principles were used in the Otto Holden GS refurbishment:

- Continuous issues resolution
- Jointly developed targets
- Access to shared information systems
- Early involvement of stakeholders
- Collaborative decision making
- Financial transparency
- Shared risk and reward
- Relational contracting
- Negotiated risk distribution.

c) The most recent copies of the DNNP generated reports listed are provided as follows:

- Weekly Critical Path Schedule Report – Attachment 1 (confidential)
- Biweekly 4-week Lookahead Report - Attachment 2 (confidential)
- Biweekly 3-month Lookahead Report – Attachment 3 (confidential)
- Quarterly Risk Report – Attachment 4
- Monthly Cost Forecast – Attachment 5
- Bundle Performance Report – Attachment 6.

These reports are generated directly from the DNNP working schedule. This schedule is a working-level project management tool which supports planning, coordination and continuous improvement across the program. It is intended to provide visibility into sequencing, interdependencies, and potential areas of schedule sensitivity, and facilitate proactive identification of interface issues where further schedule refinement may be required.

The forecast and float values within Attachments 1, 2 and 3 cannot be interpreted in isolation as indicative of actual or unavoidable delay and should be understood within the broader context presented below.

Certain activities in the schedule may display notable negative float, exceeding the current schedule delays reported. In the context of this program, such values do not necessarily represent realized or forecast schedule delay. Rather, they are, in part, a function of incorporating recent lessons learned on the reactor building structure fabrication, evolving assumptions, and conservative logic ties introduced through iterative schedule development. These elements enable the DNNP project team to stress-test the schedule, highlight areas requiring further validation, and drive risk informed decision making.

This schedule is subject to ongoing refinement as the project teams evaluate and implement opportunities; interfaces are confirmed; and execution strategies are optimized. As such, it should be interpreted as a dynamic planning instrument – not

a static plan – reflecting the program's commitment to continuous improvement, transparency, and disciplined controls.

A summary of the current validated performance of the DNNP is provided in Ex. L-D2-AMPCO-086.

d) Pegasus-Global's testimony in support of Georgia Power Company's application to adjust rates to include reasonable and prudent Vogtle Units 3 and 4 and common costs is provided as Attachment 7.

Exhibit L-D2-SEC-117, Attachment 1

DNNP Generated Reports
Weekly Critical Path Schedule Report

This Attachment was filed as confidential information in its entirety.

Exhibit L-D2-SEC-117, Attachment 2

DNNP Generated Reports
Biweekly 4-week Lookahead Report

This Attachment was filed as confidential information in its entirety.

Exhibit L-D2-SEC-117, Attachment 3

DNNP Generated Reports
Biweekly 3-month Lookahead Report

This Attachment was filed as confidential information in its entirety.

ePPR | RISK MANAGEMENT

1. Current Month-End

Date Range: 2026-02-13 - 2026-03-20

Data as of: **10-Apr-26 07:58 AM**

EAC > $100M
All

Risk Type
All

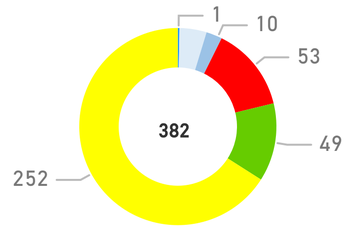
Threat/Opportunity
All

Risk Owner
All

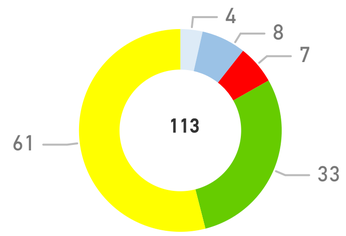
Risk Status
Active

Keyword
All

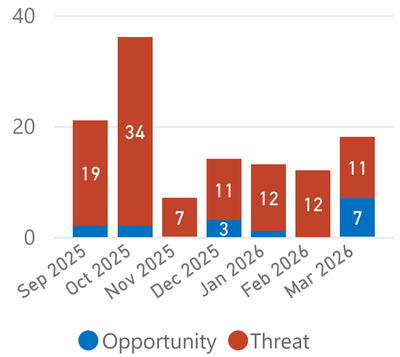
Active Risks by Score



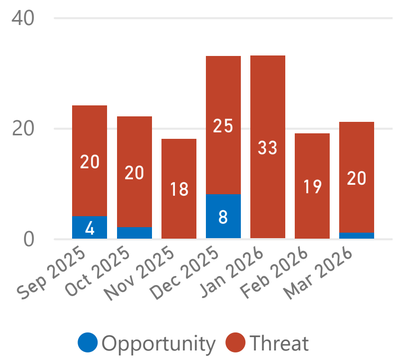
Active Risks Accepted



Activated Risks

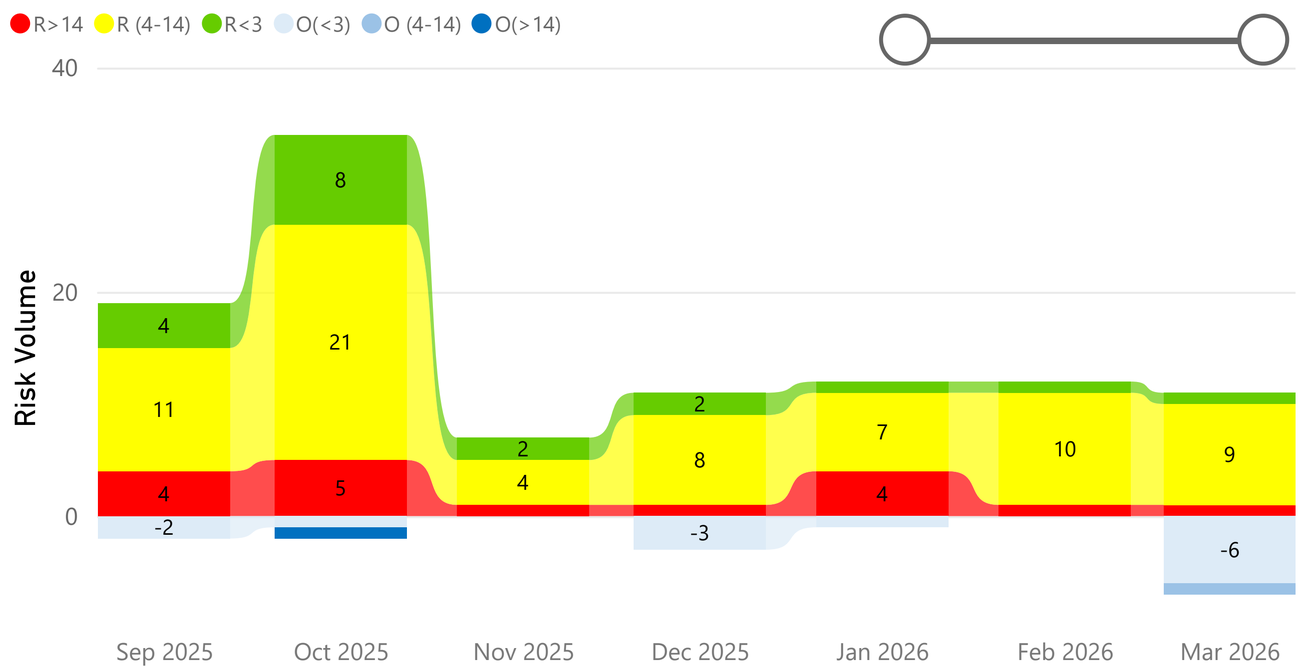


Closed Risks



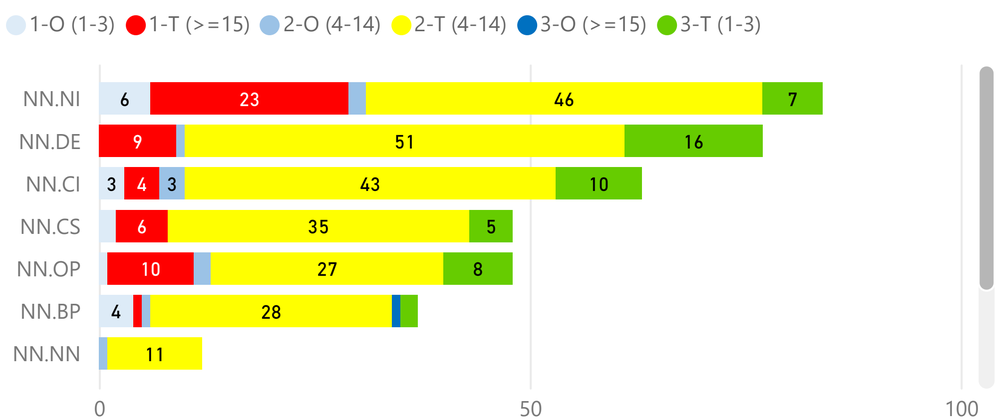
Monthly Number of Risks Activated by Current Score

9/1/2025 — 3/1/2026



Note: Cross-filtering of visuals will only function for the selected reporting period

Active Risks by Bundle



Active Risks

Project	Pulse	Scale	Risk ID	Risk Title	Risk Status	Risk Owner	Current Score	Post Score	Unit
86677 -...		S	71358	Delays in finalization of radiation parameters may result in c...	Active	VEDOVI, Jus...	25	12	U1
86659 -...		S	73257	Design completion delay of B21 RPV may drive cost increas...	Active	DABREO, Sa...	25	16	U1
86659 -...		S	73286	HGNE has not established a diverse supply chain for B21 RI...	Active	DABREO, Sa...	25	25	U1
86659 -...		S	73488	HGNE has not established a diverse supply chain for G12 F...	Active	DABREO, Sa...	25	25	U1
86659 -...		S	74415	Reactor isolation valve - Actuator supplier may not be able t...	Active	DABREO, Sa...	25	2	U1
86681 -...		S	63253	General tolerance use during fabrication may result in fit-up...	Active	WEGNER, M...	20	16	U1
86659 -...		S	64868	Delay to Ready to Ship Date of RPV Vessel due to Installatio...	Active	DABREO, Sa...	20	1	U1
86659 -...		S	68660	There is a risk that additional engineering and procurement ...	Active	DABREO, Sa...	20	20	U1
86681 -...		S	69059	Current design maturity does not deem vibration monitorin...	Active	MADHAR, D...	20	8	U1

ePPR | RISK MANAGEMENT

Data as of: **10-Apr-26 07:58 AM**

EAC > $100M
All

Risk Type
All

Threat/Opportunity
All

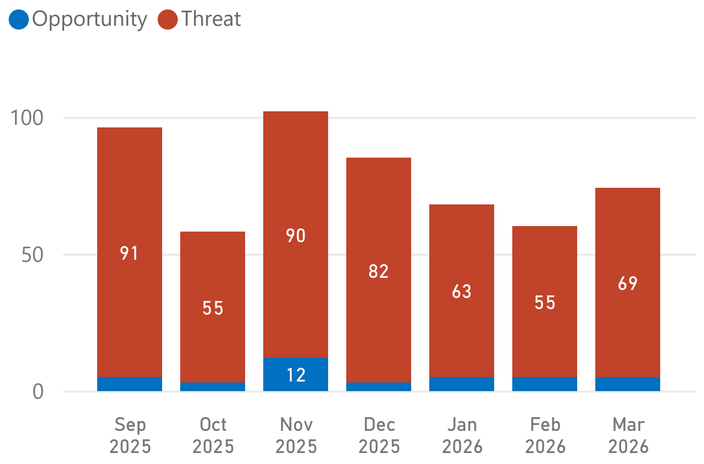
Risk Owner
All

Keyword
All

Not Reviewed > 30 Days

(Active, Draft or Request to Activate)

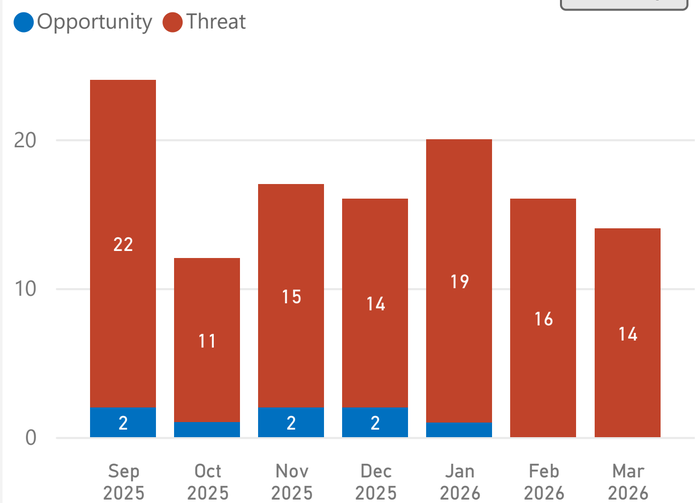
> 90 Days



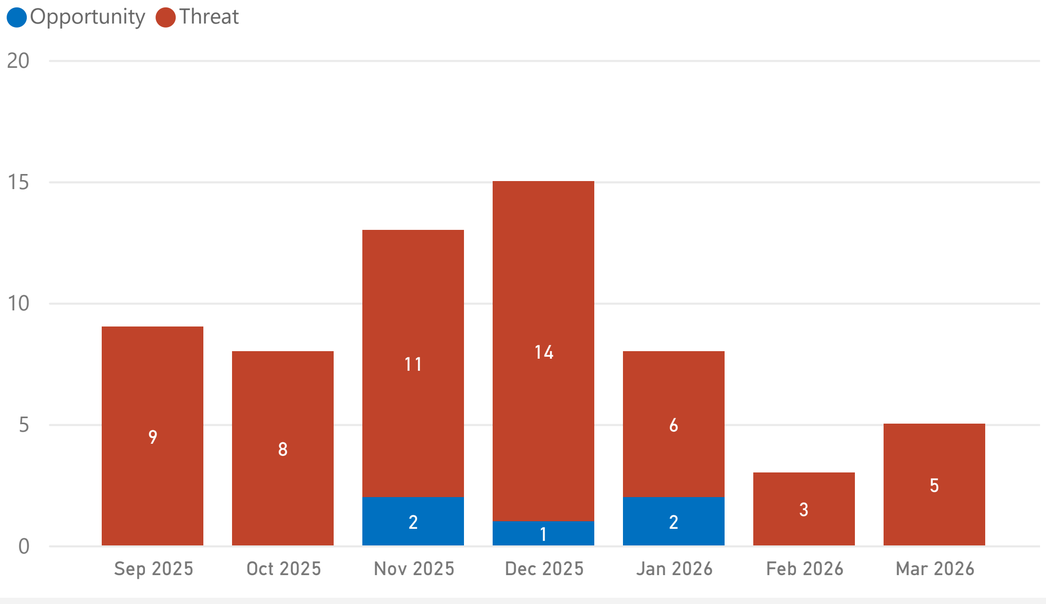
In Request to Activate > 30 Days

In Draft > 60 Days

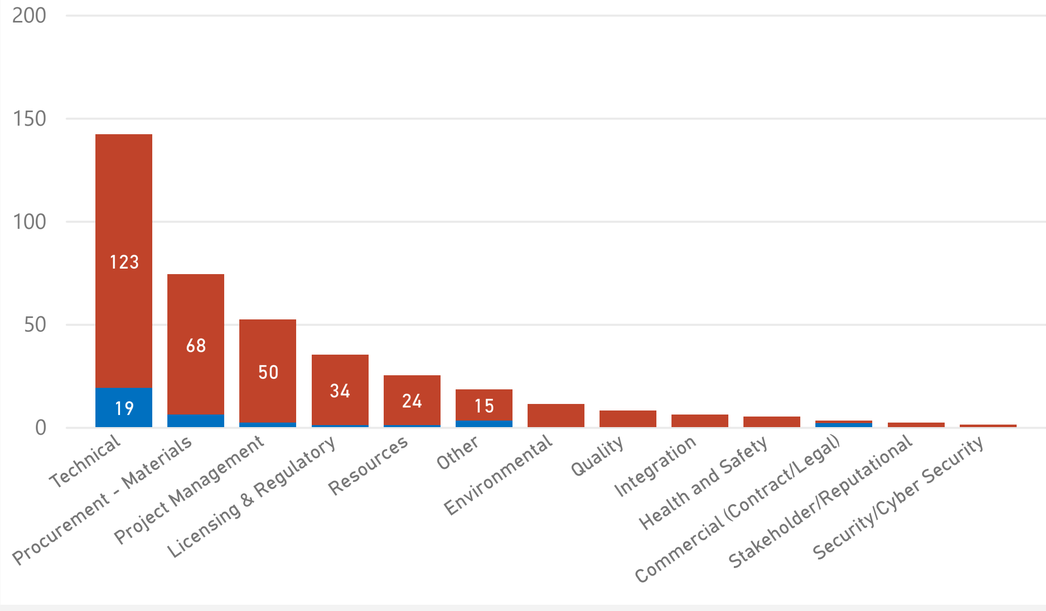
> 30 Days



Active Risks with No Active Actions



Active Risk RBS Category Breakdown



SMR-X Team

Cost Performance

IPD | Non IPD

Select a Unit: U1

Select a Bundle: Multiple selections

Select a Project: All

Select a Snapshot: 1. Current Month-End

Bundle	Approved Budget (RQE)	Project Changes	Current Budget	Actual Cost This Period	Actual Cost LTD	Earned Value This Period	Earned Value LTD	CPI This Period	CPI LTD	EAC This Period	EAC Previous Period	EAC Variance	EAC Variance to Budget
Design Engineering	$453,227K	$12,605K	$465,832K	$8,219K	$376,423K	$1,872K	$332,284K	0.23	0.88	$555,624K	$543,643K	$11,981K	$89,792K
Site Prep./Facilities and Infrastructure	$63,262K	$3,374K	$66,635K	$18K	$60,802K	($957K)	$60,941K	-52.54	1.00	$66,712K	$66,708K	$3K	$76K
BOP Project	$1,022,657K	$32,443K	$1,055,101K	$25,376K	$510,503K	$20,064K	$466,246K	0.79	0.91	$1,116,977K	$1,087,181K	$29,796K	$61,876K
Nuclear Island	$1,134,213K	$117,899K	$1,252,112K	$17,996K	$366,580K	$20,743K	$316,528K	1.15	0.86	$1,517,738K	$1,444,734K	$73,003K	$265,626K
Conventional Island	$949,289K	($32,212K)	$917,077K	$1,509K	$162,110K	($13,409K)	$119,168K	-8.89	0.74	$1,034,693K	$1,015,041K	$19,652K	$117,616K
Digital Strategy	$40,175K	$344K	$40,519K	$292K	$9,453K	$292K	$9,480K	1.00	1.00	$40,492K	$40,492K	$0K	($27K)
Owner Program & IPD PMO	$1,026,097K	$2,728,508K	$3,754,605K	$11,255K	$422,930K	$5,970K	$402,004K	0.53	0.95	$2,600,096K	$2,581,313K	$18,783K	($1,154,509...
Operational Readiness, Commissioning, & Startup	$145,484K	$214K	$145,698K	$81K	$8,435K	$131K	$8,501K	1.62	1.01	$143,877K	$144,334K	($458K)	($1,821K)
Total	**$4,834,403K**	**$2,863,1...**	**$7,697,578K**	**$64,747K**	**$1,917,237K**	**$34,707K**	**$1,715,152K**	**0.54**	**0.89**	**$7,076,207K**	**$6,923,446K**	**$152,761K**	**($621,371K)**

*Project changes include interest, escalation and contingency as planned/needed throughout the project lifecycle

SMR-X Team

Cost & Schedule Summary

IPD | Non IPD

Select a Unit: U1 | Select a Bundle: All | Select a Project: All | Select a Snapshot: 2. Previous Month-End

	Cost									Schedule						
Bundle	Current Budget	Planned (LTD)	Actual Cost	Earned Cost	Cost Variance (EV-AC)*	CPI	FAF	Estimate To Completion (ETC)	Estimate At Completion (EAC)	Planned Hrs at Completion	Planned Hrs	% Compl.	Earned Hrs	SPI	Schedule Variance (EV-PV)	Remaining Hrs
Operational Readiness, Commissioning, & Startup	$145,430K	$10,261K	$8,435K	$8,501K	$65K	1.01	1.44	$134,989K	$143,609K	673K	16K	2.4%	16K	1.00	0K	1,014K
Owner Program & IPD PMO	$1,491,405K	$521,558K	$422,930K	$402,004K	($20,926K)	0.95	0.98	$938,694K	$1,462,246K	5,741K	2,223K	38.2%	2,194K	0.99	-29K	3,478K
Digital Strategy	$40,160K	$12,972K	$9,453K	$9,480K	$27K	1.00	0.91	$26,794K	$40,133K	142K	69K	46.9%	67K	0.96	-3K	75K
Conventional Island	$915,356K	$251,902K	$162,110K	$119,168K	($42,942K)	0.74	2.66	$869,859K	$1,032,973K	2,668K	443K	11.2%	299K	0.68	-144K	2,434K
Nuclear Island	$1,248,315K	$522,334K	$366,580K	$316,528K	($50,052K)	0.86	1.28	$1,147,339K	$1,513,940K	2,703K	643K	19.4%	525K	0.82	-118K	2,468K
BOP Project	$1,049,316K	$543,487K	$510,503K	$466,246K	($44,257K)	0.91	0.79	$594,513K	$1,111,192K	4,199K	1,183K	26.4%	1,107K	0.94	-77K	3,252K
Site Prep./Facilities and Infrastructure	$63,705K	$63,691K	$60,802K	$60,941K	$140K	1.00	1.73	$143K	$63,782K	316K	316K	99.6%	315K	1.00	-1K	1K
Design Engineering	$453,978K	$375,713K	$376,423K	$332,284K	($44,140K)	0.88	1.29	$167,347K	$543,770K	5,505K	4,775K	82.1%	4,521K	0.95	-254K	1,707K
Total	**$5,407,665K**	**$2,301,918K**	**$1,917,237K**	**$1,715,152K**	**($202,085K)**	**0.89**	**1.22**	**$3,879,676K**	**$5,911,644K**	**21,948K**	**9,669K**	**41.2%**	**9,043K**	**0.94**	**-626K**	**14,429K**

OPG

DIRECT TESTIMONY OF

JOSEPH A. MILLER JR. AND MICHAEL SKAGGS

IN SUPPORT OF GEORGIA POWER COMPANY'S APPLICATION TO ADJUST RATES TO INCLUDE REASONABLE AND PRUDENT VOGTLE UNITS 3 AND 4 AND COMMON COSTS

DOCKET NO. 29849

I. INTRODUCTION AND QUALIFICATIONS

Q. MR. MILLER, PLEASE STATE YOUR FULL NAME, TITLE, AND BUSINESS ADDRESS.

A. My name is Joseph A. Miller Jr. I am President and Chief Executive Officer ("CEO") of Pegasus-Global Holdings, Inc.® ("Pegasus-Global"), an international management consulting firm that provides services in the power, energy, and infrastructure industries. My business address is 1750 Emerick Rd., Cle Elum, Washington, 98922.

Q. MR. SKAGGS, PLEASE STATE YOUR FULL NAME, TITLE, AND BUSINESS ADDRESS.

A. My name is Michael Skaggs. I am an electrical industry consultant. My business address is 9776 Clingmans Dome Drive, Knoxville, Tennessee, 37922.

Q. MR. MILLER, PLEASE SUMMARIZE YOUR EDUCATIONAL BACKGROUND AND PROFESSIONAL EXPERIENCE.

A. I graduated from Purdue University with a Bachelor of Science degree in Mechanical Engineering. I also completed twelve post graduate level courses in Business Administration at Indiana State University. I have over 30 years of experience, including four as a management consultant in utility management reviews, independent monitoring,

evaluations, and audits. In the last 12 years, I have sponsored 65 testimonies in regulatory proceedings in multiple states, including base rate, fuel, certificate of public convenience and necessity, plant abandonment, and environmental cases. I have performed extensive work on a wide range of complex engagements both for and on behalf of utilities, as well as public and private sector clients.

I began my career in 1991 as a staff engineer at Duke Energy Indiana's Cayuga Generating Station. Since that time, I held various roles of increasing responsibility in the management, operations, engineering, maintenance, and strategy areas, including the role of station manager, first at Duke Energy Kentucky's East Bend Generating Station, followed by Duke Energy Ohio's Zimmer Generating Station.

I was named General Manager of Analytical and Investment Engineering for Duke Energy in 2010. In this role, I began providing leadership in modernizing one of the largest fossil fuel generating fleets in the county. This involved supporting and directing the analysis of plant abandonments and new resource replacements and setting lifecycle strategy for the remaining plants in the fleet. My responsibilities also included carrying out all facets of environmental compliance planning for the coal plants that would remain in operation. In this role, I was also responsible for financial and engineering analysis of capital projects and project controls for the Duke Energy's fleet of nuclear, fossil, and hydroelectric plants.

Following the merger between Duke Energy and Progress Energy in 2012, I became the Vice President of Central Services. In this position, I had oversight of approximately 500 employees and responsibility for engineering, environmental compliance planning,

generation and regulatory strategy, North American Electric Reliability Corporation (otherwise known as "NERC") and regulatory compliance, technical services, and maintenance services for Duke Energy's fleet of 89 fossil and hydroelectric power plants in North Carolina, South Carolina, Ohio, Indiana, Kentucky, and Florida.

In 2019, following my retirement from Duke, I began providing strategic and regulatory consulting services primarily to utility clients undertaking transitions in the production or sourcing of their electricity. I also served as a consultant to Pegasus-Global on regulatory and dispute matters.

I was named President and CEO of Pegasus-Global in October 2022. Since joining Pegasus-Global, I have continued my work on regulatory matters, with which I was previously working alongside Pegasus-Global, and other matters including as part of the Pegasus-Global Independent Monitoring Team for large projects being undertaken by other utilities. Thus, I understand the independent construction monitoring role and reporting requirements. My experience and qualifications, including the regulatory cases in which I have submitted testimony, are attached as **Exhibit JAM-1**.

Q. HAS PEGASUS-GLOBAL PROVIDED TESTIMONY PREVIOUSLY AS IT RELATES TO THE PLANT VOGTLE?

A. Yes. In 1987, the late Dr. Kris R. Nielsen testified on behalf of Georgia Power Company ("GPC" or "Georgia Power") in the proceeding that reviewed the prudence of the costs incurred in the development of Vogtle Units 1 and 2. In 2008, Dr. Nielsen, then CEO of Pegasus-Global, provided testimony in Georgia Public Service Commission ("GPSC" or

the "Commission") Docket No. 27800 in Georgia Power's Application for the Certification of Units 3 and 4 at Plant Vogtle and Updated Integrated Resource Plan and performed an independent evaluation of GPC's proposal to construct two new nuclear units at the Plant Vogtle Site. In 2011, Dr. Nielsen filed joint testimony with Mr. Brian L. (Pete) Ivey, then Vice President of Nuclear Development Support for the Southern Nuclear Operating Company ("Southern Nuclear" or "SNC"), in GPSC Docket No. 29849 regarding the Georgia Power Company's opposition to the risk sharing mechanism proposed by the Commission Public Interest Advocacy Staff ("PIA Staff").

Q. MR. SKAGGS, PLEASE SUMMARIZE YOUR EDUCATION AND PROFESSIONAL EXPERIENCE.

A. I graduated from Texas Tech University with a Bachelor of Science degree in Mechanical Engineering. I received my Professional Engineer registration in Texas. I also received my Senior Reactor Operator certification from Tennessee Valley Authority ("TVA").

I have over 35 years of experience in the utility industry. My experience has included:

- Manager of Projects for Watts Bar Nuclear Plant ("WBN") Unit 1 during the design, construction, startup, and initial operation;
- Site Vice President at each of the TVA Nuclear Plants (Browns Ferry Nuclear Plant ("BFN"), Sequoyah Nuclear Plant ("SQN"), and WBN);
- Senior Vice President over the WBN site, which included Unit 1 operation and Unit 2 design, construction, testing, and placement in operations; and
- Chief Operations Officer ("COO") of TVA

I began my career in 1983 with Texas Utilities at the Comanche Peak Steam Electric Station. Since that time, I have held various roles of increasing responsibility in engineering, design, operations, work control, project management, project controls, maintenance and modifications, plant management, and Executive Leadership and Management of nuclear, coal, natural gas, and hydro generating stations, as well as supply chain, environmental, land management, resource management, transmission system, safety, aviation, facilities, and integrated river system management.

I was named the BFN Site Vice President in July 2004. In this role, I was ultimately responsible for the safe operation, maintenance, and leadership of the two operating units and the integration of BFN Unit 1, which was being refurbished for startup and operation.

In July 2005, I was named the WBN Site Vice President. Similar to my role at BFN, I was ultimately responsible for the safe operation, maintenance, and leadership of the operating unit. WBN was preparing to replace the four steam generators due to component degradation and I was sent to the site to lead this project.

I was subsequently named the SQN Site Vice President in November of 2010. My role at SQN was similar to the roles at BFN and WBN. The driving factor behind this assignment was to address plant performance issues at SQN requiring resolution.

In November 2011, I was named the Senior Vice President of Nuclear Generation Development and Construction at TVA. The responsibilities associated with this assignment were the development, feasibility, design, construction, licensing, testing, and initial operation of the Bellefonte Nuclear Plant and WBN Unit 2 and the replacement of

the steam generators at SQN 2. Ultimately, TVA finished WBN Unit 2 and halted work on Bellefonte. With the work stoppage on Bellefonte, I was reassigned to WBN as the Senior Vice President, Watts Bar Operations and Construction. In this role, I oversaw the safe operation and maintenance of WBN Unit 1 and managed the completion and integration of WBN Unit 2 as a generating nuclear plant. With the successful completion and operation of WBN Unit 2 in October of 2016, I was named the COO of TVA until my retirement in January of 2022.

In addition to my work at TVA, I supported the VC Summer Project as the lead over the Construction Review Board ("CRB") in 2017 and 2018 and I served on the CRB with Vogtle Units 3 and 4 ("Vogtle Project", or "Project") from April 2018 to November 2019. In both roles, I reviewed and provided feedback concerning many of the critical aspects of and decisions for the Project. For example, we reviewed the adequacy of work being performed for Engineering, Construction, Startup and Testing, Licensing, and Operational Readiness. Additionally, the CRB for both sites evaluated Project Management tools being employed and Project decision-making.

My experience and qualifications are attached as **Exhibit MS-2**.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS PROCEEDING?

A. Our testimony is on behalf of GPC.

II. PURPOSE AND SUMMARY OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of our testimony is to address fundamental concepts of prudence as they apply to decision-making during the planning and execution of a power generation project. This evaluation considered whether GPC management had an appropriate decision-making structure and appropriate processes in place to ensure that management made informed decisions based on information reasonably available to or known by management at the time. Our evaluation also considered whether GPC management reasonably and prudently implemented its decisions, with a primary focus on the time period from January 1, 2016, through the completion of Unit 3. This evaluation includes:

- An assessment of the management processes used by GPC to plan, execute, and manage engineering, procurement, and construction activities, including those of its contractors;
- An identification of management strengths and positive actions which may have impacted cost or schedule;
- An identification of any management shortcomings which may have impacted cost or schedule; and
- A determination of reasonableness of overall design procurement and construction management practices and the extent to which these management practices avoided, mitigated, or resulted in cost and/or schedule impacts.

We were specifically asked by Georgia Power to testify as to the differences between planning, managing, controlling, and completing a "megaproject." This included a comparison between a First-of-a-Kind ("FOAK") project and a typical construction project. We were also asked to opine on the project control tools to oversee project

progress, specifically the processes GPC and SNC used to measure and monitor the status of the construction of the Vogtle Project, and whether those project control tools met good utility practices and industry standards and were appropriate for the stage of the Project when the respective project control tools were developed and implemented.

Q. WHAT IS YOUR UNDERSTANDING OF THE PRUDENCE AND COSTS TO BE ADDRESSED IN THIS DOCKET?

A. Our understanding of the question of prudency in this case is informed by O.C.G.A. § 46-3A-7(a), which states:

> So long as the commission has not modified or revoked the certificate for an electric plant under Code Section 46-3A-6 and to the extent the utility seeks to add to its rate base upon completion of the plant construction costs that do not exceed 100 percent of those approved by the commission under Code Section 46-3A-5, Code Section 46-3A-6, or subsection (b) of this Code section, that construction cost amount may be excluded from the rate base only on the basis of fraud, concealment, failure to disclose a material fact, imprudence, or criminal misconduct. Inclusion of costs in excess of 100 percent of those approved by the commission shall not be permitted unless shown by the utility to have been reasonable and prudent.

We understand from Counsel that the prudence evaluation will assess the reasonableness and prudency of Georgia Power's decisions regarding Vogtle Units 3 and 4 for the period starting from December 31, 2015, through fuel load of Unit 4. The December 31, 2015, date is based on the Commission's January 3, 2017, Order Adopting Stipulation between PIA Staff, Georgia Power, the Georgia Association of Manufacturers, and the Georgia Industrial Group regarding the Construction Monitoring Proceeding for Georgia Power Company's Plant Vogtle Units 3 and 4, also known as the Supplemental Information

Review proceeding and stipulation ("SIR Stipulation").[1] In relevant part, the SIR Stipulation established that:

- None of the costs incurred, verified, or approved through the 14th Vogtle Construction Monitoring ("VCM") report should be disallowed from rate base on the basis of imprudence as specified in O.C.G.A. § 46-3A-7. The VCM 14 report covered the period June through December 2015 and stated that Georgia Power's share of the incurred construction and capital costs for Vogtle 3 and 4 was $3.569 billion as of December 31, 2015.[2] Based on the SIR Stipulation, we understand that these costs are assumed reasonable and prudent and are not subject to further prudency review.
- The revised schedule and capital cost forecast up to $5.68 billion ($5.440 billion current forecast as of the time of the SIR Stipulation plus $240 million in contingency) will be presumed reasonable and prudent and the burden of proof in any challenge to the reasonableness or prudence of these costs is on the party challenging such costs. Therefore, any costs between $3.5 billion and $5.680 billion are assumed to be reasonable and prudent.
- Georgia Power has the burden of proof to show that costs above the $5.680 billion are prudent. These are the costs that we have focused on in our prudency review, including the value to the customers of Georgia Power.

Q. WHAT WAS THE TIMEFRAME FOR YOUR PRUDENCE REVIEW?

[1] See *Order Adopting Stipulation*, Docket No. 29849 (Jan. 3, 2017). The SIR Stipulation was adopted by the Commission on December 20, 2016.
[2] See *Georgia Power Company's Fourteenth Semi-Annual Construction Monitoring Report for Plant Vogtle Units 3 and 4*, at 6, Docket No. 29849 (Feb. 29, 2016).

A. The first change in the forecasted schedule or cost after the SIR order occurred in VCM 17, filed in August 2017. Therefore, our review began with the go/no-go recommendation and decision in VCM 17, which documents GPC's efforts following the Westinghouse Company ("WEC") bankruptcy and the resulting Project changes. Our review is predicated on what was reasonably known or knowable at the time of VCM 17. We also understand that in the VCM 17 Order, the Commission found all costs up to $7.3 billion to be reasonable.[3] For practical purposes, we reviewed all costs above $5.680 billion for prudency and reasonableness. While we have focused our evaluation on the decisions after December 31, 2015, we recognize that some decisions made prior to the efforts around VCM 17, and even prior to December 31, 2015, have resulted in costs incurred and schedule impacts after December 31, 2015. Therefore, we reviewed these prior decisions to the extent they had an impact on the issues we were investigating as part of our prudency evaluation.

Q. PLEASE SUMMARIZE YOUR FINDINGS.

A. Based on this review of policies, procedures, processes, reports, detailed schedule and cost files, and other project documentation, we found that the project controls, including scope and change control management; schedule management; cost management; risk management; project controls reporting; and lessons learned management, either met or

[3] See *Order on the Seventeenth Semi-Annual Vogtle Construction Monitoring Report* at 11, Docket No. 29849 (December 21, 2017).

exceeded what would be expected on a project of this size, magnitude, scope, and complexity and generally align with common industry practices.

In general, we find that while there were several challenges encountered throughout the execution construction management and oversight, and commissioning and startup of this "first of a kind" megaproject, appropriate processes and resources were in place to plan, monitor, and actively manage the execution efforts on the Project. Specifically, we evaluated subcontract, procurement, and supplier management for the Project, concluding that, while the COVID-19 pandemic created challenges in all these areas, SNC had processes in place typical for the size, magnitude, and complexity of the Project and took appropriate actions to address the challenges in these areas. As part of the review of construction oversight, we evaluated the quality assurance/quality control process. We noted some concerns that are discussed below, but overall, we conclude that policies and procedures used for Quality Assurance ("QA")/Quality Control ("QC") on the Project align with industry standards. We note several significant improvements to improve initial testing, concluding that the Project's commissioning and startup process is typical of what we have experienced on other large projects of this size, magnitude, and complexity.

We also identified several challenges and key decisions that the Project faced. Our conclusions related to those challenges and decisions are as follows:

- One of the largest impacts unique to Vogtle 3 and 4 was the WEC bankruptcy filed on March 29, 2017, which had ricochet impacts for the Project. GPC and SNC made key decisions related to the WEC bankruptcy, including the decision

to self-perform the work, with SNC overseeing the completion of the Project on behalf of the Co-owners. As part of that decision, GPC and SNC undertook the substantial effort of developing a new Estimate to Complete ("ETC"), including commissioning several outside experts to provide opinions concerning the likely cost and schedule of various scenarios that were being considered. Also, as part of the transition from the WEC to the SNC/Bechtel project structure (the "Project Transition"), SNC and GPC made the decision to adopt an aggressive schedule, which provided schedule contingency and an incentive for getting the construction work force to work as hard as possible to meet that scheduled end date. The Project's early decision to attempt to compress the Project schedule made sense because each month saved would have offset approximately $90-$100 million. We find the ETC developed at the time of the Project Transition as well as the decision to adopt an aggressive schedule to be reasonable based on what GPC and SNC knew at the time and based on the independent assessments it had undertaken.

- With regard to cost challenges, we find that GPC and SNC had strong processes in place to monitor cost and continually update the ETC and Estimate at Completion ("EAC"). We note that the fact that the cost of the Project exceeds the VCM 17 estimate does not necessarily mean there is imprudence. The issue is whether decisions were made in a reasonable manner in light of conditions and circumstances that were known or reasonably should have been known when the

decision was made. Our conclusion is that the decisions made and the actions taken by GPC and SNC related to controlling costs were reasonable and prudent.

- With regard to scheduling challenges, we find, consistent with industry best practices, the periodic re-baselining to be typical of large complex projects over the course of execution and is normal with projects that fall behind schedule and especially those with an aggressive target schedule.

- While the productivity targets and manpower requirements were challenging throughout the Project and were further impacted with the FOAK nature of this Project and the bankruptcy of WEC, we find that the planning assumptions used by GPC and SNC were reasonable based on the information known at the time and the Companies took appropriate action throughout the Project to mitigate these risks and their impacts.

- We find that the decisions made and actions taken by GPC and SNC at the onset of the COVID-19 pandemic, including implementation of site protocols and the

scenarios conducted, allowed the Project to continue in a safe manner during the pandemic.

- We agree with the assessment that partial release for testing ("PRT") would allow earlier discovery and correction of any defects or nonconformances in the work to help in maintaining target Commercial Operation dates ("CODs").

- In our review of quality control issues, we find that the corrective actions taken to address the Institute of Electrical and Electronic Engineers ("IEEE") issues were sufficient to strengthen the QA program and assure existing IEEE issues were corrected. We agree with GPC's decision not to see recovery of costs associated with the IEEE issues, as well as the inspection report issue discovered in the fall of 2021. We also do not recommend a disallowance associated with the costs incurred for the remediation of the spent fuel pool and fuel transfer canal over-pressurization event given that the event did not result in additional delays and that the costs were covered by insurance.

Q. DID YOU FIND THE $8.826 BILLION THAT GPC IS ASKING TO RECOVER TO BE REASONABLE AND PRUDENT?

A. Yes. Our review has demonstrated that, as the first new nuclear project completed in decades, the Project is reasonable and prudent and will provide valuable, carbon-free

energy and capacity to Georgia Power and the Co-Owners'[4] customers for the next 60-80 years. As Pegasus-Global's Dr. Kris Nielsen testified in Docket No. 27800:[5]

> The increased growth in the United States, especially in the Southeast, requires that new sources of generation be constructed to meet growing energy needs. In addition, there have been growing calls from the public, and most recently, legislators to combat the effects of climate change by reducing carbon emissions. While no specific federal legislation has been passed to limit the emissions of carbon, one can assume that some form of legislation will pass in the future. Together, the need for new energy sources and the challenge of reducing carbon emissions have fueled a resurgence of public support for nuclear generation as one of the carbon-free sources of energy.

The world's efforts to reduce carbon emissions are one of the greatest challenges of our lifetime.

Nuclear energy is the largest source of zero-carbon energy in the United States, providing half of the country's clean energy, and the second largest source of low-carbon electricity in the world behind hydropower. Further, despite producing massive amounts of carbon-free power, nuclear energy produces more electricity on less land than any other clean-air source.[6] Nuclear energy is also one of the most reliable and efficient sources of clean energy. Given significant recent power outages in other parts of the country, such as the major outages in Texas in February 2021, where the energy infrastructure has not been able

[4] Oglethorpe Power Corporation, Municipal Electric Authority of Georgia ("MEAG"), and the City of Dalton through Dalton Utilities.
[5] See Direct Testimony of Dr. Kris R. Nielsen at 3-4, Docket No. 27800-U (October 20, 2008).
[6] See OFFICE OF NUCLEAR ENERGY, *3 Reasons Why Nuclear is Clean and Sustainable,* (March 31, 2021, updated June 2022), https://www.energy.gov/ne/articles/3-reasons-why-nuclear-clean-and-sustainable, (last accessed July 29, 2023).

to sustain the demands from extreme temperatures, GPC customers will benefit from an additional source of reliable clean energy.

We find that Vogtle Units 3 and 4, as noted above, will be a valuable source of carbon-free, reliable base load generation for 60 to 80 years and will hedge against potential carbon costs and fuel volatility that could impact GPC's ability to provide economic power to customers over the next several decades. Given the challenges related to climate and energy here and abroad, Vogtle is a project that the state of Georgia can be proud of as it provides energy security and was at the forefront of recognizing the value of nuclear to the customers of Georgia. We also note that the Vogtle Project has had a significant economic development impact on the local community while under construction and will continue to serve as an important fixture in the local economy providing tax revenues to fund additional infrastructure.

III. VOGTLE NUCLEAR PROJECT PRUDENCE EVALUATION PRINCIPLES

A. PRUDENCE STANDARDS

Q. IN CONDUCTING YOUR INDEPENDENT PRUDENCE REVIEW AND EVALUATION OF THE VOGTLE PROJECT, ARE YOU APPLYING CERTAIN GENERALLY RECOGNIZED PRUDENCE STANDARDS?

A. Yes. Our prudence evaluation is founded upon the following definition:

Decisions are prudent if made in a reasonable manner in light of conditions and circumstances which were known or reasonably should have been known when the decision was made.

This prudence definition is consistent with the prudence standard Pegasus-Global has applied, and the definition is consistent with definitions used by regulators in multiple jurisdictions as well as with prudence standards cited in numerous publications on the subject of prudent management decisions.[7] In essence, management makes prudent decisions when management makes an informed decision under the circumstances at the time the decision is made.

Q. WHAT PRUDENCY STANDARD HAS THIS COMMISSION ADOPTED?

A. We understand that the GPSC has adopted prudence standards consistent with these listed above. For example, in the Rocky Mountain Pumped Storage Facility case, the Commission found:[8]

> A decision must not be judged as correct or incorrect in light of perfect hindsight. Rather, a decision must be judged as to whether it was reasonable given the facts and circumstances which were known, or which reasonably should have been known at the time the decision was made. In applying this standard, it must be recognized that in any decision-making process there

7 "Cost Recovery for Pre-Approved Projects", Patricia D. Galloway and David Cousineau, Public Utilities Fortnightly, June 2013; "New Day for Prudence", Kris R. Nielsen, Patricia D. Galloway and Charles W. Whitney, Public Utilities Fortnightly, December 2009; "The Prudency Management Audit – A New Challenge for the Civil Engineer", Kris Nielsen and Patricia Galloway, Transition in the Nuclear Industry, Proceedings of the Symposium Sponsored by the Construction and Energy Divisions of the American Society of Civil Engineers in Conjunction with the ASCE Convention in Denver, Colorado, April 29 – 30, 1985. With regard to other states and FERC-accepted definitions of prudence, see, e.g., Public Utilities Commission of Ohio, Case No. 85-521-EL-COI in the matter of the Perry Nuclear Plant, *Opinion and Order*, January 12, 1988, pp.10-11 and Public Utility Commission of Texas, Docket No. 9300, *Examiner's Report regarding the Comanche Peak Steam Electric Station*, June 12, 1991, p. 9. See also, Entergy Services, 130 FERC ¶ 61,023 (quoting New England Power Co., 31 FERC ¶at 61,084).

8 GPSC Docket No. 6739-U, Order in *GPSC Staff's Review of GPC's Rocky Mountain Pumped Storage Facility,* January 14, 1998, p. 6.

> may exist a range of choices, any or all of which could have been adopted by reasonable management in good faith and under the same set of circumstances. If the Company has made a decision which falls within that "zone of reasonableness," that decision must be found to have been prudent, irrespective of whether others may have selected another alternative, and irrespective of whether in hindsight another decision may now appear in hindsight to have been a more correct decision.

We also note that in testimony before the GPSC, Dr. William Jacobs, Construction Monitor ("CM") for the GPSC, used a definition of prudence that is consistent with Pegasus-Global's definition of prudence:

> As in previous cases, I have applied the standard of prudence adopted by the Georgia Public Service Commission in Docket No. 6739-U, Review of Georgia Power Co.'s Rocky Mountain Pumped Storage Facility.
>
> […]
>
> This standard is essentially a "reasonable man standard" in that the utility's actions or decisions are compared to the reasonable actions or decisions of a qualified and experienced utility manager or operator given what was known, or reasonably should have been known, at the time the action was taken or the decision was made without the benefit of hindsight. Thus, the actions and decisions of Company personnel must be judged on what they knew, or reasonably should have known, at the time the action was taken or the decision was made without benefit of hindsight. The "reasonable man standard" does not hold Company responsible for actions or decisions that may not have been appropriate had additional information been available at the time of certain actions or decision were taken.[9]

Q. CAN YOU EXPLAIN WHAT YOU MEAN BY "INFORMED DECISION UNDER THE CIRCUMSTANCES AT THE TIME THE DECISION IS MADE"?

A. Yes. As noted in the definitions above, prudence cannot be judged with the benefit of hindsight, primarily because a hindsight perspective involves the use of information and circumstances that did not exist or were not reasonably available at the time that

[9] Direct Testimony and Exhibits of William R. Jacobs, Jr., PhD. at 5-6, Docket No. 43011 (May 1, 2020).

management had to make its decision. Only those circumstances that were known or that should have been known to management at the time the decision is made can be considered when judging the prudence of management's decisions and actions. Management decisions are not made in static conditions and may necessarily rely upon imperfect information or changing circumstances. Prudence recognizes these challenges and relies on the concept of foreseeability in two ways: (1) an action or lack of action of a utility manager is not unreasonable or imprudent if it involves or is affected by events that were unforeseen and reasonably unforeseeable at the time; and (2) the cost calculations for any imprudence we found properly reflect only the reasonably foreseeable consequences of the imprudent decision-making processes or performance.

Q. DOES THE PRUDENCE STANDARD REQUIRE PERFECTION OR THAT A DECISION BE OPTIMAL?

A. No. Prudence is a reasonable standard, and reasonableness does not demand perfection. A standard of perfection would require an entirely trouble-free project[10] and would rely impermissibly on hindsight or prescience, because perfection is only determinable once the outcome is known (at which point the course to have avoided or minimized an adverse outcome will be obvious). This information is, of course, unavailable to the project manager at the time of decision-making. Relevant factors for evaluating the reasonableness

[10] *See Re Union Electric Company,* 1985 WL 1205410, *214 (Mo. P.S.C. 1985); *see also* P. Galloway, K. Nielsen and C.W. Whitney, *New Day for Prudence,* PUBLIC UTILITIES FORTNIGHTLY, (Dec. 2009).

of decision-making are the manner and timeliness in which problems were recognized and addressed.

Q. IS IT POSSIBLE FOR THERE TO BE MORE THAN ONE PRUDENT RESPONSE TO THE SAME SET OF CIRCUMSTANCES AND INFORMATION?

A. Yes. However, the determinative issue is whether management considered factual circumstances and conditions that management should have considered in making its decision, not whether someone else might make a different decision under the same circumstances and conditions. Management decisions are seldom black and white and differences in opinion or judgment do not render a management decision imprudent. There is a zone of reasonableness in which management judgment is exercised and decisions are reasonable and prudent.

Q. ARE ALL CHANGES TO A PROJECT'S COST, SCOPE, AND SCHEDULE THE RESULT OF DECISIONS MADE BY MANAGEMENT?

A. No. There may be factors outside the control of management that impact a project. However, while it is true that factors outside the control of management can impact the Project, the processes established by management to control cost, scope, schedule, and related project elements and management's responses to such events can be evaluated in terms of the reasonableness and prudence of these responses.

Q. DOES PRUDENCE MEAN ANY RATIONAL BASIS FOR A DECISION IS ACCEPTABLE?

A. No. Prudence is not the application of a test that accepts any rational basis for a decision. Rather, a prudence determination requires an evaluation of the concurrent context for a given decision, the process for making the decision, and the performance or implementation of that decision by management. Prudence ultimately asks whether the decision is rational under all those known circumstances. This does not mean that prudence is synonymous with efficiency. Prudence does not require that decisions be made and executed in the most efficient manner; it simply requires that there be rational, deliberate processes employed by management to make and implement the decision, considering the circumstances and conditions facing management at the time.

Q. DID YOU REVIEW THE PRUDENCE AND REASONABLENESS OF THE PROJECT IN LIGHT OF THE VALUE TO CUSTOMERS?

A. Yes. In our assessment, we considered the extent to which GPC's customers will benefit from the completion of Vogtle Units 3 and 4. To the extent that we determined that any costs should not be passed on to the GPC customer, we have identified those costs in our testimony.

Q. WHAT IS THE PROPER STANDARD FOR DETERMINING WHETHER COSTS SHOULD BE DISALLOWED?

A. Disallowance recommendations for imprudence must be founded on a direct causal link between an imprudent decision or action and the specific cost associated with that imprudent decision or action, but only to the extent such results were reasonably foreseeable.

B. ANALYZING THE STRUCTURE OF THE MANAGEMENT DECISION-MAKING PROCESS

Q. IS IT NECESSARY TO EVALUATE MANAGEMENT'S DECISION-MAKING STRUCTURE WHEN REVIEWING AND EXAMINING THE PRUDENCE OF A UTILITY'S ACTIONS AND DECISIONS?

A. Yes. When conducting a prudence review and evaluation, the reviewer must focus on the management processes employed by the utility to make decisions. This evaluation should determine if there is a structure in place to make decisions and a process to ensure that management's decisions follow that structure. Management makes an informed decision if, at the time the decision is made, management considers the factors it should reasonably consider based on information that was known or should have been known at the time. An informed decision includes the identification of risks that might arise and an evaluation of those risks before reaching the decision.

Once management has made an informed decision, the prudence reviewer evaluates whether that decision resulted from an exercise of reasonable business judgment. Most, if not all, management decisions do not involve right or wrong answers; typically, multiple decisions are equally reasonable and prudent under the circumstances then facing management. If management's decisions are informed and fall within a range of reasonable business judgment, they are reasonable and prudent.

Q. WHAT DO YOU MEAN BY THE "STRUCTURE OF THE MANAGEMENT-DECISION-MAKING PROCESS"?

A. The management decision-making structure involves and follows four steps: (1) data development, (2) information flow, (3) analysis and (4) decision. These steps are described below.

(1) "Data development" addresses what information was available or should have been available to management at the time and whether the management systems and procedures were organized and implemented to produce the reasonably necessary information. Data development must be judged from the position of utility management based upon the varying sources of input that it had or reasonably could have had at the time it was deciding. Management seldom has the time or the luxury to obtain all the information that it might desire. If management waited until it had all possible information, a decision would never be made, in part because information is always changing. The very essence of management is making decisions on less than perfect information.

(2) "Information flow" addresses to whom and when the available data is transmitted and communicated and in what format. In evaluating information flow, the reviewer determines whether management received the information in a timely and understandable manner to make its decision.

(3) Next a reviewer should look at the "analysis" done by management. This step addresses how the available information was evaluated; what alternatives, if any,

were identified based on such information; and what benefits and impacts were projected by management based on the information.

(4) Finally, the "decision" step addresses what decision was made; when the decision was made; how the decision was made; how the decision supported customer, project, and corporate needs; and whether the decision was re-evaluated and modified, as necessary, when assumptions and circumstances changed. This step involves management techniques and systems to monitor performance and use that new information to improve performance.

IV. MEGAPROJECTS AND FOAK RISKS

Q. DOES THE VOGTLE PROJECT QUALIFY AS A "MEGAPROJECT"?

A. Yes. "Megaprojects" are generally defined as exceptionally large and complex investment projects that attract a prominent level of public attention or political interest because of the significant costs (generally over $1 billion) and the direct and indirect impacts on the community, environment, and companies undertaking such projects.[11] Other attributes often include the execution of an engineered facility that is complex or unusual, contains FOAK elements, has an extended schedule of more than four years, involves multiple equipment and material suppliers, and involves multiple stakeholders and investors. The Vogtle Project is a megaproject under this definition.

Q. IS THE VOGTLE PROJECT ALSO A FOAK PROJECT?

[11] "Managing Gigaprojects: Advice from Those Who've Been There, Done That", Edited by Patricia D. Galloway, Kris R. Nielsen, Jack L. Dignum, Part 1 Megaprojects to Gigaprojects, ASCE Press, 2013, p. 1.

A. Yes. While Vogtle is certainly not the first nuclear plant built in the United States, it *is* the first AP1000 nuclear plant and currently the only nuclear plant to be built in the United States in almost 30 years.[12] In addition, there are aspects of the AP1000 that are unique to this design and have never been built before. While China has also built AP1000s, there are differences between the Chinese AP1000s and the Vogtle Units, including where the owners of the China Projects deviated from the standard Nuclear Island modules for reasons such as the methods and capabilities of the Chinese companies that manufactured module components.[13] In addition, the secondary side of the Vogtle Project is different from that of the Chinese AP1000s. Thus, SNC was required to develop its own testing procedures for the secondary side of the Project, which had not yet been tried.

Q. WHAT ARE THE CHALLENGES PRESENTED BY FOAK MEGAPROJECTS?

A. Typical construction projects incur a change phenomenon which is known in the industry as "ripple effect." For example, the delivery delay of a needed commodity will "ripple" through a particular string of activities necessary to complete a specific element of the full scope of work. However, FOAK megaprojects also exhibit another effect known as the "ricochet effect." Simply put, it is almost impossible to introduce a significant change into an element of work on a megaproject that does not have some unexpected and unintended impact on some other element(s) of work. While ripple effects are generally isolated to a particular string of logically related activities within a scope of work, a ricochet effect will

[12] The exception to this is Watts Bar 2 which started construction in the 1970s but was finished in 2016.
[13] GPSC Docket No. 29849, Master List of all Staff Data Requests, Response to STF-2-5, pp. 27-28.

bounce through non-logically linked activity strings in unexpected and unpredictable ways, which results in unintended impact consequences for those other activities.[14]

For example, a piece of equipment is modified to meet a change in an operational requirement, which in turn increases the size and weight of the piece of equipment that triggers the requirement for a heavy lift crane. Use of the heavy lift crane requires a change in sequence to the project (shifting other lifts) and work along the crane's path to be cleared for the lifts. Ripple effects in this case relate to the direct impacts of the change such as the change in crane requirements, while ricochet effects in this case relate to the both the resulting impacts to the other planned lifts that must be rescheduled and the impacts to other crafts from having to clear the area where the heavy lift is now required.

In addition to change impact, there is an added impact when FOAK elements are part of the initial scope via technology, equipment, or various components. Project controls are challenged in that FOAK projects do not have a historical cost record or data from which to develop a comparable basis of estimate or the history to understand how the technology, the design, the equipment, or the components will actually perform to the "theoretical" calculations that formed the basis of the FOAK design. Thus, the schedule is more sensitive to both ripple and ricochet effects, which makes both the identification, trending, and forecasting more complicated and those effects may pass through hundreds of different and even seemingly unrelated activities.

[14] "Managing Gigaprojects: Advice from Those Who've Been There, Done That", Edited by Patricia D. Galloway, Kris R. Nielsen, Jack L. Dignum, Chapter 8 – Six Challenges to Controlling Megaprojects, pp. 154-155, ASCE Press, 2013.

Q. WHAT WERE THE FOAK RISKS THAT WERE UNIQUE TO THE VOGTLE PROJECT?

A. Vogtle had several unique FOAK (or similarly "first-in-a-while") aspects that presented risks to the Project, including but not limited to:

- The first nuclear plant constructed in the United States in almost 30 years.
- The limited availability of qualified craft labor and the challenge of achieving the necessary productivity goals considering the previously dormant nuclear construction industry.
- The limited availability of qualified material and equipment suppliers.
- Changes in licensing from that of the nuclear plants constructed in the 1960s-1980s.
- The AP1000 design, including unidentified scope risks and startup and testing risks.

Q. WHAT WERE THE FOAK RISKS ASSOCIATED WITH THE LENGTH OF TIME SINCE OTHER NUCLEAR PLANTS WERE CONSTRUCTED?

A. The building boom for domestic nuclear power plants ended in the 1980s. The last plant to enter service in the United States (other than Watts Bar 2) was Watts Bar 1 in 1996. The boom had started in the 1960s, which, by its end, increased the number of qualified craft and non-manual availability, some with 20+ years of experience. In addition, due to the number of nuclear plants under construction in this period, there were numerous equipment suppliers and multiple engineering and construction organizations directly supporting the nuclear industry. With the end of the nuclear boom in the 1980s, the number of skilled and

qualified craft available to construct the Vogtle Project was a challenge, especially given the stringent Nuclear Regulatory Commission ("NRC") requirements under which a nuclear plant in the United States must be constructed.

Q. WHAT WAS THE FOAK IMPACT OF THE LACK OF CRAFT WITH NUCLEAR EXPERIENCE?

A. Due to the lack of skilled craft labor in the nuclear industry, the ability to forecast productivity rates for the labor force and craft was challenging. Also unknown was whether early productivity rates could be maintained or improved over time given the lack of information regarding actual productivity rates for new nuclear construction in the United States. The Project's projected cost and schedule were heavily dependent on assumptions related to labor productivity. Thus, accurate projections of cost and schedule were challenging.

Q. WHAT WAS THE FOAK IMPACT RELATED TO MATERIAL AND EQUIPMENT SUPPLIERS?

A. Like the availability of skilled and nuclear-qualified craft, supply chain issues were also a known risk due to the limited number of nuclear material and equipment suppliers around when the Project began. The number of qualified suppliers and manufacturers of AP1000 components was limited, creating a potential risk to both cost and schedule stemming from the lack of reasonable alternative suppliers.

Q. WHAT WERE THE FOAK CHALLENGES RELATED TO LICENSING?

A. Since Vogtle was the first nuclear plant in the United States in almost 30 years, there was also additional FOAK risk with emerging licensing issues and design issues unique to the AP1000. Plants were previously built under the NRC's 10 CFR 50 licensing process, which allowed a utility to proceed with construction "at risk," which was a customary practice. Under the 10 CFR 50 licensing process, field engineering had the authority and latitude to resolve many issues that arose during construction. That latitude changed with the NRC's introduction of 10 CFR 52, the new licensing process by the NRC, which combined the construction and operating license into one process. The NRC's authorization to operate the plant is conditional on the licensee demonstrating that the proposed inspections, tests, and analyses performed provide assurance that the corresponding acceptance criteria have been met and that the plant has been constructed and will be operated in strict compliance with all the applicable nuclear regulatory requirements. This is referred to as the Inspections, Tests, Analyses and Acceptance Criteria ("ITAAC"), which is a new licensing process with which both utilities and craft had no prior experience.

The change in licensing also meant uncertainty as to how the NRC might interpret the new licensing requirements that might require the work to be performed differently, undertake more extensive inspections or redo already completed work. Thus, this FOAK risk unique to Vogtle created the possibility of a delay to fuel load because of ITAAC closure, licensing challenges, or inadequate QA documentation as this was the first new baseload nuclear plant to be licensed by the NRC under new regulations.

Q. WHAT WERE THE FOAK RISKS RELATED TO THE AP1000 DESIGN?

A. the AP1000 standard design was still being finalized when the construction of the Project began. While this was viewed in the industry as a means of expediting nuclear power plant construction, it also added risk of higher rates of rework as design changes were necessary throughout the Project. Being a FOAK design, unidentified scope risks could arise that could not reasonably be incorporated into the SNC ETC.

In addition, while the initial intent was that multiple licensees could build the same standard plant at the same time without separately having to achieve design approval from the NRC, the abandonment of the VC Summer Plant and the Levy Plant resulted in the Vogtle Project becoming the sole AP1000 project in the United States. This meant that GPC could no longer take advantage of lessons learned and cost sharing as member of a utility owners' group. In addition, while the AP1000 had reduced commodity quantities and a corresponding smaller footprint as compared to the nuclear plants of the 1980s, the smaller footprint contributed to a more congested site, made construction and installation more difficult, and created scheduling challenges.

Q. WERE THERE OTHER FOAK SCOPE RISKS THAT COULD NOT HAVE BEEN REASONABLY INCORPORATED INTO THE SNC ETC?

A. Yes. The lack of other existing AP1000 design plants also posed testing and startup risks. While the Project was prepared to address any problems arising out of the testing of the China units to avoid similar issues at Vogtle Units 3 and 4, there are significant differences between the Chinese AP1000 and the Project as well as differences in the licensing between the two countries. In addition, with the cancellation of the VC Summer nuclear plant, the

burden and cost of any licensing issues that might arise would fall entirely on GPC. As the Project will be the first AP1000 to operate in the United States and the first new nuclear plant in decades, the Project would be subject to an untested and extensive testing regime (ITAAC), which ran the risk of delaying the COD. Again, due to the FOAK nature of the issue, while general testing and startup risks were identified, they could not reasonably have been precisely quantified or mitigated at the time the ETC was being completed in the VCM 17 timeframe (late 2017).

Q. WERE THERE OTHER SIGNIFICANT CHALLENGES ASSOCIATED WITH THE PROJECT IN ADDITION TO THE MEGAPROJECT AND FOAK RISKS?

A. Yes. We discuss the challenges later within **Section X** of our testimony.

V. PRUDENCE EVALUATION PROCESS

Q. HOW DID YOU APPROACH THE PRUDENCE REVIEW OF THE DECISION-MAKING PROCESS?

A. The approach we utilized in the prudence review of Vogtle Units 3 and 4 is consistent with the approach previously adopted in each of the prior prudence reviews conducted by the Pegasus-Global team over the past 35 years, including Vogtle Units 1 and 2. We conducted a qualitative review that focused on the SNC transition plan and the Bechtel Construction Completion Agreement as a basis of moving forward with Vogtle Units 3 and 4 after the Commission's VCM 17 Order, including the utilization of lessons learned from the AP1000 nuclear units in China and from Vogtle Unit 3 for Unit 4. We also reviewed the requirements under which the GPSC will base its review of the Company's filing.

Q. DID YOU REQUEST AND REVIEW PROJECT DOCUMENTS AS PART OF YOUR REVIEW OF GPC'S AND SNC'S MANAGEMENT?

A. Yes. We requested, obtained, and reviewed project documentation to reasonably ensure that the conclusions reached by management were supported by facts. We had access to thousands of documents including those made available by GPC and public documents such as regulatory filings and orders. Documents reviewed included contracts, plans, policies, procedures, reports, presentations, minutes, NRC documents, schedules, etc. A list is included as **Exhibit 3**.

Q. WHY IS THE REVIEW OF PROJECT DOCUMENTATION IMPORTANT IN EVALUATING WHETHER THE DECISIONS OF THE VOGTLE PROJECT MANAGEMENT RELATIVE TO THE COST INCURRED WERE REASONABLE AND PRUDENT?

A. The documentation developed over the life of the Project conveys a number of individual snapshots as well as more complete perspectives of project issues, concerns, problems, policies, changes, responses, and practices, both positive and negative in impact. While not completely definitive, the documentation can provide valuable insight into the larger pattern of events, which can be indicative of underlying conditions and can demonstrate what was known or should reasonably have been known at particular points in time. The project documentation provides a basis to analyze and understand what happened, why it happened, when it happened, when it was known, its effect, and the response to a given event. Project documentation, such as that which we reviewed, is a key component in

developing an overall perspective and assessment of project performance – both effective and ineffective.

Q. CAN A PRUDENCE EVALUATION RELY ENTIRELY ON DOCUMENTATION?

A. No. Documentation alone does not provide a complete or entirely accurate picture of events that have transpired. For instance, not every decision is meticulously documented, and this is consistent with prudent practice, since meticulous documentation of every decision would often waste valuable project resources and unnecessarily negatively impact cost. On the other hand, documents can also be taken out of context and be improperly isolated from the "universe" of documents or broader available information that provide necessary context. While documents may indicate a larger trend or recurring condition, any individual can be influenced by events that are not always identified in documentation. Consequently, documentation must be supplemented by personal interviews to facilitate a broader and deeper appreciation of the project background and provide additional insight into historical events and conditions.

Interviews are a necessary part of fact collection and serve to confirm facts, gather new information, and fill in gaps in documentation. The combination of both document review and personal interviews aids in "rounding out" the clearest possible picture of project history and management performance. Interviews establish the factors which precipitate a condition, result in resolution of a condition, or provide the framework for future management execution.

Q. DID YOU CONDUCT SUCH INTERVIEWS OF GPC AND SNC PERSONNEL?

A. Yes. The Pegasus-Global team and both of us interviewed several key members of the Vogtle Project Management Team. The list of personnel interviewed is provided in **Exhibit 4**.

Q. DID YOU ALSO REVIEW TESTIMONY?

A. Yes, we reviewed testimony in all the VCM proceedings beginning with VCM 17 as well as selected testimony from the Certification filing.

Q. DID YOU ALSO TOUR THE VOGTLE PROJECT SITE?

A. Yes, to gain a full understanding of the scope of the Project and its complexity, we toured the Vogtle Project. Construction projects are not simply "concepts" built on paper; they are physical structures that must be seen to be understood. It is often more difficult to draw a conclusion as to the magnitude and possible impact of a change if one has not seen the conditions within which that change was accomplished.

Q. DO YOU BASE YOUR FINDINGS AND CONCLUSIONS SOLELY ON WHAT THE PROJECT MANAGEMENT TEAM TOLD YOU IN INTERVIEWS AND DURING THE SITE TOURS?

A. No. Evaluation of a large complex project is a cyclical process that starts with the project documentation and records. Having identified the issues and events to be further evaluated, we interviewed those Project personnel with direct knowledge of such issues, yielding additional insight and knowledge, which often leads to the discovery of additional documents or other sources of information that would not otherwise have been identified as relevant to the issue or event. By talking to multiple Project personnel and by examining

the widest possible document base for each issue and event, we assured ourselves that we had sufficient basis to reach informed findings and conclusions relative to each GPC decision evaluated.

Q. HAVE YOU ENCOUNTERED ANY DIFFICULTIES OR PROBLEMS IN GATHERING INFORMATION THAT YOU NEEDED FROM GPC OR SNC?

A. No.

Q. HAS GPC BEEN TRANSPARENT WITH THE INFORMATION REGARDING THE PROJECT WITH THE GPSC, THE CM, AND THE COMMISSION STAFF?

A. Yes. GPC has continued to provide information to the GPSC, the CM, PIA Staff, and PIA Staff's consultants on an on-going basis. In addition, it is our understanding that the CM and PIA Staff attend the Monthly Project Review meetings and also meet monthly with GPC to review the Vogtle Project Management Board ("VPMB") monthly presentations.

Q. HAVE YOU REVIEWED THAT INFORMATION AS WELL?

A. Yes.

VI. PROJECT OVERSIGHT AND MANAGEMENT

Q. PLEASE PROVIDE AN OVERVIEW OF THE POST-WEC BANKRUPTCY PROJECT STRUCTURE.

A. The new Project structure was implemented in 2017 as part of the Project Transition through the Georgia Power Project Oversight organization and is led by GPC's Nuclear

Development Senior Vice President.[15] This organization has comprehensive responsibilities covering the following areas:[16]

- Project performance: overseeing the metrics and reporting for overall Project performance (including engineering, procurement, and construction) and communication of such information to GPC and Co-Owner leadership; responsible for overseeing completion of direct construction and non-construction milestones that ultimately support the cost and schedule of the Project.
- Schedule oversight: overseeing the integrated Project schedule, monitoring whether Bechtel is achieving milestones as planned, focusing on critical path activities, and progressing towards the targeted in-service dates; responsible for overseeing schedule-related metrics and reporting to measure schedule performance.
- Financial oversight: tracking expenditures against projections to account for variances and to remedy them accordingly. GPC independently reviews and assesses outputs from the Project Business Operations organization, including reviewing system inputs and ensuring reconciliations to the financial general ledger. GPC established a Financial Review Board ("FRB") to review and assess Project financial metrics, trends, and issues as highlighted in VPMB materials.

[15] Plant Vogtle Units 3 and 4 Project Execution Plan ("PEP"), Version 8.1, April 2018, p. 9.
[16] Plant Vogtle Units 3 and 4 PEP, Version 8.1, April 2018, pp. 10-11.

- Risk oversight: responsible for ensuring effective processes are in place to identify, assess, report, and mitigate Project risks; manages the identification and mitigation of risks with the greatest potential to affect the Project and ensures these risks are communicated to Project leadership and addressed to mitigate potential impacts on schedule and/or cost.
- Site Operations oversight: overseeing operations with a focus on all aspects of the Project that support testing, startup, and preparation to operate.

Under the new Project structure, SNC serves as the main Project contractor with ultimate responsibility for successful completion of the Project on behalf of the Co-Owners including GPC. Bechtel, as the primary construction contractor, manages the overall execution and direction of day-to-day Project activities. WEC retained engineering design authority but under SNC direction.

Q. WHAT GOVERNING BOARDS WERE ESTABLISHED TO OVERSEE THE PROJECT?

A. As part of the new Project structure, in addition to oversight by the GPC and Southern Company Boards of Directors ("BODs"), GPC implemented different governing boards to provide specific oversight to various elements of the Project. These governing boards included:

- The FRB was established in 2019 and charged with oversight of the Project with regard to financial matters including cost estimates and risk management. It is comprised of the GPC senior executives including the Chief Financial Officer ("CFO"), Senior Vice President of Nuclear Development, Comptroller,

and legal counsel. The SNC CFO, among other Project leaders, retains a standing invitation. The FRB oversees cost and schedule changes that may impact the approved budget and maintains alignment for disclosures and forecasting.

- The Vogtle Expansion Oversight Committee ("VEOC") provides broad oversight of GPC's activities and obligations in connection with the Project. It is led by the CEO of Southern Company and is comprised of the CEO of GPC, the CFO of Southern Company, the COO of Southern Company, and the CEO of Alabama Power.
- The VPMB reviews major decisions and provides a forum for review and discussion of relevant Project information, including monthly reviews of safety, quality, performance, and cost. The VPMB reviews and approves each semi-annual budget prior to the budget being submitted to the GPSC as part of the VCM filing.[17] It is comprised of senior executive representatives from various GPC functional disciplines (power generation, project development, budgeting and financing, external affairs, etc.) and the other Vogtle Co-Owners are invited to attend the meetings.
- The Vogtle Construction Review Board ("VCRB") provided strategic advice to the Chairman, President and CEO of SNC on the execution of the Project. The VCRB was chaired by Luis Reyes, who previously worked at the NRC and has

[17] VGT 3.0 Monthly Cost/Budget-to-Actual Review, March 22, p. 8.

provided expert advice to several nuclear organizations and included other representatives with vast nuclear and construction industry experience.[18]

Q. WHAT WAS THE ROLE OF THE GPC BOARD OF DIRECTORS IN THE PROJECT OVERSIGHT AND MANAGEMENT?

A. The GPC BOD provided oversight of GPC's share of Vogtle Units 3 and 4, GPC's management of oversight on the Project, oversight of SNC's execution role, and the VPMB. Each GPC BOD committee had specific oversight responsibilities as follows:[19]

- Controls and Compliance Committee: provides oversight of Project financial controls and procedures, including oversight of the Company's internal controls, compliance, ethics, and employee concerns.
- Finance Committee: provides oversight of the capital budget and financing costs.
- Nuclear Committee: provides oversight of construction activities.

[18] As of September 2020, the VCRB transitioned into the Nuclear Safety Review Board ("NSRB") to reflect the Project's transition from construction into testing and startup.
[19] Plant Vogtle Units 3 and 4 PEP, Version 8.1, April 2018, p. 7.

Q. WHAT WAS THE ROLE OF SOUTHERN COMPANY'S BOARD OF DIRECTORS IN THE PROJECT OVERSIGHT AND MANAGEMENT?

A. The Southern Company BOD provided oversight of Southern Company's management of GPC and the construction of the Project. Each Southern Company BOD committee had specific oversight responsibilities as follows:[20]

- Audit Committee: approves financial statements for filings with the Securities and Exchange Commission ("SEC").
- Finance Committee: reviews and recommends approval of financial plans and equity contributions to subsidiaries.
- Nuclear/Operations Committee: reviews and oversees the Company's primary operating segments (nuclear operations, power generation, etc.).

Q WHAT INFORMATION WAS COMMUNICATED TO THE BOARDS OF DIRECTORS AND WHAT DECISIONS DID THEY MAKE?

A. The Georgia Power and Southern Company BODs received updates at each board meeting on the Project. These updates included information about cost, schedule, contingency, risk management, construction progress, and challenges.[21] Following the WEC bankruptcy, the Southern Company BOD gave approval to go forward with the Project but set conditions related to regulatory approvals.[22] The GPC Board makes recommendations to the Southern Company BOD to provide the funding for the Project, including funding for contingency.[23]

[20] Plant Vogtle Units 3 and 4 PEP, Version 8.1, April 2018, pp. 6-7.
[21] e.g., August 15, 2018, presentation to the GPC BOD; October 16, 2018, Joint Boards of Directors for GPC and Southern Company Meeting Presentation.
[22] Minutes for Special Meeting of the Southern Company BOD, August 30, 2017.
[23] e.g., August 2, 2018, minutes of GPC BOD meeting.

Q. WHAT WERE YOUR FINDINGS AND CONCLUSIONS PERTAINING TO EXECUTIVE AND CORPORATE MANAGEMENT AND OVERSIGHT OF THE VOGTLE PROJECT?

A. We concluded that GPC and Southern Company senior management, executive management, and the BODs: (i) had an effective oversight process in place; (ii) focused on important Vogtle Project issues; (iii) participated fully in strategic decisions; and (iv) have remained active in issue resolution, being fully informed and engaged throughout the Vogtle Project execution. Based on our experience and extensive analysis of senior executive and board involvement, we concluded that the management oversight process was thorough, complete, and consistent with what would be expected of a reasonable and prudent utility.

VII. PROJECT POLICIES, PROCEDURES AND CONTROLS

A. APPLICABLE STANDARDS FOR EVALUATION OF POLICIES, PROCEDURES, AND CONTROLS

Q. WHAT INDUSTRY STANDARDS DID YOU RELY ON TO EVALUATE THE PRUDENCY OF SNC'S PROJECT POLICIES, PROCEDURES, AND CONTROLS?

A. In addition to the vast experience we have had on similar projects, we relied primarily on industry standards published by the Project Management Institute ("PMI"), the Association for the Advancement of Cost Engineering International ("AACE"), and the Construction Management Association of America ("CMAA"), all which develop standards that suggest best practices in the execution of projects.

Q. DID YOU REVIEW THE INDUSTRY STANDARDS THAT WERE IN EFFECT AT THE TIME OF THE PERIOD OF YOUR REVIEW?

A. Yes. Many industry standards we have used in our review have been updated. We reviewed SNC's policies and procedures that were in effect at the time of the transition from the WEC Engineering, Procurement, and Construction ("EPC") structure to the SNC/Bechtel structure (the "Project Transition") and as updated through the execution of the Project.

Q. DID YOU REVIEW THE STANDARDS IN LIGHT OF GPC'S EXECUTION OF THE PROJECT?

A. Yes, we reviewed GPC's and SNC's execution over the course of the Project beginning with VCM 17 to assess whether the policies and procedures in place, as updated, were consistent with the evolution of industry standards over the same time period.

B. PROJECT POLICIES AND PROCEDURES

Q. WHAT PROJECT PLANS, POLICIES, AND PROCEDURES DID YOU REVIEW?

A. Our review of policies and procedures began with those in place at the time of the Project Transition and continued with those in place today. **Exhibit 5** provides a list of the plans, policies, and procedures we reviewed.

Q. DID YOU FIND THAT THE GPC AND SNC POLICIES AND PROCEDURES WERE CONSISTENT WITH THE UPDATES TO THE INDUSTRY STANDARDS IN EFFECT AT THE TIME OF POLICY AND PROCEDURE UPDATES?

A. Yes.

Q. WERE THE PROJECT POLICIES AND PROCEDURES TYPICAL OF WHAT YOU HAVE USED AND FOUND ON OTHER POWER PLANT PROJECTS?

A. Yes, the policies and procedures are typical of what we have used and found on other large projects of this size, magnitude, and complexity.

C. PROJECT CONTROLS

Q. WHAT ARE "PROJECT CONTROLS"?

A. "Project Controls" is a general term of art within the construction industry, which denotes those systems used by management to enable it to measure progress toward a project objective, evaluate the work remaining to be completed to achieve that project objective, and report the status information gathered to project management in a timely manner. These controls enable project management to take necessary corrective action to achieve the project objective.

For the purposes of our prudence evaluation of the Vogtle Project, we examined the following project control processes, each of which is examined in greater detail elsewhere within this testimony:

- Scope and Change Control Management;
- Schedule Management;
- Cost Management;
- Risk Management;
- Project Controls Reporting; and
- Lessons Learned Management.

These functions represent the core of program management and, as such, are most integral to the overall success of the Project.

Q. WHAT ARE THE KEY ELEMENTS OF PROJECT CONTROLS?

A. Project controls refers to a set of tools and processes that enable project management to: (1) plan and establish cost and schedule baselines for the project; (2) monitor and measure the current project conditions and progress against the baseline plan; (3) evaluate that data within the context of trends or forecasts to predict costs and schedule dates at completion; and (4) have the contextual information that can allow for corrective actions, if necessary.[24] Depending on the specific conditions of a given project, the project controls on a given project are typically customized to meet the needs of the project's owner and typically evolve over the course of the project.

Q. WHAT ARE THE PRIMARY TYPES OF PROJECT CONTROLS?

A. In the construction industry, the primary controls pertain to cost/change controls and schedule/progress controls, given the importance of cost and schedule to the overall performance of the Project. These elements are updated through the forecasting and earned value management processes in addition to being highly aligned with risk controls because realized risks generally have an associated cost and/or schedule impact. Similarly, the reporting of these elements of project controls conveys a project's status to project management and other stakeholders. In addition, projects such as Vogtle Units 3 and 4 also

[24] AACE International, Recommended Practice 10S-90: Cost Engineering Terminology, p. 97, May 15, 2023.

benefit from lessons learned from similar plants and prior unit completion (e.g., lessons learned from Unit 3 that are then applied to Unit 4).

Q. IS IT POSSIBLE TO RIGIDLY FOLLOW AN EXECUTION PLAN SET EARLY IN A PROJECT FOR THE PROJECT'S ENTIRE DURATION?

A. Typically, no. Construction projects are inherently executed within a dynamic environment, and these projects can be influenced by a myriad of factors, events, and issues arising during the project's execution. As PMI notes, "Plans may need to be revised or new plans developed to account for events or conditions that emerge."[25] Regular reviews and evaluations of the project plans and processes allow the project management team to implement continuous improvements to the plans and processes in place as more detailed and specific information is obtained.

Q. DESCRIBE THE PROJECT CONTROLS STRUCTURE FOR THE PROJECT.

A. Following the Project Transition, the Project Controls function was placed in the Business Operations Group, separate from the Construction Group with cost, schedule, and risk under the same leadership structure as all three are related. This separation ensured the Project Controls Function was not overly influenced by the Construction Team and vice versa.[26]

[25] PMI, *A Guide to the Project Management Body of Knowledge ("PMBOK® Guide") – Seventh Edition,* p. 67 (2021).
[26] July 2018 Monthly Status Report, August 20, 2018, p. 25.

Q. WHAT WERE THE ADVANTAGES OF HAVING SCHEDULE, COST, AND RISK UNDER THE SAME LEADERSHIP STRUCTURE?

A. Schedule, cost, and risk are project control tools that in our experience provide a more robust analysis of a project's status when they are aligned.

Q. DID THE TRANSITION OF PROJECT CONTROLS FROM HOW IT HAD BEEN PREVIOUSLY PERFORMED UNDER THE EPC CONSORTIUM TAKE TIME?

A. Yes. Our review of the project record determined that it took approximately six months to have a reasonable base for projections and a risk adjusted schedule, which in our experience was a reasonable period to undertake this alignment and to get all the parties aligned with the rigid schedule, cost, risk and reporting process.

D. PROJECT SCOPE AND CHANGE MANAGEMENT

Q. WHAT ARE THE GENERAL OBJECTIVES OF SCOPE AND CHANGE MANAGEMENT?

A. Project changes are inevitable and so some type of change control process is necessary. The change control process involves a change order process that controls changes in scope, schedule, and cost as measured against an established baseline. The objectives are to ensure change is managed effectively; that changes are documented, reviewed, and approved (or disapproved); that risks response strategies are employed to minimize impacts on cost and schedule; and that changes are effectively communicated.

Q. ARE THERE INDUSTRY STANDARDS TYPICALLY USED FOR MANAGING CHANGES ON A PROJECT?

A. Within the construction industry there are a number of ways in which changes can be managed that include common practices such as having change requests include estimated cost and schedule impacts and may include utilization of a Change Control Board ("CCB") to review, evaluate, and approve, defer, or reject proposed changes.[27] While these types of practices and processes are key to managing change, as noted by the CMAA in its Cost Management Guidelines, "Change order control is more of an art than a science…. There are no exact solutions…."[28]

Q. WHAT PROCEDURES WERE USED FOR SCOPE AND CHANGE MANAGEMENT?

A. SNC utilized a change control procedure for monitoring, controlling, and approving changes in cost, schedule, or scope against approved performance measurement baselines. The procedure was modified over the course of the Project.[29] The change control process is under the control of the CCB, which is made up of SNC leadership involved in Vogtle Units 3 and 4.[30] The change control procedure outlines the process by which changes are identified and documented. It identifies the threshold for presentation to the CCB and the circumstances under which the Vogtle Co-Owners may need to be notified or approve changes.[31]

[27] PMI, *PMBOK® Guide – Sixth Edition,* p. 115 (2017).
[28] CMAA, *Cost Management Procedures*, 2018 Edition, p. 78.
[29] SNC Change Control Procedure, ND-PC-VNP-006, Version 2, p. 4; Version 3, p. 4; Version 4, p. 4.
[30] SNC Change Control Procedure, ND-PC-VNP-006, Version 2, p. 7; Version 3, p. 10; Version 4, p. 8.
[31] SNC Change Control Procedure, ND-PC-VNP-006, Version 3, pp. 15, 21; Version 4, pp. 12, 15.

Q. HOW WAS THE SCOPE AND CHANGE PROCESS UTILIZED ON THE PROJECT?

A. Change control was overseen by the CCB utilizing Change Control Forms ("CCFs") to document proposed changes. CCFs are used for a wide variety of reasons, including adding scope and costs, releasing funds previously approved, changing the funding source, reductions in cost, etc. Over time, CCFs were used to document monthly the cumulative impact of approvals below the CCB threshold, such as CCFs approved by the Site Project Managers. The CCFs also tracked Bechtel Trends and WEC Project Impact Notifications, including having a box designated for if a change is specific to the Bechtel Construction Completion Agreement ("CCA").

Each CCF that meets the requirements for CCB approval is presented at a CCB meeting and its disposition recorded. The minutes document discussion of the requested change. Occasionally, the CCF is not approved or altered in some way by the CCB. The Cost Control Process evolved over time, which we find reasonable, but was effective in monitoring and evaluating changes to the Project.

Q. IS THIS PROCESS TYPICAL OF WHAT YOU FIND IN OTHER POWER PLANT PROJECTS ON WHICH YOU HAVE WORKED?

A. Yes, the process is consistent with what we have experienced on other power projects and is typical for a large construction project the size, magnitude, and complexity of the Vogtle Project.

E. SCHEDULE CONTROLS

Q. WHAT ARE THE GENERAL OBJECTIVES OF PROJECT SCHEDULE CONTROLS?

A. The general objectives of schedule controls are to identify what activities are of a critical nature (and the relationship those activities have to one another), how the various vendors' or contractors' activities relate to the critical path, and to track progress to ensure the project meets certain key milestones, including overall completion. A schedule is not a "once and done" activity; as the PMBOK® Guide notes, "Developing an acceptable project schedule is an iterative process."[32]

Q. WHAT SCHEDULE MANAGEMENT POLICIES, PROCEDURES AND PROCESSES WERE UTILIZED ON THE PROJECT?

A. Prior to the WEC bankruptcy and through VCM 16, the Consortium was responsible for the development of the initial Integrated Project Schedule ("IPS"), which was attached to the EPC Agreement with GPC. The IPS was developed as the means and methods by which the Project was to be executed. The Consortium was accountable to GPC for the IPS and was required to monitor and report its progress in completing Project work in accordance with the IPS.

Following the WEC bankruptcy, GPC made the decision to oversee the overall Project Schedule, which was incorporated into the overall IPS that was filed with the Commission in VCM 17. As discussed in **Section X** below, SNC made the decision to monitor construction progress utilizing an aggressive target schedule. After the transition planning

[32] PMI, *A Guide to the Project Management Body of Knowledge ("PMBOK® Guide") – Sixth Edition,* p. 207 (2017).

was complete, SNC controlled the IPS schedule development process with the Vogtle Units 3 and 4 Scheduling Desktop Guideline.[33] This guideline defined the division of responsibilities and the schedule development, updating and maintenance processes. These processes included the directions for critical path determination and the process for updating the schedule weekly.

Q. DOES THE FACT THAT THE IPS CONTAINED 200,000+ ACTIVITIES MAKE IT AN UNREASONABLE SCHEDULE THAT COULD NOT BE UTILIZED TO MANAGE THE PROJECT'S PROGRESS?

A. No. The IPS was more detailed than is typically seen on a construction project as he IPS developed for the Vogtle Project broke down the Project into mini projects of more detail that reflected the work to be performed in "Work Packages." It should be noted that while the overall schedule network had over 200,000 activities, the number of open activities that are actively managed was far less at any given data date. For example, in 2020, in-progress activities were between 4,300 and 4,700 across the mini projects.

Q. IS IT INDUSTRY STANDARD FOR THE LEVEL AND DETAIL OF THE CRITICAL PATH METHOD ("CPM") SCHEDULE TO EVOLVE?

A. Yes. The IPS had the appropriate level of detail in the areas of the schedule that were expected to be needed at various timeframes over the course of the Project to support the engineering, procurement, and construction activities scheduled to be completed in that same timeframe.

[33] Southern Nuclear, Vogtle Units 3 and 4 Scheduling Desktop Guideline Revision 6, (September 7, 2018) p. 4.

Q. HOW WAS THE SCHEDULE PROGRESS REVIEWED ON THE PROJECT?

A. Schedule progress was reviewed weekly in a couple of different ways. First, the critical paths were analyzed at the end of each week by performing a backward pass from the Substantial Completion milestone dates for each unit back to the current week's activities. The results of this analysis were circulated to the site scheduling team and construction personnel for concurrence. Any negativity in either Unit's schedule was monitored daily and required mitigation from the appropriate team. In addition, planned scheduled hours for the week were compared to the weekly earned hours to determine the Schedule Performance Index ("SPI") value.

Q. HOW WAS SCHEDULE PERFORMANCE DETERMINED ON THE PROJECT?

A. Schedule performance was measured using the industry best practices method of comparing planned hours divided by earned hours to determine the SPI. These SPI calculations, when evaluated over time, contributed to a trend analysis, which assisted in determining schedule modifications such as the need for re-baselining.

Q. DO CHANGES TO PROJECT MILESTONES OR RE-BASELINING OF THE SCHEDULE INDICATE THAT SCHEDULE CONTROLS ARE DEFICIENT?

A. No. As indicated above, schedule controls are designed to monitor the status of project activities, to update project progress, and to manage changes to the schedule baseline. Unexpected events occur on large complex projects and can delay the completion of impacted project milestones. Schedule controls do not cause such events; they help to monitor the effect such unexpected events may have and help to inform the appropriate adjustments to the underlying schedule.

Q. IS IT TYPICAL FOR AN IPS TO EVOLVE OVER THE COURSE OF THE PROJECT?

A. Yes. As we testified earlier, the IPS typically evolves over the course of delivering a project. It is even more common and typical in megaprojects like the Vogtle Project for the IPS to be improved and become more detailed as additional information becomes available, such as the completion of engineering to inform specific construction installation activities.

Q. IS THE IPS THE ONLY MEANS BY WHICH UTILITIES OVERSEE AND MONITOR THE WORK BEING EXECUTED?

A. No. Standard utility practice is not to solely rely on the IPS to oversee and monitor the execution of the work, but to utilize other project control tools and processes that provide more current and reliable information upon which to assist in taking reasonable and prudent actions and decisions.

Q. IS THE IPS THE ONLY METHOD ON THE VOGTLE PROJECT THAT IS BEING USED BY GPC AND SNC TO OVERSEE AND MONITOR THE WORK BEING EXECUTED?

A. No. GPC and SNC used other project control tools and processes that were instituted on the Project and by which GPC reasonably and prudently has been able to oversee the Project's progress and schedule adherence.

Q. WHAT OTHER METHOD WAS UTLIZED ON THE PROJECT TO MEASURE PROGRESS, MONITOR THE CRITICAL PATH ACTIVITIES AND REPORT ON PROGRESS PLANNED AND ACHIEVED?

A. Progress was also monitored using an Earned Value Management ("EVM") system, which is a common method in the industry used to measure construction progress. These calculations, when evaluated over time, inform a trend analysis that assists in the cost forecasting process.

Q. WHAT WERE YOUR CONCLUSIONS REGARDING THE USE OF THE SNC/BECHTEL EVM SYSTEM FOR MONITORING SCHEDULE?

A. A review of the EVM methodology applied on the Project shows that the Project captured earned value metrics for assessing performance that aligned with industry standards by using the same or similar terminology/definitions, and establishing and maintaining performance measurement baseline, change control, and periodic reviews of ETC and EAC.[34]

Q. IN YOUR REVIEW OF THE VOGTLE PROJECT, DID YOU FIND ANY EVIDENCE OF INADEQUATE SCHEDULE CONTROLS THAT CAUSED INEFFICIENCIES?

A. No. The scheduling controls used at the Vogtle Project were appropriate and in line with what is expected in typical large projects of comparable size, scope, and complexity to the Project. In our experience, it is appropriate to use desktop procedures, which are project specific and more detailed than typical company procedures. In addition, SNC's use of a Work Package based schedule is not only more detailed but also a more robust method of controlling a project than a typical Level 3 schedule.

[34] SNC, Vogtle 3 & 4 Project Cost Management Group, Cost Management Guideline, Revision 6, (January 6, 2021).

Q. WAS THE SCHEDULE EVOLUTION PROCESS THAT YOU ASSESSED ON THE VOGTLE PROJECT SIMILAR TO THE SCHEDULE EVOLUTION YOU HAVE SEEN ON OTHER MEGAPROJECTS OF THE SAME COMPLEXITY AS VOGTLE?

A. Yes. The schedule development evolution as we have described is the same process used on other megaprojects in which we have been involved.

Q. ARE THE SCHEDULE CONTROL PROCESSES TYPICAL OF WHAT YOU HAVE FOUND ON OTHER POWER PLANT PROJECTS?

A. Yes, except these processes are much more robust than that of what we have found on some other large projects of a similar size, magnitude, and complexity. Scheduling by work package does not occur on the majority of the plants we have reviewed.

F. COST CONTROLS

Q. WHAT ARE THE GENERAL OBJECTIVES OF COST CONTROLS?

A. In general, as described in industry standards such as the PMBOK and CMAA, cost controls are concerned with tracking and recording the costs incurred on a project. This is done by comparing the specific cost categories established and estimated for the project to what is being incurred for each cost category.[35]

[35] PMI, *PMBOK® Guide – Sixth Edition*, p. 259 (2017); CMAA, *Construction Management Standards of Practice*, 2015 Edition, p. 25.

Q. WHAT COST CONTROLS PROCEDURES WERE USED ON THE PROJECT?

A. SNC utilized a Cost Management Guideline on the Project that provided recommended approaches for budgeting, cost tracking, and cost analysis and control on the Project.[36] The Cost Management Guideline establishes the roles and responsibilities of those involved in the cost management processes and the fundamental approach to cost management on the Project. The Cost Management Guideline detailed the methodologies for: developing a detailed code of account structure; establishing the budget; tracking and controlling costs against the budget; forecasting the final cost of the Project; identifying and assessing cost impacts and variances; managing project uncertainty in the cost forecasts; and reporting cost data and trends.[37] The contents of the Cost Management Guideline align with what PMI prescribes for planning cost management, which is "…the process of defining how the project costs will be estimated, budgeted, managed, monitored, and controlled."[38]

The Cost Management Guideline identified the steps involved in generating cost reports and established two primary levels of cost reporting: 1) management reports (essentially overall Project costs); and 2) functional reports (detailed reports used to manage costs by cost owners and functional group leads).[39] It also established minimum reporting guidelines that included monthly variance explanations, EAC variance explanations, cash flows, resource utilization curves, action items, and risks/opportunities. The cost control

[36] SNC, Vogtle 3 & 4 Project Cost Management Group, Cost Management Guideline, Revision 6, (January 6, 2021).
[37] SNC, Vogtle 3 & 4 Project Cost Management Group, Cost Management Guideline, Revision 6, (January 6, 2021), p. 5.
[38] PMI, *PMBOK® Guide – Sixth Edition,* p. 235 (2017).
[39] SNC, Vogtle 3 & 4 Project Cost Management Group, Cost Management Guideline, Revision 6, (January 6, 2021), p. 31.

process enables the cost management team to measure the project's status relative to the budget and explain and report variances monthly.[40] The budget to actual process requires a monthly cost budget to actual review and reforecast process in place to allocate costs and analyze budget versus actual variances.[41]

Q. WHO HAD RESPONSIBILITY FOR MONITORING THE FORECASTED AND ACTUAL COSTS AND UPDATING THE ETC AND PROJECT BUDGET?

A. The Cost Management Team under the direction of the Project Controls Vice President was responsible for tracking and controlling actual costs against the budget, forecasting the final cost of the Project, and updating the budget every six months in alignment with the VCM periods.[42]

Q. HOW WERE COSTS REPORTED ON THE PROJECT?

A. SNC held recurring monthly cost review meetings with Functional Group Managers, Department Cost Owners, the Cost Management Manager, Cost Analysts, the Project Vice President, and others as necessary as part of the process for reviewing and communicating changes to the Vogtle Units 3 and 4 cost projections. These meetings gave Project leaders an opportunity to review the budget vs. actual analysis prior to the Monthly Cost/Challenge Meetings with site leadership. Project leaders also reviewed the updated forecast. There were also Risk Management Working Group ("RMWG") meetings to review "high" or

[40] SNC, Vogtle 3 & 4 Project Cost Management Group, Cost Management Guideline, Revision 6, (January 6, 2021), pp. 16-19.
[41] SNC, Vogtle 3 & 4 Project Cost Management Group, Cost Management Guideline, Revision 6, (January 6, 2021), p. 22.
[42] SNC, Vogtle 3 & 4 Project Cost Management Group, Cost Management Guideline, Revision 6, (January 6, 2021); Docket No. 29849, Response to STF-28-9, February 2022 Update.

"very high" risk events and to ensure proper risk management functions, processes, and structure around the Project. Each month, cost and schedule updates were discussed with GPC and SNC leaders and the Co-Owners through the various governing boards.[43] In addition, updates on the cost and schedule are provided monthly to the Commission and the CM.[44]

Q. DID THE MONITORING OF COSTS LEAD TO UPDATES IN THE ESTIMATES TO COMPLETE AND ESTIMATES AT COMPLETION?

A. Yes. In addition to the update to the ETC and EAC at VCM 17, the ETC and EAC were updated monthly, and those updates were reflected in each VCM filed with the Commission. These major updates are discussed below in the Key Challenges and Decisions in **Section X**.

Q. THE PROJECT WILL BE COMPLETED AT A COST WELL ABOVE THE ORIGINAL ESTIMATE. IS THAT EVIDENCE OF IMPRUDENCE ON THE PART OF GPC AND SNC?

A. Not necessarily, as we previously referenced, assessing prudence involves determining if decisions were made in a reasonable manner in light of conditions and circumstances which were known or reasonably should have been known when the decision was made. From a cost perspective, this often centers around an evaluation of the information and decisions made in establishing the baseline cost budgets and understanding the decisions and other

[43] SNC Vogtle Process Controls Narrative, VGT 3.0 Monthly Cost/Budget to Actual Review, Version 3, March 2022.
[44] e.g., July 2018 Monthly Status Report, August 20, 2018.

cost drivers that influence the actual costs incurred. We review these cost drivers and the surrounding decisions later within **Section X.B.**

Q. ARE THE COST CONTROL PROCESSES TYPICAL OF WHAT YOU HAVE FOUND ON OTHER POWER PLANT PROJECTS?

A. Yes, these processes are typical of what we have found on other large projects of this size, magnitude, and complexity.

G. RISK CONTROLS/CONTINGENCY

Q. WHAT ARE THE GENERAL OBJECTIVES OF RISK MANAGEMENT?

A. As described in industry standards, the basic objective of risk management is to identify and mitigate the impact of challenges to the project, as well as to optimize the likelihood of realizing positive impacts to the project.[45] Typically, identifiable risks are reviewed for probability and impact, as well as being assigned a category (e.g., cost, schedule, technology, etc.) and a responsible party for monitoring a specific risk.

Q. WHAT PROCESSES ARE INVOLVED IN PERFORMING RISK MANAGEMENT?

A. Industry standard risk management processes include risk management planning, risk identification, risk analysis, risk response planning and implementation, and monitoring and reporting of risk on the project.[46]

[45] CMAA, *Construction Management Standards of Practice*, 2015 Edition, p. 127.
[46] PMI, *PMBOK® Guide – Sixth Edition,* p. 395 (2017).

Q. WHAT DID SNC DO TO ENSURE EFFECTIVE RISK MANAGEMENT PROCESSES WERE IN PLACE ON THE PROJECT?

A. To ensure effective risk management processes were in place on the Project, SNC planned, developed, and implemented a Risk Management Program for the Project.[47] The Risk Management Program defined risk management roles and responsibilities in addition to detailing the risk management process itself. Risks were not only identified, but response strategies were also developed to avoid, transfer, mitigate, or accept the risks. Specific actions were taken to implement the selected strategies.[48]

Q. WHAT WERE THE PRIMARY ROLES AND RESPONSIBILITIES IDENTIFIED FOR RISK MANAGEMENT?

A. Risk management for the Project was an iterative effort performed across the executive, senior, and project management groups with different responsibilities assigned to each group to collectively support the implementation of risk management on the Project. Implementation of the Risk Management Program was largely the responsibility of the Risk Management Group that developed and maintained the risk management processes and tools, monitored the status of risk management activities, and reported the current status of such activities to senior management. The health of the Risk Management Program was monitored by the RMWG, which was chaired by the Project Controls Director and comprised of the director/manager leadership team. The RMWG also participated in monthly risk management meetings, providing concurrence to high and very

[47] SNC Risk Management Program, ND-PC-VNP-010, Version 3.0, August 27, 2020.
[48] e.g., There was also a risk closure process whereby, upon reaching a probability threshold (e.g., greater than 80% probability of occurrence), the cost of the risk was transferred from project contingency to the appropriate project line-item budget through the change control process.

high-risk statuses. The executive leadership team participated in quarterly challenge reviews of the risk register to ensure all significant project risks were identified and were actively being managed.[49]

Q. HOW WERE RISKS COMMUNICATED ON THE PROJECT AND TO PROJECT EXECUTIVE MANAGEMENT?

A. While the risk register itself served as a primary document that communicated the risks and their respective statuses to the project participants, risks were also communicated through the RMWG meetings, risk workshops/reviews, and quarterly meetings with senior executives. For example, SNC's monthly project review meetings highlight top risks from the reporting period for review and discussion; the VPMB reviews and discusses the key risks during its meetings; and key risks are presented as part of the Project updates presented to the Southern Company and GPC BODs.[50] Risks are also communicated to the Commission and Staff via GPC's monthly status reports through Staff's request STF-142-4, which requests monthly risk updates.

Q. DID BECHTEL PARTICIPATE IN THE RISK MANAGEMENT EFFORTS ON THE PROJECT?

A. Yes. Bechtel was responsible for performing risk management over its scope of work. Its risk management practices were similar in function to those of SNC, such as monthly risk reviews and risk register updates. In addition, SNC's risk manager conducted monthly reviews of Bechtel's risk register to assess for variances and/or gaps between Bechtel and

[49] SNC Risk Management Program, ND-PC-VNP-010, Version 3.0, pp. 6-8, August 27, 2020.
[50] e.g., Project Executive Review Meeting, slides 7-9, 14, 19, April 23, 2021.

SNC's risk registers to ensure qualified risks were captured and being managed appropriately.

Q. DO THE RISK MANAGEMENT PROCESSES ESTABLISHED ON THE PROJECT ALIGN WITH INDUSTRY STANDARDS?

A. Yes. The Risk Management Program established for the Project is more granular in its detail, which is expected from a Project-specific process compared to a broader industry standard, but the Risk Management Program contained all the fundamental processes described within industry standards. In addition, the Project Management Team monitored and reviewed the implementation of the Risk Management Program during execution of the Project and updated it as needed.

Q. WAS THE RISK MANAGEMENT PROCESS TYPICAL OF WHAT YOU HAVE FOUND ON OTHER POWER PLANT PROJECTS?

A. Yes, the risk management process is typical of what we have experienced on other large projects of this size, magnitude, and complexity.

Q. HOW DOES RISK MANAGEMENT INFORM THE CURRENT VIEW OF CONTINGENCY FOR THE PROJECT?

A. Overall project contingency is managed by SNC with the contingency balance informed by an assessment of the project risks. The project team utilizes the risk register, reviews the work to-go, assesses risks and opportunities across each functional area, including looking at both short-term and long-term risks and impacts. Based on this review of risk

items, cost drivers, and schedule and site performance, the project team presents a contingency forecast for management approval.

Q. HOW WAS CONTINGENCY DEVELOPED?

A. There were multiple types of contingency on the Project: SNC Project contingency; SNC management reserve; Bechtel construction contingency; Bechtel management reserve; and SNC schedule reserve. We discuss each of these below.

As part of the Project Transition, SNC recalculated the necessary contingency for the Project. SNC considered the updated Risk Register, as well as the risks associated with the risk of VC Summer cancellation and the potential need for craft per diem. SNC arrived at updated contingency for the Project of $1.1 billion, which included $400 million of management reserves. Management reserves were unallocated but were reserved in part for Cost Performance Index ("CPI") performance gaps for construction execution. The category also accounts for unknowns, i.e., issues that will be encountered during construction that have not been foreseen.[51]

Schedule contingency was established during the VCM 17 process to represent the delta between the +23 and the +29 ETC.[52] The contingency level was adjusted as the Project schedule was updated.[53] (See discussion below for definitions and details on the "+23" and "+29" schedules.)

[51] GPSC Docket No. 29849, VCM 17 Report, pp. 15-17 of ETC; Master List of all Staff Data Requests, Response to STF-123-4, p. 2397.
[52] ETC Variance Difference Background.
[53] Review of VCM Top-Bottom.

Bechtel also established a construction contingency and a management reserve. Bechtel established a drawdown plan, which it monitored over the course of the Project.[54] The monthly cost review included a review of SNC contingency, including the need for drawdowns or additions. SNC also reported on the level of Bechtel construction contingency and management reserve.[55] Presentations to the VPMB, GPC BOD, and Southern Company BOD included information on the status of contingency.[56]

Q. HOW WAS SNC CONTINGENCY FUNDED?

A. The VPMB monitored the level of contingency and approved additional funding as needed. If the request impacted Southern Company's financial plan, GPC requested approval by the Southern Company BOD.[57]

Q. IS CONTINGENCY EXPECTED TO BE SPENT ON A PROJECT?

A. Yes, as noted by the AACE, contingency is: [58]

> … [a]n amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs…and is expected to be expended.

Q. WAS THE CONTINGENCY PROCESS TYPICAL OF WHAT YOU HAVE FOUND ON OTHER POWER PLANT PROJECTS?

[54] e.g., Bechtel Monthly Status Report, February 2021.
[55] GPSC Docket No. 29849, VCM 19 GPC Testimony of Haswell/McKinney, p. 12; Minutes of Southern Company BOD, August 30, 2017, pp. 3-4.
[56] e.g., January 28, 2020, presentation to VPMB, slides 15-16; December 9, 2019, presentation to Southern Company BOD, slides 11-12; August 18, 2021, presentation to GPC BOD, slides 7 & 9.
[57] e.g., Minutes for Special Meeting of the Southern Company BOD, August 30, 2017.
[58] AACE Recommended Practice No. 10-90, "Cost Engineering Terminology", p. 26, October 8, 2018.

A. Yes, the contingency process is typical of what we have experienced on other large projects of this size, magnitude, and complexity.

H. PROJECT CONTROLS REPORTING

Q. WHAT ARE THE GENERAL OBJECTIVES OF PROJECT CONTROLS REPORTING?

A. The main objective of reporting is to provide the necessary information to project management in a reasonable time and in an understandable format that allows management to make the necessary decisions based on the project's reported status. As noted above, decision-making requires information flow as part of the process. Project reporting offers a collection of performance data to monitor the project.

Q. CAN YOU DESCRIBE THE BASIC PROGRESS REPORTING PROCESS USED ON THIS PROJECT?

A. Progress reporting on the Project centered on the development and distribution of key metrics to monitor the status of the Project. Project metrics focused on Project execution, industrial safety, quality/compliance, schedule, and regulatory/other.[59] The Project Metrics Reporting procedure identified three primary types of metrics reports: monthly metrics; monthly project report; and weekly metrics.[60] Beyond the metrics reports, other reports or progress review meetings on the Project included SNC and Bechtel monthly project

[59] Plant Vogtle Units 3 and 4 PEP, Version 8.1, April 2018, p. 32.
[60] SNC Project Metrics Reporting, Procedure ND-PC-NVP-003, Version 4.0, March 15, 2016.

reviews and reports, VPMB meetings, VCRB meetings, and GPC/Southern BOD presentations.

Q. WERE THERE OTHER REPORTING OBLIGATIONS ASSOCIATED WITH THE PROJECT?

A. In addition to the standard project management and executive reporting, the Project had regulatory reporting requirements that included reports for the GPSC and reports to meet requirements of the U.S. Department of Energy ("DOE") loan guarantee. As mentioned previously, the GPSC also engaged a CM to independently monitor and report on the status of the Project. The GPSC reports generally covered cost, schedule, and scope updates and were issued in monthly summary reports and semi-annual construction monitoring reports. The DOE reports essentially included the same material as sent to the PSC staff, including the construction status, information from GPSC filings, VPMB meeting materials, filings with the SEC and other financial information, and similar requirements. The CM reports were also issued to the GPSC and were based on the CM attending the monthly project review meetings held on the Project. These reports summarized the status of the reporting period's activities and included observations on the status from the CM's viewpoint.

Q. WAS THE PROJECT CONTROLS REPORTING ON THE PROJECT TYPICAL OF WHAT YOU HAVE SEEN ON OTHER POWER PLANT PROJECTS?

A. Yes, and the project controls reporting on this Project is also what would be expected of a project of this size, magnitude, and complexity.

I. LESSONS LEARNED

Q. WITHIN PROJECT MANAGEMENT, WHAT ARE LESSONS LEARNED?

A. Lessons learned within project management involve the identification and capturing of the actual experience encountered on a project to inform the planning and execution of future efforts (which can be applied to the next phase of the same project and/or used on future projects).

Q. WHAT PROCESSES WERE IN PLACE FOR LESSONS LEARNED FOR THE PROJECT?

A. SNC's goal was to develop a lessons learned and best practices program to include lessons learned from AP1000 projects in China as well as from its own construction experience.[61] As part of this effort, SNC tracked the progress and performance from the Chinese AP1000 projects to capture and incorporate lessons learned from the FOAK technology.[62] In addition, lessons learned from Bechtel's extensive construction experience were incorporated into the Project. For example, Bechtel utilized lessons learned from its past experience in developing its crane plan for the Project.

In practice, following the Project Transition, the implementation of the lessons learned program on the Project was through three primary approaches: 1) SNC's Corrective Action Program ("CAP"); 2) Bechtel's QA program (primarily construction focused); and 3) WEC's program (primarily design focused). Lessons learned identified by Bechtel and WEC were assessed and implemented by SNC as warranted. Lessons learned were a part of the reporting and communications with Project and Executive Leadership and were

[61] Plant Vogtle Units 3 and 4 PEP, Version 8.1, April 2018, p. 42.
[62] GPSC Docket No. 29849, VCM 19 Report, p. 7, filed August 31, 2018.

regularly reviewed in the Monthly Project Review Meetings, VPMB meetings, Bechtel monthly reports, WEC monthly reports, and other meetings and reports.

Q. WHAT ARE EXAMPLES OF MORE NOTABLE LESSONS LEARNED APPLIED ON THE PROJECT?

A. Lessons learned were collected and applied on the Project in multiple areas and disciplines, including in the design, construction, and start up and testing aspects of the Project. For example, design changes on Unit 3 were applied to Unit 4 prior to testing. From a project execution standpoint, one of the most notable and concentrated efforts on the Project was assessing craft performance and identifying actions to improve that performance. These lessons learned productivity improvement initiatives are discussed in **Section X.D.** Other examples of impactful lessons learned were the change in approach to scaffolding and having Bechtel complete work closeouts earlier. These lessons learned were applied to Unit 4, based on the experience observed on Unit 3. In addition, lessons learned on the Unit 3 test sequence were applied to Unit 4. Further, as we discuss later in our testimony, lessons learned on the PRTs performed on Unit 3 allowed SNC to scope Unit 4 more strategically to reduce the number of PRTs employed on Unit 4.

Q. WHAT WERE YOUR OVERALL FINDINGS ON THE VOGTLE LESSONS LEARNED PROGRAM?

A. In reviewing the lessons learned program on the Project, we have found that SNC appropriately captured lessons learned from the actual project experience, the Chinese AP1000 projects, and other nuclear industry initiatives that were reviewed and incorporated into the execution of the Project as appropriate.

By implementing a robust lessons learned program, SNC was able to identify and apply lessons learned from its experience to reduce risks to the Project and improve performance on the remaining work. Application of these lessons learned often resulted in enhanced craft performance and worker safety among other benefits to the Project.

Q. WAS THE LESSONS LEARNED PROCESS TYPICAL OF WHAT YOU HAVE FOUND ON OTHER POWER PLANT PROJECTS?

A. Yes, the Vogtle Project's lessons learned process is typical of what we have experienced on other large projects of this size, magnitude, and complexity.

J. INTERNAL AND EXTERNAL AUDITS

Q. WHAT IS THE PURPOSE OF AUDITS?

A. Audits are a common method for the assessment of project controls. Policies, procedures, and controls in place are audited to determine if they are meeting their intended objectives and, if they are not, to recommend possible improvement actions. As noted in the PMBOK® Guide, audits are an independent process to determine whether the project activities are complying with the organizational policies, processes, and procedures. Audits typically identify what are the best practices being implemented as well as the identification of any nonconformities and gaps. Audits assist management by proactively providing assistance to improve implementation of the processes.[63]

Q. ARE AUDITS AN IMPORTANT PART OF THE STRUCTURE OF THE MANAGEMENT DECISION-MAKING PROCESS?

[63] PMI, *PMBOK® Guide – Sixth Edition*, pp. 294-295 (2017).

A. Yes. Conducting, using, and reviewing audits is prudent management practice and is essentially a form of ongoing, real-time prudence self-review by the utility. In addition to its own internal audit group, utilities may retain outside consultants to review, audit, and make recommendations relative to project performance. Our prudence review included reviewing various internal and independent audit reports prepared over the Vogtle Units 3 and 4 Project.

Q. WHAT ARE THE VARIOUS TYPES OF AUDITS?

A. Audits can be performed to evaluate many things other than financial accuracy. Audits can evaluate governance processes; compliance with policies, plans, procedures, laws, and regulations; the efficiency and effectiveness of resource deployment; the effectiveness of the risk management process; and the means of safeguarding assets. Audits can be performed by an internal audit function that is functionally separate from the area audited or by external auditors.[64] In addition, QA audits are performed to ensure the quality of construction.[65]

Q. WHAT INTERNAL AUDIT POLICIES, PROCEDURES, OR PROCESSES WERE USED ON THE PROJECT?

A. The Internal Audit ("IA") process for SNC is under the oversight of the Audit Committee of the Southern Company BOD. According to the IA Charter: [66]

> Internal Auditing is responsible for assessing the adequacy and effectiveness of governance, risk management, and internal control, providing recommendations to improve business processes, and timely

[64] Southern Company Internal Audit Playbook, May 2022, pp. 30-31.
[65] Plant Vogtle Units 3 and 4 PEP, Version 8.1, April 2018, pp. 24-25.
[66] Southern Company Internal Audit Charter, April 12, 2023.

reporting of its activities to the Audit Committee, Controls and Compliance Committees and other similar committees and management.

The SNC Internal Audit Policy is set forth in the IA Internal Requirements and Guidelines document. These guidelines make clear that when an internal audit is performed, the auditors have "free, full and unrestricted access to all records, properties, functions and personnel necessary to effectively discharge its responsibilities."[67] The IA function also has the Southern Company Internal Auditing Playbook, which outlines the policies, procedures, and work practices for internal auditing, tying each to the International Standards for the Professional Practice of Internal Auditing.[68]

The SNC PEP included plans to perform internal and external audits of various departments, suppliers, and/or contractors.[69] The Bechtel transition plan similarly committed to implement a comprehensive project QA internal audit program.[70] The SNC audit plan also includes a requirement for an annual independent peer audit of the QA organization.[71] Bechtel performed limited scope audits of its processes and procedures and SNC conducted monthly audits of Bechtel's QA program.[72] Bechtel reported its audit findings in its monthly status reports, including corrective action plans related to findings.[73]

[67] IA Internal Requirements and Guidelines, December 13, 2021, p. 3.
[68] Southern Company Internal Auditing Playbook, May 25, 2022 version, p. 5; see also, e.g., Sept 2022 IA Report GPC2022-09, p. 2, which notes that Internal Audits are conducted in conformance with the International Standards for the Professional Practice of Internal Auditing; January 2017; https://www.theiia.org/en/content/guidance/mandatory/standards/international-standards-for-the-professional-practice-of-internal-auditing/
[69] Plant Vogtle Units 3 and 4 PEP, Version 8.1, April 2018, pp. 10-11.
[70] Bechtel Transition Plan, June 2017, p. 37.
[71] e.g., Independent Industry Peer Audit Report of Nuclear Development Quality Assurance, NC-I-QA-2022, February 23,2022.
[72] e.g., Bechtel Monthly Status Report, June 2020, pp. 2, 17.
[73] e.g., Bechtel Monthly Status Report, December 2019, pp. 15-17; June 2019, pp. 15-16.

Q. HOW WERE INTERNAL AUDITS CONDUCTED?

A. Southern Company Internal Audit personnel continually monitored the Project. Each summer, an audit plan for the upcoming year was developed based on the observations of Internal Audit with advice from Project leadership. A typical list of internal audits conducted in any given year is provided in **Exhibit 6**. Audit plans and results were presented to the Southern BOD Audit Committee and to the Nuclear Oversight Committee ("NOC") regularly.[74] Findings and Observations Logs tracked audit results as well as management action items.[75] Reports were issued to report close out of action plans, where appropriate.[76]

Q. SHOULD INDIVIDUAL AUDIT FINDINGS BE USED TO DRAW CONCLUSIONS ABOUT IMPRUDENT PROJECT MANAGEMENT?

A. No. It is prudent for management to evaluate its processes during the course of a large, complex project and to correct any deficiencies or make any improvements or adjustments as the project continues. To attack management on its self-critical findings not only discourages the self-evaluation and improvements that result from this tool, but also the transparency associated with it. That said, audits are not automatically conclusive of prudency either. Audits are typically conducted to ensure compliance in the use of practices and processes across targeted functional areas, including, but not limited to, accounting practices, financial reporting, engineering quality practices, project management

[74] e.g., January 11, 2023, presentation to Audit Committee or the Corrective Action Program Governance Audit; Southern Nuclear Operating Company Nuclear Oversight Committee, November 2018 minutes, p. 1, Southern Nuclear Operating Company Nuclear Oversight Committee, November 2019, pp. 10-13.
[75] e.g., 2021 Findings and Observation Log.
[76] e.g., August 25, 2021, correspondence from Katie Hill to Steve Owen, on Report No. GPC2020-11.

performance, and construction execution.[77] Audits are just one of a selection of information sources a utility should consider in making decisions.

Q. WERE THERE EXTERNAL AUDITS AS WELL?

A. Yes. For example, an independent industry peer audit of the Nuclear Development QA Organization was conducted in 2017.[78]

Q. WAS THE INTERNAL AND EXTERNAL AUDIT PROCESS TYPICAL OF WHAT YOU HAVE FOUND ON OTHER POWER PLANT PROJECTS?

A. Yes, the Vogtle Project's audit processes are typical of what we have experienced on other large projects of this size, magnitude, and complexity.

K. OVERALL ASSESSMENT OF PROJECT CONTROLS

Q. WHAT IS YOUR OVERALL ASSESSMENT OF THE PROJECT CONTROLS?

A. We reviewed substantial documentation in the form of policies, procedures, processes, reports, detailed schedule and cost files, and other project documentation. Based on this review, we found that the project controls either met or exceeded what would be expected on a project of this size, magnitude, scope, and complexity and generally align with common industry practices.

[77] PMI, *The Standard for Program Management – Third Edition*, p. 65, 2013.
[78] e.g., February 2017 Audit Report ND-I-QA-2017.

VIII. CONSTRUCTION MANAGEMENT/OVERSIGHT

A. CONSTRUCTION MANAGEMENT APPROACH

Q. WHAT DOES CONSTRUCTION MANAGEMENT INVOLVE?

A. Construction management is the oversight and implementation of the execution phase of a project. According to CMAA's Construction Management Standards of Practice: [79]

> Construction management is the practice of professional management applied to the planning, design, and construction of capital projects from inceptions to completion for the purpose of achieving project objectives, including meeting all time, scope, cost, and quality goals.

Q. WHO WAS RESPONSIBLE FOR OVERSEEING CONSTRUCTION ON THE PROJECT?

A. While Bechtel was engaged at the Project Transition for managing and completing the construction of the Project, SNC was ultimately responsible for overseeing the completion of the entire Project on behalf of the Co-Owners including GPC.

Q. IN PRACTICE, HOW WAS THE CONSTRUCTION MONITORED ON THE PROJECT?

A. On the site, there were recurring daily, weekly, and monthly meetings to assess and review the status of the construction efforts on the Project. This included, among several other meeting types, a "Plan of the Day" meeting, "Work to Go" meetings, Testing Control

[79] CMAA, *Construction Management Standards of Practice*, 2021 Edition, p. 7.

Center and Operation Control Center meetings and was supplemented by topical deep dive meetings as warranted.[80]

Weekly scorecards, critical path analysis, and metric reports were produced and distributed that provided current views of production, productivity, and schedule performance across the unit, building, and major commodity detail levels. Within the monthly project review meetings, many different aspects of the construction execution were reviewed, including:

- Construction metrics, such as percent complete and CPI/SPI;
- Upcoming construction activities/milestones;
- The critical path schedule;
- Work package development/completion; and,
- Construction quality.

This information generally included data specific for Unit 3 and Unit 4 as well as the overall Project and was then reviewed and discussed with the meeting participants, which typically included senior and executive management from SNC, GPC, representatives from Oglethorpe, Dalton, and MEAG, Bechtel, and the GPSC's CM and PIA Staff.[81]

Q. HOW DID SNC RESPOND TO CONSTRUCTION-RELATED ISSUES ON THE PROJECT?

A. Through the recurring monitoring of construction progress, SNC regularly identified actions to mitigate issues and improve performance. For example, in the April 2018 monthly project review meeting, process and organizational improvements were introduced to support construction including:[82]

[80] TS Attachment STF-241-1-03, p. 58; TS Attachment STF-177-4-d; Monthly Project Review Meeting, September 18, 2019, p. 6; Bechtel Monthly Status Report, December 2019, pp. 6, 8, 18, Project Action Item List ("PAIL").
[81] e.g., Monthly Project Review Meeting, September 23, 2020.
[82] Vogtle Construction Monitor Report, April 11, 2018.

- Resurrecting the Project Management Organization to increase construction accountability;
- Establishing a Construction Support Center to provide rapid response to issues impeding field construction; and,
- Implementing process improvements that included:
  - Reducing the delay in getting material in the hands of craft;
  - Minimizing impact of engineering changes in the field;
  - Revising the corrective action program; and,
  - Reducing the time needed to onboard new craft.

These types of process and organization improvements were implemented throughout the execution of the Project in response to the issues and needs at the time.

Q. DID SNC IMPLEMENT SITE-WIDE STAND-DOWNS?

A. Yes. On July 25, 2018, a site wide stand-down occurred to address project performance issues, establish leadership expectations, and reinforce work product ownership. Site walkdowns and inspections were performed to identify actions needed to reset project performance and restore site productivity in line with expectations.

Q. CAN YOU PROVIDE AN EXAMPLE OF THE TYPE OF PROGRESS MONITORING THAT OCCURRED ON THE PROJECT AND HOW THAT INFORMED MANAGEMENT ACTIONS?

A. Yes. In April 2020, the monthly progress review meeting reported the earned hours per discipline was behind the schedule refinement plan from February 2020.[83] The variance was predominantly within the electrical discipline, which prompted an improvement plan that identified the factors impacting production and identified actions to address those items.

[83] SNC Monthly Project Review, pp. 4-6, April 22, 2020.

Q. WHAT ARE YOUR OVERALL FINDINGS ON THE CONSTRUCTION MANAGEMENT APPROACH USED ON THE PROJECT?

A. While there were several challenges encountered throughout the execution of the Project, we find that appropriate processes and resources, as well as the use of a continuous improvement approach, were in place to plan, monitor, and actively manage the construction efforts on the Project.

B. SUBCONTRACT APPROACH AND MANAGEMENT

Q. WHAT ARE THE INDUSTRY STANDARDS CONCERNING SUBCONTRACTOR MANAGEMENT?

A. Within the construction industry, the use of subcontractors is a common approach to address specific skills, scopes, or other services needed to support the overall Project objectives. CMAA's Construction Management Standards of Practice identifies common practices towards subcontractor management from the procurement of subcontractors through execution of the works to contractor closeout.[84] In general, these practices are similar to the approaches used on construction management and involve the planning and coordination of the work, monitoring the execution of the work, and verifying the quality and status of the work.

Q. WHAT PROCESSES DID SNC AND BECHTEL USE IN THE SELECTION AND MONITORING OF SUBCONTRACTORS?

[84] CMAA, *Construction Management Standards of Practice*, 2021 Edition.

A. Most of the existing subcontracts were rejected in the WEC bankruptcy. SNC entered into bridge agreements to contractually cover the period between the rejected WEC subcontracts and SNC's long-term agreements, thus allowing construction to continue while SNC and Bechtel renegotiated subcontracts under the new Project structure.[85] The Bechtel CCA outlined the scope of work to be performed by SNC-managed subcontracts and scope to be performed by Bechtel-managed subcontracts.[86] As the team worked on the Subcontract Alignment Process, which was completed in October 2018, SNC, GPC and Bechtel continually challenged the contract values and adjusted some scope to direct hire.[87]

The Bechtel CCA outlined a three (3) phased process to align existing subcontractors post-Project Transition ("Subcontractor Alignment Process"). The Subcontractor Alignment Process was conducted in three phases: [88]

- Phase 1 – Review existing subcontract/scope to assess current ETC
- Phase 2 – Review re-bid/negotiation of subcontract scope to assess current ETC
- Phase 3 – Agreement with Owners on adjustment needed (if any) to target construction cost and target completion date(s) (if any).

These contractor-managed subcontracts included mostly specialty subcontractors such as the subcontract with FE Moran for fire protection\detection\suppression.[89] Bechtel determined that subcontracting work to specialized outfits who predominately do the

[85] GPSC Docket No, 29849, VCM 18 Report, pp. 4-5, 14 (February 28, 2018).
[86] GPC and Bechtel CCA, pp. 75, 315-327 (October 23, 2017).
[87] Bechtel Corporation, Vogtle Units 3 and 4 Construction Completion Monthly Status Report June 2018, p. 7; Bechtel Corporation, Vogtle Units 3 and 4 Construction Completion Monthly Status Report October 2018, p. 9
[88] GPC and Bechtel CCA, (October 23, 2017), pp. 75, 315-327.
[89] GPC and Bechtel CCA, (October 23, 2017), p. 322.

related type of work is far more productive than Bechtel supervising direct hire craft who would likely have limited experience in this type of work. Also, to minimize impact to the schedule, Bechtel awarded critical subcontracts to trusted and approved contractors to support near term construction milestones.[90]

In November 2018, SNC's subcontract team initiated a series of cross-functional workshops to formally identify, trend, and develop mitigating action plans for subcontract risks and opportunities. The subcontracts team reviewed these actions on a weekly basis and conducted schedule integration workshops to ensure proper planning was in place for the subcontractors in alignment with the Project needs.[91]

Q. WHAT PROCESS WAS USED TO PROVIDE UPDATES ON SUBCONTRACTOR PERFORMANCE?

A. SNC and Bechtel included subcontractor progress in the weekly metrics, which provided greater visibility into subcontractor performance. SNC and Bechtel also established "war rooms" for subcontractors and Bechtel to work through coordination challenges.[92]

Q. WAS THE SUBCONTRACTS MANAGEMENT PROCESS TYPICAL OF WHAT YOU HAVE FOUND ON OTHER POWER PLANT PROJECTS?

A. Yes, the Vogtle Project's subcontracts management process is typical of what we have experienced on other large projects of this size, magnitude, and complexity.

[90] Bechtel Corporation, Vogtle Units 3 and 4 Construction Completion Monthly Status Report December 2017, p. 8.
[91] October 2018 VCRB Report Response, December 20, 2018, p. 5.
[92] GPSC Docket No. 29849, VCM 20/21 Report, (August 30, 2019), p. 32.

C. SUPPLIER APPROACH AND MANAGEMENT

Q. WHAT WAS SNC'S PROCUREMENT AND SUPPLIER MANAGEMENT APPROACH?

A. Prior to the Project Transition, most of the procurement risk resided with WEC as the EPC contractor. However, GPC oversaw the fabrication of major equipment at international and domestic vendor locations and paid close attention to challenges associated with design and testing to ensure those were adequately resolved before installation.[93] In VCM 17, GPC explained that although the Owners would assume many of the purchase orders from WEC, WEC would continue to support the Project pursuant to the Services Agreement. In some cases, the Owners did not assume the existing contracts but instead renegotiated agreements with the same parties or reached agreements with new parties.[94]

Nevertheless, GPC identified procurement as a risk that could impact the cost and schedule. SNC committed in VCM 17 to maintain a robust oversight program for procurement and to add resources to oversee vendors who did not perform to expectation or where additional oversight resources were otherwise deemed appropriate.[95] There was also a recognition that the VC Summer abandonment could affect procurement costs.[96]

[93] See e.g., GPSC Docket No. 29849, VCM 14 Report (February 2016), p. 19.
[94] GPSC Docket No. 29849, VCM 17 Report, August 31, 2017, Public Version, pp. 34-35, 41-42.
[95] GPSC Docket No. 29849, VCM 17 Report, August 31, 2017, Public Version, p. 96.
[96] GPSC Docket No. 29849, VCM 17 Report, August 31, 2017, Public Version, pp. 99-100.

Q. HOW DID SNC MONITOR SUPPLIERS?

A. SNC conducted frequent internal audits related to procurement with no deficiencies or findings, except in the August 2020 audit. [97] The audit called for additional training of supply chain personnel. Subsequent audits in 2021, 2022, and 2023 evaluated the effectiveness of SNC's Subcontracts Management program implementation including training records and had no further findings.[98]

Q. WHAT SPECIFIC PROCUREMENT/SUPPLY CHAIN CHALLENGES DID THE PROJECT EXPERIENCE AND HOW WERE THESE CHALLENGES HANDLED?

A. The completely unknown and unforeseeable COVID-19 global pandemic that affected the Project since early 2020 also created supply chain challenges. The pandemic exposed the Project to many of the same supply chain issues and delivery delays as other industries. GPC and SNC's response to COVID-19 challenges is discussed in **Section X.E.**

Q. WAS THE PROCUREMENT PROCESS TYPICAL OF WHAT YOU HAVE FOUND ON OTHER POWER PLANT PROJECTS?

A. Yes, the Vogtle Project's procurement process is typical of what we have experienced on other large projects of this size, magnitude, and complexity.

[97] SNC Nuclear Development Quality Assurance ("NDQA") Audit Report of Compliance Monitoring and Subcontracts (CMP/SC), ND-SC-CMP-SC-2018, (May 16, 2018); SNC Quality Assurance (NDQA) Audit Report for Supplier Compliance and Subcontract Management, ND-SC-SCMSC-2019, (April 11, 2019); SNC Quality Assurance (NDQA) Audit Report for Subcontract Management, (April 16, 2020); SNC Quality Assurance (NDQA) Audit Report for Subcontract Management – ND-SC-SCMGMT-2020, (August 17, 2020).
[98] SNC Quality Assurance (NDQA) Audit Report for Subcontract Management, ND-S-SC-2021, (April 21, 2021); SNC Quality Assurance (NDQA) Audit Report for Subcontract Management, ND-S-SC-2022, (March 10, 2022); SNC Quality Assurance (NDQA) Audit Report for Subcontract Management, ND-S-SC-2023, (February 7, 2023).

D. QUALITY ASSURANCE PROCESS

Q. WHAT ARE THE GENERAL OBJECTIVES OF QUALITY CONTROL ("QC") AND QUALITY ASSURANCE ("QA")?

A. A Quality Management Plan ("QMP"), helps ensure that the project as built meets the owner's expectations and intended purpose and complies with all applicable rules and regulations. The QMP will contain all aspects of the project's quality oversight, including QC and QA. As defined by the CMAA in its Standard of Practice:[99]

> **Quality Control**
> The continuous review, certification, inspection, and testing of project components, including persons, systems, materials, documents, techniques, and workmanship to determine whether or not such components conform to the plans, specifications, applicable standards, and project requirements.
> **Quality Assurance**
> The application of planned and systematic examinations or verifications, which demonstrate that quality control procedures are being effectively implemented.

Essentially, QC is the verification of the installed and completed work to ensure it meets all requirements, and QA verifies that the QC policies and procedures are being followed on the Project.

Q. WHAT INDUSTRY STANDARD PROCESSES ARE INVOLVED IN PERFORMING QA/QC MANAGEMENT?

A. Project quality management includes the processes and activities to ensure the project fulfills the purpose for which it was undertaken and involves putting into place objectives,

[99] CMAA, Construction Management Standards of Practice, pp. 51-52, (2015).

policies, and roles and responsibilities to that end.[100] The PMBOK® Guide lays out the three key quality management processes as: 1) Plan Quality Management – identifying the requirements/standards for the project and defining deliverables to demonstrate compliance; 2) Management Quality – translating the quality management plan into executable activities; and 3) Control Quality – monitoring the results of performing quality management activities.[101]

Q. ARE THERE SPECIFIC QA/QC REQUIREMENTS FROM THE NRC?

A. Yes. The NRC requires all applicants for an operating license or a combined license to establish a Quality Assurance Program, which comprises all systemic actions necessary to ensure that the plant will perform satisfactorily during operations. The Quality Assurance Program includes and governs all Quality Control activities.[102] The QA/QC program must meet all quality requirements prescribed by the NRC. Specifically, the program must meet:[103]

- 10 CRF 50.55, Conditions of construction permits, early site permits, combined licenses, and manufacturing licenses, and 10 CRF 50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants;
- 10 CRF 52, Licenses, Certifications, and approvals for Nuclear Power Plants; and,
- American Society of Mechanical Engineers ("ASME") NQA-1-1194, Quality Assurance Requirements for Nuclear Facility Applications.

[100] The 5th edition of the PMBOK® Guide indicated that, "Project Quality Management includes the processes and activities of the performing organization that determine quality policies, objectives, and responsibilities so that the project will satisfy the needs for which it was undertaken. PMI, *PMBOK® Guide – Fifth Edition*, p. 227 (2013). The 6th edition of the PMBOK® Guide updated this description by stating, "Project Quality Management includes the processes for incorporating the organization's quality policy regarding planning, managing, and controlling project and product quality requirements in order to meet stakeholders' objectives. Project Quality Management also supports continuous process improvement activities as undertake on behalf of the performing organization." PMI, *PMBOK® Guide – Sixth Edition*, p. 271 (2017).
[101] PMI, *PMBOK® Guide* – Fifth Edition, p. 227 (2013); *PMBOK® Guide* – Sixth Edition, p. 271 (2017).
[102] 10 CFR 50 Appendix B – Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants
[103] Project Execution Plan, Version 8.1, pp. 24, 25 (April 2018).

Q. WHAT WERE THE QA/QC PROCESSES UTILIZED ON THE PROJECT BY SNC AND WERE THEY APPROPRIATE FOR THE PROJECT?

A. Yes. The Nuclear Development QA maintains the Nuclear Development Quality Assurance Manual ("NDQAM"), which describes the overarching nuclear quality program with which SNC, Bechtel, its subcontractors, and project vendors are required to comply. The NDQAM is a regulatory document approved by the NRC as part of the preliminary safety analysis report, which must be submitted as part of the application for a construction permit.[104] The NDQAM establishes roles and responsibilities for the QA/QC process. Nuclear Development QA ensures and implements its program by:[105]

- Ensuring compliance with regulatory requirements and procedures through audits and surveillances;
- Monitoring processes to ensure conformance to commitments and licensing document requirements; and,
- Ensuring vendors provide quality services, parts, and materials to SNC that meet the requirements of 10 CFR 50, Appendix B.

Q. HOW WAS QA/QC REPORTED ON THE PROJECT?

A. The Bechtel Monthly Status Reports contained a section for Quality Status, which reviews QA/QC activities conducted over the previous month. The reports detail any surveillances conducted on the quality assurance program, report on any significant conditions or

[104] 10 CFR 50.34(a)(7) specifies that, "A description of the quality assurance program to be applied to the design, fabrication, construction, and testing of the structures, systems, and components of the facility. Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," sets forth the requirements for quality assurance programs for nuclear power plants and fuel reprocessing plants. The description of the quality assurance program for a nuclear power plant or a fuel reprocessing plant shall include a discussion of how the applicable requirements of appendix B will be satisfied." The Project may make changes to the quality assurance program provided it does not reduce the commitments required by the NRC. Changes must be submitted to the NRC within 90 days. (10 CFR 50.55(f)(3)) Changes that do reduce the commitments must be submitted to the NRC with a forwarding letter that identifies the change, reason for the change, and basis for concluding that the change still complies with 10 CFR 50 Appendix B. (10 CFR 50.54(a)(3)).

[105] Plant Vogtle Units 3&4 PEP, Version 8.1, pp. 24, 25 (April 2018). The NDQAM was updated frequently with the most recent version being Version 23 NCQAM, Version 23.0, (December 20, 2022).

deficiencies identified in construction and report metrics on quality performance. The reports also contain graphics that report construction quality performance by tracking the acceptance rate of inspected works and classifying them as satisfactory, monitoring or action required.

Q. DO THE QA/QC PROCESSES ESTABLISHED ON THE PROJECT ALIGN WITH INDUSTRY STANDARDS?

A. Yes. The policies and procedures used for QA/QC on the Project align with industry standards, but are also subject to NRC requirements, which are much more stringent than what the general construction industry would be required to use, making these policies and procedures much more detailed and defined than what would be recommended by comparable industry standards. The NDQAM incorporates industry standard QA/QC processes, which were defined and adopted for use on the Project.

Q. WAS THE QA/QC PROCESS TYPICAL OF WHAT YOU HAVE FOUND ON OTHER POWER PLANT PROJECTS?

A. Yes, the Vogtle Project's QA/QC program is typical of what we have experienced on other large projects of this size, magnitude, and complexity.

E. SYSTEM COMPLETIONS

Q. CAN YOU ELABORATE ON THE DIFFERENCES BETWEEN BULK COMMODITIES INSTALLATION AND COMPLETE SYSTEMS?

A. Yes. Bulk commodities installation is the process of installing large quantities of commodities in certain areas of the plant, such as pulling multiple cables through an

electrical raceway at a single time. Normally this is referred to as working by "areas" in a construction project, such as a specific building. Before a project begins to start its Initial Test Program ("ITP") activities, it begins to focus on completing "systems" which can encompass multiple areas and buildings. It is generally considered more efficient to stay in bulk commodities installation for as long as possible before focusing on completing individual systems.

Q. IS THIS CONSISTENT WITH INDUSTRY BEST PRACTICES AND IS THIS COMMON IN THE INDUSTRY?

A. Yes. In our experience, we find it is normal for construction projects to begin work in bulk commodities installation before transitioning to a systems completion-based focus. The Construction Industry Institute ("CII") highlights the importance of this transition as listed as Critical Success Factor Number 15 - Transition to Systems-Based Management:[106]

> Plan to transition from construction progress tracking on an area basis to a systems-completion basis so that construction forces may be most effectively redirected as needed. Involve [Construction/Start-up ("CSU")] staff in construction planning at approximately 60-80% system construction completion (for each single major system) in order to help mitigate construction punch list items (with particular early focus on utility systems).

CII states that CSU should be getting involved when construction reaches 60-80% completion. We agree with this approach.

[106] CII, Identification and Implementation of Critical Success Factors in the Commissioning and Startup of Capital Projects, p. 57, (August 2016).

Q. ARE YOU FAMILIAR WITH SNC'S DECISION TO FOCUS ON CONSTRUCTION OF COMPLETE SYSTEMS INSTEAD OF BULK COMMODITIES INSTALLATION?

A. Yes. The Project planned to stay in bulk commodities installation for as long as possible while supporting the turnover of required systems to meet the startup schedule. The Project did not abandon bulk commodities installations when it began to turnover partial systems; rather, it continued to work in bulk in areas that were available while it instituted system completion crews that focused on finishing construction for near term system turnovers. There was not a hard cutoff where bulk work stopped.

When the first partial system turnover was accelerated to August 2018, the total Project was reported as 69.6% complete, with overall construction at 55.3% complete (combined Units 3 and 4, through the end of July 2018).[107] This is slightly earlier than typical, but this early turnover was done as a 'pilot' to capture lessons learned for incorporation into future system turnover efforts.[108] The Project ITP activities appear to have started around the earlier bound of the recommended percentages of 60-80%, but overall, we find their approach to early testing to be reasonable given it provided an early identification of issues that otherwise would have been encountered later in the startup process, likely with greater impact.

We find the Project's decision to remain in bulk construction for as long as possible while trying to support the startup schedule with complete systems to be reasonable and prudent.

[107] GPSC Docket No. 29849, VCM 19 Report, p. 17, filed August 31, 2018.
[108] Monthly Project Review Meeting, June 12, 2018; Monthly Project Review Meeting, August 17, 2018, p. 14.

IX. INITIAL TEST PROGRAM

Q. HOW IS THE INITIAL TEST PROGRAM USED IN THE NUCLEAR INDUSTRY?

A. The NRC requires all applicants for a combined license to maintain an ITP program that verifies that all structures, systems, and components ("SSCs") will perform satisfactorily when the plant is in service.[109] The NRC provides guidance on specific tests that are recommended or required to be performed, including tests on the reactor coolant system; reactor control systems; reactor protection systems; fuel storage and handling systems; power conversion system; and preliminary and secondary containments. [110]

The ITP consists of three phases of testing that align with industry standards: (1) component testing, which aligns with pre-commissioning activities; (2) preoperational testing, which aligns with commissioning activities and includes milestone tests prior to fuel load such as integrated flush and Hot Functional Testing ("HFT"); and (3) startup, which is consistent across industries and starts with initial fuel load and goes through power ascension testing.

Q. HOW WAS ITP ORGANIZED ON THE PROJECT?

A. The initial organization arrangement for ITP was for the Bechtel Construction Completion Group to coordinate completion of physical construction. Then the system or area would be turned over to the SNC ITP Group, which would be responsible for managing the commissioning of the plant systems, testing during

[109] 10 CFR Part 50 Appendix B (XI) Test Control.
[110] NRC Regulatory Guide 1.68, Initial Test Programs for Water-Cooled Nuclear Power Plants, (June 2013).

startup activities, and finally transitioning the systems to plant operations, which would operate the plant.

Q. WHAT WERE THE ITP PROCESSES UTILIZED ON THE PROJECT?

A. Before the Project Transition to SNC, SNC utilized the Conduct of Operations for the ITP Group.[111] The majority of the Conduct of Operations procedures were later superseded and rolled into a single conduct of operations. This Vogtle 3 and 4 Conduct of Operations Procedure laid out the organization and functions of the SNC Project Staff from a high level. This identified the Senior Manager of Testing and Turnover as being responsible for the ITP Group.[112] The Project also utilized the ITP Administration and Organization Manual. The ITP Administration Manual defines the procedures used to control the testing activities, including:[113]

- Controls for test procedure contents;
- Controls for the format of individual test procedures;
- Controls to provide for participation of the Responsible Design Organization;
- Controls to provide for ITP personnel qualifications; and
- Controls for handling of approved documents.

The Project also used the Bechtel System Completion and Turnover Procedure, and the SNC Project Completion and Transition to Operations Procedure to manage the system and area turnovers from construction to ITP to operations.[114]

[111] SNC Conduct of Operations for Initial Test Program Group Procedure, NC-CO-013, Version 7.0, May 30, 2017.
[112] SNC Vogtle 3&4 Conduct of Operations Procedure, ND-CO-026, p. 10.
[113] SNC ITP Administration and Organization Procedure, B-GEN-ITPA-001, Version 7.2, April 29, 2020.
[114] Bechtel System Completion and Turnover, 26139-000-4MP-T81C-N1601, Revision 10, November 11, 2020; SNC Project Completion and Transition to Operations Procedure, ND-AD-VNP-029, Version 5.1, April 30, 2019.

Q. IS EARLY PLANNING AND PROJECT INTEGRATION ESSENTIAL FOR ITP SUCCESS?

A. Yes. Industry best practices advise that it is essential for the goals and objectives of ITP to be started early in the project phases. The Project engaged the ITP Group significantly early, starting during the Project Transition period in 2017 when it assumed all the testing governance from WEC. The ITP Group then spent the first half of 2018 with construction and engineering to integrate testing activities into the IPS. After the April 2019 schedule re-baseline, ITP developed a resource loaded schedule for the IPS.

Q. WHAT ACTIONS DID THE PROJECT TAKE TO IMPROVE THE ITP ORGANIZATION?

A. The Project took several significant actions to improve the ITP Group knowledge and processes. SNC brought in ITP personnel with experience from the Watts Bar Nuclear Plant, which was commissioned in 2016. SNC sent ITP personnel to China to observe the preoperational testing and startup activities there, and to capture lessons learned for implementation on the Project. In 2019, the Project established the Testing Control Center to resolve issues during component and preoperational testing and to maintain the "Lock-Out-Tag-Out" program. The Project also formed a joint SNC and Bechtel Testing and Completion Group to allow for more efficient turnover of systems from Bechtel to SNC.

Q. WAS THE COMMISSIONING AND STARTUP PROCESS TYPICAL OF WHAT YOU HAVE FOUND ON OTHER POWER PLANT PROJECTS?

A. Yes, the Vogtle Project's commissioning and startup process is typical of what we have experienced on other large projects of this size, magnitude, and complexity.

X. KEY CHALLENGES AND DECISIONS

Q. WHAT CHALLENGES AROSE DURING THE PROJECT AND WHAT KEY DECISIONS DID GPC/SNC MAKE TO ADDRESS THE CHALLENGES?

A. We found that the major challenges on the Vogtle Project included:

- Transitioning from the WEC EPC to the self-perform model with SNC and Bechtel
- Continuing challenges to the forecasted costs
- Continuing challenges to maintain the schedule
- Craft productivity and retention
- COVID-19 pandemic
- System turnover & PRTs
- QC challenges

We discuss these challenges and key decisions GPC/SNC made in the corresponding sections below.

A. PROJECT TRANSITION

Q. WHAT WERE THE MAJOR CHALLENGES RELATED TO THE PROJECT TRANSITION?

A. One of the largest impacts unique to Vogtle 3 and 4 was the WEC bankruptcy filed on March 29, 2017. WEC had obtained NRC approval for the AP1000 standard design that was being constructed in China and, as we noted previously, was also to be constructed by two other utilities in the United States. Given that WEC was the entity responsible for the AP1000, including the EPC package that included the design, procurement and construction of the AP1000, the WEC bankruptcy that occurred in the middle of Project construction had significant ricochet impacts for the Project. GPC had obtained an EPC

Contract for which significant risks were allocated to WEC under its fixed price contract and under which WEC would be the organization responsible for engineering, procurement, and construction. However, once WEC filed for bankruptcy, GPC was faced with an environment that not only changed the way in which the Project would be completed, but resulted in additional unforeseen ripple and ricochet events that impacted both Project cost and schedule as we will discuss later in our testimony. In Pegasus-Global's testimony for the Application for Certification of Vogtle 3 and 4 sponsored by Dr. Kris Nielsen, Dr. Nielsen testified that the construction labor availability and productivity was the responsibility of the EPC contractor, relieving GPC of the responsibility for labor difficulties like those experienced in constructing Vogtle Units 1 and 2.[115] The unforeseeable WEC bankruptcy transferred that labor responsibility risk to GPC.

The WEC bankruptcy further exacerbated the FOAK risk impacts that resulted in both ripple and ricochet effects throughout the course of the Project. As we noted above, the WEC bankruptcy created a significant challenge, which precipitated the need to transition the Project from an EPC-managed Project to a new governance structure. In evaluating the options available, GPC was aware that it was the realization of these FOAK risks that ultimately led to the bankruptcy of WEC.

Further, the WEC bankruptcy created the need for SNC to develop a more thorough understanding of where the Project stood regarding cost, schedule, procurement, etc.

[115] GPSC Docket No. 27800-U, Direct Testimony of Dr. Kris Nielsen, October 20, 2008, pp. 5-6.

leading up to the Project Transition. At the time of the WEC bankruptcy event, the details of the basis of the cost estimate and the assumptions under which the schedule had been prepared were not available to the Owners under the fixed price contracting model. As acknowledged in VCM 17, GPC's insight into WEC's costs and schedule were limited to the deliverables that WEC provided to the Owners.[116]

Q. WHAT KEY DECISIONS DID GPC/SNC MAKE WITH REGARD TO THE ISSUES RELATED TO THE PROJECT TRANSITION?

A. GPC and SNC were faced with difficult decisions considering the WEC bankruptcy. Those key decisions included:

- Self-performing the work versus retaining an alternate EPC Contractor
- Developing an ETC for completing the Project
- Executing the Project via an Aggressive Schedule

i. SELF-PERFORMING VERSUS RETAINING AN EPC CONTRACTOR

Q. WHAT STEPS WERE TAKEN TO TRANSITION FROM THE EPC-LED STRUCTURE TO THE SELF-PERFORMANCE STRUCTURE?

A. GPC/SNC recognized that attempting to complete the Project under another EPC contracting model was unrealistic as (1) there were too many unknown risks that an EPC contractor would need to build into the costs of a fixed-price contract for a project already under construction and (2) the timing to undertake an EPC contractor search effort would most certainly result in significant delay to COD. Replacing WEC with another EPC contractor would have required a significant amount of time to allow bidding contractors

[116] GPSC Docket No. 29849, VCM 17 report, dated August 31, 2027, Public Version, p. 28.

to get scope, estimate, schedule, and bid the work to complete. It is even highly possible that no other contractor would have submitted an EPC bid due to the Project being a FOAK project, with WEC in bankruptcy and the engineering being incomplete.

Moreover, pausing the Project to gain a sufficiently clearer understanding of the current situations caused by the WEC bankruptcy and thoroughly analyzing all available options was not a viable option. GPC and SNC had to take quick action to provide bridge solutions to keep the Project moving forward notwithstanding the WEC bankruptcy. For example, as work was ongoing, there were subcontractors, vendors and suppliers who had not been paid. GPC reached an Interim Agreement with WEC and made the decision to pay the outstanding debts of WEC related to the Vogtle Project through calling on the Toshiba Parent Guarantee ensuring that key subcontractors, vendors, and suppliers continued to work at the site.

As we discussed earlier, once SNC developed its transition planning and developed the ETC assessment of the cost and schedule (as discussed below), including a review of the remaining quantities to install, SNC decided to engage Bechtel to be responsible for construction of the Project, and Bechtel developed its own transition planning for the Project. .[117]

Bechtel's transition plan, developed in June 2017, described the scope of work Bechtel proposed to perform in support of project completion. The Bechtel transition plan described the activities for the transfer of the construction responsibilities for the Project from WEC

[117] GPSC Docket No. 29849, VCM 17 Report, August 31, 2017, pp. 46-50.

to Bechtel.[118] The transition from WEC to the SNC/Bechtel structure resulted in several new contracts to manage the Project. One was the Services Agreement with WEC, which allowed WEC to continue with the engineering under the direction of SNC, and another was the CCA with Bechtel, which established Bechtel's responsibilities for construction and the Level 3 Construction Schedule.

Q. DID YOU FIND THAT THE NEW MANAGEMENT STRUCTURE WAS REASONABLE?

A. Yes. As a result of various analyses discussed below, GPC concluded it was in the best interest of customers to complete the Project with a new management structure.[119] The structure was for GPC, along with SNC, to act as Project Manager, with Bechtel serving as the prime construction contractor.

ii. DEVELOPMENT OF THE NEW ETC

Q. HOW DID GPC AND SNC DEVELOP THE NEW ETC?

A. Developing a new ETC required determining the quantities remaining, applying unit rates to those quantities, and then calculating the labor hours of direct work remaining on the Project. When the decision was made to self-perform, GPC looked to two contractors, Bechtel and Fluor, who both had nuclear experience internationally and domestically, and in our experience, were the best in the industry. The initial unit rates used were those developed by Fluor, specific to the size, type, and location for each commodity to be installed on the Project. SNC then retained independent consultants to assess the unit rates

[118] Bechtel Transition Plan, June 2017, p. 7.
[119] GPSC Docket No. 29849, VCM 17 Report, August 31, 2017, pp. 90-91.

used for piping and electrical commodity installations because of the potential impact installing those quantities may have on the critical path of the installation of these commodities. That independent assessment resulted in an overall difference in work hours of less than 3.5%, which supported the reasonableness of the Fluor unit rates in its basis of estimate. Based on the concept of transferring Unit 3 labor to Unit 4, SNC included a 12.5% performance factor improvement, which we find reasonable and consistent with other multi-unit plants with which we have been involved.[120]

Q. WHAT IS A PERFORMANCE FACTOR AND WHY IS IT USED IN THE MANHOUR EVALUATION?

A. As mentioned above, SNC used an average performance factor to estimate the remaining manhours to complete the work where Quantity x Unit Rate x Performance Factor = Total Manhours to Go. The average performance factor is a blended, weighted factor for the total scope of direct manhours based on quantity of hours by building and by building performance factor. The performance factors were the result of the estimate product from Fluor's Basis of Estimate. The average performance factor was used to include a target productivity in the estimate.[121]

iii. EXECUTING THE PROJECT VIA AN AGGRESSIVE SCHEDULE

Q. PLEASE DESCRIBE HOW THE VOGTLE PROJECT SCHEDULE WAS DEVELOPED IN LIGHT OF THE WEC BANKRUPTCY.

[120] GPSC Docket No. 29849, VCM 17 Report, August 31, 2017, pp. 486, 488.
[121] GPSC Docket No. 29849, VCM 17 Report, August 31, 2017, p. 488.

A. Similar to the analysis undertaken for the labor unit rates, GPC and SNC undertook assessments along with a Bechtel independent review of the project schedule to establish target dates leading to commercial operation dates of May 2021 and May 2022 for Units 3 and 4 respectively (the "+23 schedule"). GPC undertook several studies to determine the best path forward, including an effort by SNC to determine the cost to complete the Project with SNC, themselves, managing the project completion efforts. As part of this effort, SNC had to prepare a new project schedule to assist in determining those costs. Bechtel's assessment included walkdowns and an independent review of congestion, schedule logic, craft productivity and other items including key risks that the Project may encounter. The critical path was determined to be through the Auxiliary Building due to the work required to complete the electrical work. The remaining manhours to complete the Project as of June 1, 2017, were approximately 21 million as estimated using Fluor rates, which were detailed by size, type, and location of each commodity. The piping and electrical rates were evaluated independently by a third party (Work Management, Inc.), due to the importance of piping and electrical work in determining the Project's outcome. The outcome of that comparison was less than 3.5% difference, which was considered insignificant, although the difference in cost was added to contingency. The schedule evaluation was presented to the senior management team, recommending a +23-month schedule with a 12-month gap between units for managing the pipefitter and electrical trade manpower requirements. SNC considered these assessments along with the WEC Services Agreement, the new organizational structure and the review of subcontracts that would remain in place on the

Project to develop staffing curves for construction management and project oversight to develop an ETC for the Project.[122]

Q. DID GPC INDEPENDENTLY VALIDATE THE NEW ETC AND ADOPT THE +23 SCHEDULE FOR COMPLETING THE PROJECT?

A. Yes. To gain an understanding of where the Project stood as well as to obtain independent assessments as to cost and schedule, GPC, on behalf of all Owners, undertook various tasks including commissioning several outside experts to provide opinions concerning the likely cost and schedule of various scenarios that were being considered.[123]

- Kenrich Group LLC ("Kenrich") provided an analysis of the cost and schedule to complete Units 3 and 4 using independent assumptions based on their familiarity with the project as an expert for litigation for the Project involving Westinghouse. Kenrich's projections included improved, similar-to-historical, and worsened productivity scenarios.[124] Kenrich's range (excluding owners' costs) was $7.4 billion to $10.1 billion total Project cost.[125]
- Bechtel provided an independent assessment and estimate of the cost-to-complete and the schedule. Bechtel's review included "an analysis of the logic of civil and structural activities, peak craft density, and congestion. In its review, Bechtel applied rates that were informed by Bechtel's historical experience in nuclear

[122] GPSC Docket No. 29849, VCM 17 Report, August 31, 2017, pp. 53, 771.
[123] GPSC Docket No. 29849; VCM 17 Report, August 31, 2027; Public Version, p. 45.
[124] GPSC Docket No. 29849; VCM 17 Report, August 31, 2027; Public Version, p. 51.
[125] GPSC Docket No. 29849; VCM 17 Report, August 31, 2027; Public Version, pp. 45, 51-52.

plant construction. Historical data from previous Bechtel nuclear power projects was used as a basis for the schedule assessment."[126]

- Pegasus-Global assisted in the development of cancellation costs for two scenarios: the cancellation of Unit 4; and the cancellation of Units 3 and 4. The cancellation estimate included site demobilization, potential liability to subcontractors and vendors, employee severance, and GPC and SNC overhead to manage the cancellation efforts. The range developed for cancellation of both units was $730 to $760 million (total Project).[127]
- Black & Veatch Corporation ("B&V") provided estimates of the costs associated with demobilization of the Project and securing the site for the cancellation under either cancellation scenario, as well as an estimate of the likely costs of deferral going forward.[128]
- PricewaterhouseCoopers ("PwC") developed a quantitative risk analysis for the three options that were presented for consideration: complete both units based on SNC's ETC, cancel both units, and complete Unit 3 and cancel Unit 4.[129]

In addition to its own internal assessments, SNC sought independent external challenge assessments from the executive leadership team at Watts Bar Unit 2, including the Senior Vice President of WBN Operations and Construction, the Director of Engineering and

[126] GPSC Docket No. 29849; VCM 17 Report, August 31, 2027; Public Version, pp. 45, 57.
[127] GPSC Docket No. 29849; VCM 17 Report, August 31, 2027; Public Version, p. 53.
[128] GPSC Docket No. 29849; VCM 17 Report, August 31, 2027; Public Version, pp. 45, 54.
[129] GPSC Docket No. 29849; VCM 17 Report, August 31, 2027; Public Version, pp. 45, 55-56.

Construction, the WBN2 Scheduling Manager, and the WBN2 Startup Manager, LES/URECO for fuel enrichment facility, and the Southern Company executive teams.

Q. DID GPC IDENTIFY CRITICAL ASSUMPTIONS THAT COULD STILL IMPACT THE NEW ETC AND SCHEDULE?

A. Yes. The VCM 17 filing noted critical assumptions that could have a major impact on the costs that were outside the control of GPC and other Owners:[130]

1. Will Toshiba Corporation ("Toshiba") be financially stable enough to meet the payment obligations of the Parent Guaranty?
2. Will WEC meet its obligations under the new services agreement?
3. Can the labor force and craft maintain the productivity improvements seen recently as the number of craft is increased as required to meet the new schedule?
4. Will the Project continue to meet the FOAK challenges, including such questions as will the NRC be able to process and close the ITAACs in a timely fashion to support the schedule?
5. Will the Project's tax credits be extended and expanded as assumed?
6. Will the DOE Loan Guarantee be extended as assumed?

Q. DID YOU REVIEW THE ETC AND SCHEDULE AT THE TIME OF VCM 17 AND DID YOU FIND IT TO BE REASONABLE?

A. Yes. We found the ETC to be reasonable based on what GPC and SNC knew at the time and based on the independent assessments it had undertaken. The Commission also found the revised schedule and cost forecast to be "reasonable" and set the approved revised capital cost forecast at $7.3 billion (after netting of the Toshiba Parent Guaranty). The Commission declined to set a cost cap on the Project, but did make clear that:[131]

> The Commission further finds that any costs spent up to the revised cost forecast will be deemed reasonable, but will be subject to the findings and

[130] GPSC Docket No. 29849; VCM 17 Report, August 31, 2027; Public Version, p. 9.
[131] GPSC Docket No. 29849, *Order on VCM 17*, Issued December 21, 2017, pp.11, 13.

presumptions as defined in the Stipulation approved on January 3, 2017. This includes the Company retaining the burden of proof on prudency on all capital costs above $5.680 billion.

Q. HOW DID SNC MAKE THE DECISION TO USE AN "AGGRESSIVE SCHEDULE" FOR THE VOGTLE PROJECT?

A. SNC's schedule evaluation showed that a +23-month schedule had a 50% probability of meeting the end date and their +29-month schedule had an 80% probability of meeting the end date. These evaluations were the result of performing Monte Carlo simulations of a summarized version of the Project schedule. As set forth in VCM 17, SNC made the decision to carry costs in their ETC for a +29-month schedule and use a +23-month schedule as a target schedule for the construction forces. Bechtel performed an assessment that relied on SNC background documents for current project status (that were not independently verified or assessed by Bechtel) and historical data from previous Bechtel Nuclear projects. Bechtel's independent analysis of the cost and schedule to complete the Project resulted in a +19-month schedule with a 50% probability as the target to challenge the construction forces even more. The +19-month schedule gave credibility to SNC's +23 assessment.

The Project eventually settled on a +21-month schedule as a target schedule. The Bechtel CCA established the Baseline Schedule based on an "early target" schedule, meaning the Project was executed on the basis on completion of both units earlier than the date set by GPC and with the GPSC.[132] The aggressive schedule provided schedule contingency and

[132] The Bechtel CCA, in Section 9.1 discusses the baseline schedule stating: 9.1 Baseline Schedule. Notwithstanding the Unit 3 and Unit 4 Target Completion Dates, the Parties agree to utilize an "early target" as the Baseline schedule, which as of the Effective Date is premised upon Mechanical Completion for each of Unit 3 and Unit 4

an incentive for getting the construction work force to work as hard as possible to meet that scheduled end date. At the peak of the Project, each month of construction added approximately $90-$100 million per month in time-driven costs to the cost of the Project. The Project's early decision to attempt to compress the Project schedule made sense because each month saved would have offset approximately $90-$100 million.[133]

Q. WHAT DID YOU FIND REGARDING THE REASONABLENESS OF THE USE OF AN AGGRESSIVE SCHEDULE?

A. SNC's decision to use an aggressive schedule was a reasonable decision that in our experience is a common approach used on megaprojects.[134] Our experience finds that it is quite normal to use an aggressive target schedule as a means of incentivizing work and often allows a project to finish earlier than the later end date. Bechtel, one of the most experienced major contractors in the world, suggested a +19-month schedule, based on the information that was available to them at the time. It was reasonable for SNC to rely on Bechtel's vast experience in this decision process, but to temper that reliance with its own analysis and experience.

Q. DID YOU FIND THAT THE DECISIONS MADE BY GPC AND SNC MANAGEMENT WITH REGARD TO THE PROJECT TRANSITION WERE REASONABLE AND PRUDENT?

being achieved two (2) months earlier than the respective Target Completion Date for each of Unit 3 and Unit 4 ("Early Completion Targets") (each such two month period is referred to herein as "Schedule Contingency"). For purposes of this Agreement, Schedule Contingency is considered to be for the exclusive use and benefit of Contractor." GPC and Bechtel CCA, p. 105 (October 23, 2017).

[133] Project Management Board Meeting, p. 19, July 28, 2020.

[134] Ibbs, C. W., Lee, S. A., & Li, M. I. (1998). Fast-tracking's impact on project change. Project Management Journal, 29(4), 35–41.

A. Yes. We find reasonable, consistent with the Commission's order on VCM 17,[135] the decision to move forward with construction, the revised schedule with COD dates for Unit 3 of November 2021 and for Unit 4 of November 2022 (an additional 29 months for each unit from the then currently approved schedule), and GPC's $8.77 billion share of the total capital cost (as of July 1, 2017).[136] We also find reasonable the decision to use an aggressive schedule to provide schedule contingency and incentivize work. We find the time to fully transition to an execution phase to be reasonable based on what was known at the time of the WEC bankruptcy.

We also find the transition plans developed and implemented by SNC and Bechtel to be comprehensive and served as a reasonable plan from which to prepare the Project for execution post-WEC bankruptcy. We further find that the time to transition the Project to the new organizational structure and divided responsibilities between WEC and Bechtel through the CCA, as well as SNC's overall role to manage the Project, was challenged by late documentation and information that trickled in from WEC and the bankruptcy court and the continued discovery of unanticipated uncompleted work in the field as we will discuss later in this testimony. Based on the unforeseen time to gather and review all the necessary information, we find the time to fully transition to an execution phase to be reasonable based on what was known at the time of the WEC bankruptcy.

B. CHALLENGES TO MAINTAINING ESTIMATE AT COMPLETION

[135] GPSC Docket No. 29849, Order on VCM 17, Issued December 21, 2017, p. 13.
[136] GPSC Docket No. 29849, VCM 17 Report, p. 7, Public Version.

Q. WHAT KEY DECISIONS DID GPC/SNC MAKE WITH REGARD TO THE UPDATED EACS?

A. Over the course of the Project, based on the situation at the time and based on what information was known, GPC decided that major reforecasts of its EAC were necessary as included in updated ETCs within VCM 19, VCM 25 and VCM 26.

i. VCM 19

Q. WHY DID GPC REFORECAST THE EAC IN VCM 19?

A. The Project Transition began immediately following the WEC bankruptcy but continued well into 2018. As discussed by SNC witnesses Kuczynski and Abramovitz in their VCM 19 direct testimony, SNC determined that certain categories of cost estimates contained in the VCM 17 ETC were insufficient in that they did not fully anticipate or address certain costs, circumstances and events that were incurred by the Project.[137] SNC determined that it would be necessary to implement changes to lower Project risks, maintain its schedule, and address cost estimates that were included in the VCM 17 ETC. Accordingly, SNC performed a full cost reforecast for the Project. The reforecast updated assumptions, reflecting contractor duties for Bechtel, increased field supervision, engineering support, and craft incentives. The reforecast also reflected the costs of the 60-plus subcontracts that had not yet been negotiated at the time of the VCM 17 ETC.[138] The reforecast resulted in over $1 billion increase from the EAC in VCM 17. This increase was reported in VCM 19.

[137] GPSC Docket No. 29849, SNC Direct Testimony of Stephen Kuczynski and Aaron Abramovitz, VCM 19, filed October 12, 2018, p. 7.
[138] GPSC Docket No. 29849, SNC Direct Testimony of Stephen Kuczynski and Aaron Abramowitz, VCM 19, filed October 12, 2018, pp. 7-8.

GPC announced that it would not seek to recover $694 million of the increase, stating, "[GPC] has made the judgment that it is in the best long-term interests of customers, investors, and other stakeholders that it not disrupt Project momentum by seeking approval of the base capital cost increase so soon after receiving Commission approval to continue the Project." GPC stated that it may seek recovery of the $366 million contingency estimate.[139]

ii. VCM 25

Q. WHY DID GPC REFORECAST THE EAC IN VCM 25?

A. The next significant change in the forecasted cost was reflected in VCM 25, which reflected the impact of COVID-19 on the Project as well as the increased cost associated with the schedule extension of seven months for Unit 3 and two months for Unit 4. In his direct testimony in VCM 25, SNC witness Stephen Kuczynski noted the challenges in achieving target earned hours and CPI assumed in the base cost forecast. He also noted that the large focus on the Unit 3 construction remediation work was resulting in higher spend than was anticipated following HFT. He further acknowledged that these pressures were continuing and could impact costs further.[140]

Q. WHAT EFFORTS WERE MADE TO ADDRESS THESE CHALLENGES?

A. We address SNC's response to productivity challenges below but add that with respect to the VCM 25 reforecast, SNC witness Stephen Kuczynski described the response to the productivity challenges, noting the "heightened focus" towards first-time quality, with a

[139] GPSC Docket No. 29849, VCM 19 Report, p. 5, filed August 31, 2018.
[140] GPSC Docket No. 29849, Direct Testimony of Stephen Kuczynski, VCM 25, filed October 21, 2021, pp. 18-19.

"sign as you go" strategy, an increased focus on work package closure, and continuing onboarding of craft and other resources.[141]

iii. VCM 26

Q. WHY DID GPC REFORECAST THE EAC IN VCM 26?

A. The reforecast reported in VCM 26 reflects the increasing cost pressures due to continuing productivity challenges and the need for remediation work which led to schedule extensions.[142] As noted in the VCM 25 discussion, focus continued on work package closure. In addition, there was a focus on preventing a repeat of Unit 3 quality issues on Unit 4.[143]

Q. DID GPC CONTINUALLY EVALUATE WHETHER GOING FORWARD WITH THE PROJECT WAS IN THE BEST INTEREST OF CUSTOMERS?

A. Yes. In each VCM through VCM 23, GPC provided an updated comparison of the economics of the Project.[144] In each economic analysis presented, GPC concluded that completing the Project was the best option for customers.[145]

Q. DID YOU FIND THAT THE DECISIONS MADE BY GPC AND SNC MANAGEMENT WITH REGARD TO THE REFORECASTS WERE REASONABLE AND PRUDENT?

[141] GPSC Docket No. 29849, Direct Testimony of Stephen Kuczynski, VCM 25, filed October 21, 2021, pp. 17-18.
[142] GPSC Docket No. 29849, VCM 26 Report, February 17, 2022, p. 8.
[143] GPSC Docket No. 29849, Direct Testimony of Stephen Kuczynski and John Williams, VCM 26, filed April 13, 2022, pp. 13-14.
[144] The Stipulation approved in VCM 23 removed the requirement to continue to provide the economic analysis beginning the VCM 24. GPSC Docket No. 299849, *Order Adopting Stipulation,* February 16, 2021.
[145] e.g., GPSC Docket No. 29849, VCM 18 Report, February 2018, p. 34; VCM 23 Report, August 2020, pp. 46-47.

A. Yes. GPC and SNC had strong processes in place to monitor costs and continually update the ETC and EAC. Issues impacting costs were recognized and efforts put in place to address the issues. As we noted earlier, a project exceeding original cost projections is not necessarily evidence of imprudence or unreasonable decision-making. We found the actions taken by GPC and SNC to be both reasonable and prudent with regard to the cost challenges the Project faced.

C. CONSTRUCTION SCHEDULE CHALLENGES

Q. WHAT WERE THE MAJOR CHALLENGES RELATED TO MAINTAINING PROGRESS ON THE SCHEDULE?

A. GPC and SNC closely monitored the Project's schedule and cost. At a point in time when the schedule progress is behind due to reasons such as lack of progress due to insufficient manpower numbers, poorer than expected productivity, or an increase in quantities, it is vital to the project to re-baseline and make the schedule be a realistic target to measure progress against. Over the course of the Project, SNC recognized the need to conduct a re-baseline of the schedule to address schedule pressures. The schedule pressures included the impacts of the COVID-19 pandemic, continuing challenges with productivity, and the identification of issues necessitating remedial work.

Q. WHAT KEY DECISIONS DID GPC/SNC MAKE WITH REGARD TO THE SCHEDULE CHALLENGES?

A. As discussed earlier in our testimony, when circumstances and conditions change that impact the schedule to which no further recovery efforts can be made, the schedule must

be re-baselined to provide a realistic base from which to monitor progress. Based on the circumstances and information known at the time, SNC made the decision to formally re-baseline the schedule four times. We discuss each of the re-baselines below, including the drivers for each.

i. APRIL 2019 RE-BASELINE

Q. WHY DID SNC RE-BASELINE THE SCHEDULE IN APRIL 2019?

A. In May 2019, the Plant Vogtle Units 3 and 4 Schedule and Cost Update showed that the Project underwent a comprehensive and collaborative re-baseline effort as part of an ongoing review of cost and schedule. This re-baseline effort was intended to incorporate the latest information into the cost forecast and the site work plan.

Q. DID TARGET IN-SERVICE DATES CHANGE?

A. No. While the site work plan forecasted a slip in its target in-service date, these dates remained within the margin of regulatory approved dates. Therefore, the April 2019 re-baseline did not change the approved commercial operation dates of November 2021 for Unit 3 and November 2022 for Unit 4.

ii. FEBRUARY 2021 RE-BASELINE

Q. WHY DID SNC RE-BASELINE THE SCHEDULE IN FEBRUARY 2021?

A. In 2020, SNC determined that the pressures on the November 2021 COD for Unit 3 and November 2022 COD for Unit 4 required a review of the schedule. GPC testified in VCM 24 that, by the end of 2020, productivity impacts of the COVID-19 pandemic had consumed an estimated three to four months of the schedule margin previously embedded

in the site work plans for both units. This was much of the remaining margin in the Unit 3 schedule. The COVID-19 pandemic certainly exacerbated previously existing challenges associated with lower production, work package closure, component testing, and schedule sequencing issues. In addition, in preparation for starting HFT, SNC identified several issues that required remediation work. These are also discussed below. These issues would delay HFT, which would ultimately delay the completion date.[146]

Q. HOW WAS THE FEBRUARY SCHEDULE UPDATE ACCOMPLISHED?

A. As a result of the schedule pressures, a schedule update was made in February 2021. The Vogtle Project Team worked with Bechtel and subcontractors to remove barriers to production and to support their efforts to increase production, as well as continuing efforts to remove constraints to testing and pre-operational activities. GPC committed in the re-baselining effort to continue to ensure quality and design standards were met prior to critical testing activities (i.e., HFT), Fuel Load, and ultimately operations.

Q. WHAT WERE THE RESULTS OF THE FEBRUARY 2021 SCHEDULE RE-BASELINE?

A. The re-baselining effort resulted in adding seven months to the Unit 3 COD (moving from November 2021 to June 2022) and two months to the Unit 4 COD (moving from November 2022 to January 2023).

iii. AUGUST 2021 RE-BASELINE

[146] GPSC Docket No. 29849, VCM 24 Direct Testimony of David McKinney and Jeremiah Haswell, filed April 20, 2021, pp. 6-7. GPSC Docket No. 29849, VCM 24 Direct Testimony of Stephen Kuczynski and Aaron Abramovitz, filed April 20, 2021, p. 7.

Q. WHY DID SNC RE-BASELINE THE SCHEDULE IN AUGUST 2021?

A. Unit 3 schedule challenges were tied to "three major activities or milestones: (1) completion of construction remediation work; (2) completion of system turnovers, testing, [ITAACs], and other activities prior to Fuel Load; and (3) transitioning from Fuel Load to plant operation." To address these challenges at Unit 3, the Project team worked with Bechtel and subcontractors to address obstacles to productivity, increased walk downs of construction areas to identify open work scopes, removed constraints to testing/pre-operational activities, and increased field non-manual support to close out remaining work packages to support the transition of the Project to Fuel Load. Also, progress on Unit 4 had slowed during this period, due to some craft and support resources being diverted from Unit 4 temporarily to support construction efforts on Unit 3. Project leadership, noting this diversion, continued to try to add craft labor and field non-manual support resources, particularly pipefitters and electricians, in order to increase production.[147]

Q. WHAT WERE THE RESULTS OF THE AUGUST 2021 SCHEDULE RE-BASELINE?

A. As a result of the schedule pressures, a schedule update was made in August 2021 forecasting targeted in-service dates for Unit 3 in third quarter 2022 and for Unit 4 in second quarter 2023.

iv. FEBRUARY 2022 RE-BASELINE

Q. WHY DID SNC RE-BASELINE THE SCHEDULE IN FEBRUARY 2022?

[147] GPSC Docket No. 29849, VCM 25 Direct Testimony of Stephen E. Kuczynski, pp. 6-7, filed October 21, 2021.

A. During this period, Unit 3 continued to face significant challenges with construction productivity, remediation work, pace of system turnovers, spent fuel pool repairs, timeframe/duration for hot functional and other testing, and documentation completion (e.g. inspection reports). Unit 4 continued to have challenges with productivity. [148]

Q. WHAT WERE GPC AND SNC DOING WITH REGARD TO THESE CHALLENGES?

A. GPC witnesses noted the slowed production in Unit 4 was due to the diversion of resources to Unit 3 but also stated that: [149]

> progress continues for the necessary work to support the continuation of [open vessel testing], while construction production has supported the successful completion of several testing evolutions …. With construction production constraints primarily in the electrical disciplines, the workforce has been augmented by utilizing specialty contractors for specific work evolutions, such as safety-related terminations. Additionally, the incorporation of lessons learned from Unit 3 continues to improve first-time quality with changes to work sequencing expected to reduce the amount of congestion from Subcontractors as electrical resources increase.

Q. WHAT WERE THE RESULTS OF THE FEBRUARY 2022 SCHEDULE RE-BASELINE?

A. In the VCM 26 Report, the target in-service dates were again adjusted forecasting Unit 3 during the fourth quarter of 2022 or the first quarter of 2023 and Unit 4 during the third quarter or the fourth quarter of 2023.

v. FEBRUARY 2023 RE-BASELINE

[148] GPSC Docket No. 29849, VCM 26 Report, February 17, 2022, pp. 4-5.
[149] GPSC Docket No. 29849, VCM 26 Direct Testimony of David L. McKinney and Jeremiah C. Haswell, April 13, 2022, p. 8.

Q. WHY DID SNC RE-BASELINE THE SCHEDULE IN FEBRUARY 2023?

A. The adjustment to Unit 3 targeted in-service date was due to required remediation work to certain equipment and components that was identified during start-up testing. Due to the lessons learned in Unit 3 start-up testing efforts, Unit 4 targeted in-service date was adjusted to increase margins to account for current pace of start-up testing efforts.[150] GPC witness testified that: [151]

> Unit 4's projected in-service date primarily depends on potential impacts arising from Unit 4 testing activities overlapping with Unit 3 start-up and commissioning; maintaining overall construction productivity and production levels, particularly in subcontractor scopes of work; and maintaining appropriate levels of craft laborers.

Q. WHAT WERE THE RESULTS OF THE FEBRUARY 2023 SCHEDULE RE-BASELINE?

A. In the VCM 28 Report, the target in-service dates were again adjusted forecasting Unit 3 during the second quarter of 2023 and Unit 4 during the fourth quarter of 2023 or first quarter 2024.

Q. DID YOU FIND THAT THE DECISIONS MADE BY GPC AND SNC MANAGEMENT WITH REGARD TO RE-BASELINING THE SCHEDULE WERE REASONABLE AND PRUDENT?

A. Yes. Consistent with industry best practices, SNC periodically re-baselined the project target schedule to account for events that occurred at the time. We find the re-baselining to

[150] GPSC Docket No. 29849, VCM 28 Report, February 16, 2023, p. 5.
[151] GPSC Docket No. 29849, VCM 28 Direct Testimony of John B. Williams and Jeremiah C. Haswell, filed May 5, 2023, pp. 6-7.

be typical of large complex projects over the course of execution and is normal with projects that fall behind schedule and especially those with an aggressive target schedule.

D. CRAFT PRODUCTIVITY AND RETENTION

Q. WHAT WERE THE MAJOR CHALLENGES RELATED TO CRAFT PRODUCTIVITY AND RETENTION?

A. Throughout the execution of the Project, and reflective of a non-existent domestic nuclear construction industry, challenges were encountered relative to having the adequate amount of qualified and skilled craft to support the Project needs and maintaining the required productivity on the site to maintain the schedule.

Q. WHAT KEY DECISIONS DID GPC/SNC MAKE WITH REGARD TO THE ISSUES RELATED TO CRAFT PRODUCTIVITY AND RETENTION?

A. As craft availability/retention and productivity were both among the top risks to the Project (including both being identified as one of Bechtel's top 10 risks nearly every month), Project Management continuously assessed actual performance and identified actions to minimize these risks. GPC/SNC made decisions to improve productivity and craft retention by conducting various productivity studies throughout the Project and implementing various initiatives as discussed below to both improve productivity and retain craft.

Q. HOW DID GPC/SNC ASSESS PRODUCTIVITY AND DETERMINE WHAT ACTIONS TO TAKE?

A. For craft availability and retention, the Project maintained current projections of the craft staffing needs by discipline to have informed views on when and where additional craft

were needed. Labor studies were also conducted to monitor competing projects in the region and their labor demands. To address these needs, the Project maintained regular communication with the labor unions and sought other avenues to boost craft availability, such as applying to use travelling craft from Puerto Rico and Canada (this latter effort was ultimately successful for Puerto Rico but unsuccessful for Canada as the application was denied). To retrain the craft on site and reduce turnover, the Project implemented retention bonuses, wage increases, per diem increases, sign-on and referral bonuses, and related efforts. These types of incentives/bonuses were universal in some cases (such as a retention incentives applicable to all craft), while in other cases they were more targeted (such as wage increases for electricians, pipefitters, and tower crane operators when those resources demands were of a higher risk to the Project).[152] Project Management also moved craft on the site as needed to address project needs, such as shifting resources from Unit 4 to Unit 3 or implementing a "helping hands" initiative where other types of craft could be engaged to perform supporting work when the direct craft type was limited or unavailable.

For craft productivity, metrics were tracked across craft disciplines and by unit to provide Project Management with a view of where productivity was improving (or worsening) that then provided a measure of the success of productivity improvement initiatives already implemented (or identifying areas that warranted further attention and/or actions to improve performance). SNC also conducted detailed productivity assessments that

[152] SNC Project Review Meeting, November 13, 2018, slides 8-9.

included a study of productive vs. non-productive time and identified actions to improve performance.[153]

Q. WHAT TYPES OF ACTIONS WERE UNDERTAKEN TO IMPROVE PRODUCTIVITY?

A. Throughout the course of the Project, many different initiatives were undertaken to improve productivity on the Project. Some actions were targeted to specific areas or disciplines, others were broadly applicable across the Project. One of the more significant productivity improvement efforts took place in the form of a formal productivity improvement plan introduced in August 2018. This plan identified six key areas for targeted improvements and specific actions for each of the building managers to undertake to improve productivity. The key areas targeted for improvement included:[154]

- **Time at the work face**: Placing supervision at the work face during critical times (i.e., first 90 minutes of the shift and before/after lunch).
- **"Ready-Ready" program**: Process to ensure that work packages issued contain implementable designs, are free from paperwork issues, and all required material and labor needs are identified and available.
- **"Right-Sizing" crews**: Additional emphasis on using daily quantity tracking sheets and related tools to ensure the appropriate number of personnel are assigned to a given task based on the budget and complexity of the task.
- **Reducing travel/wait time/non-productive time**: Several related actions to remove barriers to performing the work and improving work planning (e.g., utilizing advance requests for weld rod to minimize wait times at the rod room).
- **Internal milestones**: Utilize aggressive internal milestones that meet or beat the project schedule dates and communicate these schedules to supervision to ensure required completion dates for activities are well understood.
- **Optimize night shift utilization**: Focus night shift work on support for critical/near critical path activities and scopes that can be assigned independently to the night shift.

[153] SNC Monthly Project Review, p. 12, February 14, 2018; SNC Monthly Project Review, p. 9, August 17, 2018.
[154] Vogtle Units 3 and 4 Construction Completion Project, Productivity Improvement Plan, August 7, 2018.

Monitoring the progress of the work and identifying areas for improvement was an ongoing and recurring effort throughout the execution of the Project.

As previously mentioned, a craft incentive program was introduced November 15, 2018, to improve absenteeism and craft retention.[155] A rate increase and per diem were introduced to attract additional pipefitters and electricians, as well as a visa process to attract available and qualified Canadian workers. These are only the recovery improvements instituted through early 2018; the Project had a continuous improvement mindset that included craft training, craft leadership changes, specific work for each shift to avoid rework and take advantage of the learning curve, right sizing crews for specific work efforts, and using certain crews for work that the crew excels in executing.

Q. DID THE DECISIONS MADE AND STEPS TAKEN BY GPC AND SNC IMPROVE THE CRAFT PRODUCTIVITY AND RETENTION?

A. Yes. Following implementation of specific initiatives such as those discussed above, improved performance and retention was observed. This improvement, however, did not eliminate the risks associated with craft productivity and craft retention. Nevertheless, we found GPC and SNC appropriately monitored and communicated the current status of these challenges to allow informed decisions to be made to support the Project.

Q. DID YOU FIND THAT THE DECISIONS MADE BY GPC AND SNC MANAGEMENT WITH REGARD TO CRAFT PRODUCTIVITY AND RETENTION WERE REASONABLE AND PRUDENT?

[155] CCF 2018-218, dated October 30, 2018, approved November 15, 2018.

A. Yes. While the productivity targets and manpower requirements were challenging throughout the Project and were further impacted with the FOAK nature of this Project and with the bankruptcy of WEC, we find that the planning assumptions used by GPC and SNC were reasonable based on the information known at the time and that the Companies took appropriate action throughout the Project to mitigate these risks and their impacts.

We find it is important to emphasize that this Project was the first nuclear power plant built in nearly 30 years in this country, resulting in the historical data being dated and most of the craft resources having little or no experience working under nuclear QA/QC conditions. The containment vessel in the AP1000 unit was significantly smaller than the older design, which caused increased craft congestion and contributed to lower-than-expected productivity. Very few projects require the large numbers of highly skilled workers as a nuclear power plant and typically the only way to draw those numbers of workers is to pay higher hourly rates and a per diem to draw travelers from other parts of the country. Many of the quality requirements are very demanding on electricians and having a workforce unfamiliar with the demands exacerbated the productivity issues and, in some instances, led to a significant amount of rework.

Our experience indicates that it is normal on a power plant project for pipefitter and electrician work to become the critical work of the plant. The manhours of work to complete associated with these crafts is so substantial from the peak work period through the completion of the plant that it is essential to have the right numbers of workers with the correct skill set. SNC increased both per diem and rates of these craft disciplines to both attract and retain the appropriate levels of skilled workers. SNC understood its own

monthly time-driven costs and offered these incentives to reduce the duration SNC monthly management costs were incurred.

E. COVID-19 PANDEMIC

Q. WHAT CHALLENGES DID THE COVID-19 PANDEMIC PRESENT TO THE PROJECT?

A. SNC witnesses described the on-going challenges caused by the COVID-19 pandemic in their VCM testimonies. In the VCM 23 testimony, SNC witnesses Kuczynski and Abramovitz described higher than normal absenteeism and the disruptive effects of having to stop or change work based on persons requiring isolation. They also noted the supply chain disruptions associated with the pandemic. In the VCM 24 testimony, these same witnesses reiterated these challenges, adding the fact that subcontractors were facing the same obstacles as well as degradation in performance.[156]

Q. WHAT KEY DECISION DID GPC/SNC MAKE WITH REGARD TO THE COVID 19 PANDEMIC?

A. When COVID-19 was declared a pandemic in March 2020, GPC and SNC took two immediate actions to quickly take appropriate actions to be able to consider whether the Project could continue or not, including: (1) implementation of a number of site protocols to reduce the likelihood of exposure to the virus (e.g. expanding medical clinic capabilities onsite, suspending bus services, modifying break schedules, etc.); and, (2) preparation and

[156] GPSC Docket No. 29849, VCM 24 Direct Testimony of Stephen Kuczynski and Aaron Abramovitz, filed October 21, 2020, p. 4.

evaluation of different scenarios based on different levels of site activity due to the pandemic.[157]

Q. DID YOU FIND THAT THE DECISIONS MADE BY GPC AND SNC MANAGEMENT WITH REGARD TO THE COVID-19 PANDEMIC WERE REASONABLE AND PRUDENT?

A. Yes, we find that the decisions made by GPC and SNC based on the implementation of site protocols and the scenarios conducted allowed the Project to continue in a safe manner during the pandemic.

F. SYSTEM TURNOVER & PARTIAL RELEASE FOR TESTING

Q. ARE YOU AWARE OF THE DECISION TO USE THE PARTIAL RELEASE FOR TESTING PROCESS?

A. Yes. We are aware that the Project utilized a PRT process.

Q. CAN YOU EXPLAIN WHAT THE PRT PROCESS IS?

A. Under the PRT process, complete systems are broken down into smaller partial systems and turned over to ITP. These partial turnovers can be further broken down into mechanical and electrical partial turnovers. Some of these partial turnovers can contain exceptions, which are scopes of work within the turnover boundary that is not yet complete, and it may include a punch list of work items that still must be completed.

[157] SNC Monthly Project Review Meeting, April 22, 2020, slides 9-12.

Q. DO YOU FIND THE DECISION TO USE PRT ON THE PROJECT TO BE PRUDENT?

A. Yes. During execution of the Project, it was determined that construction was not proceeding fast enough to complete a full system for turnover on the dates that ITP planned to begin its testing. The Project made the decision that its priority should be to test the equipment and partial systems as soon as possible to discover any defects or nonconformances in the Work. The earlier discovery of issues would allow the Project to correct them earlier, which would help in maintaining their target COD dates. The Project determined that the value of early discovery of defects would be a net benefit. We agree with this assessment.

G. QUALITY CONTROL

Q. WHAT WERE THE MAJOR CHALLENGES RELATED TO QUALITY ASSURANCE ON THE PROJECT?

A. There were three main challenges related to quality assurance, IEEE 384 cable separation remediation, Inspection Reports backlog, and Spent Fuel Pool and Fuel Transfer Canal remediation. We discuss each challenge below.

i. IEEE REMEDIATION

Q. CAN YOU PROVIDE A BRIEF SUMMARY OF THE IEEE 384 REMEDIATION?

A. Yes. On May 5, 2020, the NRC notified SNC that it had found deficiencies in the construction of the IDS battery racks, specifically misaligned spring bolts, also referred to as channel nuts. After additional correspondence and clarification by the NRC, a Root

Cause Determination ("RCD") was initiated, and SNC determined that Condition Reports ("CR") were not properly being generated and entered into the Corrective Action program ("CAP") upon discovery of non-conforming work. SNC and Bechtel leadership took steps to ensure CRs were being written when required by the CAP.[158]

On December 22, 2020, a CR was generated to identify a trend of electrical cable installations not meeting IEEE 384 cable separation and spacing requirements, based on 57 individual CRs that had been written since November 2020. IEEE 384 sets the criteria for physical separation and isolation of electrical circuits between Safety Related cables and Non-Safety Related cables. On January 25, 2021, additional issues relating to electrical commodity installations were captured in a CR and an RCD was initiated. The initial IEEE-384 separation issues investigation identified approximately 600 issues within 64 rooms.[159]

From June 21 to July 2, 2021, the NRC conducted a special investigation at Vogtle and on August 26, 2021, the NRC issued three findings and violations to SNC:[160]

- Preliminary White Finding: Failure to Promptly Identify and Correct IEEE 384 Cable Separation and Seismic/Structural Nonconformances;
- Preliminary Greater than Green: Failure to Accomplish Separation for Class 1E System Field Installations in Accordance with Applicable Instructions, Procedures, and Drawings; and

[158] RCD for CR Number: 50064326 / CAR Number: 80003772; pp. 3,9,28; December 4, 2020.
[159] RCD for CR Number: 50075757 / CAR Number: 80004436; p. 4; April 15, 2021.
[160] NRC, Vogtle Electric Generating Plant, Units 3 and 4 – NRC Special Inspection Reports 05200025/2021010, 05200026/2021010 and – Preliminary White and Greater than Green Findings for Unit 3 – p. 1, Enclosure 1, p. 2-3, August 26, 2021; The NRC uses a color-coding system to more easily convey information to the general public regarding safety significance of its findings. The NRC uses Green, White, Yellow, and Red to prioritize its findings according to safety significance. The color green represents very low safety or security significance, the color white represents low to moderate safety or security significance, the color yellow represents substantial safety or security significance, and the color red represents high safety or security significance. https://www.nrc.gov/reactors/operating/oversight/rop-description.html

- Green: Failure to Install Electrical Raceways and Connections in Accordance with Applicable Instructions, Procedures, and Drawings.

After reviewing a response from SNC submitted on October 5, 2021, the NRC made final significance determinations of the three findings on November 17, 2021, confirming the white finding for the failure to promptly identify and correct IEEE 384 cable separation and seismic/structural nonconformances, and upgrading the Greater than Green Finding to a White Finding for the failure to accomplish separation for Class 1E System Field Installations.[161]

The Project spent a significant amount of time and resources from spring of 2021 to summer of 2022 to identify and correct these deficiencies. On April 19, 2022, the NRC issued a Supplemental Inspection Report and Follow-up Letter that found that "… the completed or planned corrective actions were sufficient to address and preclude repetition of the performance issues that led to the White Findings…*"* and subsequently closed all findings.[162]

Q. DID YOU EVALUATE SNC'S RESPONSE TO THE NONCONFORMANCE OF ELECTRICAL WORKS THAT RESULTED IN THE IEEE REMEDIATION?

A. Yes. We examined the information surrounding the IEEE Remediation, which included the discovery of the nonconforming works, communications with the NRC, actions taken to correct the nonconforming works and prevent recurrence, implementation of training for

[161] NRC, Vogtle Electric Generating Plant, Unit 3 – Final Significance Determination of a Preliminary White Finding, A Preliminary Greater than Green Finding, Notice of Violation, and Assessment Follow-up Letter; NRC Special Inspection Report 05200025/2021011; p. 1-2; November 17, 2021.
[162] NRC, Vogtle Electric Generating Plant, Unit 3- Supplemental Inspection Report 05200025/2022010 and Assessment Follow-Up Letter; p. 1; April 19, 2022.

electrical craft on IEEE standards, and updates to the policies and procedures to ensure future compliance with IEEE standards.

Q. WHAT CORRECTIVE ACTION DECISIONS DID SNC MAKE TO AVOID REOCCURRENCE?

SNC implemented several corrective action decisions to address the IEEE Remediation efforts including:

- Revisions to SNC's electrical installation specifications procedure;[163]
- Revisions to Bechtel's procedures to ensure that field inspectors document deficiencies in a CR;[164]
- Revisions to SNC's work package planning and development procedure;[165]
- Implementation of changes to the Engineering Service Request ("ESR") database;[166]
- Development and implementation of a process for the QC Inspectors to review Safety Related Work Packages;[167]
- Lessons learned with IEEE remediation were captured on Unit 3 and applied on Unit 4;
- Continuous SNC field oversight to ensure issues are identified and corrected during installation;
- Conducted a site-wide standdown on March 18, 2021;[168] and
- Implementation of a new electrical training module.

Q. WERE THE CORRECTIVE ACTIONS TAKEN TO ADDRESS THE DEFICIENCIES REASONABLE AND PRUDENT?

A. Yes. We found that the corrective actions taken to address the IEEE issues were sufficient to strengthen the QA program and ensure existing IEEE issues were corrected and no new

[163] RCD for CR Number: 50075757 / Corrective Action Record (CAR) Number: 80004436, March 19, 2021, p. 18.
[164] RCD for CR Number: 50075757/CAR Number: 80004436, March 19, 2021, p. 16.
[165] RCD Report for CR Number: 50064326/CAR Number: 80003772, December 11, 2020, pp. 4-5.
[166] RCD for CR Number: 50075757/CAR Number: 80004436, March 19, 2021, p. 17.
[167] RCD for CR Number: 50064326/CAR Number: 80003772, December 11, 2020, pp. 4-5.
[168] RCD for CR Number: 50075757/CAR Number: 80004436, March 19, 2021, p. 17.

issues occurred in the field. We found the management decision to implement these corrective actions to be reasonable and prudent.

Q. HAS GPC RECOGNIZED THE COSTS TO INSTITUTE THE CORRECTIVE ACTIONS AS COSTS THAT IT WILL NOT PASS ON TO ITS CUSTOMERS?

A. Yes. GPC has conveyed to us its intentions to not seek recovery of costs from the IEEE remediation. We strongly agree with GPC's decision not to seek recover of these costs from its customers.

ii. INSPECTION REPORTS

Q. CAN YOU BRIEFLY EXPLAIN THE ISSUES REGARDING INSPECTION REPORTS?

A. Yes. After HFT was completed for Unit 3 in July 2021, the Project was focused on closing out ITAACs to receive its Unit 3 103(g) letter. Along with the IEEE Remediation issues the Project was facing, the Project noticed in the fall of 2021 that work package closure curves were flat and not declining as expected. Bechtel notified SNC that the Project needed to focus on Inspection Records ("IRs") necessary for completion of the ITAACs. The Project started to assess open IRs in fall of 2021 and determined in early 2022 that there were an estimated 24,441 IRs that needed to be closed for the 103(g) letter. The Project began specifically tracking and reporting on IR closure in the IR Burndown Curve provided in the Monthly Status Reports and Presentation Slides.[169] All Unit 3 ITAACs required for fuel load were closed on August 18, 2022.

[169] Monthly Project Review Meeting Presentation, p. 4, January 2022.

Q. WHAT CORRECTIVE ACTIONS DID SNC IMPLEMENT AS A RESULT OF THIS ISSUE?

A. SNC had already implemented numerous corrective actions to address related issues that had been occurring during execution and felt that any corrective actions that would be recommended had already been implemented and additional actions were not necessary at that time. Corrective actions that had been implemented included:

- Improvement measures taken to address IEEE Remediation as discussed above;
- The Bechtel QC program increased its number of QC inspectors and SNC added additional support and leadership to the Bechtel QC program to help drive quality;[170]
- Increased effectiveness of the ITAAC War Room;[171]
- Bechtel organized daily accountability meetings to monitor IR closure rates;[172]
- Reinforcing the "Sign As You Go" Standard for all work packages; [173] and
- Changing Rules of Credit for Bechtel construction to require IRs and work package closure before 100% credit can be earned.

The Project transferred lessons learned from Unit 3 to ensure that the same issues did not reoccur on Unit 4.

Q. HAS GPC RECOGNIZED THE COSTS TO INSTITUTE THE CORRECTIVE ACTIONS AS COSTS THAT IT WILL NOT PASS ON TO ITS CUSTOMERS?

A. Yes. GPC has conveyed to us its intentions to not seek recovery of costs from the IR closure efforts. We strongly agree with GPC's decision not to seek recover of these costs from its customers.

[170] Monthly Project Review Meeting Presentation, p. 11, January 2022.
[171] Monthly Project Review Meeting Presentation, p. 10, January 2022.
[172] Monthly Project Review Meeting Presentation, p. 5, December 2021.
[173] Monthly Project Review Meeting Presentation, p. 11, February 2022.

iii. SPENT FUEL POOL AND FUEL TRANSFER CANAL

Q. ARE YOU AWARE OF REMEDIATION WORK PERFORMED ON THE SPENT FUEL POOL AND FUEL TRANSFER CANAL?

A. Yes. The Spent Fuel Pool ("SFP") is a pool filled with boronated water that is used to store nuclear fuel rods underwater and the Fuel Transfer Canal ("FTC") is where a shuttle system is used to transfer the fuel rods for loading into the reactor. The walls and floor of the pool consist of stainless steel liners, which are welded together to form a leak tight boundary.[174]

The SFP was initially filled in August 2019 and ITP drained it in October of 2019. After draining, a small amount of water leakage was discovered. The Radioactive Waste Drain System ("WRS"), which contains the leak detection and monitoring equipment, was not operational at that time, so the source of the leakage was not determined. The SPF was filled a second time by ITP in April 2020 and drained again in May 2020, but no leak evaluation was performed.

On February 27, 2021, the SFP was filled for a third time. On March 16, 2021, two gallons per minute of leakage was discovered in several drains in the SFP and FTC.[175] After several failed attempts to isolate the source of the leakage in the WRS, ITP attempted to identify the source of the leakage by applying pressurized air to the WRS while the SFP was filled in an attempt to create air bubbles that would float to the top of the SFP. The test was initially run with 30 pounds per square inch ("PSI") and, when no bubbles appeared, the

[174] Westinghouse CA20 Leakage Apparent Cause Analysis Input – ESRs 50083161 and 50083422, p. 2, May 14, 2021.
[175] Westinghouse CA20 Leakage Apparent Cause Analysis Input – ESRs 50083161 and 50083422, p. 4, May 14, 2021.

ITP Test Engineer increased the pressure to 60 PSI.[176] After the pressure was increased, the ITP Test Engineer heard metallic pinging sounds, and the PSI was reduced to 45. The leak chases have a design pressure of 20 PSI and the leak chase piping has a design pressure of 30 PSI. After the testing connections were removed the leak rate increased to 6.2 gallons per minute.

This over pressurization event had caused significant stress to the welds, which caused new leakage paths and exacerbated existing leakage paths, which caused the overall leakage rate to increase. To address the leak, SNC removed all the floor panels, redesigned the floor panels to include fewer welded seams, and re-installed new floor plates.

Q. DO YOU RECOMMEND A DISALLOWANCE OF COSTS INCURRED FOR THE REMEDIATION OF THE SFP AND FTC?

A. No. During the SFP and FTC remediation efforts the Project was already being delayed by the IEEE remediation efforts, so no delay costs can be specifically attributed to this remediation. The Project also recovered significant remediation funds through its builder's risk policy, so we understand that customers will not be paying costs associated with this remediation.

[176] Westinghouse CA20 Leakage Apparent Cause Analysis Input – ESRs 50083161 and 50083422, p. 4, May 14, 2021.

XI. OVERALL ASSESSMENT OF THE OVERSIGHT AND MONITORING OF THE VOGTLE PROJECT

Q. WHAT IS YOUR OVERALL ASSESSMENT OF THE OVERSIGHT AND MONITORING OF THE VOGTLE PROJECT?

A. We conclude that SNC and GPC exercised appropriate oversight and monitoring of the Project and that the Project is reasonable and prudent. Our review has demonstrated that, as the first new nuclear project completed in decades, the Vogtle Project will provide valuable, carbon-free energy and capacity to Georgia Power and the Co-Owners' customers for the next 60-80 years.

Q. DO YOU FIND THAT THE COMPANY'S REQUEST OF $8.826 BILLION TO BE REASONABLE RESULTING IN VALUE TO THE CUSTOMER?

A. Yes, based on our assessment as discussed in our testimony.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

Exhibit JAM-1 – Joe's CV

Exhibit MS-2 – Mike's CV

Exhibit 3 – List of Documents Reviewed

- Bechtel Construction Completion Agreement and Amendments thereto;
- Bechtel Transition Plan;
- Project Management Organization ("PMO") and Development;
- SNC Policies and Procedures;
- Change Control Forms ("CCFs");
- Cost Management Guidelines
- SNC Monthly Progress Presentations;
- Bechtel Monthly Status Reports;
- Westinghouse Monthly Status Reports;
- Monthly Cost Monitoring Reports;
- Monthly Cost Reports;
- Project Cost Contingency Analysis;
- Weekly Metrics;
- Inspection Reports;
- Quality Assurance Aggregate Trend Reports;
- Project Execution Plans ("PEPs");
- Construction Execution Plan;
- Risk Management Program;
- Risk registers;
- Project Schedules;
- Organizational charts;
- Meeting minutes/notes;
- Cost estimates and reforecasts;
- Budgets and cost reports;
- Contractor/Vendor proposals;
- Purchase Orders;
- Southern Company and GPC Board of Directors ("BOD") information;
    - Meeting Minutes; and
    - Presentations to the Board of Directors and Board Committees.
- Construction Review Board ("CRB") Meeting Minutes and Presentations;
- Vogtle Project Management Board ("VPMB") Meeting Minute and Presentations;
- Vogtle Construction Review Board ("VCRB") Meeting Minutes and Presentations;
- Change Control Board ("CCB") Minutes
- Internal audit reports
- External audit reports
- The Institute for Nuclear Power Operators ("INPO") Principles for Excellence;
- NRC Correspondence;
- NRC Inspection Reports;
- Root Cause Determinations;
- Lessons Learned;
- Industry Standards;

- Industry data, presentations, and reports;
- GPC filed pleadings with the GPSC;
- Testimony filed and Orders issued in the GPSC Dockets 29849 and 27800;
- Data Requests and corresponding responses submitted by the Staff, CM, and various Intervenors.

Exhibit 4 – Personnel Interviewed

- GPC Executive Vice President, CFO, and Treasurer
- GPC Nuclear Development, Regulatory Support
- Executive Vice President, Vogtle 3 & 4
- Work Management Director
- Budgeting and Reporting Manager
- Project Oversight Director
- Internal Audit Director
- Construction Project Director
- SNC Chairman, President, and CEO
- Site Vice President, Unit 3
- GPC Senior Vice President, Nuclear Development
- ITP Director
- GPC Regulatory & External Affairs Project Manager
- Vice President, Project Controls
- Principle Project Scheduler (Lead)
- Cost Management Manager
- Vice President, Business Operations
- Business Operations Director
- GPC Commercial Director, Nuclear Development

Exhibit 5 – List of Policies and Procedures Reviewed

- SNC Change Control Procedure, ND-PC-VNP-006, Versions 2.0-4.0
- SNC Vogtle Units 3 and 4 Scheduling Desktop Guideline, Revision 6-12
- SNC Vogtle 3 & 4 Project Cost Management Guideline, Revision 6
- SNC Vogtle Process Controls Narrative, VGT 3.0 Monthly Cost/Budget to Actual Review, Version 3
- SNC Risk Management Program, ND-PC-VNP-010, Version 3.0
- Plant Vogtle Units 3 and 4, Project Execution Plan, Version 8.1
- SNC Project Metrics Reporting, ND-PC-NVP-003, Version 4.0
- Southern Company Internal Audit Playbook
- SNC Conduct of Operations for Initial Test Program Group Procedure, NC-CO-013, Version 7.0
- SNC Vogtle 3&4 Conduct of Operations Procedure, ND-CO-026
- SNC Project Completion and Transition to Operations Procedure, ND-AD-VNP-029, Version 5.1
- SNC ITP Administration and Organization Procedure, B-GEN-ITPA-001, Version 7.2

Exhibit 6 – Internal Audits for 2019

Q1

- Contract Administration/Contractor Flowdown Compliance Review
- Physical Site Security Review
- Information management Review
- Vendor Quality Oversight Review

Q2

- Budget/Cost Management Review
- Project Interaction Review (VPEP Sub-Plans)
- PRISM Application Review
- Project Metrics Review

Q3

- Owner Controlled Insurance Program Assessment
- Schedule Assessment
- Operational Readiness – Unit 3
- Vendor Management – Accenture SLA Review
- Accrual Assessment
- DOE Loan Guarantee Review

Q4

- Regulatory Compliance Review
- Information Management Review
- Environmental, Health, and Safety Audit

Projects On-Going Throughout the Year

- Vendor Contract Management Reviews

From: November 7, 2019, presentation to Southern Nuclear BOD and Nuclear Oversight Committee, slide 13

Board Staff Interrogatory #081

Interrogatory

Reference:
Ref 1: OPG_Working_Excel_Table D_Cap_Proj_20251219 / Tab D2-1-3 Table 1a to 2g & Tables 5a to 5d

Preamble:

At Reference 1, OPG identifies which of the OPG nuclear facilities projects are eligible for the Capacity Refurbishment Variance Account (CRVA).

Question(s):

a) Please list and explain the criteria OPG uses to determine whether a nuclear project is eligible for CRVA treatment.

b) Referencing the criteria for part a), please explain the basis upon which OPG has assessed the Tritium Removal Facility Major Component Replacement Program as CRVA eligible.

Response

a) Eligibility for CRVA treatment is established by O. Reg. 53/05 Section 6(2)4 that requires the OEB to ensure that OPG recovers "capital and non-capital costs and firm financial commitments incurred in respect of the Darlington Refurbishment Project or incurred to increase the output of, refurbish or add operating capacity to a [prescribed] generation facility," if the OEB “is satisfied that the costs were prudently incurred and that the financial commitments were prudently made”.

Accordingly, OPG considers all projects that increase the installed operating capacity of a generating station, being the maximum capacity rating electric output the facility can physically produce, increase the output from the existing installed operating capacity through either efficiency gains or extension of the facility’s operating life, and/or refurbish a generating station as eligible for the CRVA. With respect to refurbishing, eligible projects include those that replace or rehabilitate the equipment, structures and components that are necessary to enable the continued safe and reliable operation of a generating station, which, for clarity, may at the same time increase the installed operating capacity of, increase the output from or extend the life of the station. As a practical matter, OPG limits the application of the CRVA to such major equipment, structures or components.

In recognition of materiality considerations and in support of regulatory efficiency, beginning with the 2027-2031 IR term, OPG does not propose to track Tier 3 capital projects for CRVA eligibility, as noted at Ex. H1-1-1, p. 19, footnote 23.

b) OPG has assessed the Tritium Removal Facility ("TRF") Major Component Replacement ("MCR") Program as being CRVA eligible as it satisfies the eligibility criteria described in part a). In particular, the TRF MCR Program encompasses work to refurbish this facility to address equipment aging, degradation and obsolescence issues, ensuring its continued and reliable availability to provide heavy water management services essential to the continued operation of the Darlington, Pickering and Bruce stations. If the TRF cannot meet the demand to detritiate unit moderators, the tritium levels could increase until operating limits are reached, potentially requiring the generating units to be shut down. The TRF is physically interconnected with the Darlington station and is an integral part of the plant design. For further details, refer to Ex. D2-1-3, p. 18, Ex. L-D2-Staff-089, and the Business Case Summary at Ex. L-D2-AMPCO-052, Attachment 1.

Board Staff Interrogatory #082

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 1 / Schedule 2 & 3

Preamble:

At Reference 1, OPG proposes multiple major capital initiatives at Darlington during the 2027–2031 period, including but not limited to turbine rotor replacements, steam generator chemical cleaning, primary moisture separator replacements, turbine control upgrades, Tritium Removal Facility (TRF) major component replacement, and other outage-dependent work scopes.

Several of these projects are scheduled during planned outages and are identified as having potential outage critical path interactions.

Question(s):

a) Please provide a consolidated outage schedule for Darlington Units 1–4 for the 2027–2031 period identifying, by unit and outage, all major capital work scopes proposed to be executed, including estimated outage duration impacts attributable to each scope.

b) Please identify any outages during the IR term in which more than one Tier 1 capital project (over $30 million) is scheduled concurrently and describe:
   i. The combined critical path duration
   ii. Schedule contingency incorporated
   iii. The quantified risk of outage extension to the extent possible

c) Please explain how cumulative schedule risk across these projects has been assessed, including whether integrated schedule risk modelling (e.g., Monte Carlo or equivalent probabilistic analysis) has been performed.

Response

a) Attachment 1 provides a consolidated planned outage schedule for Darlington Units 1-4 for the 2027-2031 IR term identifying, by unit and outage, major capital

work scopes proposed to be executed, and the estimated outage duration impacts attributable to each scope.[1]

b) Every Darlington outage during the IR term includes more than one Tier 1 capital project that is executed concurrently (i.e., in parallel). For each outage, Attachment 1 shows:
   i. The combined critical path: see column (d) “Planned Outage Duration (Days)”.
   ii. Allowance days, which are discussed in Ex. E2-1-1, Section 2.2, p. 3, lines 26-30 and p. 4, lines 1-4. Such allowances are typically used in planned outages. For schedule allowance days incorporated: see column (g) “Schedule Allowance (Days)”
   iii. The quantified risk of outage extension would not be available until outage scope freeze milestone, which is within 12 months from outage start.

c) Planned outage schedules identify the number of days required for inspections and maintenance activities to ensure the continued safe, reliable, and long-term operation as discussed in Ex. E2-1-1, Section 2.2.

Cumulative schedule risks across projects are assessed and risk modelling is developed through an integrated risk monitoring process as part of OPG’s Planned Outage Management procedure (N-PROC-MA-0013). This procedure includes defined milestones to plan, execute, monitor, and control outage activities. As part of the procedure’s risk milestone, OPG performs a Monte Carlo risk analysis, to develop a risk-adjusted outage duration forecast and identify schedule risks. The evaluation includes a review of risks from recent planned outages, equipment failure risks, start-up activity duration risks, and project risks affecting safety, scope, cost, and schedule duration. Risk mitigation plans are developed, and high impact teams and accountable leads are assigned, and the plans are reviewed cross-functionally and communicated to outage stakeholders and outage control center managers.

[1] Attachment 1 includes projects listed in the preamble except for the Tritium Removal Facility Major Component Replacement, as work for this project is carried out separately from Darlington unit outages.

Darlington Units 1-4 2027-2031 Planned Outages - Major Capital Scope Impacts

#	Unit	Outage Code	Planned Outage Duration (Days)	Capital Projects	Outage Impacts (Days	Schedule Allowance (Days)
(a)	(b)	(c)	(d)	(e)	(f)	(g)
1	2	D2721	366.3	Project 87151 – DN SG Primary Moisture Separators Replacement	351.3	33.4
				Project 83664 - DN Unit 2 TG Controls	15.0	
2	VBO D2701	D2711	45.9	Project 84552 - DN VBO Power Operated Valve Replacements Project 83480 - DN 4KV Motor Replacement (ECI Pump)	15.0	11.9
		D2731				
		D2741				
3	D1-4	TBD	15.0	N/A - Equipment Risk Outage	N/A	N/A
4	1	D2811	120.2	Project 86314 – DN Steam Generators Soft Chemical Clean Project 89464 - DN Primary Side Clean (4 SGs)	45.3	31.2
5	4	D2941	74.9	No Capital projects extending planned outage duration	N/A	19.5
6	D1-4	TBD	15.0	N/A - Equipment Risk Outage	N/A	N/A
7	3	D2931	124.2	Project 87807 - Turbine Rotor Replacement	124.2	32.2
8	D1-4	TBD	15.0	N/A - Equipment Risk Outage	N/A	N/A
9	2	D3021	124.2	Project 87807 - Turbine Rotor Replacement	124.2	32.2
10	D1-4	TBD	15.0	N/A - Equipment Risk Outage	N/A	N/A
11	1	D3111	124.2	Project 87807 - Turbine Rotor Replacement	124.2	32.2
12	D1-4	TBD	15.0	N/A - Equipment Risk Outage	N/A	N/A

Board Staff Interrogatory #083

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 1 / Schedule 2 & 3

Preamble:

Nuclear capital operations Tier 1 projects (over $30 million total project cost) in the 2027–2031 period are at varying Business Case Summary Gate phases (e.g., Development, Definition, partial Definition releases). OPG's Gate process is intended to progressively refine scope and cost estimates as projects mature.

Question(s):

a) For each nuclear Tier 1 project included in the 2027-2031 forecast, please provide in a tabular format:
   i. The current Gate phase
   ii. The estimate class (e.g., AACE Class 5-3) associated with the current total project cost.
   iii. The expected accuracy range for that estimate class.

b) For nuclear operations capital Tier 1 projects completed historically, please provide:
   i. The Gate phase and estimate class at the time of Execution phase approval
   ii. The final actual project cost
   iii. The variance of the actual project cost relative to the execution phase estimate, and whether that variance fell within the expected accuracy range.

c) Please comment on how the Gate phase and estimate maturity of the 2027-2031 Tier 1 projects support the reasonableness of the forecast in-service amounts included in this application.

Response

a) The requested information for Nuclear Tier 1 projects included in the 2027-2031 IR term is provided in a tabular format in Chart 1 below. The expected accuracy range for an estimate class is defined as per the Association for the Advancement of Cost Engineering International ("AACE") Estimated Class guidance, which is included in Ex. D2-1-1, Attachment 1, p. 2, lines 15-17.

Chart 1
Project information by current gate and estimate class
2027-2031 Forecast Period

Index Number	Project Title	Project Number	Current Gate[1]	Estimate Class
1	DN Class II Uninterruptable Power Supply Replacement	31412	Gate 3c	Class 3
2	DN Major Pump-Sets Vibration Monitoring System Upgrades	33819	Gate 3b	Class 3
3	DN Standby Generator Controls Replacement	33973	Gate 3b	Class 2
4	DN OH180 Aging Management Hardware Installation	80022	Gate 3b	Class 3
5	DN R22 Refrigerant Air Conditioning Unit Replacement	80036	Gate 3b	Class 3
6	DN Digital Control, Common Process And Sequence Of Events Monitoring Computer Aging Management	80078	Gate 2b	Class 4
7	DN Main Power Output Protection System Replacement	80122	Gate 3	Class 3
8	DN Group II Pressure Transmitter Replacement	80123	Gate 3	Class 3
9	DN Obsolete Controller Replacement	80124	Gate 3a	Class 3
10	DN Fuel Handling Computer Input/ Output Subsystem Interprocessor Communication Replacement	80148	Gate 2b	Class 4
11	DN Fire Resistant Fluid Pump Improvement	80150	Gate 2b	Class 4
12	DN Fuel Handling Head Major Component Replacement	82947	Gate 3	Class 3
13	DN Rapid Delivery Machine	83039	Gate 3c	Class 3
14	DN Main Output Transformer & Unit Service Transformer Replacement	83296	Gate 3a	Class 3
15	DN Large Moderator Temperature Control Valve Replacement	83297	Gate 3	Class 3
16	DN Secondary System Obsolete Control Valve Replacement	83298	Gate 3	Class 3
17	DN 4KV Motor Refurbishment and Replacement	83480	Gate 3a	Class 4
18	DN Isolated Phase Bus Refurbishment	83484	Gate 3a	Class 4

19	DN Unit 2 Turbine Control and Auxiliary Systems Upgrade	83664	Gate 3	Class 3
20	DN Motor Operated Valve Replacements	84551	Gate 3	Class 3
21	DN Revenue Metering Transformer Replacement	84939	Gate 3	Class 3
22	DN Public Address System Upgrade	31708	Gate 2b	Class 5
23	DN Breathing, Instrument and Service Air Compressor Replacement	83933	Gate 2a	Class 4
24	DN Powerhouse Elevator Replacement	84135	Gate 2	Class 4
25	DN Powerhouse Cranes Refurbishment	84139	Gate 2a	Class 4
26	DN Vacuum Building Outage Power Operated Valves Replacement	84552	Gate 2a	Class 4
27	Tritium Removal Facility Major Component Replacement Program	84764	Gate 2a	Class 4
28	DN Low Pressure Service Water Strainer Backwash Motorized Valves Replacement	86280	Gate 2a	Class 5
29	DN Motor Operated Valve Replacement Innage	86795	Gate 2	Class 4
30	DN Lighting Fixtures Light Emitting Diode Replacement	86910	Gate 3a	Class 4
31	DN Copper Upgrades Phase III	86915	Gate 3	Class 3
32	DN Unit 2 and 3 Steam Generator Moisture Separator Replacement	87151	Gate 3b	Class 3
33	DN Tritium Removal Facility Cryogenic Refrigeration System Turbine Replacement	87191	Gate 2	Class 5
34	DN Turbine Rotors Replacements & Capital Spare	87807, 87811	Gate 2	Class 4
35	DN Smartops Sensor Integration	87808	Gate 2a	Class 5
36	DN Unit 1 and 2 Generator Stator Rewind	89281	Gate 2	Class 4
37	DN Steam Generator Soft Chemical Clean	89462	Gate 2	Class 4
38	PN 058 Boiler Room and Turbine Hall Crane Upgrade	89535	Gate 3	Class 3
39	PN 058 Turbine Auxiliary Building, Reactor Auxiliary Building Hoist & Cranes	89536	Gate 2	Class 5
40	P58 Second Simulator and Pickering Learning Centre Extension	89581	Gate 2	Class 5

Note 1: Per Ex. D2-1-1, Figure 2, there are three funding gates: Gate 1 (G1) – Development Phase, Gate 2 (G2) – Definition Phase, Gate 3 (G3) – Execution Phase. Gate 2 and Gate 3 can also have partial release Business Case Summaries and would be identified with “a” or “b” after the gate number in the chart.

b) See Attachment 1. OPG has provided the requested information for Tier 1 projects reported complete in Ex. D2-1-3, Table 1b.

c) OPG's project and portfolio management processes, including project lifecycle phases and gates, support the reasonableness of the forecast in-service amounts for this Application. All Nuclear Operations projects have oversight and approval from Project Management Oversight Committees ("PMOCs"). PMOCs ensure accountability in phase-gating by reviewing all Business Case Summaries ("BCS"). As shown in part a), allocated Tier 1 projects in the 2027-2031 forecast have progressed through a phased gating approach and have class estimates supporting the reasonableness of the estimates. The maturity of the estimate is related to the estimate class as per the AACE Estimated Class guidance and included in Ex. D2-1-1 Attachment 1, p. 2, lines 15-17. As projects move through the phase gates, their planning, scope, engineering, procurement, and execution strategies are further refined, advancing the level of project definition. OPG continues to refine its processes by applying lessons learned and applying rigorous project management initiatives that are further described in Ex. D2-1-1, Section 3.5.

Additional details on the project portfolio management process, project lifecycle phases and gates can be found in Ex. D2-1-1, Section 3.0 and Attachment 1.

Attachment 1
Nuclear Operations Capital Tier 1 Completed Projects Variances

Index	Project Name	Project Number	Start Date	Final In-Service Date	Total Project Cost ($M)	1st Execution BCS ($M)	Variance ($M)	1st Execution BCS Date	Gate Phase at Execution	Class Estimate in BCS	Project Completed within Class Estimate Range
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h) = (f) - (g)	(i)	(j)	(k)	(l)
1	DN Shutdown Cooling Heat Exchanger Replacement	31710	Nov-12	Nov-21	85.5	56.1	29.4	Apr-14	Definition and Execution - Partial	Class 3	No
2	DN Auxiliary Heating System[1]	34000	Mar-06	Jun-18	106.4	45.6	60.8	Dec-12	Execution - Partial	Class 3	No
3	DN Zebra Mussels Mitigation & Improvements	38948	Nov-12	Dec-21	37.1	21.5	15.7	Sep-15	Execution - Full	Class 2	No
4	DN RS Primary Heat Transport Pump Motor Replacement	73566	Jul-15	Oct-22	77.9	26.7	51.2	Jul-15	Execution - Partial	Class 3	Yes[2]
5	DN Primary Heat Transport Pump Motor Overhaul	80144	Jul-15	Dec-21	43.6	102.8	(59.2)	Jul-15	Execution - Partial	Class 3	Yes[2]
6	DN Copper Piping Replacement	83049	Aug-16	Aug-23	44.3	29.3	15.0	Sep-17	Execution - Partial	Class 3	No

Notes:

1 Consistent with the EB-2016-0152 Decision and Order, the cost of this project for rate base inclusion is limited to $75.2M.

2 Projects 73566 and 80144 first execution BCS amounts are derived from the BCS combined amount ($129.5M) per EB-2016-0152 Ex. D2-1-3 Attachment 1, Tab 33, pp. 1-14. The total variance of both projects combined falls within the first execution BCS amount released.

Board Staff Interrogatory #084

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 1 / Schedule 3

Preamble:

Reference 1 describes how certain capital projects (e.g., turbine rotor replacements and related upgrades) are expected to increase generating output and/or reduce forced loss rate.

Question(s):

a) Please confirm whether projected output improvements and forced loss rate reductions associated with capital projects in the 2027–2031 period are reflected in forecast production and revenue assumptions.

b) If so, quantify the incremental MWh assumed in each year attributable to these projects.

c) If not, explain how the incremental generation output is reflected in the revenue requirement framework.

Response

a) OPG confirms that the projected output improvement associated with the Darlington Turbine Rotors Replacement Project, as discussed in part b), is reflected in the 2027-2031 forecast production and proposed payment amounts for the IR term. The Turbine Rotors Replacement Project is the only Nuclear Operations capital project that is expected to result in a specific output improvement during the IR term. As discussed in Ex. L-D2-Staff-086, while planned capital project investments collectively support the achievement of annual forced loss rate ("FLR") targets during the IR term, individual capital projects are not tied to specific FLR reduction targets.

b) The Turbine Rotors Replacement Project is expected to deliver a power output improvement of 21 MWe per unit, leading to expected incremental production increases of 1,167 MWh in 2029, 181,942 MWh in 2030, and 445,201 MWh in 2031.

c) Not applicable (see response to part b).

Witness Panel: Nuclear Operations and Nuclear Projects

Board Staff Interrogatory #085

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 1 / Schedule 3

Preamble:

Several nuclear projects cite supply chain constraints, vendor capacity limitations, or long lead times as factors influencing the timing of the projects.

Question(s):

a) Please identify all nuclear projects in the IR term for which project timing has been advanced or early procurement commitments have been made in order to mitigate supply chain constraints (e.g., long lead manufacturing slots), rather than due to immediate technical necessity.

b) For the projects identified in (a), please provide the analysis performed to evaluate the trade-off between advancing procurement/project versus deferring the work, including any estimate of cost escalation risk associated with deferral by three and five years.

c) Confirm whether any long lead procurement commitments have been made prior to Execution Phase (Gate 3) approval. If so, describe associated cancellation or stranded procurement risks.

Response

a) and b) There are no nuclear projects in the IR term for which project timing has been advanced in order to mitigate supply chain constraints. Project timing is driven by the underlying technical needs and risk to operations. Decisions around procurement commitments are made with a view to meeting these timelines, taking into account current and expected market conditions.

c) Confirmed. Long lead procurement commitments have been made prior to Execution Phase (Gate 3) approval. For example, engineered equipment (with long lead time) has been procured in the project Definition Phase (Gate 2). Refer to Ex. L-A1-Staff-015 for additional information.

To mitigate potential associated cancellation or stranded procurement risks, OPG negotiates termination clauses into its contracts and seeks to obtain fair market termination rights, which generally limit termination costs to actual vendor mitigated costs.

In addition, Project Management Oversight Committees ensure oversight and accountability in phase-gating by reviewing all BCSs, allowing for risk-based decision making throughout the project life cycle, including risks related to project cancellation or stranded procurement. The phase-gating strategy is risk-based and reflective of the cost and complexity of the project. If a BCS is approved, the project moves forward for the appropriate funding approval release according to the Organizational Authority Register (Ex. D2-1-1, Section 3.3).

Board Staff Interrogatory #086

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 1 / Schedule 3

Preamble:

Multiple capital projects in the 2027–2031 period identify reliability improvements, forced loss rate (FLR) reductions, and maintenance optimization as expected outcomes.

Question(s):

a) Please describe how OPG has assessed and aggregated project FLR reductions from individual nuclear capital projects over the IR term, including the total expected fleet-level FLR reduction and how potential overlap among project-level benefit estimates was addressed to avoid any double counting.

b) Please quantify the expected incremental energy production (MWh) associated with the FLR reductions in part a), by year (2027-2031), and confirm whether these MWh impacts are reflected in OPG's forecast energy production for the IR term. If not, please explain how the benefits are reflected in the application.

Response

a) and b)
OPG determines its FLR targets based on historical plant performance, any known improvements or component condition issues, initiatives to improve equipment reliability, and with consideration of post-refurbishment risks (refer to Ex. L-E2-Staff-155). In this framework, sustaining capital projects are considered in aggregate with other equipment reliability initiatives as supporting achievement of Darlington's sustaining FLR target over the IR term, rather than being assigned specific FLR reduction values. As such, project-attributable FLR reductions and associated production impacts over the IR term are not quantified. As discussed in Ex. E2-1-1, p. 15, lines. 9-13, taking into account the above factors, including projects in the IR term, Darlington's FLR target has been set at 2.0% (after each unit transitions to post-refurbishment normal operations).

Board Staff Interrogatory #087

Interrogatory

Reference:
Ref 1: OPG_Working_Excel_Table D_Cap_Proj_20251219 / Tab D2-1-3 Table 1a
Ref 2: Exhibit D2 / Tab 1 / Schedule 3 / Attachment 1 / Tab 26 (Project #83664 BCS)
Ref 3: Exhibit D2 / Tab 1 / Schedule 2 / Term-over-Term Changes – Nuclear Operations, pp. 10-24
Ref 4: Exhibit D2 / Tab 1 / Schedule 1 / pp. 4-5

Preamble:

At Reference 1 in line number 27, OPG states that the total project cost per EB-2020-0290 for Project #83664 was $112.7 million. At Reference 2, OPG provides an updated total project cost estimate of approximately $194.6 million, with a completion date in June 2028.

At Reference 3, OPG identifies Project #83664 as a significant contributor to the increase in Nuclear Operations non-portfolio in-service additions during the 2027–2031 period.

OPG has further stated that turbine control and auxiliary system replacements were completed on Darlington Units 1, 3, and 4 through the DRP, but that installation on Unit 2 was excluded from the Unit 2 DRP scope because the existing control system had useful remaining life and to mitigate first-of-a-kind risk (FOAK), given that Unit 2 was the first unit refurbished.

At Reference 4, OPG states that “OPG’s current asset management and investment planning process overseen by the asset management governing body consists of the following three steps”, one of which is “investment assessment”.

Question(s):

a) Please reconcile the previous total project cost estimate of $112.7 million from EB-2020-0290 with the updated total project cost estimate of approximately $194.6 million. The explanation should clearly break down the cost increase and attribute the variance, to the extent possible, to specific drivers such as:
   - Scope changes (what was added, removed, or modified)
   - Schedule deferral, including the impact of shifting the in-service date from the D2421 outage to the D2721 outage
   - Contingency adjustments or risk-based revisions

- Any other material cost drivers

The response should quantify each driver to the extent feasible and describe how each contributed to the overall increase.

b) Please provide all decision documentation approving the deferral of this work from the Unit 2 refurbishment scope due to FOAK risks. If such documentation does not exist, then please explain why.

c) Please provide a copy of the "investment assessment" document that would have been carried out for this project as per OPG's asset management and investment planning process. If no investment assessment was carried out, explain why. Was lifecycle-cost comparison (e.g., evaluating completion during refurbishment versus deferral) considered as a part of that investment assessment? If not, please explain why not.

Response

a) As part of the pre-filed evidence (Ex. D2-1-3, Section, 3.4.1, p. 27), a variance explanation was submitted to explain the cost increase of $81.9M from the total project cost estimate of $112.7M submitted in EB-2020-0290. The quantification of the three key drivers discussed in the pre-filed evidence for the cost increase is:

- Driver 1: Deferral of execution window from an originally planned outage in 2025 to a planned outage in 2027 due to the original outage being deferred to support grid reliability and manage resource constraints during concurrent nuclear outages in the province (refer to Ex. E2-1-1, Section 3.0). The deferral resulted in additional interest, escalation, OPG and contractor project management, and material storage costs, with a cost impact of $35.8M. For generation plan impacts related to the project deferral, please refer to Ex. L-E2-CCC-065.

- The following two drivers had a combined cost impact of $46.1M. Due to interdependent impacts between the two drivers, each driver cannot be quantified separately.
    - Driver 2: The previous estimate was based on a preliminary level of project definition at an early engineering phase prior to Darlington Unit 3 installation lessons learned and finalization of the contract for field execution.
    - Driver 3: Incorporation of lessons learned and design improvements from the execution of this work for Darlington Unit 3 (which was first-of-a-kind), Unit 1, and Unit 4, as part of the Darlington Refurbishment Program

("DRP"), to enhance reliability, after return to service of the turbine control system.

b) OPG declines to provide this information on the basis of relevance. As part of the DRP release quality estimate, Darlington Unit 2's refurbishment excluded upgrades to the turbine control and auxiliary system replacements, which remained in scope for subsequent units. As discussed in EB-2016-0152, the exclusion of this scope from Unit 2 was recommended by the Blue Ribbon Task Force and accepted by the Program Scope Review Board as there was still useful life left in the existing control system on Unit 2. Moreover, deferral provided a risk mitigation measure for Unit 2.[1] In its Decision and Order, the OEB accepted OPG's proposed capital additions for the DRP, including the proposed in-service amounts for the turbine generator scope of work, as reasonable.[2] Consistent with this approach, in EB-2020-0290, OPG planned to undertake Project #83664 Darlington Unit 2 Turbine Control and Auxiliary System Upgrade.[3] As articulated in EB-2016-0152, OPG explained that this project was excluded from Unit 2 refurbishment to mitigate risk as incorporating this large first-of-a-kind modification on the conventional side would have introduced unnecessary additional risk into the planning and execution of the Unit 2 refurbishment. This project formed part of the Nuclear Operations projects accepted in the OEB-approved settlement proposal in EB-2020-0290. Accordingly, the exclusion of the turbine control and auxiliary system replacements from the DRP scope was already reviewed and accepted by the OEB over multiple applications and revisiting these prior decisions is not relevant to any issues on the approved Issues List of this proceeding.

c) Refer to part b) of this response with respect to evaluations of completion of the project as part of refurbishment versus deferral.

As this investment decision predated OPG's current Value Framework-based asset management and investment planning process described at Ex. D2-1-1, such investment assessment documentation does not exist.

[1] Refer to EB-2016-0152, Ex. D2-2-5, Section 4.2 for details on the decision to defer this work from the Unit 2 refurbishment scope.
[2] Decision and Order, EB-2016-0152, pp. 32-33 and 36.
[3] EB-2020-0290, Ex. D2-1-3, p. 11.

Board Staff Interrogatory #088

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 1 / Schedule 3 / Attachment 1 / Tab 26 (Project #83664 BCS)

Preamble:

At Reference 1, OPG states that:

> "Preliminary research completed using Electric Power Research Institute (EPRI) guidelines has found that Printed Circuit Boards (PCB) used in the nuclear industry have a reliable lifespan of approximately 10 to 15 years; the cards at DNGS are over 20 years old and are approaching the end of life. Recent card failures, which were documented in numerous SCRs by both Maintenance and Performance Engineering, are considered to be precursors of higher card failure rates that occur towards the end of equipment life. OPEX from other nuclear stations in Canada and US show the turbine and generator control systems were replaced after approximately 20 years of service."

Question(s):

a) Please provide the following evidence supporting the conclusion that PCB aging at Darlington Nuclear Generating Station (DNGS) warrants the proposed scope and timing of replacement:
   i. A summary of the EPRI guidelines relied upon, including the specific references and recommended life-expectancy criteria.
   ii. A quantitative summary of the card failures that are described in Reference 1 over the past 10 years (e.g., number per year, failure modes, trend).

b) Please provide details on operating experience (OPEX) "from other nuclear stations in Canada and US" that OPG refers to in Reference 1.

c) Please provide a comparison of DNGS operating conditions to the OPEX examples cited (Canada/US), and an explanation of how these analogues support OPG's replacement timing.

d) Please explain whether alternative approaches (e.g., targeted replacement, enhanced testing, selective life-extension measures) were assessed and why full-scope replacement is the prudent option. If they were considered, please provide the detailed analysis. If not, please explain why.

e) Please confirm whether any interim mitigation measures or enhanced maintenance activities were required between Unit 2's return to service in 2020 and the planned 2027 upgrade to maintain reliability of the existing control system, and if so, quantify the associated costs.

Response

In the course of responding to this interrogatory, OPG identified that the age of the cards noted in Reference 1 was based on component condition assessments performed in 2010. The cards are now actually 35 years old and are well past their end of life.

a) i) The following are the main EPRI reports that were relied upon:

- EPRI Report 1016731, Operating Experience Insights on Common-Cause Failures in Digital Instrumentation and Control Systems
- EPRI Report 1009072, Life Cycle Management Sourcebooks – Volume 9: Main Turbine Electro-Hydraulic Controls
- EPRI Report 1011710, Handbook for Evaluating Critical Digital Equipment and Systems.

Within EPRI Report 1009072, Table 6-4 shows the expected life of typical electronic components for printed circuit boards ("PCBs"), with a failure-free life expectation of 5 to 10 years. When combined with a review of available operating experience ("OPEX"), a reliable lifespan of approximately 10-15 years was determined in the planning phase for the project scope.

Additionally, the following reports were also reviewed:

- EPRI Report 1022246, Guidance for Aging Management of Instrumentation and Control Circuit Cards and Components Based on Électricité de France (EDF) Experience. This report focuses specifically on instrument and control circuit cards, their aging mechanisms, observed failure trends, and aging management practices based on a large EDF operating fleet.

- EPRI Report 1011709, Evaluating the Effects of Aging on Electronic Instrument and Control Circuit Boards and Components in Nuclear Power Plants. This is the foundational EPRI research report on electronic circuit board aging in nuclear plants. It evaluates component-level degradation, failure modes, and implications for long-term operability of electronic boards.

ii) Refer to Attachment 1 for a quantitative summary of the card failures that are described in Reference 1. Attachment 1 is based on the analysis performed in the

Initiation phase of the project and shows the increasing number of card failures per module each year from 2000-2015. The failures can be attributed to aging card components.

b) An OPEX report was completed in 2009, which studied the following owner/ operators:
- Dalhousie 1, New Brunswick
- DC Cook, Michigan
- Bruce Power, Ontario
- Point Lepreau, New Brunswick
- Duke Oconee, South Carolina
- Hope Creek, New Jersey
- Springerville, Arizona
- Duke Energy- Catawba, South Carolina.

As per this OPEX report, turbine and generator control systems were being replaced after approximately 20 years of service based on concerns in respect of obsolescence, lack of spare parts and maintainability.

c) OPG has not compared Darlington's operating conditions to the operating conditions of the stations cited in part b), as this information was not a pertinent factor to consider as part of the OPEX review, given that PCB conditions between the stations were similar.

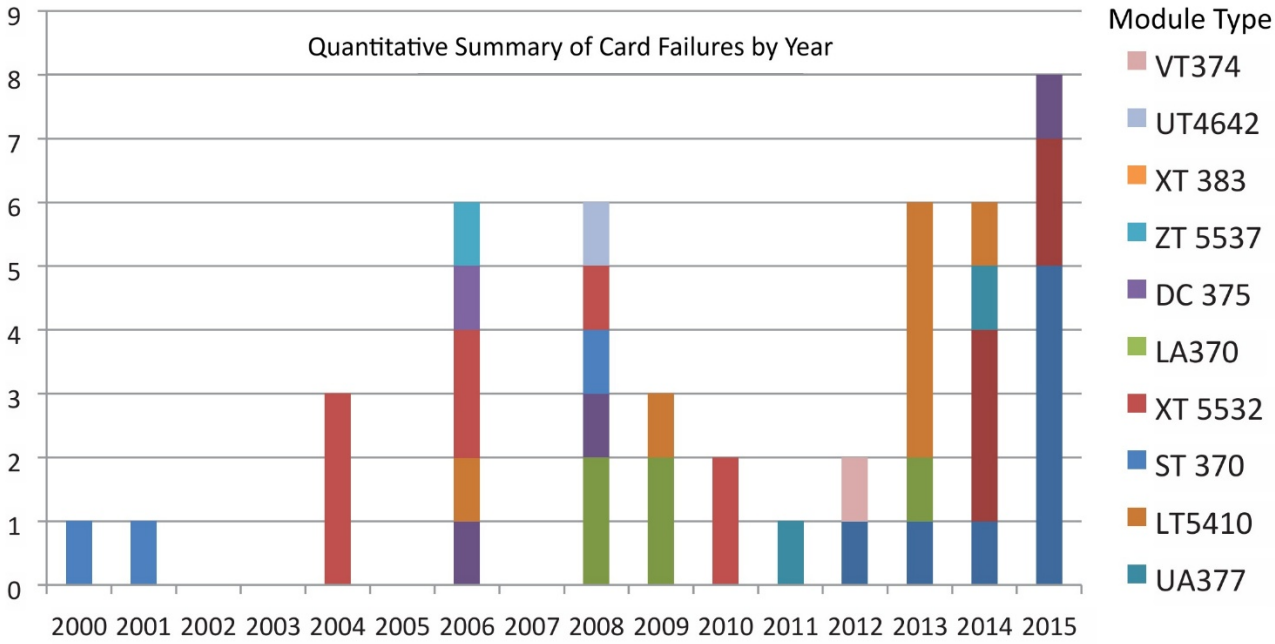
d) OPG did not assess alternative approaches, as full-scope replacement is considered necessary per Reference 1. This approach will align Darlington Unit 2's turbine control system, generator auxiliary skids, and generator excitation system with the systems installed on Units 1, 3 and 4. The new design of the generator auxiliaries and excitation controls are incompatible with the current control system, and thus the turbine control, generator auxiliaries and generator excitation must all be upgraded at the same time. Additionally, the control systems must be identical and interchangeable across the four units. This will also ensure reliable support from the OEM, as it no longer supports the existing analog technology and has moved on to a digital-based platform in keeping with other major turbine manufacturers.

e) In addition to the regular maintenance strategy, a bridging strategy for Darlington Unit 2 has been in place since 2016 to maintain reliability of the turbine generator ("TG") control system until it is replaced, and no incremental interim mitigation measures or enhanced maintenance activities are required between Unit 2's return to service in 2020 and the planned work in 2027.

This bridging strategy consists of the following elements:

1. Refurbish high-risk turbotrol/decontic cards and generator excitation modules during outages
2. Designate the main output control & protection equipment room (“MOCPER”) as a Protected Equipment Zone due to age-related degradation of the TG control cards to limit susceptibility to disturbances associated with maintenance activities in the MOCPER (e.g., scaffolding installation/removal and in-situ/online control card checks)
3. Overhaul electro-hydraulic convertors
4. Retain spare cards from other units to increase spares availability

The bridging strategy was performed through in-house resources, and any costs (expected to be non-incremental) were incorporated into the regular base maintenance program.


Quantitative Summary of Card Failures by Year
9
8
7
6
5
4
3
2
1
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
Module Type
VT374
UT4642
XT 383
ZT 5537
DC 375
LA370
XT 5532
ST 370
LT5410
UA377

Board Staff Interrogatory #089

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 1 / Schedule 3 / TRF Major Component Replacement Program, p. 18

Preamble:

At Reference 1, OPG includes a new non-portfolio project titled "Tritium Removal Facility Major Component Replacement Program" with forecast in-service amount of $452.0 million with $157.6 million over the 2027–2031 period. OPG states that the Tritium Removal Facility (TRF) will reach the end of its expected service life in 2025, that annual throughput (Mg D_2O processed) has shown a continued decline in performance, and that delaying refurbishment is not a viable alternative.

OPG's capital schedule indicates that spending on this project commenced in 2024.

The TRF Major Component Replacement Program was not identified as a discrete project in EB-2020-0290.

Question(s):

a) Please explain why the need for major component replacement at the TRF, with an expected end-of-life in 2025, was not identified in EB-2020-0290. Confirm whether, at the time of EB-2020-0290, OPG had identified degradation trends or remaining useful life concerns for the TRF. If so, explain why a major component replacement program was not included in that application.

b) Please clarify the extent to which the TRF Major Component Replacement Program was, at any time, part of the Darlington Refurbishment Program scope and $12.8 billion Darlington Refurbishment Program budget. If it was not part of the program scope at any time, please explain why.

c) Provide the year in which OPG first determined that the TRF would reach the end of its expected service life in 2025 and describe the analysis supporting that determination.

d) Provide internal asset management or capital planning documentation from 2018-2022 indicating when this project first entered OPG's long-term capital forecast.

e) Provide the original design life of the TRF (in years and cumulative Mg D_20 processed), the cumulative throughput to date, and the percentage of design life consumed. In addition, provide annual throughput for the past 15 years compared to nameplate capacity and quantify the observed decline in performance and its technical causes.

f) Identify the specific components being replaced and confirm whether the project constitutes lifecycle replacement of end-of-life assets, failure-driven replacement, or performance enhancement beyond original design capability.

g) OPG states that delaying refurbishment is not a viable alternative. Please quantify the operational risks and regulatory risks, to the extent possible, associated with deferral and provide any supporting risk assessment or engineering studies, including the maximum deferral period evaluated.

Response

a) The Tritium Removal Facility Major Component Replacement Program ("TRF MCR") was identified as the Tritium Removal Facility Life Extension project in EB-2020-0290, Ex. D2-1-3, Table 5a, line 37, and it was included in that application with a potential start date in 2021. At the time of EB-2020-0290, OPG had identified that there was a need for the project based on the degradation trend and the project was in the initiation phase at the time. The TRF is interconnected with the Darlington station, and, as discussed in Ex. D2-1-3, p. 18, is an integral part of the plant design and has a critical role in heavy water management for Darlington, Pickering and Bruce stations. The TRF MCR Program encompasses work to refurbish the facility to address equipment aging, degradation and obsolescence issues to ensure continued and reliable operation until 2055. If the TRF cannot meet the demand to detritiate heavy water, the tritium levels could increase until operating limits are reached, potentially requiring the generating units to be shut down (refer to the Business Case Summary at Ex. D2-1-3, Attachment 1, Tab 41).

b) The TRF MCR was never part of the Darlington Refurbishment Program ("DRP") $12.8 budget and scope. Work on the TRF and other ancillary systems was excluded from the DRP scope, as the DRP scope included the replacement of life-limiting critical components, the completion of upgrades to meet applicable regulatory requirements, and the rehabilitation of components at Darlington's four units (refer to Ex. D2-2-1, p. 1).

c) OPG first determined in 2010 that the TRF would reach the end of its expected service life in 2025 as part of the life cycle management process. Life cycle

management (or aging management) involves a systematic and integrated approach to managing an asset for its entire service life.

d) The requested internal asset management information was provided in EB-2020-0290, at Ex. L-D2-01-SEC-053, Attachment 2 (excerpt provided as Attachment 1). The project first entered OPG's long-term capital forecast in 2019 as an unallocated project.

e) The TRF has exceeded its original design life of 30 years. At the end of 2025, the TRF performance had a cumulative throughput of approximately [redacted] since commencing operations in 1989. The requested TRF annual throughput information for the last 15 years is shown in Chart 1. There is no straightforward relationship between design life and cumulative throughput readily established. The original TRF design incorporates numerous single points of vulnerability, which have reduced reliability of aging equipment and increased the need for planned outage windows. This has in turn introduced additional operational stresses associated with repeated warm-up and cool-down thermal (cryogenic) cycling. These thermal cycles are understood to accelerate equipment degradation, thereby increasing the likelihood of unplanned or forced outages. The TRF has averaged approximately [redacted] of targeted throughput in the past five years.

Chart 1
Tritium Removal Facility Throughput for 2011-2025

Year	[redacted]
2011	
2012	
2013	
2014	
2015	
2016	
2017	
2018	
2019	
2020	
2021	
2022	
2023	
2024	
2025	

f) Chart 2 lists the specific components being replaced as part of the TRF MCR. The scopes of each item are derived from component condition assessments to address degradation, obsolescence and the main causes of historical reliability issues. The TRF MCR constitutes a lifecycle replacement of end-of-life assets.

Chart 2
Tritium Removal Facility Major Component Replacements

Project Number	Project Name
86818	DN TRF Bulk Helium Supply
87084	DN TRF Redundant Moisture Analyzer
87085	DN TRF Double Block and Bleed Isolation
87086	DN TRF Low Pressure Service Water (LPSW) Replacement
87087	DN TRF Drain and Purge Compressors
87088	DN TRF Dedicated Vacuum/Roughing Pump
87089	DN TRF H2 Compressors Replacement
87090	DN TRF Hydrogen Flame Detection
87091	DN TRF Obsolete Instrumentation
87092	DN TRF Fisher Bellow Valves
87093	DN TRF Simplify / Improvement Tritium Immobilization System
87094	DN TRF Modify Flow Transmitters
89248	DN TRF MCR Replacement of Cryo-adsorbers
89249	DN TRF MCR Separate Deuterium Make-up System (DMS) From Feed Treatment System
89479	DN TRF MCR-Air Cleanup System/Glove Box Cleanup System (ACS/GBCS) System Control Modification
89480	DN TRF MCR-Stage 2 Obsolete Components I&C
89481	DN TRF MCR-Stage 2 Obsolete Components Mechanical

g) The TRF MCR deferral is not a viable option for the reasons set out in the latest Business Case Summary provided in Ex. L-D2-AMPCO-052, Attachment 1, and OPG has not assessed a maximum deferral period. If the TRF MCR was to be deferred, it would result in a significant equipment reliability risk and more frequent and extended outages and increased costs due to degraded equipment, affecting the TRF's ability to provide detritiation services to the Darlington, Pickering and Bruce nuclear stations. The stations rely on the TRF to provide low curie water, and any reliability risk could seriously impact

operations as well as the stations' ability to minimize worker dose and tritium emissions. Tritium concentration limits for the applicable stations are mandated through Operating Policies and Principles, which form part of the stations' operating licences, issued by the CNSC. If the TRF cannot meet the demand to detritiate unit moderators, tritium levels could increase until operating limits are reached, potentially requiring the generating units to be shut down. Given the critical nature of this asset to Ontario's nuclear fleet, the TRF MCR is required to address the above risks.

L-D2-Staff-089
Attachment 1

D2-01-SEC-053-Attachment 2

Ref.	Project Name	Strategy	Strategy Description	Mitigated Risk Areas	Mitigated Risk Value (PV in $M)	Total Cost (PV in $M)	[Asset Investment Net Value (NPV) =Mitigated Risk Values (PV)+Financial Impact (PV)-Cost (PV)] ($M)
D2-T1-S3-Table 5a	**Tritium Removal Facility Life Extension and Tritium Removal Facility Cryogenic Refrigeration System Hydrogen Compressor Upgrade**	Recommended Strategy	Carryout major refurbishment of the existing DTRF to improve reliability and availability and extend service life. It is recommended that major refurbishment of the existing DTRF be integrated with six (6) regularly scheduled extended outages that would be completed over a 12-year period of TRF operation, post 2025. This will allow the TRF to continue to operate on a regular schedule over the TRF refurbishment period. Current projects are in progress to ensure TRF will continue to operate during the refurbishment period post 2025.The final scope of work for TRF Life extension needs to be proposed, challenged, and accepted based on risk to continued reliable plant operation and cost. The screening and approving process should be similar to the process used for unit refurbishment scope to initiate a program for TRF refurbishment.The refurbishment scope would include: * Replacement / refurbishment of key heat exchangers to increase throughput. * Replace existing 2 x 50% duty compressors with 2 x 100% duty compressors to lengthen operating time between outages (improve reliability and capacity factor). * Replace service water piping to reduce leaks and increase reliability. * Add redundancy to key instrumentation and double isolation points where warranted to increase reliability and maintainability * Replace aged and obsolete; transmitters, sensors, transmitters, heaters, etc. as identified in the CCA. * Replacement of Cry absorbers toward end of refurbishment program.	Financial Risk	1000.4	145.0	1360.7
				Radiological Risk	240.1		
				Environmental Risk	210.1		
				Reputation & Social License Impact	12.5		
				Regulatory Risk	5.8		
				Financial Impact	36.8		
				TOTAL	1505.8		
		Alternate Strategy 1	Design and build a new Tritium Removal Facility (TRF) at the Darlington site based on current process and technology (as used in tritium removal facilities in Korea and Romania). The cost of a new build consists of intensive capital expenditures. Building a new TRF, is expected to take 10 years from start to finish. OPG will maintain full control over the overall process: planning, design, procurement, installation, commissioning and close-out. Assuming the first phase (planning) starts in 2020, close-out would not be expected until 2030, which is outside the schedule tolerance of 2-4 years beyond EOL 2025. A bridging strategy or partial life extension may be required at an extra cost. Locating the facility at DNGS would be challenging as there is no unused real-estate around the existing TRF. This may also require a new environmental assessment and/or a revision to site license.	Financial Risk	1113.5	576.3	1087.0
				Radiological Risk	318.0		
				Environmental Risk	318.0		
				Reputation & Social License Impact[1]	-63.6		
				Regulatory Risk[1]	-66.8		
				Financial Impact	44.2		
				TOTAL	1663.4		
		Alternate Strategy 2	**No other viable alternate strategy**	N/A	N/A	N/A	N/A

Board Staff Interrogatory #090

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 1 / Schedule 3 / Darlington Steam Generator Primary Moisture Separators Replacement Projects, pp. 13–15
Ref 2: Exhibit D2 / Tab 1 / Schedule 2 / Section 3 Capital Expenditures p. 5

Preamble:

At Reference 1, OPG states that inspections during Darlington Unit 3 refurbishment identified deterioration of the primary moisture separators due to flow-assisted corrosion. OPG subsequently expanded inspections to other units and determined that replacement of all primary moisture separators across the four Darlington units was required.

Project #86693 has a total estimated cost of $359.2 million and Project #87151 has a total estimated cost of $275.0 million. OPG indicates that replacement of these components was not part of the Darlington Refurbishment Program (DRP) scope.

Further at Reference 2, OPG states that the need for this project arose from the detailed inspections conducted during the DRP of components not typically accessible during regular planned outages.

Question(s):

a) Please confirm whether OPG was unable to conduct inspections of the primary moisture separators prior to the DRP and was therefore not aware of their condition. If this is not the case, please provide historical inspection and condition assessment results for the primary moisture separators for each Darlington unit for the past 10 years. Indicate when flow-assisted corrosion was first identified and how the condition trended over time.

b) Please clarify the extent to which primary moisture separator replacements at units 1 through 4 were, at any time, part of the DRP scope and $12.8 billion DRP budget. If the primary moisture separator replacements were not part of the program scope at any time, please explain why.

c) Provide the engineering assessment and risk analysis that supported the decision to replace all primary moisture separators across all four units rather than pursuing targeted replacement or enhanced monitoring.

d) Explain whether executing work outside of the original refurbishment outage windows resulted in incremental costs. If so, quantify those incremental costs.

e) Identify any changes to scope, schedule, or cost since the projects were first approved internally, and explain the drivers of those changes.

Response

a) Not confirmed. Refer to Ex. L-D2-ED-008, part a), i).

b) The replacement of PMS was never part of the DRP's $12.8B RQE budget and scope, as inspections did not show any indication of flow assisted corrosion ("FAC") prior to the DRP. As discussed in Ex. L-D2-ED-008, part a), i), the need for this emergent work was established following the Unit 3 DRP inspections.

c) Attachment 1 contains the engineering analysis and risk assessment that was performed immediately upon discovery of the condition during the Unit 3 refurbishment. This was a comprehensive assessment that was considered bounding and applicable for the other three units' steam generators. One of the follow-up actions from this initial assessment was to assess through inspections the conditions of the PMS in each of the other three units at the earliest available opportunity. These follow-up inspections confirmed that the condition seen on Unit 3 during the Unit 3 refurbishment was present on all other Darlington units' steam generator primary moisture separators.

d) As discussed in parts a) and b) above, the need for this emergent work was established subsequent to the start of the DRP, and as such there were no incremental costs associated with executing the work outside of the original refurbishment outage windows.

e) There have been no changes to the scope, schedule, or cost estimate of the Darlington Steam Generator Primary Moisture Separators Replacement Projects since their first execution Business Case Summaries were first approved.

Filed: 2026-04-22
EB-2025-0297
Exhibit L
D2-Staff-090
Attachment 1
Page 1 of 131

Darlington U3

Degradation of SG Steam Separators Type III EDM

Chris McConnell / Rosita Mousavi / Kirshan Kandiah

September 16, 2021

ONTARIO POWER GENERATION

Where a brighter tomorrow begins.

Agenda

1 | Preamble

2 | Problem Statement / Background

3 | Component Function

4 | Inspection Findings

5 | Foreign Material Found

6 | Findings Conclusion

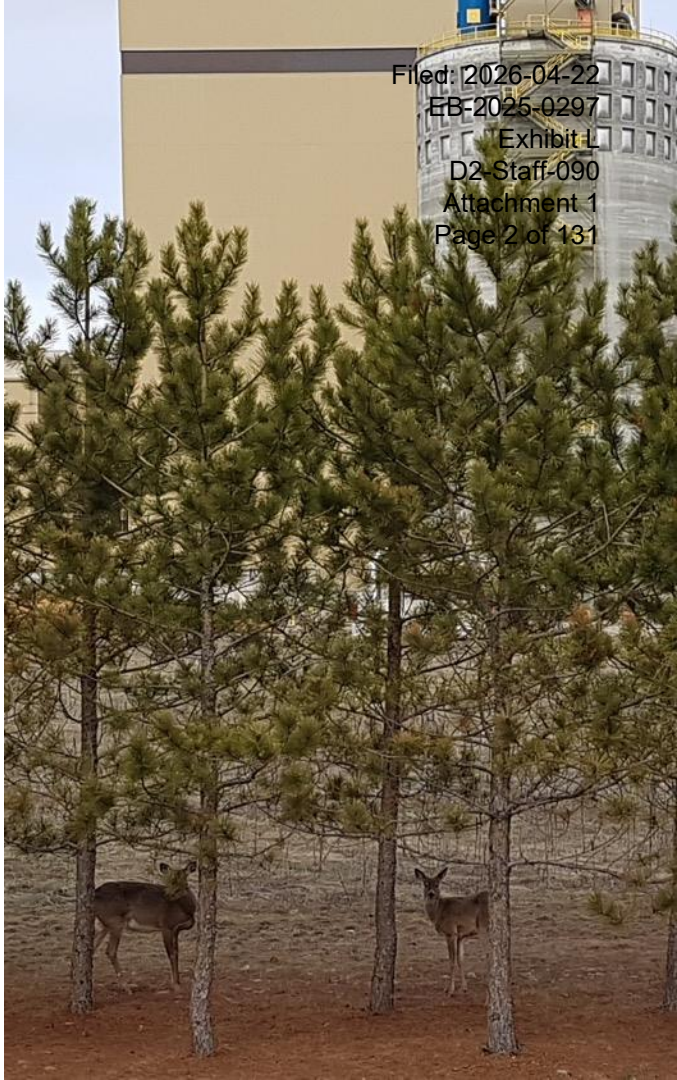
7 | Impacts of Degradation, SG FFS, and Unit 3 RTS

8 | Industry OPEX

9 | Alternatives

10 | Recommendations, Voting, Questions

11 | Appendices



Filed: 2026-04-22
EB-2025-0297
Exhibit L
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Attachment 1
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Nuclear Safety Culture Trait

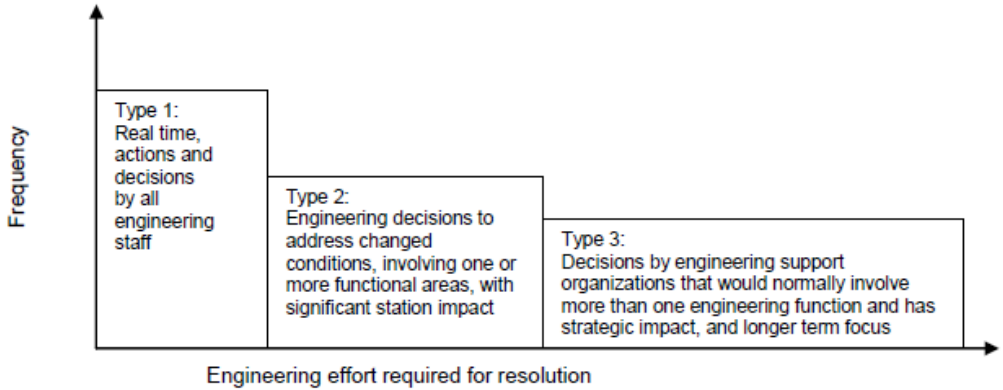
1. Personal Accountability
2. Questioning Attitude
3. Effective Safety Communication
4. Leadership Safety Values and Actions
5. Decision Making
6. Respectful Work Environment
7. Continuous Learning
8. Problem Identification and Resolution
9. Environment for Raising Concerns
10. Work Processes

Type III EDM

This is a **Type III Engineering Decision Making (EDM) Meeting.**

The EDM meeting is a process of making decisions that may typically affect nuclear safety, plant reliability, strategic direction, operational efficiency, and/or have business impact.

A Type III EDM is required to make an engineering decision in response to conditions that are not normally defined in standard procedures. These are situations where engineering input is required to deal with a system and/or equipment failure or significant business issues. These type of decisions often require multi-disciplined input into the decision-making process.



Quorum

Introduction

- Chief Nuclear Engineer (Chair)
- Darlington Station Engineering Director
- Additional Station Engineering Director
- Engineering & Modifications Director
- Darlington Design Engineering Director
- Performance Improvement Director
- Performance Engineering Manager(s)
- Components and Equipment Manager
- Reactor Safety Manager
- Regulatory Affairs Manager
- Contrarian/Black Hat

EDM Meeting Norms

Limit Side Discussions

- Direct your comments to the presenters

Minimize meeting disruptions

- Communication devices turned OFF or on VIBRATE
- If participating remotely, ensure your microphone is on mute when not speaking

Speak Clearly (into microphones)

- Ensure that everyone can hear you
- If participating remotely, email all questions to the Nuclear Safety Manager/delegate who will read your questions to the quorum members

Focus discussions on the Nuclear Safety aspects

- Work planning and scheduling will be handled outside this forum

Save questions until the presentation is complete

Problem Statement

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Problem Statement

Significant degradation of the Primary Moisture Separators was observed in the Unit 3 Steam Generators (SG) during inspections performed as part of DNRU3 Window 037.

The purpose of this Engineering Decision Making Meeting are as follows:

- Inform the EDM Quorum of the condition of the Primary Moisture Separators (PMS) and Secondary Moisture Separators (SMS) and its associated complications to the short term and long-term safe operation of the Darlington Unit 3 Steam Generators and at-risk downstream components (e.g., Main Steam Line, HP Turbine, etc).
- Provide the alternatives evaluated and the SIR team recommended corrective action(s) to the Type 3 EDM Quorum for decision making (and further actions as required).

Background

As part of the SG LCMP, inspections of the PMS and SMS were performed during DNRU3 W037. The original scope was to inspect 20 of 104 steam separators (both primary and secondary pairs) in each SG (based on OPEX from external utilities).

- Significant degradation was identified in 3-33110-BO2 PMS including significant loss of the top steel plate (171mm diameter; 2.6mm nominal thickness) and stiffener plates.
- A cross-functional team (CFT) was formed which has been elevated to a significant issue resolution (SIR) team. Under the mandate of these teams, inspections were expanded to all PMS and SMS in each SG to understand the extent of degradation (total: 104 PMS and 104 SMS per SG).
- Evidence of degradation, including wall thinning, was observed in all SGs (on the SMS and the SMS).

Moisture Separators

Functions Overview

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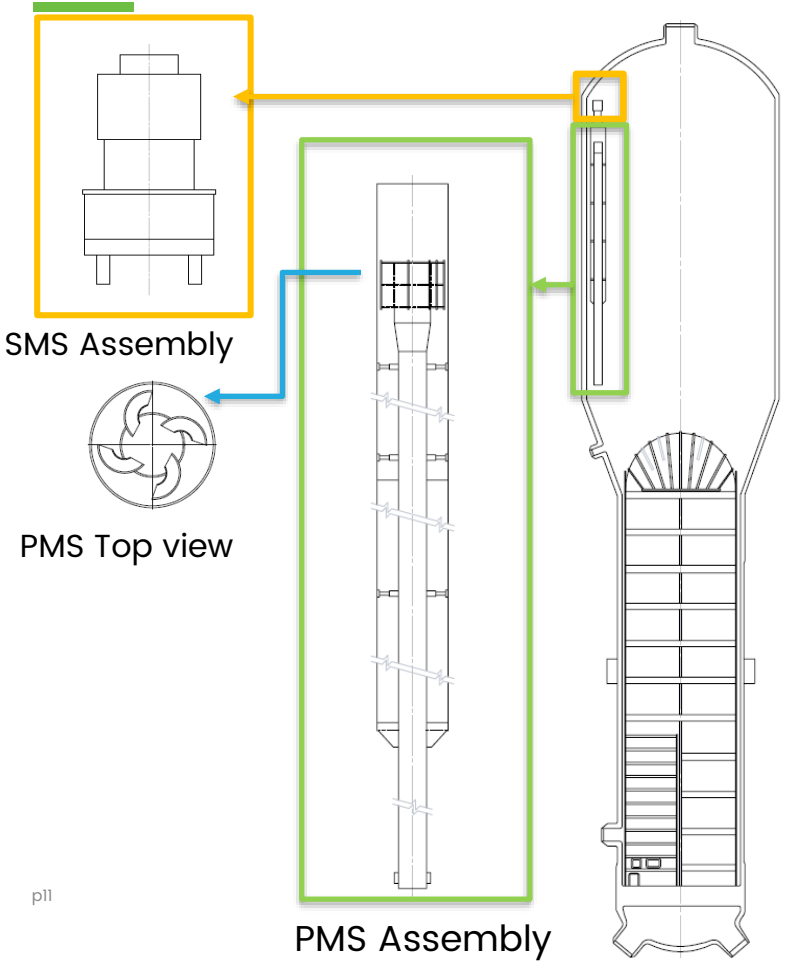
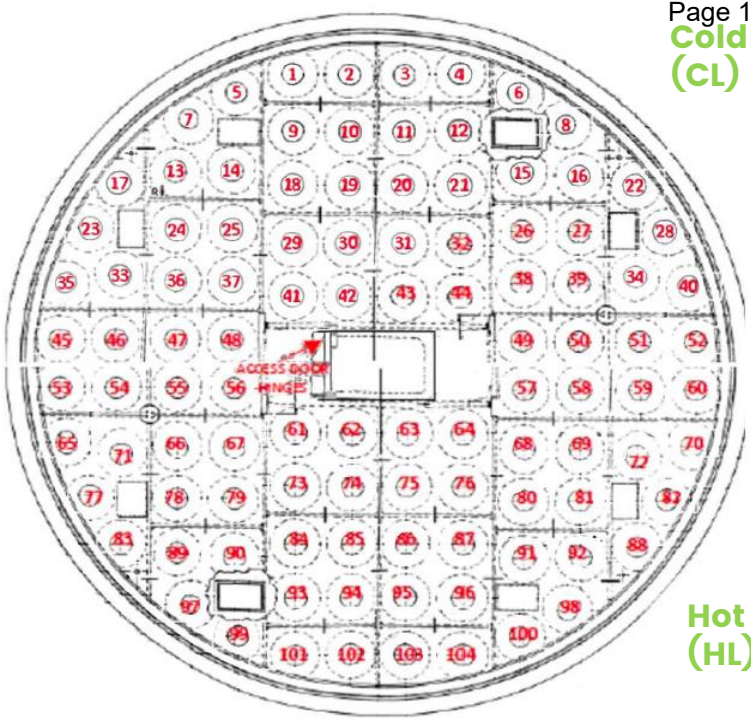
Location of Separators

There are 104 separator pairs in each SG in DNGS

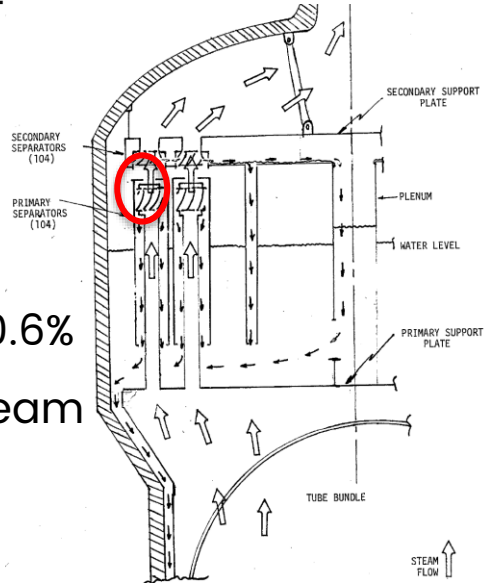




Steam Drum Top View

Moisture Separator Function

- There are 104 Primary Moisture Separators (PMS) and 104 Secondary Moisture Separators (SMS) in each Darlington Steam Generator (total: 416 PMS and 416 SMS per unit).
- The PMS removes over 90% of moisture from the steam
- The remaining moisture is removed by the SMS
- Limits on Main Steam Moisture – 1st limit: 0.25%, 2nd limit: 0.6%
- Moisture content increase will result in increased main steam flow, lower enthalpy, and less MWe output



Inspection Findings

See Appendix A for Supplementary Slides

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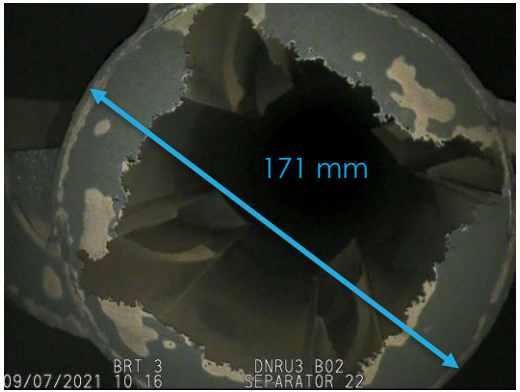
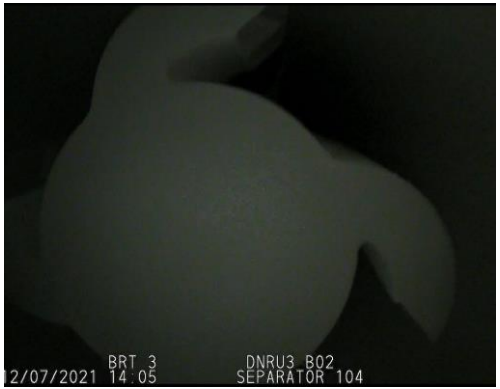
Inspections Performed

- Original scope in DNRU3 was to perform visual inspections on 20 separators in each SG.
- During DNRU3, this scope was increased to all steam separators after a missing top plate was reported on a PMS in SG2.



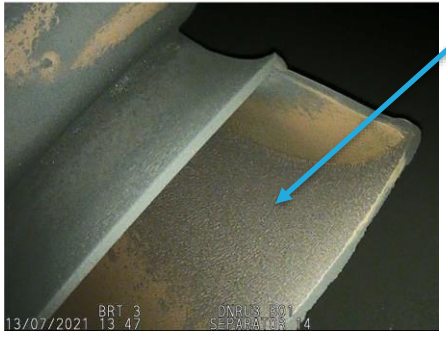
Missing Top Plate and degraded internals SG2



Top Plate in good condition SG2

Inspections Performed

- Visual technique (VT) inspections using a borescope are performed starting from the top of the secondary separator deck
- Inspections are limited to the externals/internals of the SMS and the externals of the PMS (due to access limitations)



SG	# Inspections Reviewed	Primary Separator Degradations Observed			
		Missing top plate	Other material loss (including perforations of top plate)	Discoloration	None observed in accessible areas
D3-SG1	104/104	0	4	48	56
D3-SG2	104/104	6	15	56	48
D3-SG3	104 /104	0	8	48	56
D3-SG4	104/104	0	5	38	66

Inspections Performed (PMS - Visual)

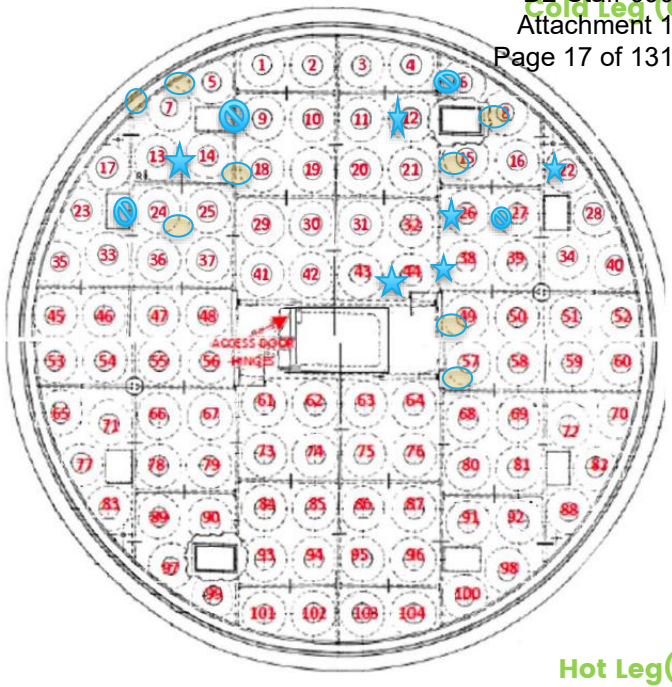
Material loss seen in separators that have not lost the top plate:

Material loss in the vane stiffening plate

Material loss beginning on the top plate

Distribution of Degradations

- Various extent of degradation was reported in PMS
- This schematic shows the location of specific separators reported with complete loss of top plate, presence of holes in the top plate and material loss in the stiffener plate
- Significant degradation was dominantly present in the CL of SG2.

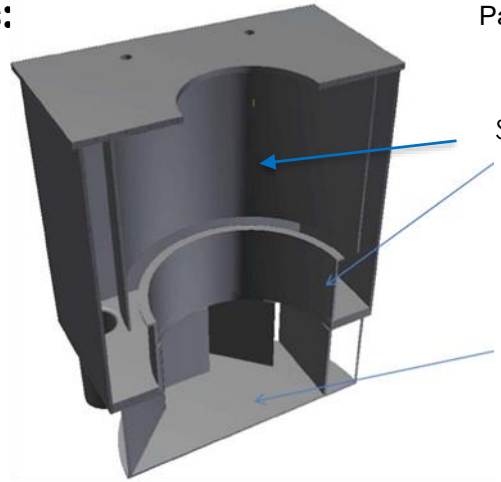


Inspections Performed (SMS - Visual)

Degradation observed in the secondary separators:

Shiny spot in center of SMS – **common to most separators**

Discoloration and material loss in 1 SMS in SG2



- Only visual inspection was performed
- Shiny spot in the center of base plate was reported as common to all separators
- Based on Mc Guire 2 and BP OPEX shiny spot in the center of the SMS base plate is indicative of active erosion
- No wall thickness measurement was performed in the skimmer cylinder walls or base plate

Inspections Performed (SMS – Replication)

- Replica molds taken on 9 SMS baseplates in SG3.
- This technique was utilized in the absence of capability to perform laser profilometry or UT thickness measurement.
- Baseplates and cylinder walls are susceptible locations to degradation in SMS assembly. Replication was only performed on the base plate.
- The 9 locations for replication was selected based on review of the visual inspection results.
- No replication was performed in SG2 where evidence of wall loss was reported by VT.
- No evidence of wall loss was reported in the 9 replicas taken in SG3.
- It is important to note that this technique is not qualified for the detection of wall loss at OPG and not utilized in any PWR for assessment of integrity of SMS.
- Therefore, there is value in performing further inspections with the technique qualified to accurately measure remaining thickness (i.e., UT, laser profilometry, etc.).

Foreign Material Retrieved From BO2

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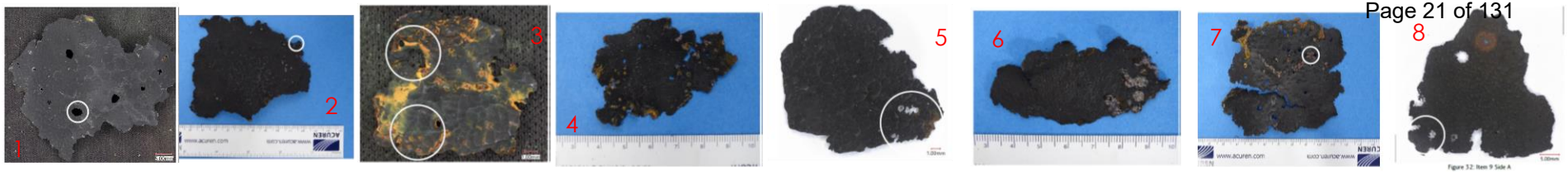
Actual Pieces of FM Found (From the Primary Separator)



- 8 pieces of FM was removed from SG 2 top of the tube sheet.
- One piece of FM was removed from top of a SMS in SG2.

- There are several pieces of FM which retrieval has not been successful at this time.

- The total surface area of FM retrieved is less than the surface area missing.

	Dimensions (mm)	Thickness (mm)	Weight (g)
1	50x47	0.40	2.5
2	**105x89**	0.34	**10.6**
3	18x13	0.35	0.15
4	55x44	0.34	2.5
5	18x17	0.33	0.27
6	63x31	0.34	2.1
7	84x80	0.35	9.8
8	41x41	0.34	1.5

Degradation Consequences:

Impact to SG Fitness For Service

ONTARIO POWER GENERATION

Tube Fretting from Primary Moisture Separators FM

1. Presence of foreign material in the steam generators is the number 1 cause of forced outages from SG tube leak
2. The only forced outage in DNGS been from debris fretting in D2-SG4 preheater region
3. Presence of FM on top of the tubesheet (TTS) has a significantly higher risk of tube fretting due to presence of maximum velocity vectors on TTS
4. There has been two events in industry when presence of large pieces of FM resulted in SG tube rupture
5. Based on the structural integrity assessment of DNGS SG tubes, the size of the FM generated from separators has the potential of SG tube rupture if resulted in a uniform fret >40 mm long
6. Based on thermal hydraulic analysis completed, larger volume of fret will require longer operating interval to exceed the structural integrity limits of DNGS SG tubes
7. Presence of smaller and various pieces of FM is more likely to cause a SG tube leak in shorter operating interval.
8. Fretting rate assessment has been completed to predict the operating interval of a bounding conservative scenario over which a SG tube rupture is plausible
9. For the purpose of this assessment EPRI methodology was utilized with input from DNGS SGs thermal hydraulic code

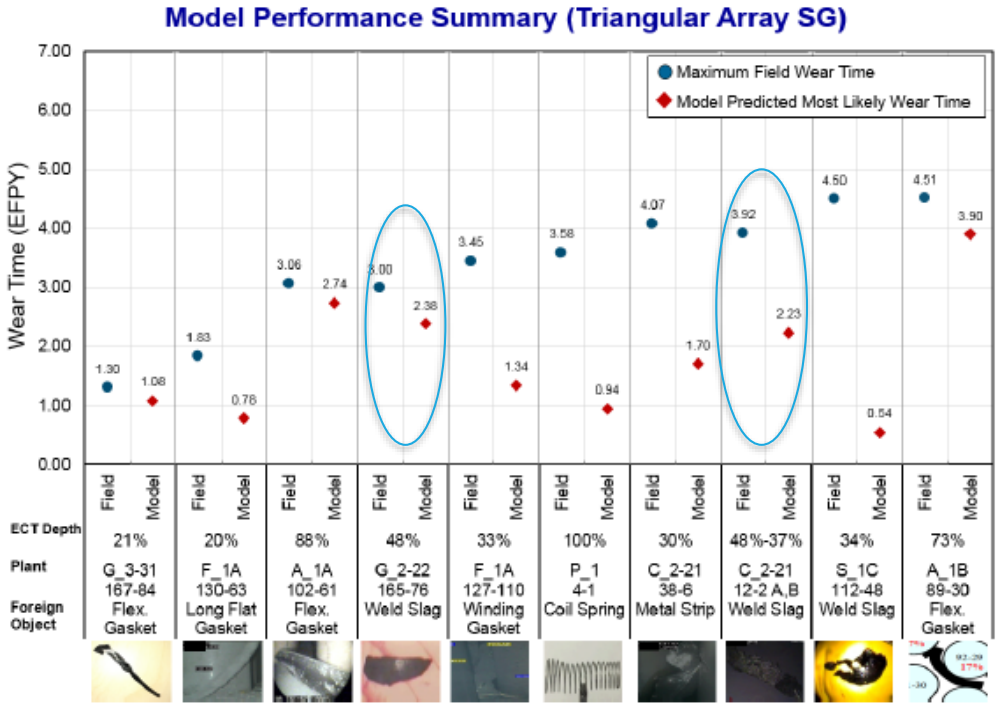
Fretting Rate Assessment

Utilizing industry methodology, the fretting rate was assessed for 3 base cases along with 5 cases of sensitivity studies as summarized below, changed variables are shown in orange.

	Base Case 1	Base Case 2	Bae Case 3	SS Case 1	SS Case 2	SS Case 3	SS Case 4	SS Case 5
Shape of FM	round	**round**	Round/ Tapered	Rectangular *	round	round	round	round
Wear Coefficient [Pa-1]	50×10^{-15}	**50×10^{-15}**	50×10^{-15}	50×10^{-15}	22.17×10^{-15}	50×10^{-15}	50×10^{-15}	50×10^{-15}
Flow Strength (MPa)	420	**420**	420	420	420	445	420	420
Gap Velocity (m/s) above H01/ PTP	0.01	**0.01**	0.01	0.01	0.01	0.01	1.0	1.0
Gap velocity TTS to H01/ PTP (m/s)	3.4	5.57	3.4	3.4	3.4	3.4	3.4	5.57
Free Stream Velocity TTS to H01/ PTP (m/s)	1.67	1.8	1.67	1.67	1.67	1.67	1.67	1.8
Time to MTFS (yrs) (safety factor of 3)	3.8	**2.15**	3.79	6.01	8.62	4.12	3.49	2.14
Time to through wall penetration (yrs) (Accident level pressure 11 MPa)**	6.23	**3.51**	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated	Not Calculated

*Diagonal 171mm
**Normal operating pressure is 9.9 MPa at start up and shut down

Success of the EPRI Model in Predicting Wear Rate



It is evident that in all examples EPRI methodology been more conservative than the actual Unit Experience. In DNGS we have additional conservatism associated with the size of FM assumed in the assessment.

Degradation Consequences:

Impact to Unit 3 RTS and Operation

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Impact to Unit 3 Return to Service and Operation

- SG tubes fretting from large pieces of separator does not have LBB, (i.e. Rupture not Leak at an onset of tube failure is probable)
- **Operating interval post RTS is subject to CNSC acceptance of the disposition and is limited by the time that a postulated flaw from FM results in a fret depth exceeding the applicable structural integrity limits, or replacement of separators**
- With existing separators, unit operation is at high risk of SG tube leak from debris fretting.
- Fretting rate assessment for a postulated bounding case FM, supports an operating interval of 3.5 operating years over which a tube rupture is not postulated under normal and upset operating pressures (i.e. 11 MPa)
- Fretting rate assessment for operating interval over which a SG tube leak is likely can not be performed as the exact dimensions and locations of possible FMs are infinite
- With existing separators, moist steam will increase FAC and erosion degradation to main steam line, HP turbine blades, and other components down stream the SGs.
- With existing separators, moist steam will eventually result in MW losses. See Appendix I for additional details.

Other Impacts of Degradation

See Appendix B for Supplementary Slides

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Impacts of Degradation

1. Generation of foreign material (FM) in SG tube bundle will negatively impact pressure/containment boundary integrity (i.e.., elevated risk of tube leak/ rupture) and structural integrity of downstream components (i.e., HP turbine, valves, main steam and associated branch piping)
   - Preliminary results indicate that debris of the form we retrieved can be carried from the SG into the downstream piping and components.
   - Therefore, there is a need to perform FOSAR during DNRU3 as this will be an active risk that we will see during return to service (see Appendix J & K)
2. Degradation of one separator in each boiler can accelerate the degradation of others as the duty of the remaining separators increase
   - Currently there no predetermined assessment to define fitness for service of separators themselves.
   - SGs OEM (BWXT) has indicted that failure of all separators will still meet the design basis of the steam generator and will not impact the cooling function of the steam generator

Impacts of Degradation (continued)

3. Wet steam will also result in megawatt loss (i.e., higher steam flow rate, lower enthalpy, lower MWe)*
4. Wet steam will result in increased flow accelerated corrosion/erosion rate on downstream components (i.e.., HP turbine blade, valves, main steam and associated branch piping)
   - Limits on Main Steam Moisture – 1st limit: 0.25%, 2nd limit: 0.6%
   - SGs OEM (BWXT) conservative assessment anticipates one degraded PMS will result in an overall SG moisture carryover greater than the limit
   - See Appendix I for detailed information

OPEX (Repair/ Replacement)

See Appendix C for Supplementary Slides

ONTARIO POWER GENERATION

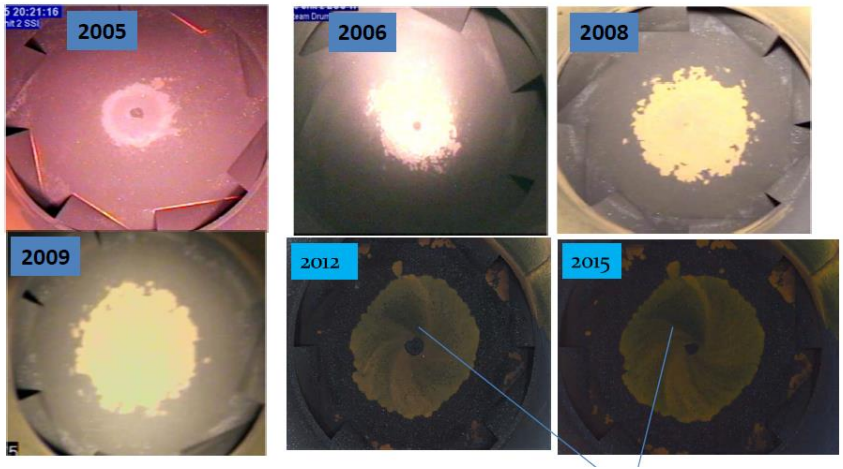
OPEX (Separator Degradation)

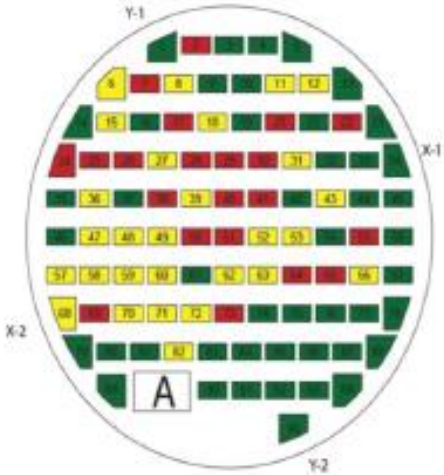
	Reactor	SG in Service Date	PMS	SMS	Replaced PMS	Replaced SMS	Repaired PMS	Replaced PMS
			Deg. Observed Date					
DNGS 3	**CANDU**	**1993**	**2021**	**2021**	**TBD**	**TBD**	**TBD**	**TBD**
Wolsong 2	CANDU 6	1997	Yes-2019	No	**PMS Yes-2020**	**No**	**No**	**No**
Wolsong 3	CANDU 6	1998	Yes-2019	No	**PMS Yes-2020**	**No**	**No**	**No**
Wolsong 4	CANDU 6	1999	Yes 2019	No	**PMS Yes-2020**	**No**	**No**	**No**
Cernavoda 1	CANDU 6	1982	Yes-2020 (early stage)	Unknown	**Under review for 2022**		**No**	**No**
Embalse	CANDU	1984	Yes-2016		**Yes-2016**	**No**	**No**	**No**
Bruce 5	CANDU	1978	Yes-1998		**Yes-1999**	**No**	**No**	**Yes**
Bruce 8	CANDU	1979	Yes-1998		**Yes-1999[1]**	**No**	**No**	**Yes[1]**
McGuire 2	PWR	1997	Not inspected	Yes-2018	**No**	**Yes**	**No**	**Yes-ongoing[2]**
Ginna	PWR	1996	Not inspected	Yes-2017	**No**	**No**	**No**	**No [3]**

1- Except SG 1 and SG5
2- Patch repair was done
3-No components have been replaced as of yet. The next inspection outage Fall 2021 / Spring 2023 will have contingency plans to install patch plates on the secondary moisture separator Baseplates where Ginna has been trending degradation for several years. There are currently no plans to replace entire separator assemblies, only patch plate repairs.

OPEX- McGuire 2 – PWR Secondary Separators *

Review of the same separator over 10 yrs (2005-2015)





Red: >50% TW
Yellow: 30-50% TW
Green: <30% TW

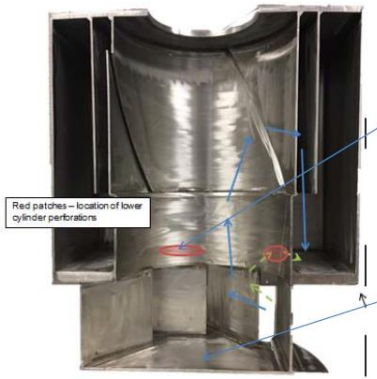
- McGuire 2 is a PWR Unit with BWXT SGs similar to DNGS

- McGuire 2 has monitored degradation of base plate every 3 years for the last 15 years
- Currently 89 of the secondary separators in MGN2 required path plate repair (of total 380 separators)

- Additional 75 secondary separator base plates are thinned to 30-50%tw and inspection and monitoring of all separators are required every refueling outage (18 months)

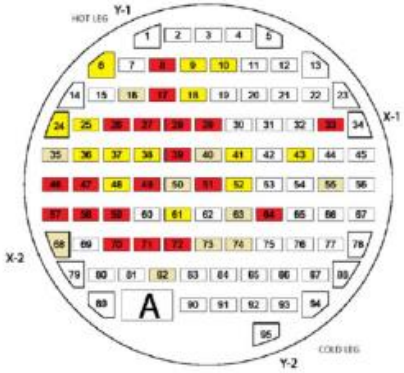
* Courtesy of Dan Myers (Duke Energy)

OPEX- McGuire 2 - PWR Secondary Separators- Skimmer wall



Skimmer wall erosion: Steam enters the drain box, but only in small amounts. Max bypass is 5%. Small holes in the skimmer wall may increase moisture removal. Continued erosion may cause vortex issues.

Existing baseplate degradation: A hole in the middle of the separator baseplate stops the vortex and prevents the centrifugal removal of water. Max of 10 separators before MCO is >.25%



Red: Largest (~ 0.75" - 1.5")
Yellow: Medium (~ 0.5")
Light Yellow: Smallest (~ < 0.5")

- During refueling cycle 23, 2020, perforation was reported inside the cylinders and MGN was approved to operate for 18 months (fall 2021) to develop repair/replacement strategy of secondary separators and inspect primary separators

- MGN has confirmed that degradation of SMS resulted in MCO of greater than 1%

Findings Summary

See Appendix D for Supplementary Slides

ONTARIO POWER GENERATION

Summary – Primary Moisture Separators

- Significant and broad degradation has been observed on the top plate of a large number of the PMS.

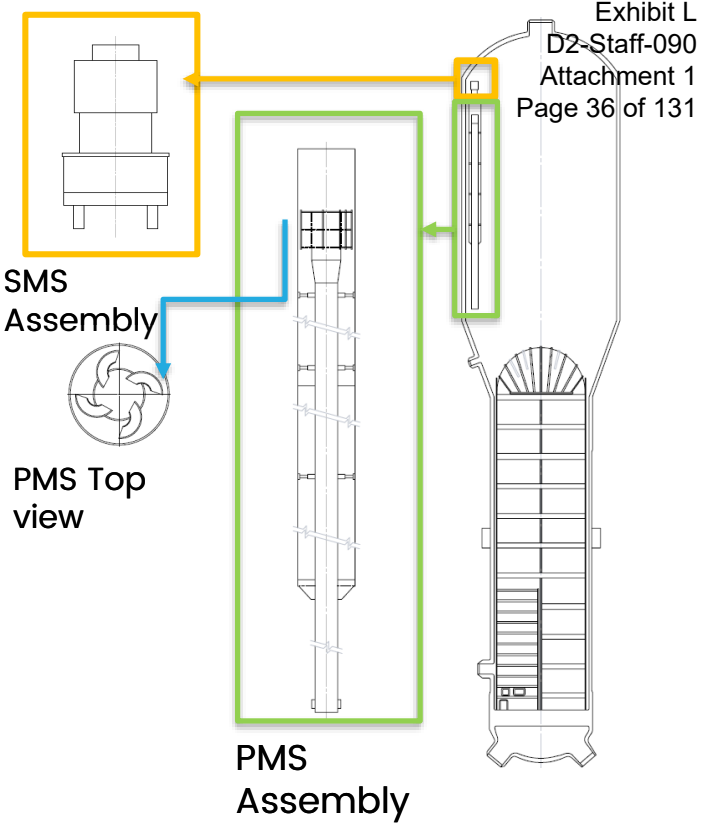
- BO2 PMS are more severely degraded than the other SGs (and has resulted in FM generation).
- BO1/BO3/BO4 PMS are less severely degraded, ranging from minor discoloration to beginnings of material loss (and will lead to future FM generation).

- Mode of degradation is FAC (based on FM observed under microscope).
- Direct inspection of the area where degradation is occurring cannot be performed.

- As this is an active degradation mechanism, it is expected that degradation will continue.

- But due to the lack of NDE data and other factors, assessments cannot be formed to predict time to failure. Additionally, in-situ repair cannot be performed.

- The solution needs to address the above limitations/factors as well as risks to the operating unit over its extended life (2055 and beyond).



Summary – Secondary Moisture Separators

- Minor and limited degradation has been observed on the bottom plate of a small number of the SMS.

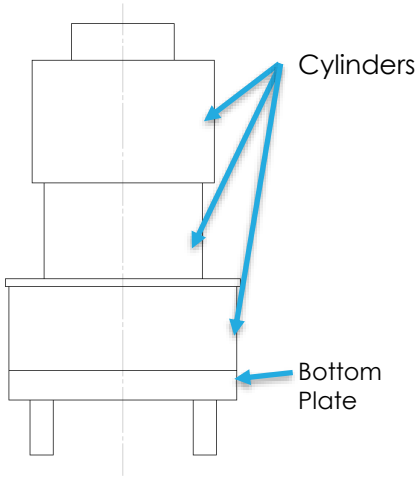
- Most show a shiny or partially shiny spot at the center of the bottom plate
- SMS (#62) in BO2 showed the greatest degradation and potential material loss on the bottom plate.

- Expected modes of degradation are erosion and FAC.
- Direct inspection of the area where degradation is most prominently occurring can be performed.
- VT inspections have been completed on these areas.

- As this is an active degradation mechanism, it is expected that degradation will continue.
- With NDE thickness measurements, the remaining life of critical components can be assessed, and in-situ repair can be performed.*

- The solution needs to address the above limitations/factors as well as risks to the operating unit over its extended life (2055 and beyond) as it is impractical to perform a full SMS-only replacement in a future outage.

- **The ability to repair the SMS is based on access to the most likely component to degrade (based on OEM feedback). It is possible but unlikely that further inspections will identify other subcomponents of the SMS that would necessitate replacement due to the inability to repair.*



Alternatives Evaluated

See Appendix E and F for Supplementary Slides

ONTARIO POWER GENERATION

Alternatives Ruled Out of Discussion*

Alternative 1: DO NOTHING

Alternative 2: REPLACE FULL PRIMARY SEPARATORS (SOME BUT NOT ALL)

Alternative 3: REPLACE PARTIAL LENGTH PRIMARY SEPARATORS

Alternative 4: REPLACE FULL PRIMARY SEPARATORS

Alternative 5: REPLACE FULL PRIMARY SEPARATORS AND FULL SECONDARY SEPARATORS

Alternative 6: COMPLETE STEAM DRUM INTERNALS MODULE REPLACEMENT

**Material and design changes (as required) will be assessed through the EC process*

Alternatives Ruled Out of Discussion

Alternative 2: REPLACE FULL PRIMARY SEPARATORS (SOME BUT NOT ALL) **(See Appendix G)**

- No available thickness measurements
- Active degradation (i.e., requires continual monitoring, inspection, and/or repair)
- Similar level of field effort as Alternative 4 (Full Primary Separators)

Alternative 3: REPLACE PARTIAL LENGTH PRIMARY SEPARATORS **(See Appendix G)**

- No available thickness measurements on bottom sections
- Dissimilar metals, significant additional cutting, critical to separator function welding
- Similar level of field effort as Alternative 4 (Full Primary Separators) (excluding MSL work)

Alternative 6: COMPLETE STEAM DRUM INTERNALS MODULE REPLACEMENT **(See Appendix G)**

- Requires cutting and re-welding SG pressure boundary, cutting and re-installation of concrete structures/reactor area building roof, lifting/rigging SG steam drum with heavy lift crane

Assessment of Alternatives 1, 4, and 5

See Appendix F for Supplementary Slides

ONTARIO POWER GENERATION

Assessment of Alternatives

Alternative 1: DO NOTHING

Pros	Cons
• PMS and SMS replacement in the Unit 3 SGs is not performed	• Reduced operating periods with significantly increased inspection scope each outage (both primary and secondary side campaigns) • Increase in MCO with each degraded primary separator with potential downstream component risks (i.e., degradation of MSL, Turbine Blades, Governor Valves, etc.) and generation loss • FM generated by failing primary separators at the tubesheet may cause tube wear • FM generated by failing primary separators may migrate to the steam line with potential damage to downstream components • The impact of the above two increases the risk of forced outages (as assessments and inspections cannot accurately disposition all risk) • Regulatory, reputational, and environmental risk and oversight will increase significantly as duration operating with degraded separators increases • Thickness measurements of PMS top-plate required to confirm acceptability of option; however, not possible with currently used NDE technology • Thickness measurements of the SMS baseplates and side walls also required to confirm acceptability of this option • Partial patch repair of SMS is not feasible • Comprehensive inspection program for PMS/SMS likely required each operating interval until a thinning rate and FFS strategy established to support longer inspection frequencies (i.e., total 5 x 10hr shifts to include 100% VT SMS & PMS per SG)

Assessment of Alternatives

Alternative 4: FULL REPLACEMENT OF ALL PRIMARY SEPARATORS

Pros	Cons
• Majority of the cons associated with Alternative 1 are addressed (with exception to those associated with secondary separators) • Full replacement allows opportunity for design changes to eliminate or minimize future degradation (i.e., FAC-resistant materials) • Reduces the PMS inspection scope of separators to 20% in one SG per unit every 10 years • Contingency in-situ repair of select SMS baseplates be performed • Contingency in-situ repair of select cylinder walls can be developed (based on OEM feedback)*	• High cost and schedule impact to either Refurbishment or Planned outage • Estimated costs are $90M and timelines are 6 months for full replacement (no impact to DNRU3 critical path, significant impact to D4F outage critical path, additional challenges associated with heatsink recall during D4F outages) • Conventional and radiological safety risk of execution will be greater than Alternatives 1, 2, and 3 (albeit not having official estimates from the Vendor) • Elevated execution/FM risk as cutting/grinding/welding will be performed in an enclosed space with significant access constraints. Inspection and retrieval of any FM that falls into the primary deck or down the downcomer will be challenging. • Comprehensive inspection program for SMS likely required each operating interval until a thinning rate and FFS strategy established to support longer inspection frequencies (i.e., total 2 x 10hr shifts to include 100% VT SMS per SG excluding open/close) • Not all potentially susceptible areas of the SMS component are available for inspection or in-situ repair • Replacement of SMS as-a-whole (if req'd) in separate outage not feasible without impacting newly installed PMS

Assessment of Alternatives

Alternative 5: FULL REPLACEMENT OF ALL PRIMARY AND SECONDARY SEPARATORS

Pros	Cons
• All the cons associated with Alternative 1 are addressed (i.e., Eliminates the risk associated with future degradation of PMS and SMS) • Full replacement allows opportunity for design changes to eliminate or minimize future degradation (i.e.., FAC-resistant materials) • Reduces the PMS inspection scope of separators to 20% in one SG per unit every 10 years • Reduces/eliminates potential SMS inspection scope (con from Alternative 4)	• High cost and schedule impact to either Refurbishment or Planned outage • OPG internally estimated costs* are $125M with timelines ranging from 6 – 9 months for full replacement (potential 0 – 2 month impact to DNRU3 critical path; significant impact to D4F outage critical path, additional challenges associated with heatsink recall during D4F outages) • Conventional and radiological safety risk of execution will be greater than Alternatives 1, 2, 3, and 4 (albeit not having official estimates from the Vendor) • Elevated execution/FM risk as cutting/grinding/welding will be performed in an enclosed space with significant access constraints. Inspection and retrieval of any FM that falls into the primary deck or down the downcomer will be challenging • Lack of quantitative NDE data on SMS baseplates and cylinders (only qualitative NDE data, i.e., VT inspection data, is available) to assist with decision making

Alternatives Compared

See Appendix G & H for Supplementary Slides

ONTARIO POWER GENERATION

Alternatives Compared

	Alt 1 Do Nothing	Alt 4 All PMS Replace	Alt 5 All PMS & SMS Replace
Cost	$0m	$90M (2021)	125M*
Execution Risk	N/A	High (FOAK)	High (FOAK)*
Schedule	N/A	6 months (No assessed impact to DNRU3 Critical Path)	6 - 9 months* (0 – 2 month impact to DNRU3 Critical Path)

*Internal estimate based off numbers provided by Vendor for Alt 4

Alternatives Compared

	Alt 1 Do Nothing	Alt 4 All PMS Replace	Alt 5 All PMS & SMS Replace
Impacting to Aging Management	Significant inspection, monitoring, & repair program required for PMS/SMS	Irregular inspection, monitoring, repair program required for SMS	Inspection monitoring required every 10 years to satisfy PIP
Impact to Generation	Significant increase to current forced outage risk, potential shorter operating duration, & lower MW generated	Minor to no increase in current forced outage risk, operating duration, & MW generated	No increase in current forced outage risk, operating duration, & MW generated
Impact to SG	Significant increase in wear rates on SG tubes, existing PMS/SMS, etc	Minor to no increase in wear rates on SG tubes, existing PMS/SMS, etc	No increase in wear rates on SG tubes, existing PMS/SMS, etc
Impact to D/S Components	Significant increase in wear rates on MSL, HP/LP turbine, and valves	Minor to no change in current wear rates on MSL, HP/LP turbine, and valves	No increase in current wear rates on MSL, HP/LP turbine, and valves

Recommendation

ONTARIO POWER GENERATION

Considerations for Recommendation

As a result of the following factors:

- **Significant and broad** degradation has been observed on the top portion of a **large number** of the PMS
  - Where direct inspection of the degradation area **CANNOT** be performed
  - Where in-situ repair **CANNOT** be performed

- **Minor and limited** degradation has been observed on the bottom plate of a **small number** of the SMS
  - Where direct inspection of the area where degradation is most prominently occurring **CAN** be performed
  - Where in-situ repair **CAN** be performed on SMS baseplates and developed for cylinder sidewalls

  NOTE: The ability to repair the SMS is based on access to the perceived most likely component to degrade. Degradation of other components have been reported by industry (i.e., cylinder degradation). It is possible that further and future inspections will identify other subcomponents of the SMS that would necessitate replacement due to the inability to repair. Replacement of SMS as-a-whole (if req'd) in separate outage not feasible without impacting newly installed PMS.

Considerations for Recommendation

- Continuous risk of SG tube leak/rupture as a result of foreign material
- Separator degradation is inherent to less than adequate design
- Industry OPEX (all utilities have or will replace original carbon steel PMS)
- Impact of moist steam on the health of the main steam line, turbine components, and other downstream components
- Impact to future replacement and inspection campaigns to the D4F outage schedule / heat sink recall plans/etc
- Impact to the planned remaining life of DNGS SGs (assuming no planned SG replacements)

Recommendation (Page 1 of 2)

The SIR Team recommendation to the EDM Quorum is as follows:

DURING THE DARLINGTON NUCLEAR REFURBISHMENT UNIT 3 OUTAGE:

1. **PERFORM FULL** replacement of **ALL OF THE** Unit 3 **PRIMARY MOISTURE SEPARATORS (ALTERNATIVE 4)**
2. **TO ADDRESS** the risk of **NOT PERFORMING SECONDARY MOISTURE SEPARATORS** replacements:
   - **DEVELOP and PERFORM** baseline NDE (UT, Laser Profilometry, etc) of **ALL OF THE** the Unit 3 **SECONDARY MOISTURE SEPARATORS**
   - **DEVELOP and PERFORM CONTINGENCY in-situ repair** of the original Unit 3 **SECONDARY MOISTURE SEPARATORS** (based on baseline NDE inspection results)
3. **TO ADDRESS** the potential of FM carryover from currently degraded SMS into downstream components, **PERFORM** FOSAR of the Main Steam Line immediately downstream of 3-33110-BO2 (see Appendix J & K)

NOTE: Following replacement of PMS, only patch repair of SMS is feasible. Replacement of SMS in future will impact newly installed PMS.

Recommendation (Page 2 of 2)

The SIR Team recommendation to the EDM Quorum is as follows:

DURING DARLINGTON UNIT 3 POST-REFURBISHMENT OPERATION (TO 2055):

1. **PERFORM INSPECTION AND MONITORING,** using quantitative NDE (i.e., UT, laser profilometry), of the Unit 3 **SECONDARY MOISTURE SEPARATORS** (frequency and scope subject to determination based on findings from baseline NDE)

Questions?

ONTARIO POWER GENERATION

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Appendix A

Inspection Findings

Supplementary Slides

ONTARIO POWER GENERATION

Inspection Results – Summary

Steam Generator 1:

Primary Moisture Separators (PMS):

- Approx. 50% are showing various levels of changes
- Ranging from minor discoloration to beginnings of material loss
- Four (4) locations show small level material loss in the PMS CASA vanes
- Twelve (12) locations showed some texture to the discolored areas (including the 4 above)

Secondary Moisture Separators (SMS):

- Most show shiny or partially shiny spot at the center of the bottom plate
- Three (3) locations show small amount of discoloration

Steam Generator 2:

Primary Moisture Separators (PMS):

- Approx. 50% are showing various levels of changes
- Ranging from minor discoloration to significant material loss
- Six (6) locations showed the worst degradation with much of the upper 171mm diameter section of the PMS CASA top plate missing completely along with visible material loss to the structures inside the separators
- Additional fifteen (15) locations inspected show some levels of holes or material loss

Secondary Moisture Separators (SMS):

- Most show shiny or partially shiny spot at the center of the bottom plate
- One location showed degradation and material loss on the bottom plate

Inspection Results – Summary (Cont'd)

Steam Generator 3:

Primary Moisture Separators (PMS):

- Forty-two (42) are showing various levels of changes
- Ranging from minor discoloration to beginnings of material loss
- Eight (8) locations showed possible material loss
- Eleven (11) locations showed some texture to the discolored areas (including the 8 above)

Secondary Moisture Separators (SMS):

- Most SMS show shiny or partially shiny spot at the center of the bottom plate
- Seven (7) locations show small amount of discoloration

Steam Generator 4:

Primary Moisture Separators (PMS):

- Thirty-eight (38) are showing various levels of changes
- Ranging from minor discoloration to beginnings of material loss
- Five (5) locations showed possible material loss
- Nine (9) locations showed some texture to the discolored areas (including the 5 above)

Secondary Moisture Separators (SMS):

- Most SMS show shiny or partially shiny spot at the center of the bottom plate
- Five (5) locations showed small amount of discoloration

Appendix B

Other Impacts of Degradation

Supplementary Slides

ONTARIO POWER GENERATION

Current Health of the U3 Main Steam Line

Based on the detailed UT inspections performed during the DNRU3 FAC campaign, the current health of the main steam line is assessed to be green.

What this means:

Assuming that there are no changes to the MCO beyond design basis, based on this as-found condition of the main steam line, there are no existing concerns that would require inspection scope expansion, repairs, or replacements beyond what are defined as normal practices across the station.

Current Health of the U3 HP/LP Turbine and Governor Valves

Based on detailed VT inspections of the turbines and valves that were performed during the DNRU3 TGR campaign,
the current health of the HP/LP turbines and the governor valves is assessed to be green.

What this means:

Assuming that there are no changes to the MCO beyond design basis, based on the current health of the HP / LP turbines as well as the governor valves, there are no existing concerns requiring inspection scope expansion, repairs, or replacements beyond what are defined as normal practices across the station.

Impact To Downstream Components

However, active primary and secondary moisture separator degradation will have the following impacts to the health of downstream components:

- **INCREASED RATE OF MOISTURE CARRYOVER BEYOND DESIGN BASIS**
  - Based on very conservative OEM assessment, it is highly anticipated that the elevated moisture carryover from the SMS in the vicinity of one degraded PMS will result in the moisture carryover output from one SG exceeding the first limit on Main Steam Moisture – 1st limit: 0.25%, 2nd limit: 0.6%.
  - However, accurate estimates as a function of separator degradation by lab testing is not available and not feasible with analytical evaluation; therefor it is recommended that MCO is monitored through field testing.
  - An increase in the moisture carryover (i.e.., more wet steam) will result in increased flow accelerated corrosion and erosion rates on downstream components (i.e.., HP turbine, valves, main steam and associated branch piping).
  - The short-term impact will be a larger inspection scope covering the impacted areas (i.e.., more frequent inspections over a wider inspection area).
  - The long-term impact will be an increase in wear and tear seen on components that can result in premature thinning, failure, and replacement.

Impact To Downstream Components

However, active primary and secondary moisture separator degradation will have the following impacts to the health of downstream components:

- **RISK OF DEBRIS CARRY OVER TO MSL**
  - Risks include foreign material blocking smaller branch lines (NPS8 or lower); damaging or getting stuck in internal valve components (e.g., valve discs, valve stems, etc.); or impacting instrumentation operation (e.g., temperature, pressure, flow measurement).
  - Large portions of the main steam line are accessible for VT inspections (e.g., rover, borescope, or person going into confined space).
  - OEM is performing debris transport assessment in the region above the secondary separator deck to establish the likelihood of plate-like debris of various dimensions to be transported by steam flow out of the SG.
  - Preliminary results indicate that debris of the form we retrieved can be carried from the SG into the downstream piping and components.
  - Therefore, there is a need to perform FOSAR during DNRU3 as this will be an active risk that we will see during return to service.
  - Inspections should be focused on lines downstream of boilers where significant degradation was identified.

Impact To Downstream Components

However, active primary and secondary moisture separator degradation will have the following impacts to the health of downstream components:

- **RISK OF DEBRIS CARRY OVER TO HP/LP TURBINES**
  - 41162-MV1/MV2/MV3/MV4 are the Turbine Governing Valves located immediately upstream of the HP Turbine
  - Turbine Governing Valves have steam strainers installed on them (Part 41).
  - The sizes of the steam strainers are 1.5mm and 2.5mm.
  - Debris smaller than the strainer sizes are determined to within the design basis of the HP/LP Turbines.
  - Sseparator FM > 1.5mm by 1.5mm would be caught by the smallest sized steam strainer.
  - Based on initial inspections that were performed by the OEM (GE) during DNRU3, there were no immediate findings identified (i.e.., obvious damage/broken strainers/FM caught in strainers/etc.).
  - Valves are also overhauled every outage (under MWO 595221) which provide an opportunity to inspect the steam strainers for FM and damage.

Impact To Downstream Components

However, active primary and secondary moisture separator degradation will have the following impacts to the health of downstream components:

- **RISK OF DEBRIS CARRY OVER TO BOILER BLOWDOWN LINES**
  - Risk of debris stacked in SG isolation valves preventing their closure. SG isolation valves are containment boundary and are closed if tube leak is detected to prevent radionuclides to the CW duct.
  - Blockage of continuous blowoff line will result in unavailability of continuous blowoff system that is used for normal chemical and concentration control. In addition, this flow is counted in reactor heat balance calculations.
  - Continuous blowoff system FCVs are opened during normal operation, their flow is around 1 kg/s.
  - After analyzing previous WOs, it was determined that the current risk to SG isolation valves of debris stacked and continuous blowoff blockage is low.
  - Additionally, based on BO2 OPEX, it is expected that most foreign material will have a bias to settle on the top of the tubesheet (as flow pushes towards the middle during operation).

Appendix C

OPEX

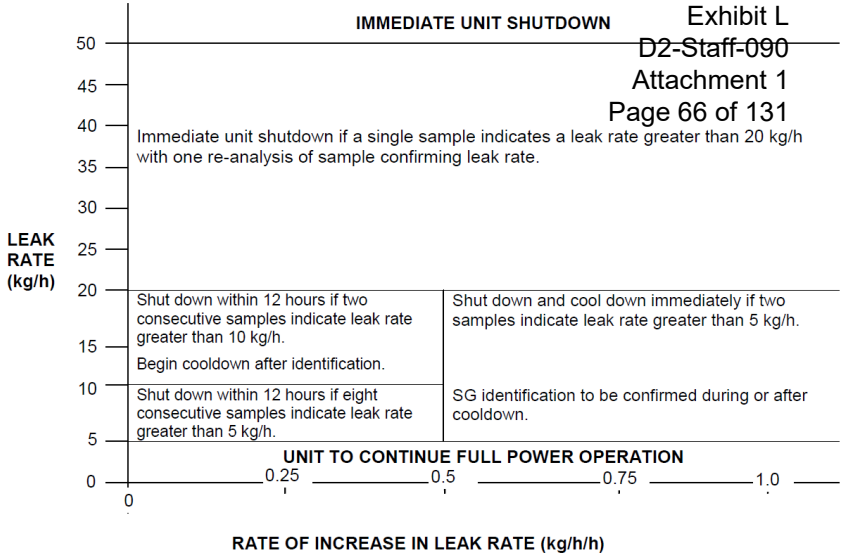
Supplementary Slides

ONTARIO POWER GENERATION

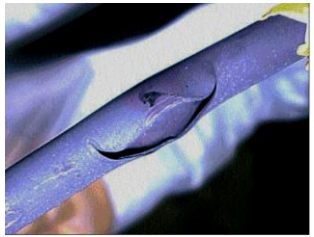
SG Tube Leak Rate Based on Fret Length

Fret Length (mm)	CLA kg/s (kg/hr)	MTFS (%tw)	Time to MTFS
25	2.1(7,560)	64	TBD
30	3.4 (12,240)	63	
35	5.4 (19,440)	62	
40	8.7(31,000)	62	
80	10 (36,000)*	61	
120	10 (36,000)*	60	
171	10 (36,000)*	59	

* EXCEEDS DNGS SITE DOSING LIMIT for SG TUBE RELEASE to PUBLIC



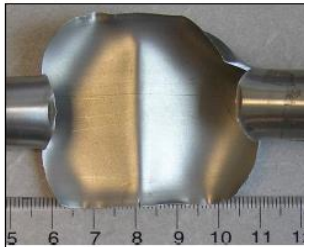
The pieces of FM from separators degradation are too large with respect to SG tube integrity assessment when the fret depth exceeds applicable structural integrity limits



Non OPG failure from irregular fretting

Actual support structure Fret Scar D1 SG3-2004

25 mm at >MTFS, 13 MPa Test



50mm >MTFS, 13 MPa Test

OPEX- SG Tube Rupture from FM

While there have been many steam generator tube leaks from FM in industry, there has been only two events associated with rupture of a steam generator tube from a foreign material:

Event 1:
US NRC Information Notice No. 79-27: INPO SOER 82-12:

October 2, 1979 at the Prairie Island 1 Nuclear Power Plant.

Cause of Event:

- Licensee examination of the steam generator tube determined that a single tube (out of 3388 in the steam generator) had ruptured.
- **The size of the rupture was 2 inches (51 mm) long and 3/8 inch (9.5 mm) wide in the wall of the 7/8 in (22 mm) diameter tube.**
- **A coil spring 8.5" (216 mm) long, 1.26 in (32 mm) in diameter and made of 3/32" (2.4 mm) gauge steel** was found on the tubesheet adjacent to the defective tubes.
- The spring is believed to have been part of a hose used to loosen and remove sludge products from the tube support sheet during an early refueling outage.
- It can be noticed that the size of the opening was significantly less than the size of the FM

OPEX - SG Tube Failure From FM

Event 2:

US NRC information Notice No. 83-24 / INPO SOER 82-12

On January 25, 1982, the R.E. Ginna plant experienced a steam generator tube rupture at full power conditions.

Cause of Event:

- Based on visual and eddy current inspections, **the tube break was approximately 4 inches (102 mm) long and 3/4 inch (19 mm) wide and was located about 3 inches (76 mm) above the tube sheet.**
- The ruptured tube was located three rows from the periphery of the tube bundle.
- Several plugged tubes in the vicinity of the rupture were completely severed from the tube sheet.
- **A 3.2 pound piece of the carbon steel downcomer flow resistance plate** which, had been removed in 1975 was found near the damaged tubes (this was the largest piece found). Additional 8 pieces of FM were also reported. (i.e..: a piece of FM 3.2 pounds known in service in 1975 at the red zone of TTS caused a tube rupture in 1982).

OPEX – Embalse PMS Replacement

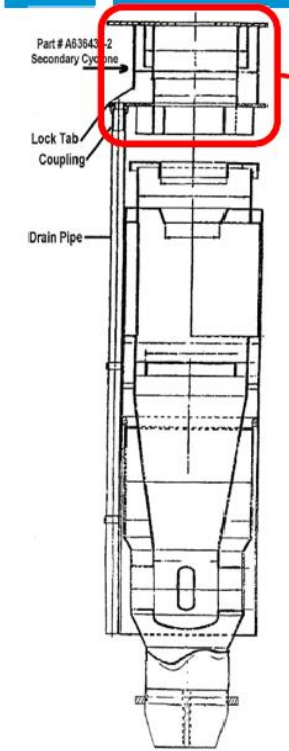
- During Embalse Refurbishment, as part of core scope, the SG steam drum was cut and stored inside the reactor building and lower portion of the SG (i.e., cartridge) was replaced with newly manufactured components.
- Steam drum (PB) was in good condition, internals had undergone FAC, similar as Darlington.
- During the outage, the decision was then made to replace the PMS during the refurbishment outage.
- Installed through the manway which lined up with the inside well (unlike DNGS which is at an angle).
- No degradation observed for SMS (based on aging management assessment).
- Therefore, replacement of SMS was not performed

Other Notes:

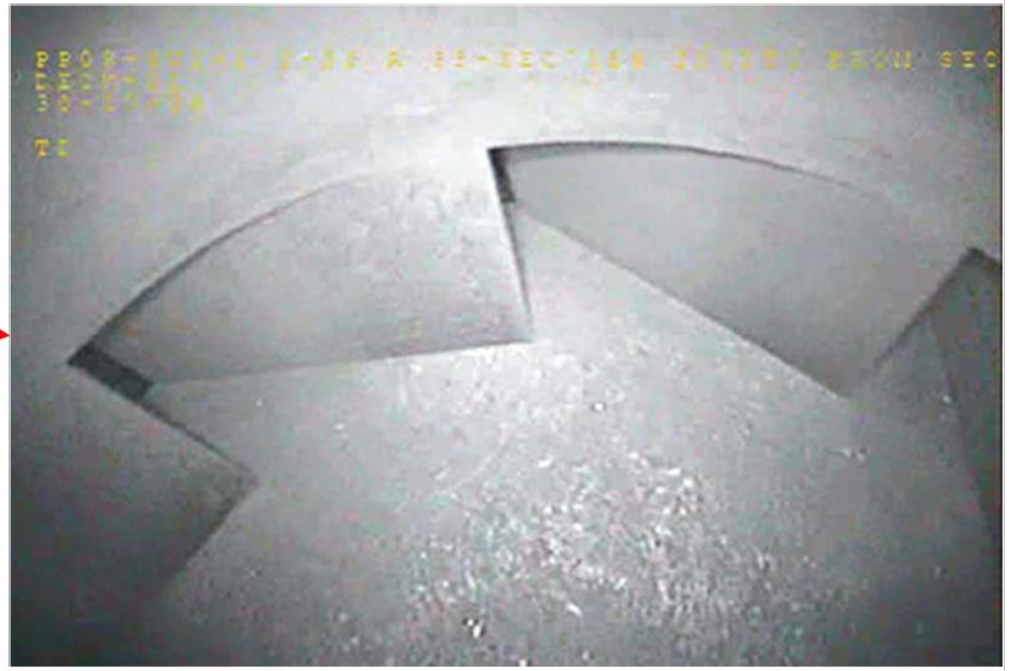
- 4 bolts flange design for bottom plate, we (OPG) have a complete weld.
- Significant difference between units. Welding is old technique.
- SMS black or shiny spot in the middle was fine. Thinnest point is center.
- Measured from top through 4” hole and using hand tool.
- BWXT did the plan for the inspection campaign (with local resources for field execution).
- BWXT wrote a recommendation report to support 30 years post-Refurb operation.

OPEX – Embalse PMS Replacement

REASON OF REPLACEMENT

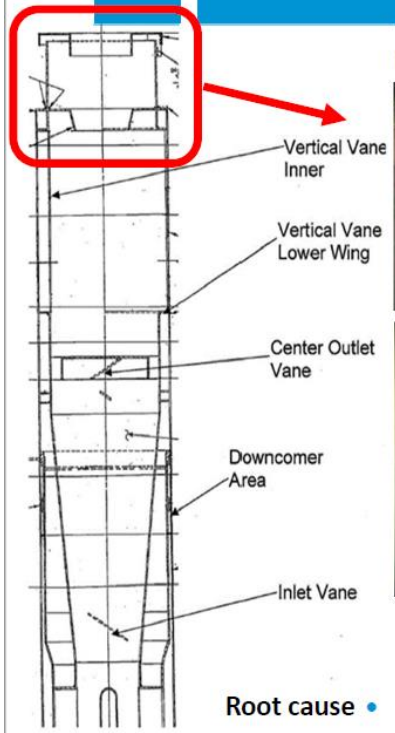


SECONDARY SEPARATORS WERE IN GOOD CONDITION

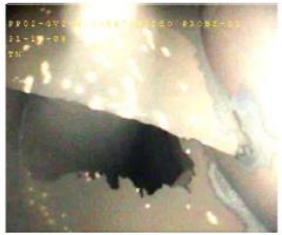


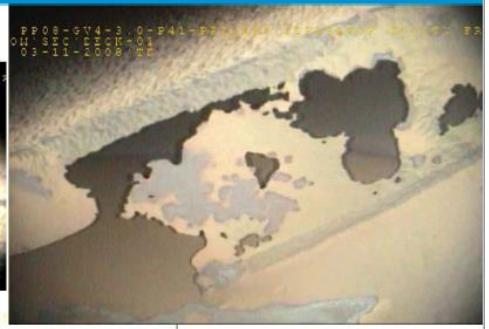
OPEX – Embalse PMS Replacement

REASON OF REPLACEMENT



Flow assisted corrosion of primary cyclones





Root cause • Susceptible material (low Cr carbon steel)

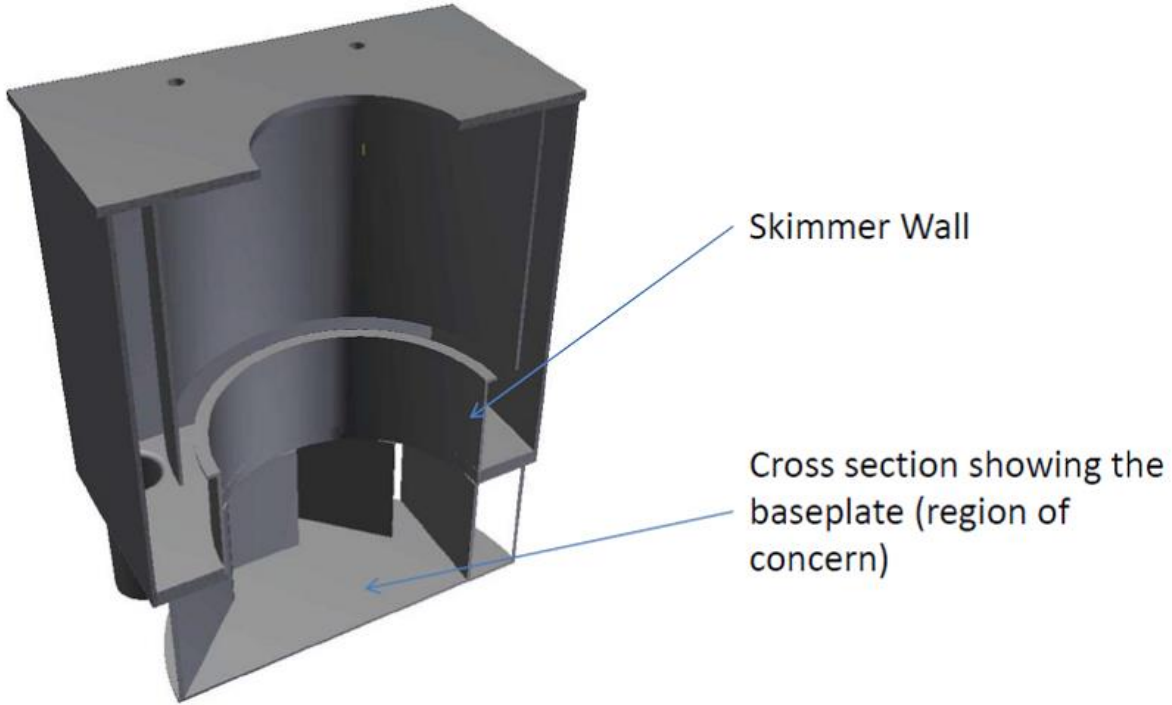
OPEX – Embalse PMS Replacement

REPLACEMENT METHOD

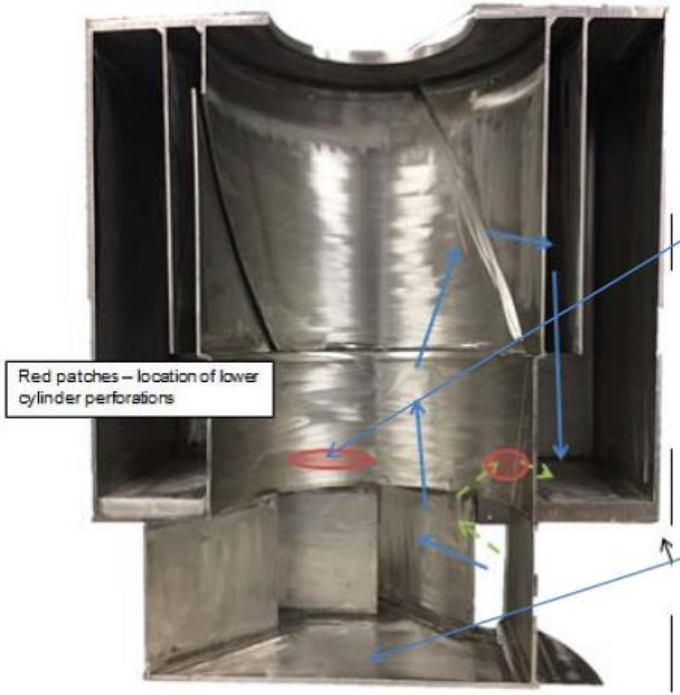
NEW MOISTURE SEPARATORS ARE

SA-240 TYPE 304L

OPEX – McGuire 2 SMS Images



OPEX – McGuire 2 SMS Images



Skimmer wall erosion: Steam enters the drain box, but only in small amounts. Max bypass is 5%. Small holes in the skimmer wall may increase moisture removal. Continued erosion may cause vortex issues.

Existing baseplate degradation: A hole in the middle of the separator baseplate stops the vortex and prevents the centrifugal removal of water. Max of 10 separators before MCO is >.25%

Appendix D

Findings Summary

Supplementary Slides

ONTARIO POWER GENERATION

Discussion – Primary Moisture Separators

Brief Summary of Results

- The PMS are designed to remove 90% of the moisture in the steam generated at the U-bends
- BO2 PMS are more severely degraded than the other SGs
- Six (6) locations showed the worst degradation with much of the top plate missing completely
- Additional fifteen (15) locations inspected show some levels of holes or material loss
- BO1/BO3/BO4 PMS are less severely degraded, ranging from minor discoloration to beginnings of material loss
- A significant portion of the primary separators in each SG, primary those on the hot leg side appear to be un-degraded or minimally degraded

Suspected Mode of Degradation

- The suspected mode of degradation is flow accelerated corrosion
- Differences in plain carbon steel degradation can be attributed to slight differences in trace chromium content
- The measured chromium content from the separator pieces retrieved from the bundle entrance and separator deck were very low at 0.020 to 0.035%
- This is below the threshold where significant protection from 2-Phase FAC is provided

Suspected Location of Degradation

- Primary moisture separator internals (i.e.., bottom side of top plate, inside of the vanes)

Discussion – Primary Moisture Separators

Inspection Limitations

- Direct inspection of the area where degradation is occurring cannot be performed
- VT inspections can only inspect primary moisture separator externals (i.e.., top side of the top plate, partial inspections of the inside of the vanes)
- Foreign material retrieved from BO2 indicate that using degradation on the areas available VT inspection as a screening criteria is not valid (i.e.., FM had minimal indications of visible wear to the top side of the top plate)
- Foreign material retrieved from BO2 indicate that failure can be "break before pinholes start forming" (i.e.., equivalent to external inspection of pipe to determine internal thinning).
- UT inspection for remaining wall thickness cannot be performed with current tools
- UT inspection will likely require removal of secondary separator deck and/or SMS for access

Gaps in Knowledge

- Current health of the PMS that do not have thru-wall failures (due to lack of thickness measurements)
- Degradation rate (i.e.., when each primary moisture separator is expected to fail)
- Remaining life (as a consequence of the above)
- Location of all foreign material generated from PMS top plate degradation

Areas for Future Improvement

- Development of an inspection technique to assess the health, degradation rate, and remaining life of the PMS
- Utilization of the above NDE inspection technique on Unit 3 as well as Units 1/2/4

Discussion – Secondary Moisture Separators

Brief Summary of Results

- The SMS are design to remove the remaining 9.75% to 10% of the moisture in the steam generated at the U-bends

- Most SMS show shiny or partially shiny spot at the center of the bottom plate
- No significant degradation of the inlet cylinder sidewalls was noted (in areas accessible for inspection)
- One location (#62) in BO2 showed degradation and material loss on the bottom plate
- There were no locations that showed material loss that would have generated in FM (unlike the PMS)

Suspected Mode of Degradation

- The suspected mode of degradation is flow accelerated corrosion
- Differences in plain carbon steel degradation can be attributed to slight differences in trace chromium content
- However, this cannot be verified to the same extent that it was on the PMS (as there are no pieces of FM to test/examine)

Suspected Location of Degradation

- Secondary moisture separator internals (i.e.., top side of bottom plate, cylinder internals – based on OPEX)

Discussion – Secondary Moisture Separators

Inspection Limitations

- VT inspection performed on the top side of the bottom plate (suspected to be the area that would see the most degradation)
- VT inspection of the complete cylinder internals cannot be performed (only the partial) (suspected to also be degrading based on OPEX)
- NDE inspection for remaining wall thickness on the top side of the bottom plate cannot be performed with readily available tools/procedures; based on the available access and OPEX from Bruce, this inspection is possible and can be developed

Gaps in Knowledge

- Current health of the SMS complete cylinder internals (due to lack of inspection access)
- However, this is suspected to be bounded by inspections performed on the top side of the bottom plate and partial areas of the cylinder internals that were accessible for inspection (which shows minimal degradation on the top side of the bottom plate)
- Degradation rate (i.e.., when each SMS is expected to fail due to lack of thickness measurements)
- Remaining life (as a consequence of the above factors)

Areas for Future Improvement

- Development of NDE inspection technique to assess the health, degradation rate, and remaining life of the SMS
- Utilization of the above NDE inspection technique on Unit 3 as well as Units 1/2/4
- Validation of repair/replacement technique to address the need for repair/replacement for SMS during future planned outages (up to and including 2055)

Appendix F

Alternatives Evaluated by BWXT

Supplementary Slides

ONTARIO POWER GENERATION

Alternatives Evaluated by BWXT

Alternative 1: DO NOTHING

Pros	Cons
• Allows more time to carefully plan out and prepare replacement strategy (specific to DNRU3) • No impact to refurbishment schedule (specific to DNRU3)	• Potential increase in MCO with each degraded primary separator with potential downstream component risks and electrical generation loss • FM generated by failing primary separators at the tubesheet may cause tube wear • FM generated by failing primary separators may migrate to the steam line with potential damage to downstream components • Actual in-site thickness measurements of the CASA top-plate required to confirm feasibility of retaining some of the carbon steel primary separators • Thickness measurements of the side wall and baseplates of the secondary separators also required to compare their acceptability • Retention of the separators would need to be supported by a thorough chemistry review to validate degradation growth rates

Alternatives Evaluated by BWXT

Alternative 2: REPLACE SELECTED PRIMARY SEPARATORS

Pros	Cons
• Reduces procurement cost of materials and components compared to replacing all primary separators • Minimizes foreign material risk from in-boiler work as less components are removed and replaced • Less in-boiler time lowers conventional and radiological safety risk	• Heightened inspection scope and expansion potential for remaining carbon steel separators in future inspection and maintenance campaigns • Actual in-site thickness measurements of the CASA top-plate required to confirm feasibility of retaining some of the carbon steel primary separators • Thickness measurements of the side wall and baseplates of the secondary separators also required to compare their acceptability • Retention of the original separators (some of the primary and all the secondary) would need to be supported by a thorough chemistry review to validate degradation growth rates

Alternatives Evaluated by BWXT

Alternative 3: REPLACE PARTIAL LENGTH OF PRIMARY SEPARATORS

Pros	Cons
• Only targets replacement of material which have been severely degraded/failed during operation reducing material cost • Repair has the potential of being completed through the manway without removing the steam line	• Increased conventional safety risk due to confined space work and extensive critical-to-separator function welding inside the SG • Upper section of the primary separators will require re-design for piece-wise assembly in the SG; without negative impact to the separator test qualification • Redesign of the upper support structure may be required, increasing design complexity, execution time, and schedule • Limited crew size that can perform the repair work in parallel from the access tunnel • Elevated FM risk as cutting/grinding/welding will be performed in an enclosed space with significant access constraints. Inspection and retrieval of any FM that falls into the primary deck or down the downcomer will be challenging • Thickness measurements of the side wall and baseplates of the secondary separators also required to compare their acceptability • Retention of the secondary separators would need to be supported by a thorough chemistry review to validate degradation growth rates

Alternatives Evaluated by BWXT

Alternative 4: FULL REPLACEMENT OF ALL PRIMARY SEPARATORS

Pros	Cons
• Stainless steel primary separators are not susceptible to FAC degradation, so minimizes the risk of future primary separator degradation issues. • Relaxation of separator inspection scope during future inspection and maintenance campaigns for primary separators	• Increased material cost and schedule impact to replace all primary separators, as compared to replacing only unacceptably degraded primary separators. • Increased in conventional and radiological safety risk due to larger replacement scope compared to Alternative 3. • Thickness measurements of the side wall and baseplates of the secondary separators also required to compare their acceptability • Retention of the secondary separators would need to be supported by a thorough chemistry review to validate degradation growth rates

Alternatives Evaluated by BWXT

Alternative 5: FULL REPLACEMENT OF ALL PRIMARY AND SECONDARY SEPARATORS

Pros	Cons
• Stainless steel primary separators are not susceptible to FAC degradation, so minimizes the risk of future primary separator degradation issues. • Relaxation of separator inspection scope during future inspection and maintenance campaigns for primary separators	• Increased material cost and schedule impact to replace all primary separators, as compared to replacing only unacceptably degraded primary separators. • Increased in conventional and radiological safety risk due to larger replacement scope compared to Alternative 4.

Alternatives Evaluated by BWXT

Alternative 6: COMPLETE DRUM INTERNALS MODULE REPLACEMENT

Pros	Cons
• Minimizes the amount of work to be performed inside the SG, relative to the above in-situ "stick built" options. • Replaces all primary and secondary separators with 304L stainless steel, ensuring immunity to future FAC degradation of any steam separator component. • The primary separator support structure design will not require a redesign and can be used with the replacement stainless steel primary separators	• Significant impact to cost and schedule of DNRU3 outage compared to Alternatives 2, 3, 4, and 5. • Major disruption to plant structures requiring cutting and re-welding to the SG pressure boundary, cutting and restoration of the concrete above the SG to allow steam drum-head/shell removal, removal of reactor-building roof sections to facilitate lifting/rigging by an external heavy-lift crane. • Volumetric weld quality of the new closing girth-seam can be challenging based on OPEX, leading to additional cost and schedule for repair welds • Field PWHT is challenging, requiring SG internal insulation and possible vacuum or inert environment to protect internals from impacts of heat

Alternatives Evaluated by BWXT

Additional Considerations: SMS CONDITION/REPAIR/REPLACEMENT

- Additional confirmatory measurements of the secondary separators should be performed to establish a degradation growth rate of the various components of the secondary separators
- Laser profilometry or UT thickness checks may be feasible given the access afforded from the secondary deck to the internals of the secondary separators
- In-situ repairs to secondary separators bottom-plates have been performed for a number of Bruce B and US PWR replacement SG secondary separators, essentially consisting of a stitch welded patch plate on the upper surfaces of the bottom plate, installed through the open end of the secondary separator from the top of the secondary deck
- The repairs have proved effective for approximately 10 years of operation to date
- Thus, there is a proven long-term method of repairing the base-plates

Alternatives Evaluated by BWXT

Additional Considerations: SMS CONDITION/REPAIR/REPLACEMENT

- Side wall degradation of the secondary separator inlet cylinders has been observed in some plants, although the visual inspections of the Darlington Unit 3 secondary separators do not show evidence of this being an active degradation mechanism
- An in-situ repair for side-wall degradation has been conceptualized, but not proven
- Degradation of the secondary separators to the extent of side-wall significant thickness degradation (or perforation) should be a consideration for secondary separator replacement
- It may be possible to confirm this through UT thickness measurement

Alternatives Evaluated by BWXT

<u>Additional Considerations:</u> PMS Monitoring OPEX from BWXT

- **QUESTION: What are the critical components of Primary Separators that need to be monitored and measured? What does BWXT propose for Darlington?**

- **ANSWER: The critical components of Primary Separators that need to be monitored and measured on an ongoing basis are:**
  - Primary Separator Top Plate – BWXT proposes the use of visual inspections and UT thickness measurements to verify component conditions. UT technique to take these measurements has not been developed yet but could be developed. There are some challenges though to overcome with respect to accessibility as some of the separators are not easily accessible.
  - Primary Separator Curved Arms and Stiffener Plate – This is typically done by visual inspections and has the same challenge of accessibility for some of the separators.

Alternatives Evaluated by BWXT

<u>Additional Considerations:</u> SMS Monitoring OPEX from BWXT

- **QUESTION: What are the critical components of Secondary Separators that need to be monitored and measured? What do we do at Bruce? And what does BWXT propose for Darlington?**

- **ANSWER: The two critical components of Secondary Separators that need to be monitored and measured on an ongoing basis are:**
  - Secondary Separator Base Plate – BWXT currently uses laser profilometry at Bruce to measure and quantify the degradation of these base plates. And based on the acceptance criteria established for Bruce, they either are left as is or are repaired with a welded patch plate. BWXT manufactures and takes sufficient quantities of patch plates with us to support any in-situ repairs. We generate procedures, procure tooling and qualify welders to do this repair. It is typically done during the planned outage with no impact to the planned outage schedule. BWXT proposes the same technique with a laser profilometry to be developed and tooling to be made specific for Darlington.
  - Secondary Separator Cylinder Side-Wall – These are visually inspected at Bruce. BWXT has not observed any degradation of these cylinder walls at Bruce, Cernavoda or Pt. LePreau, although this degradation has been observed at one PWR plant in the US. Operation with side-wall degradation can be justified (with a risk of elevated moisture carryover and low risk of small loose parts). A repair for the sidewalls can be developed if required. BWXT proposes the same approach for Darlington.

Appendix G

Assessment of Alternatives 2, 3, and 6

Supplementary Slides

ONTARIO POWER GENERATION

OPG Assessment of Alternatives

Alternative 2: REPLACE FULL PRIMARY SEPARATORS (SOME BUT NOT ALL)

Pros	Cons
• Addresses replacement of primary separators that are greatest concern to short-term operations and component fitness for service • Reductions to cost and schedule during replacement planning and execution • Reductions to conventional safety and radiological safety risk	• Same cons as Alternative 1 for primary separators that were not replaced • High cost and schedule impact to either Refurbishment or Planned outage; estimated costs range from $0M to $90M and timelines from 0 to 6 months* • The recommended process for removal and replacement of the separators is not changed compared to replacing all primary separators • Scope selection would require in-situ thickness measurements as well as thorough chemistry review to effectively determine replacement scope (currently not feasible) • Heightened inspection scope and expansion requirement for remaining carbon steel separators in future inspection and maintenance campaigns • Potential to go back and replace unreplaced primary separators during future outage • Potential degradation to secondary separators is not addressed

OPG Assessment of Alternatives

Alternative 3: REPLACE PARTIAL LENGTH OF PRIMARY SEPARATORS

Pros	Cons
• Majority of the cons associated with Alternative 1 are addressed (with exception to those associated with secondary separators, the bottom portion of the primary separators, and potentially new degradation mechanisms due to new welds) • Potential reductions to cost and schedule during replacement planning and execution • Potential reductions to conventional safety and radiological safety risk • Repair has the potential of being completed through the manway without removing the temporary removal of the main steam line (i.e.., 4000kg lift)	• High cost and schedule impact to either Refurbishment or Planned outage • Estimated costs range from $60M to $90M and timelines from 3 to 6 months* • Re-design required for piece-wise assembly inside the SG to ensure no impact to separator qualification • Material incompatibilities between old and new PMS separator piece welds will limit the materials available for replacement (i.e.., stainless steel may not be feasible, impacts of dissimilar materials/welds to operating conditions including degradation – potential for enhanced FAC on old components or new welds) • Increased difficulty for execution as a result of additional critical cutting/welding inside the SG • Potential degradation to the bottom portions of the primary separators are not addressed • Thickness measurements of the side wall and baseplates of the secondary separators also required to compare their acceptability • Retention of the separators should be supported by a thorough chemistry review to validate degradation growth rates

OPG Assessment of Alternatives

Alternative 6: COMPLETE DRUM INTERNALS MODULE REPLACEMENT

Pros	Cons
• All the cons associated with Alternative 1 are addressed • Separator installation will replicate what is done during original manufacturing • Full replacement allows opportunity for design changes to eliminate or minimize future degradation (i.e.., FAC-resistant materials of construction) • Eliminate/reduce both primary and secondary separator inspection scope during future inspection and maintenance campaigns (i.e.., typically 5 x 10hr shifts to include 100% of primary and secondary separators in one SG)	• Very high cost and schedule impact to either Refurbishment or Planned outage • Estimated costs are >>>$90M (estimate is greater than 100% increase) with timelines ranging from >>>9 months for full replacement (>>>1 – 2 month impact to DNRU3 critical path; significant impact to D4F outage critical path) • Significant impact to cost and schedule of DNRU3 outage compared to Alternatives 2, 3, 4, and 5. • High risk welding and significant chance for re-work due on SG shell to shell welds (including need to perform NDE and Field PWHT – which may require an inert or vacuum environment) • Major disruption to plant structures requiring cutting and re-welding to the SG pressure boundary, cutting and restoration of the concrete above the SG to allow steam drum-head/shell removal, removal of reactor-building roof sections to facilitate lifting/rigging by an external heavy-lift crane.

Appendix G

Alternatives Compared

Supplementary Slides

ONTARIO POWER GENERATION

Alternatives Compared*

	Alt 1 Do Nothing	Alt 4 All PMS Replace	Alt 5 All PMS & SMS Replace
Cost	$0m	$90M (2021)	>>$90M* (Likely 30-40% more)
Execution Risk	N/A	High (FOAK)	Very High (FOAK)*
Schedule	N/A	6 months (No assessed impact to DNRU3 Critical Path)	6 - 9 months* (1 – 2 month impact to DNRU3 Critical Path)
Conventional Safety Risk	N/A	N/A	N/A
Nuclear Safety Risk	L4 Cons ($10-$25M) P5 Probability (10-25%)	L4 Cons ($10-$25M) P2 Probability (0.1-1%)	L4 Cons ($10-$25M) P1 Probability (0.0-0.1%)
Radiological Safety Risk	L1 Cons ($0-0.2M) P5 Probability (-25%)	L1 Cons ($0-0.2M) P2 Probability (0.1-1%)	L1 Cons ($0-0.2M) P1 Probability (0.0-0.1%)

*Consequence and Probability were qualitatively assessed for the purpose of this EDM only (using N-GUID-08120-00003-R000). Assessment performed over the life of the facility (i.e., probability and consequence of event occurring from DNRU3 to 2055). Provided here for information only to show relative risk between options themselves.

Alternatives Compared*

	Alt 1 Do Nothing	Alt 4 All PMS Replace	Alt 5 All PMS & SMS Replace
Social License & Reputation Impact	L5 Cons ($25-$50M) P5 Probability (10-25%)	L5 Cons ($25-$50M) P2 Probability (0.1-1%)	L5 Cons ($25-$50M) P1 Probability (0-0.1%)
Financial Risk	L7 Cons ($100-$500M) P5 Probability (10-25%)	L7 Cons ($100-$500M) P2 Probability (0.1-1%)	L7 Cons ($100-$500M) P1 Probability (0-0.1%)
Regulatory Risk	L5 Cons ($25-$50M) P5 Probability (10-25%)	L5 Cons ($25-$50M) P2 Probability (0.1-1%)	L5 Cons ($25-$50M) P1 Probability (0-0.1%)
Environmental Risk	L4 Cons ($10-$25M) P5 Probability (10-25%)	L4 Cons ($10-$25M) P2 Probability (0.1-1%)	L4 Cons ($10-$25M) P1 Probability (0.0-0.1%)
Lost Generation	L7 Cons ($100-$500M) P5 Probability (10-25%)	L7 Cons ($100-$500M) P2 Probability (0.1-1%)	L7 Cons ($100-$500M) P1 Probability (0-0.1%)

*Consequence and Probability were qualitatively assessed for the purpose of this EDM only (using N-GUID-08120-00003-R000). Assessment performed over the life of the facility (i.e., probability and consequence of event occurring from DNRU3 to 2055). Provided here for information only to show relative risk between options themselves.

Appendix I

Risk Definition Tables from

N-GUID-08120-00003-R000

ONTARIO POWER GENERATION

The following tables define the consequence levels for each risk area.

Table 3: Definition of Consequences for Safety Risk – Conventional

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Safety Risk – Conventional - measures potential conventional safety incidents.							
1. Safety Risk – Conventional	Medically treated injury not resulting in Lost Time	Lost Time Injury OR Permanent Partial Disability	Multiple Lost Time Injuries OR Multiple Permanent Partial Disabilities	Fatality OR Permanent Total Disability	Multiple Fatalities AND/OR Multiple Permanent Total Disabilities (Detailed definitions for L5, L6, and L7 can be found in the Asset Management Tool)		

Table 4: Definition of Consequences for Safety Risk – Nuclear

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Safety Risk – Nuclear - measures potential impact on reactivity management, safe shutdown of the reactor and/or maintaining safe-shutdown condition or ensuring barriers to radiation release.							
1. Safety Risk – Nuclear	Minimal adverse effect on the ability to control, cool or contain caused by a component failure in a SOE (Safe Operating Envelope) system	Minor adverse effect on the ability to control, cool or contain caused by a component failure in a SOE (Safe Operating Envelope) system	Some adverse effect on the ability to control, cool or contain caused by a component failure in a SOE (Safe Operating Envelope) system	Moderate adverse effect on the ability to control, cool or contain caused by a SOE (Safe Operating Envelope) system or component failure	Major adverse effect on the ability to control, cool or contain caused by a SOE (Safe Operating Envelope) system or component failure	Severe adverse effect on the ability to control, cool or contain caused by a SOE (Safe Operating Envelope) system or component failure	Inability to control, cool or contain caused by a catastrophic system failure in a SOE (Safe Operating Envelope) System

Table 5: Definition of Consequences for Safety Risk – Radiological

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Safety Risk – Radiological - measures potential unplanned radiological exposure or contamination, and lost opportunity for dose savings (refer to N-STD-RA-0018).							
1. Safety Risk – Radiological	• Exposure control level (ECL) exceedance AND/OR • Unplanned exposure	• Administrative dose limit (ADL) exceedance AND • Below CNSC regulatory limit	• Exposure exceeding CNSC regulatory limit AND • Below CNSC Emergency Dose Limits	• Acute Exposure exceeding CNSC Emergency Limit AND • Below LD_{50}	• Multiple Acute Exposures exceeding LD_{50} (Detailed definitions for L5, L6, and L7 can be found in the Asset Management Tool)		
	• Lost opportunity for dose savings of <1 rem/year	• Lost opportunity for dose savings of 1-5 rem/year	• Lost opportunity for dose savings of 5-50 rem/year	• Lost opportunity for dose savings of 50-125 rem/year	• Lost opportunity for dose savings of 125-250 rem/year	• Lost opportunity for dose savings of 250-500 rem/year	• Lost opportunity for dose savings of >500 rem/year

Table 6: Definition of Consequences for Regulatory Risk

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Regulatory Risk - measures potential non-compliance incidents with applicable regulations. - Regulatory risk is used to capture the impact of an event or a failure which would cause the organization to fail to comply with a government or regulatory mandate or internal policy. - Compliance consequences are typically determined by the fines that would be assessed for non-compliance, or the cost to the organization of operating restrictions imposed because of the non-compliance. - The description below is specific to CNSC; however this table should also be used for any other regulatory risks, excluding electricity rate regulation.							
2. Regulatory Risk	• CNSC Action Items OR • Reportable Condition with minimal Regulatory Action	• Reportable Condition requiring minor Regulatory Action	• Event Requiring some Regulatory Action • Increased regulatory inspections or frequency of reporting	• Event Requiring moderate Regulatory Action • Undesirable license condition • Degraded CNSC Ratings • Enhanced regulatory oversight	• Ongoing regulatory oversight • Regulatory enforcement with major impact on business plan • Forced unit derate for a period of < 1 year	• Charges against an OPG officer, director or employee • Forced unit derate for a period of > 1 year	• Permanent shutdown • Facility License Revocation

Table 7: Definition of Consequences for Environmental Risk

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Environmental Risk - measures potential environmental damage, and remediation costs (on and off site). - The Environmental Risk Value Model should not be used for risks including radiological emissions, as such these are captured under Environmental Risk – Radiological Emissions (See **Table 8**)							
3. Environmental Risk	• Impact to on-site environment that can be quickly mitigated • Inability to perform environmental monitoring that can be quickly mitigated • Minimal regulatory impact	• Impact to on-site environment that can be mitigated without legal or permit violations	• Impact to on-site environment resulting in legal or permit violation • Inability to perform environmental monitoring resulting in legal or permit violation	• Detrimental on-site impact, possible to mitigate in the long term • Detrimental off-site short-term impact, possible to mitigate in less than 3 years	• Civil penalties or regulatory violations resulting from detrimental off-site impact, possible to mitigate in the long term (> 3 years)	• Civil penalties, regulatory violations / interventions resulting from catastrophic off-site impact that will be impossible to mitigate • Impact in the range of $50 M – $100 M	• Civil penalties, regulatory violations / interventions resulting from catastrophic off-site impact that will be impossible to mitigate • Impact in the range of $100 M – $500 M

Table 8: Definition of Consequences for Environmental Risk – Radiological Emissions

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Environmental Risk – Radiological Emissions - measures potential environmental damage caused by radiological emissions, and remediation costs (on and off site).							
3. Environmental Risk – Radiological Emissions	Exceeding Internal Investigation Level, but less than an Action Level whether measured or estimated from a non-monitored release	Reaching or exceeding Action Level for the reporting period	Greater than the Derived Release Limit (DRL) for the reporting period (monthly for water, weekly for air)	In excess of the limits that are specified in the licensing documents, possible to mitigate in less than three years	In excess of the limits that are specified in the licensing documents, possible to mitigate in the long term (>3 years)	Emission of radioactive material due to a catastrophic event that is impossible to mitigate, with impact ranging $50 M - $100 M	Emission of radioactive material due to a catastrophic event that is impossible to mitigate, with impact ranging $100 M - $500 M

Table 9: Definition of Consequences for Security Risk – Cyber Security (Asset subject to CSA N-290 or NERC CIP)

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Security Risk – Cyber Security (Asset subject to CSA N-290 or NERC CIP) - measures potential cyber security breaches, specifically to assets that are subject to CSA N-290 or NERC CIP. - Cyber Security Risk is used to capture cyber security concerns. - But if there is also a potential regulatory risk event arisen from the cyber security breach, it should also be assessed and included separately under Regulatory Risk.							
4. Security Risk – Cyber Security (Asset subject to CSA N-290 or NERC CIP)	Plant equipment disruption OR exposure of Confidential information leading to: • CNSC Action Items, • A Reportable Condition with minimal Regulatory Action, or • A self-report of a potential Non-Compliance to IESO	Plant equipment disruption OR exposure of Confidential information leading to: • A Reportable Condition requiring minor Regulatory Action, or • A minor financial penalty for NERC CIP Non-Compliance	Plant equipment disruption OR exposure of Confidential information leading to: Some Regulatory Action and some impact on plant operation, or • Some financial penalty for NERC CIP Non-Compliance	Plant equipment disruption OR exposure of Confidential information leading to: • Moderate Regulatory Action and moderate impact on plant operation • An Undesirable licence condition	Plant equipment disruption OR exposure of Confidential information leading to: • Ongoing regulatory oversight and major impact on plant operation	Multiple plant equipment disruption OR exposure of Confidential information leading to: • Facility Licence Revocation / Enforced (<1 year)	Multiple plant equipment disruption OR exposure of Confidential information leading to: • Permanent shutdown, or • Persistent breaches of the market rules lead to suspension or termination from the market and disconnection from the IESO-controlled grid

Table 10: Definition of Consequences for Security Risk – Cyber Security (Other)

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Security Risk – Cyber Security (Other) - measures potential cyber security breaches for assets that are not subject to CSA N-290 or NERC CIP. - Cyber Security Risk is used to capture cyber security concerns. - But if there is also a potential regulatory risk event arisen from the cyber security breach, it should also be assessed and included separately under Regulatory Risk.							
4. Security Risk – Cyber Security (Other)	Business systems (All Cyber Assets) vulnerabilities identified and risk mitigated before exposed	Business systems (Priority Three IT or OT) disruption OR alteration of critical information OR exposure of OPG Internal Use Only or OPG Proprietary information	Critical business systems (Priority Two IT or OT) disruption OR alteration of critical information OR exposure of OPG Confidential information	Critical business systems (Priority One IT or OT) disruption OR alteration of critical information OR exposure of OPG Confidential Exclusive information	Critical business systems (Priority One IT or OT) extended disruption OR unrecoverable alteration of critical information	Unrecoverable critical business systems (Priority One IT or OT) disruption, with impact ranging $50 M - $100 M	Unrecoverable critical business systems (Priority One IT or OT) disruption, with impact ranging $100 M - $500 M

Table 11: Definition of Consequences for Social Licence and Reputation Impact

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Social Licence and Reputation Impact - measures potential failure or event that will cause the organization's customers or other external stakeholders to lose confidence in the organization.							
5. Social Licence & Reputation Impact	• Minimal impact on employee engagement • Minimal impact on external stakeholders	• Minor impact on employee engagement • Minor impact on OPG's public reputation (e.g., public escalating legitimate issues to Senior Management, etc.)	• Some impact on employee engagement • Some impact on OPG's public reputation (Individual occurrence of some negative perception by the media, communities of interest and/or the shareholder)	• Potential for labour conflicts • Moderate impact on OPG's reputation (Individual occurrence of moderate negative perception by the media, communities of interest and/or the shareholder)	• Labour conflicts • Major impact on OPG's reputation (e.g., sustained major negative perceptions by media, communities of interest and/or the shareholder)	• Severe impact on OPG's reputation (e.g., sustained severe negative perceptions by media, communities of interest and/or severe loss of confidence by the shareholder)	• Complete loss of confidence by the shareholder resulting in shutdown

Table 12: Definition of Consequences for Lost Generation Risk

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Lost Generation Risk = Number of additional outage days required x (Daily Lost Net Revenue + Daily Incremental Outage Cost) x *Likelihood of Risk Event occurring that will result in lost generation * Likelihood may be a combination of asset failure probability and other reasonable adjustments due to factors such as system redundancy and spare parts availability							
6. Lost Generation Risk	Lost Generation Revenue <$200 K	Lost Generation Revenue $200 K – $1 M	Lost Generation Revenue $1 M – $10 M	Lost Generation Revenue $10 M – $25 M	Lost Generation Revenue $25 M – $50 M	Lost Generation Revenue $50 M – $100 M	Lost Generation Revenue $100 M – $500 M

Table 13: Definition of Consequences for Financial Risk

CONSEQUENCE	L1	L2	L3	L4	L5	L6	L7
Financial Risk - measures potential financial losses due to damage to equipment or company assets.							
7. Financial Risk	< $200 K	$200 K – $1 M	$1 M – $10 M	$10 M – $25 M	$25 M – $50 M	$50 M – $100 M	$100 M – $500 M

Appendix I

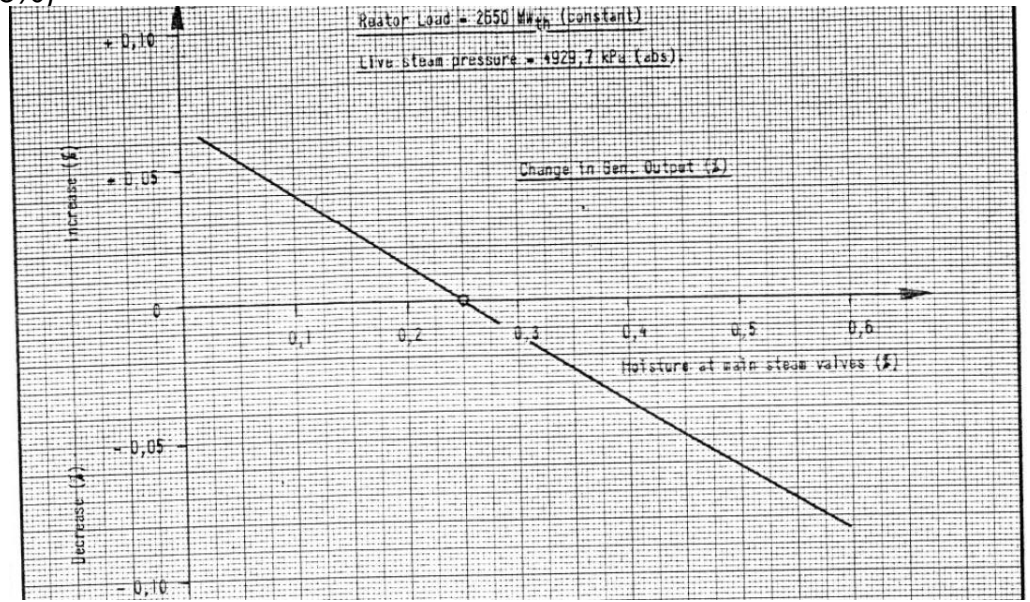
SG Main Steam Moisture Impacts

ONTARIO POWER GENERATION

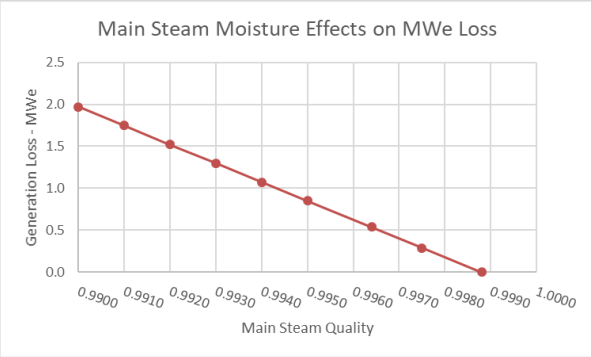
Main Steam Moisture Effect on Generation

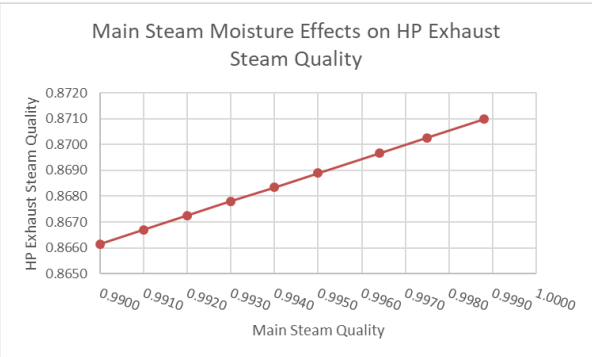
Design Moisture: 0.25%

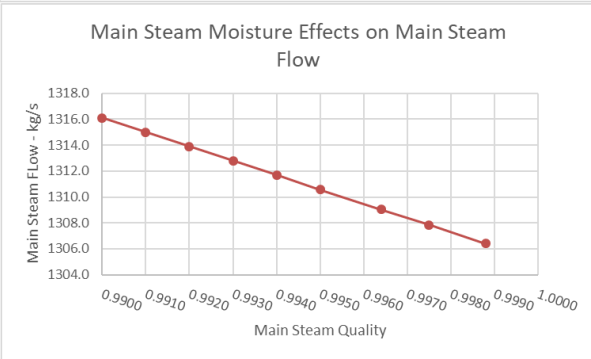
Assumed Moisture Doubled to be 0.5%, Mwe Loss – 0.56MWe (0.06%)

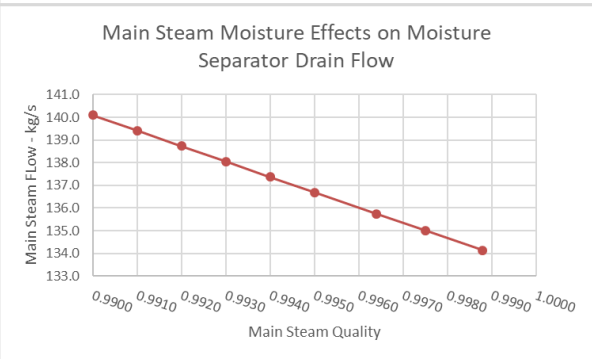


Main Steam Moisture Effects on Secondary Side – PESPE Modelling Study







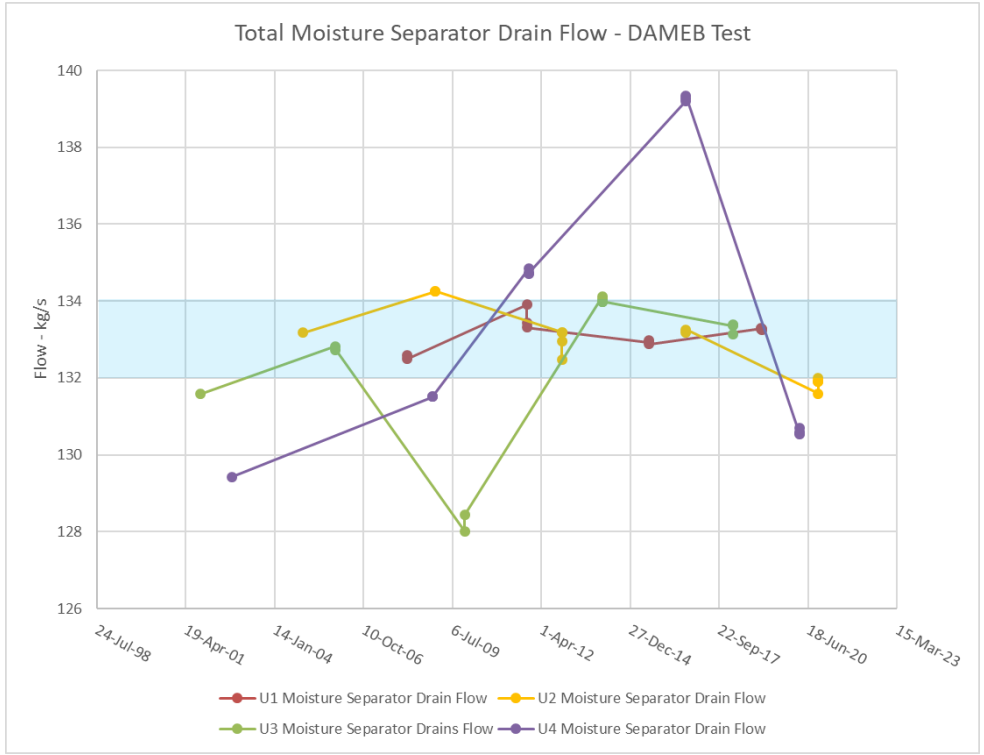


Main Steam Moisture Effects on Secondary Side – PESPE Modelling Study

Main Steam Quality Effects on Secondary System

Case No.	Darlington	OPGPEPSE Runs for Main Steam Quality Effects on MW, Piping Flows							
		Boiler Thermal Power MWth	Turbine Output Mwe	MW Difference from Case 1	Main Steam Quality	Main Steam Enthalpy kJ/kg	Main Steam Flow kg/s	HP Exhaust Steam Quality	Moisture Separator Drain Flow kg/s
1	Reference Case (Acceptance Test on U3 in 1994) Main Steam Quality, MSQ=0.9988 (Moisture=0.12%)	2660.00	930.61	0.00	0.9988	2792.65	1306.402	0.8710	134.14
2	BBC Design Main Steam Quality, MSQ=0.9975 (Moisture=0.25%)	2660.00	930.32	0.29	0.9975	2790.51	1307.831	0.8703	135.01
3	Degradation Main Steam Quality, MSQ=0.9964 (Moisture=0.36%)	2660.00	930.07	0.54	0.9964	2788.71	1309.040	0.8697	135.75
4	Degradation Main Steam Quality, MSQ=0.9950 (Moisture=0.50%)	2660.00	929.76	0.85	0.9950	2786.40	1310.581	0.8689	136.70
5	Degradation Main Steam Quality, MSQ=0.9940 (Moisture=0.60%)	2660.00	929.54	1.07	0.9940	2784.76	1311.685	0.8683	137.38
6	Degradation Main Steam Quality, MSQ=0.9930 (Moisture=0.70%)	2660.00	929.31	1.30	0.9930	2783.12	1312.789	0.8678	138.05
7	Degradation Main Steam Quality, MSQ=0.9920 (Moisture=0.80%)	2660.00	929.09	1.52	0.9920	2781.47	1313.896	0.8673	138.74
8	Degradation Main Steam Quality, MSQ=0.9910 (Moisture=0.90%)	2660.00	928.86	1.75	0.9910	2779.83	1315.005	0.8667	139.42
9	Degradation Main Steam Quality, MSQ=0.9900 (Moisture=1.00%)	2660.00	928.64	1.97	0.9900	2778.19	1316.115	0.8662	140.10

Trend on Moisture Separator Drain Flow – DAMEB Test



MWe Loss – Effects of MS Moisture on Reactor Power Calibration

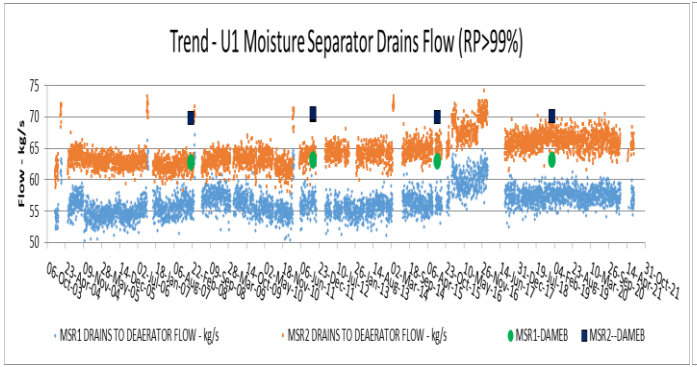
The analysis is based on the U3 TPI data from June 8th, 2020

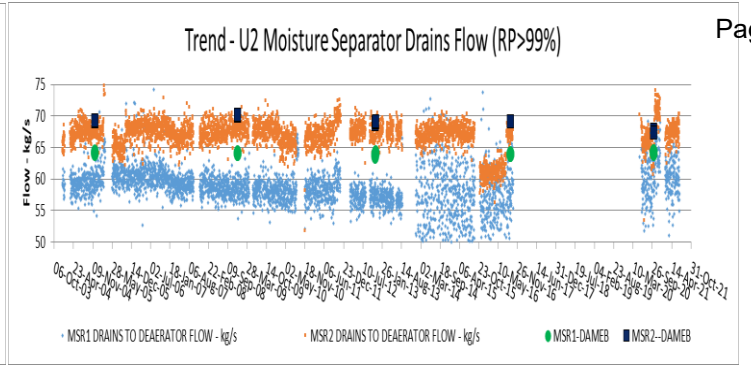
Items	Unit	Existing Moisture	Increased Moisture	Difference
MS Pressure	kPaa	4978.65	4978.65	
MS Moisture	%	0.25	0.5	-0.25
MS Enthalpy	kJ/kg	2790.25	2786.16	4.09
Calculated SG Power	%	99.71	99.51	-0.2
Actual Generation	Mwe			939.68
MW Loss	MWe			-1.9

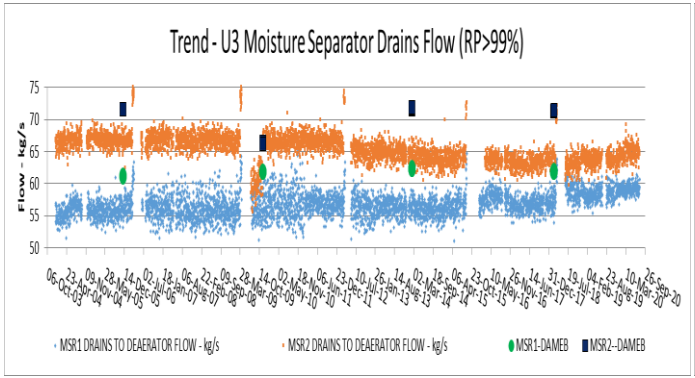
Existing Moisture		6/8/2020 3:02	
Thermal Power Calculations :	***U3***		***Units***
1. Boiler Blow Off Flow (total)	6.66	kg/s	
2. IUFW Flow (total)	5.73	kg/s	
Boiler Powers			
B01	668.91	MWth	
B02	661.87	MWth	
B03	668.68	MWth	
B04	652.89	MWth	
Total Calorimetric Boiler Power	**2652.35**	**MWth**	
% Boiler Power	99.71	%	

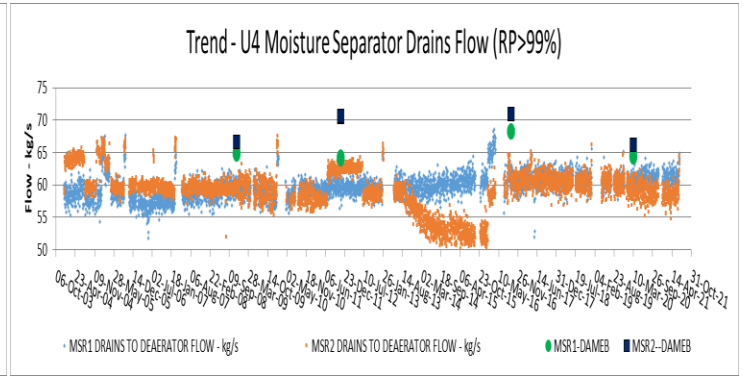
Increased Moisture by 0.25%		6/8/2020 3:02	
Thermal Power Calculations :	***U3***		***Units***
1. Boiler Blow Off Flow (total)	6.66	kg/s	
2. IUFW Flow (total)	5.73	kg/s	
Boiler Powers			
B01	667.58	MWth	
B02	660.55	MWth	
B03	667.34	MWth	
B04	651.58	MWth	
Total Calorimetric Boiler Power	**2647.05**	**MWth**	
% Boiler Power	99.51	%	

Trend on Moisture Separator Drain Flow – PI Data (2004-2021)







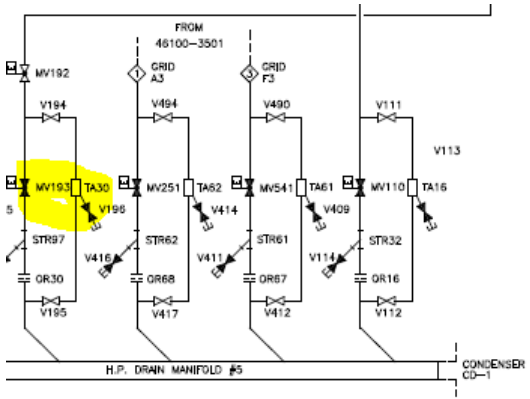


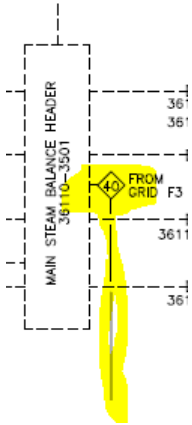
Suspected Increased MS Moisture on Unit 3

3-48500-PV205 spurious opening while U3 at 98% RP

Operation's Observation on March 8, 2020

While U3 was at 98%FP, 3-48500-PV205 was opening every 1.5-2 hours, resulted in a 15-20 MW loss each time for minimum 5 minutes. It doesn't really make sense for such a small power reduction the steam quality would be affected so much that liquid would develop in the balance header required PV205 to operate. It has sporadically been open for months now. At 100% reactor power, it opens at least once every 2 weeks for 5 minutes reviewing the trends.





Determining Main Steam Quality

ASME PTC6, Section 4.19 – Methods of Determining Main Steam Quality

NK38-REP-41000-{146749} – Darlington Unit 3 Turbine Acceptance Test Report

The sodium tracer technique, a solution of sodium nitrate injected into the boiler drum, the sodium is carried over in the steam by the water fraction only.

Table 4

Darlington Unit 3

Main Steam Quality Measurement

October 31, 1994

Unit Load 927 MW

Main Steam Line	Boiler Na Concentration ppb	Steam Na Concentration ppb	Percent Carry Over
L3 (MV3)	254	0.25	0.098
L2 (MV2)	240	0.25	0.104
L1 (MV1)	222	0.27	0.122
L4 (MV4)	208	0.32	0.154
Average	-	-	0.120

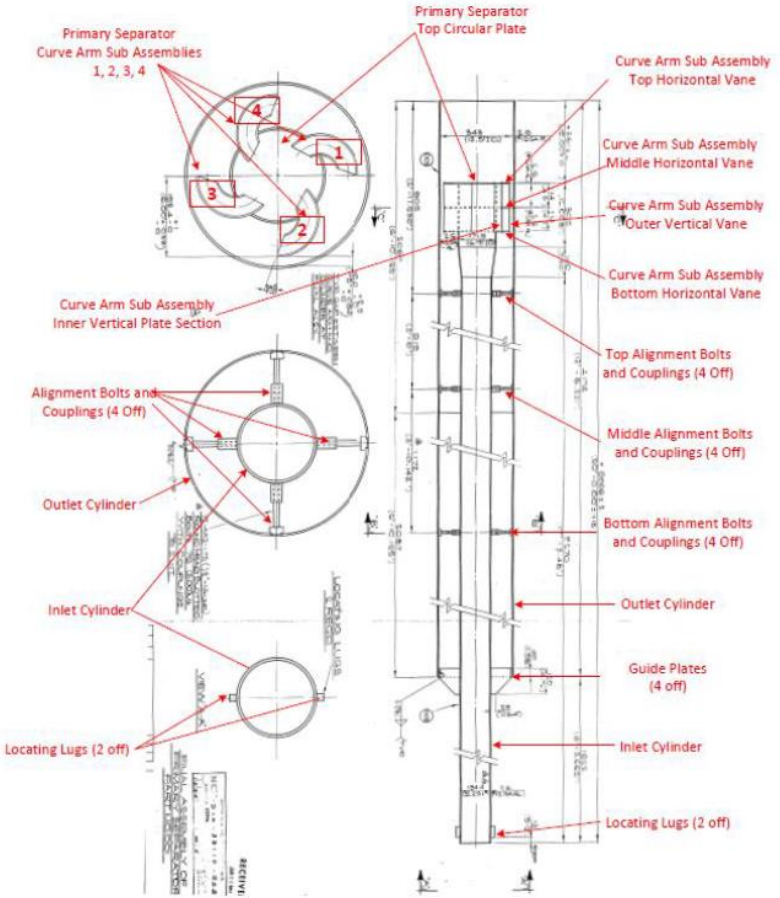
Conclusion and Recommendation

- There were no noticeable changes (steam flow, MSR drains flow etc.) that were detected that could be attributed to a change in steam quality as a result of steam separator degradation.
- Performing steam quality measurements or monitoring specific parameters for long term changes should be explored if feasible.

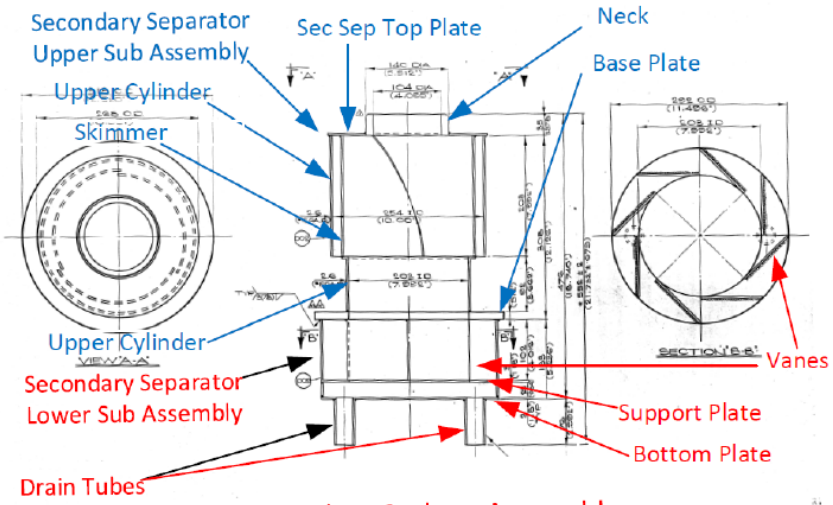
Appendix J

Pictures and Drawings

ONTARIO POWER GENERATION



Primary Separator Parts Labeling



Secondary Cyclone Assesmbly

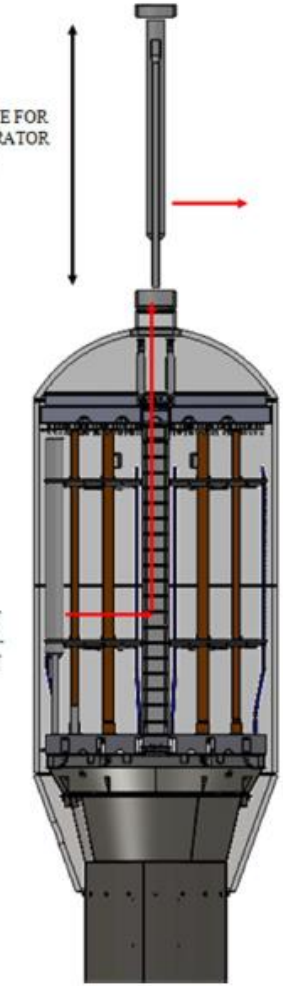


Fig. 4

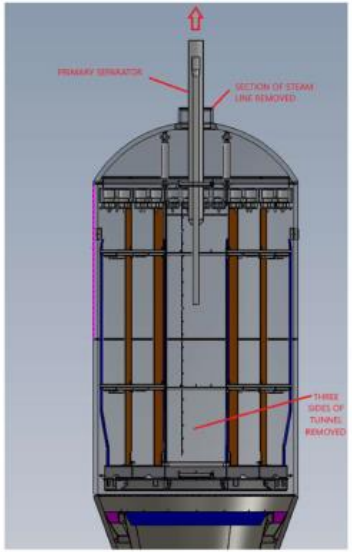


Fig. 5

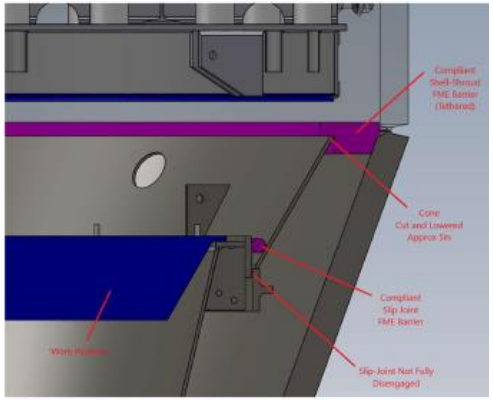


Fig. 6

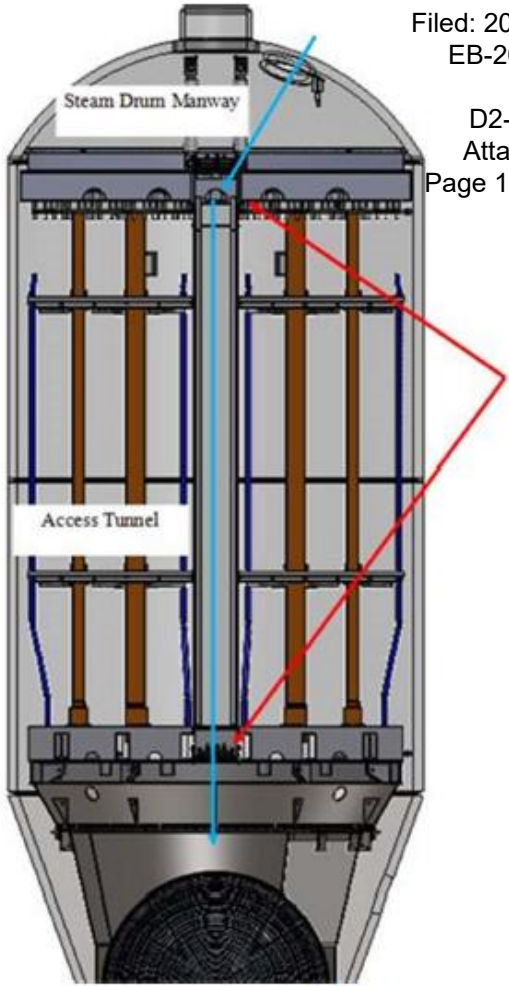


Fig. 7

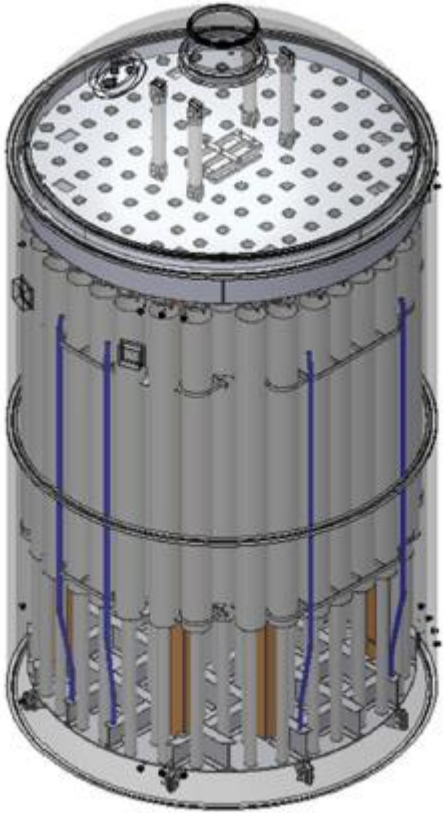


Fig. 1

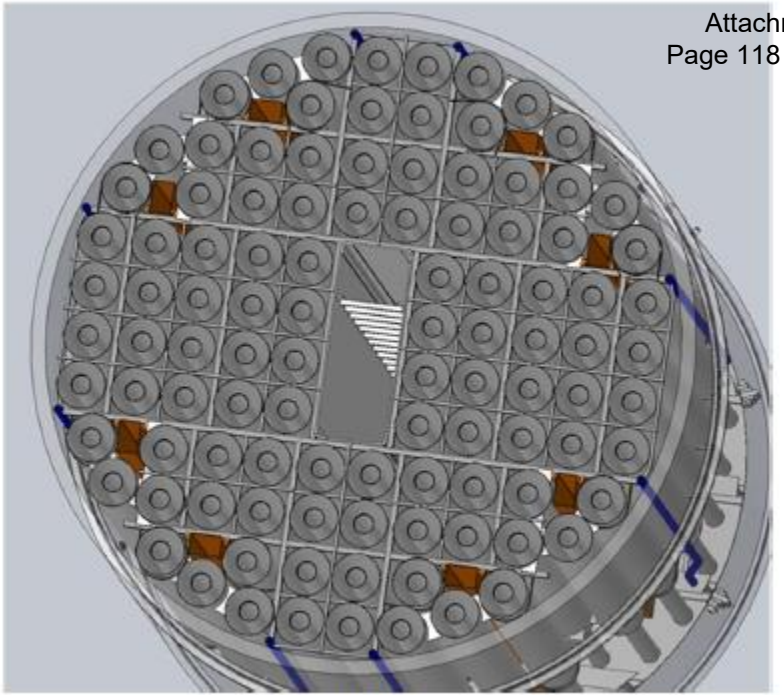
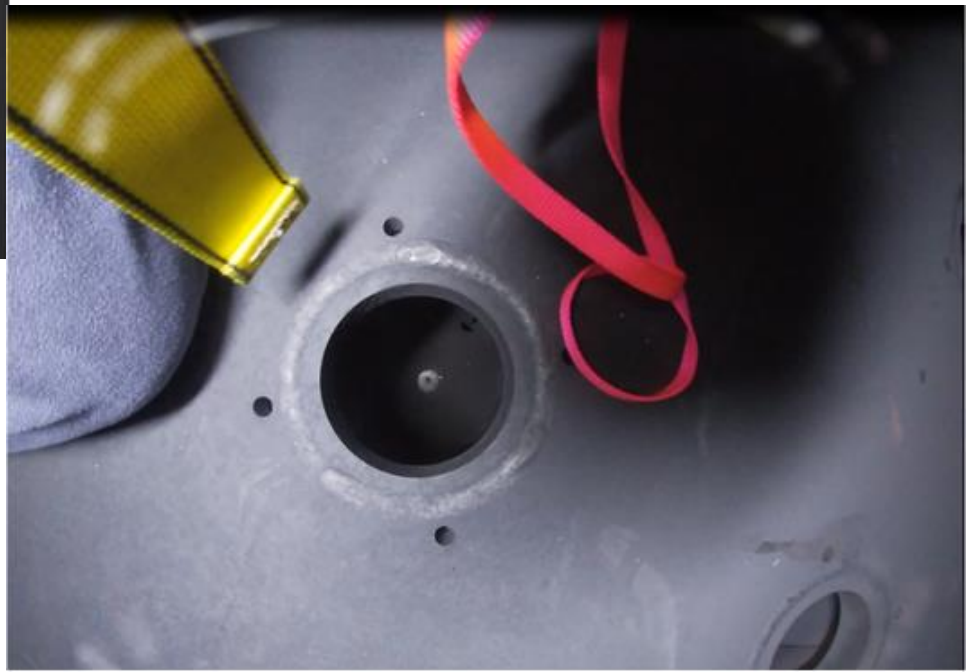
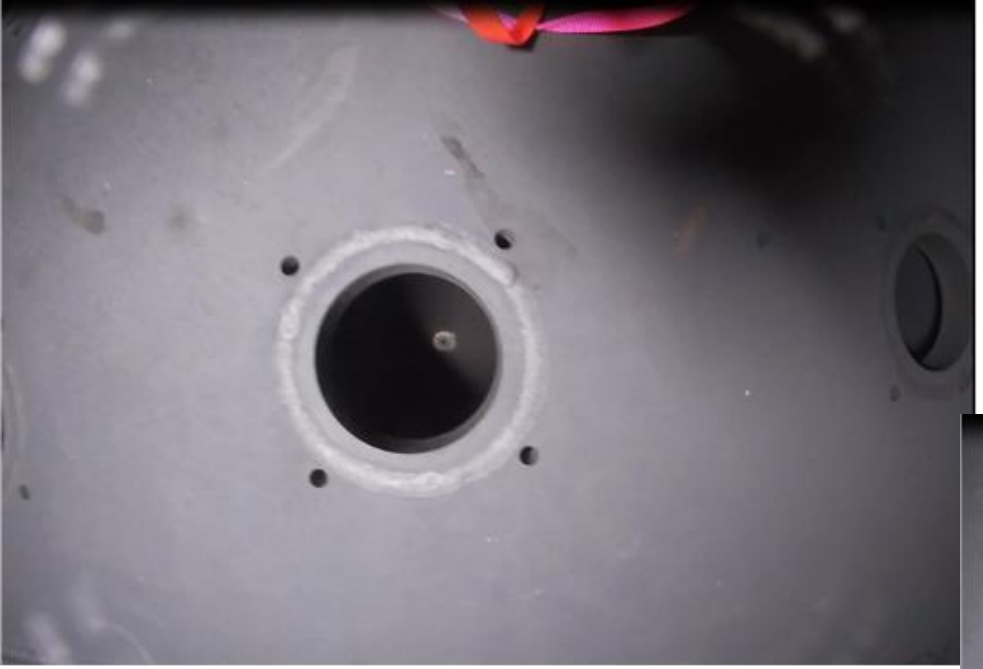


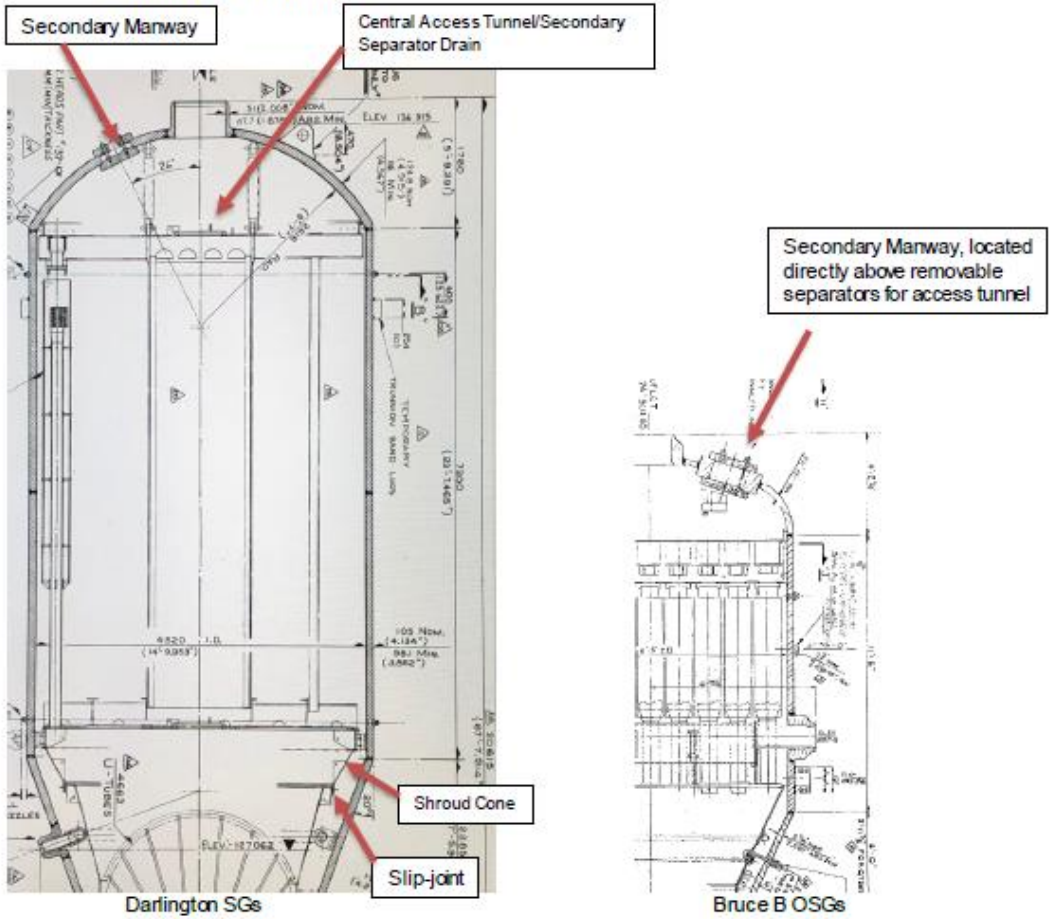
Fig. 2





Filed: 2026-04-22
EB-2025-0297
Exhibit L
D2-Staff-090
Attachment 1
Page 121 of 131

Figure 1: Comparison of Bruce B OSG and Darlington SG Steam Drum Internals
(Shown approximately to scale)



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EB-2025-0297
Exhibit L
D2-Staff-090
Attachment 1
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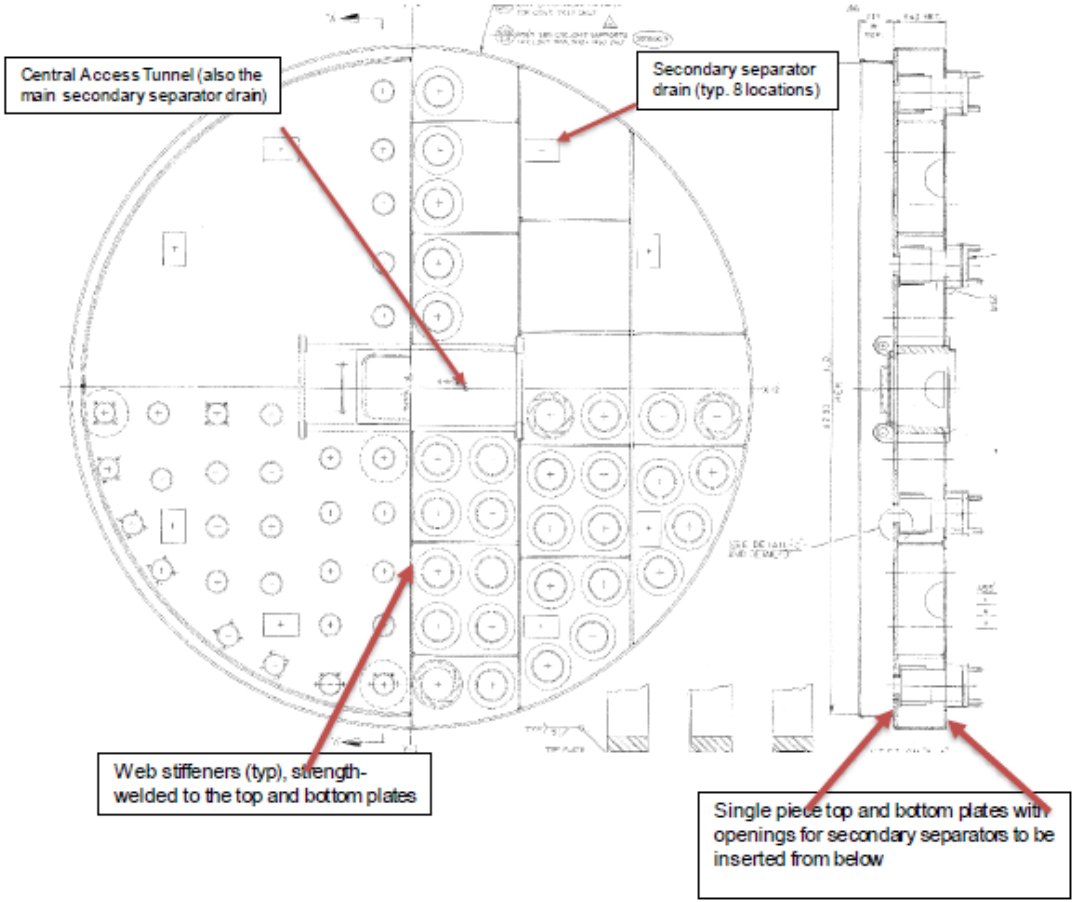
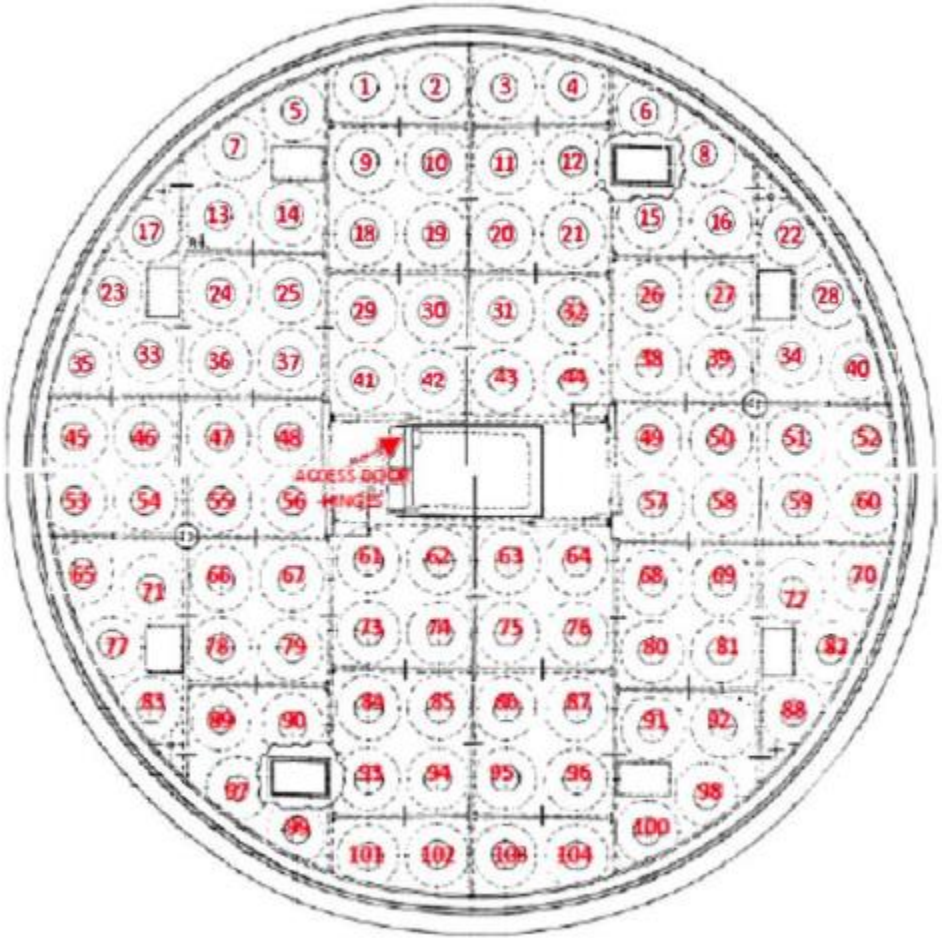
Figure 2: Darlington SG Secondary Separator Deck Arrangement





SECONDARY SEPARATORS NUMBERING

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EB-2025-0297
Exhibit L
D2-Staff-090
Attachment 1
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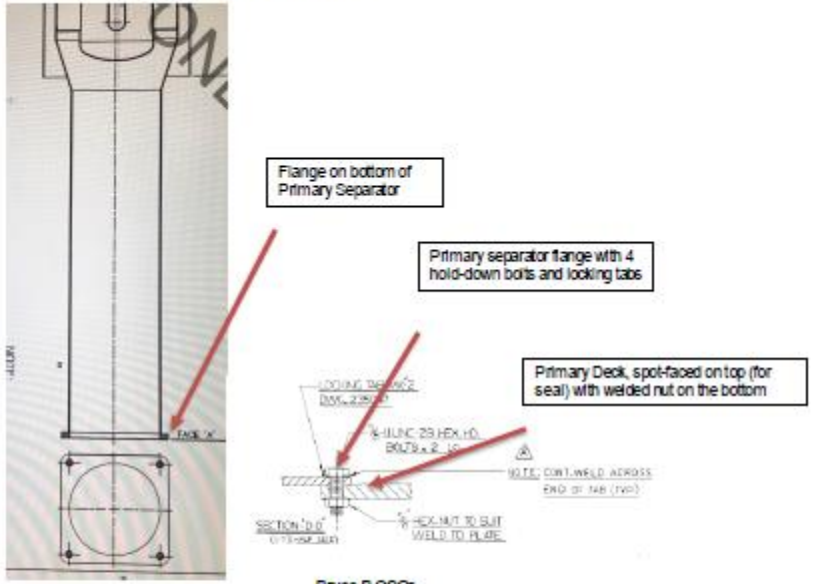
Figure 3: Primary Separator Attachment Configuration



Bruce B OSGs

Darlington SGs

Filed: 2026-04-22
EB-2025-0297
Exhibit L
D2-Staff-090
Attachment 1
Page 125 of 131

Figure 4: Arrangement of Darlington SG Primary Deck (Stiffeners are on top-side of the primary deck)

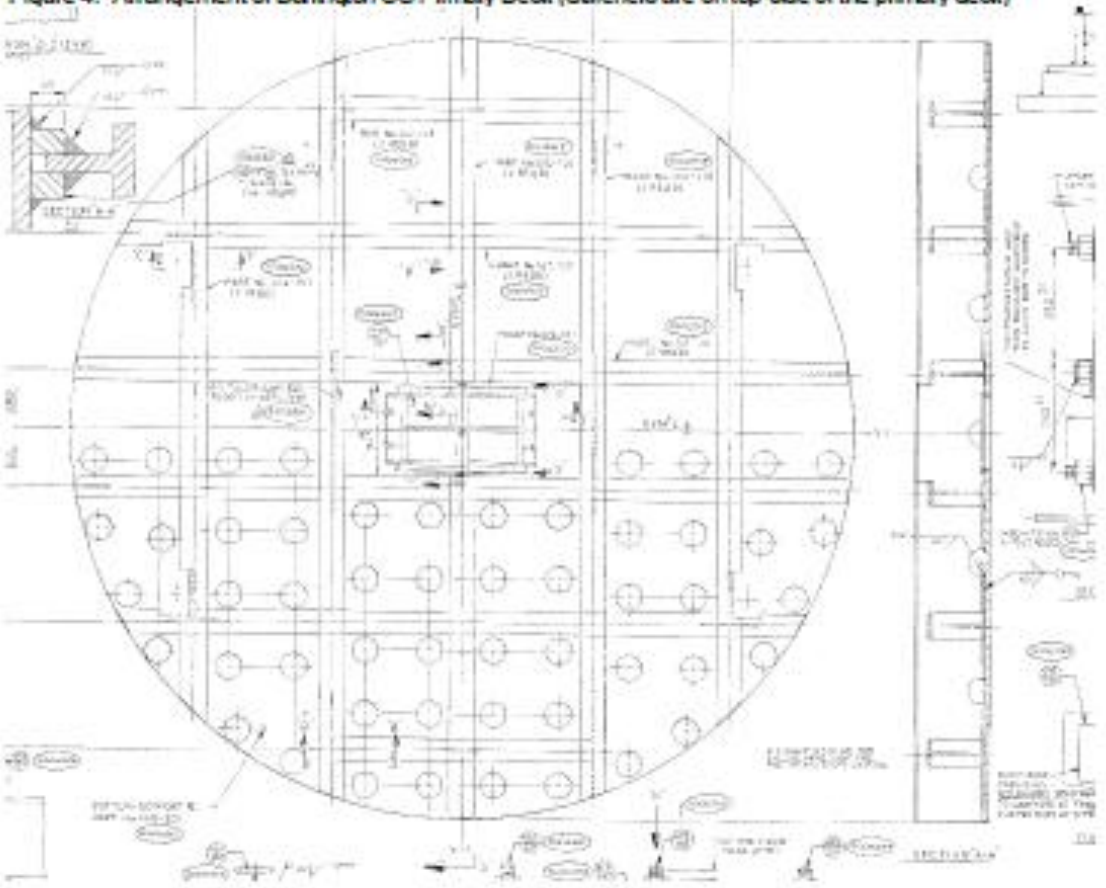
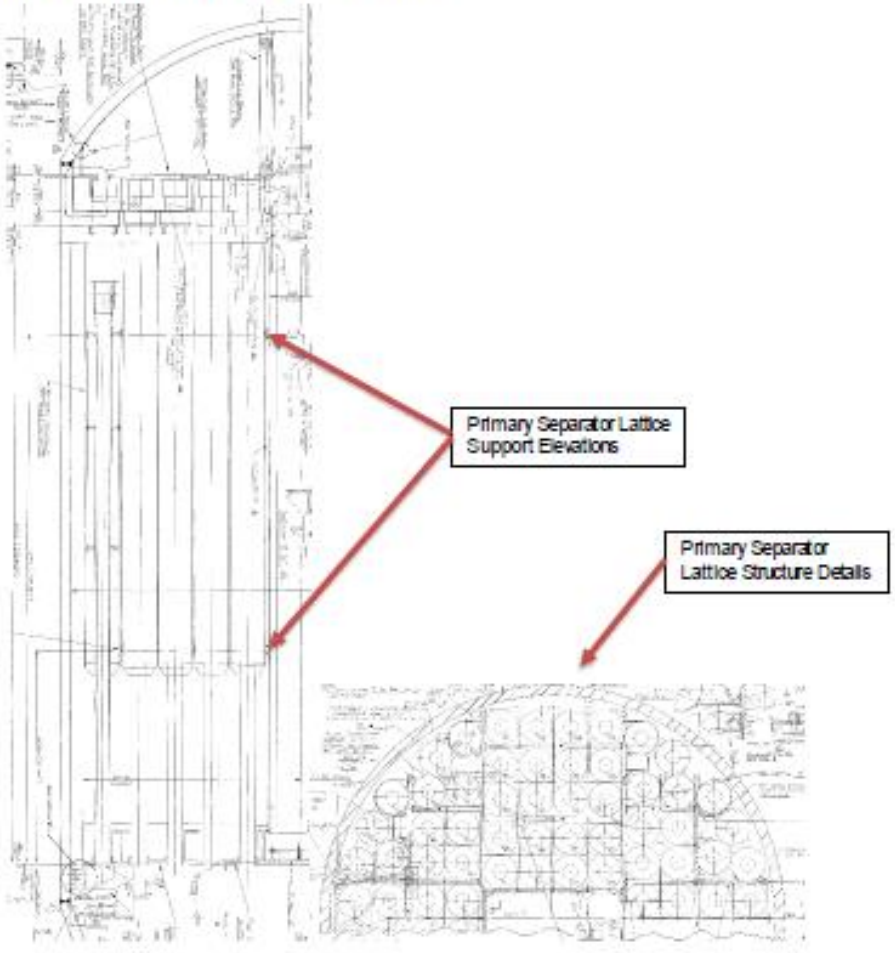


Figure 5: Darlington SG Primary Separator Supports



Filed: 2026-04-22
EB-2025-0297
Exhibit L
D2-Staff-090
Attachment 1
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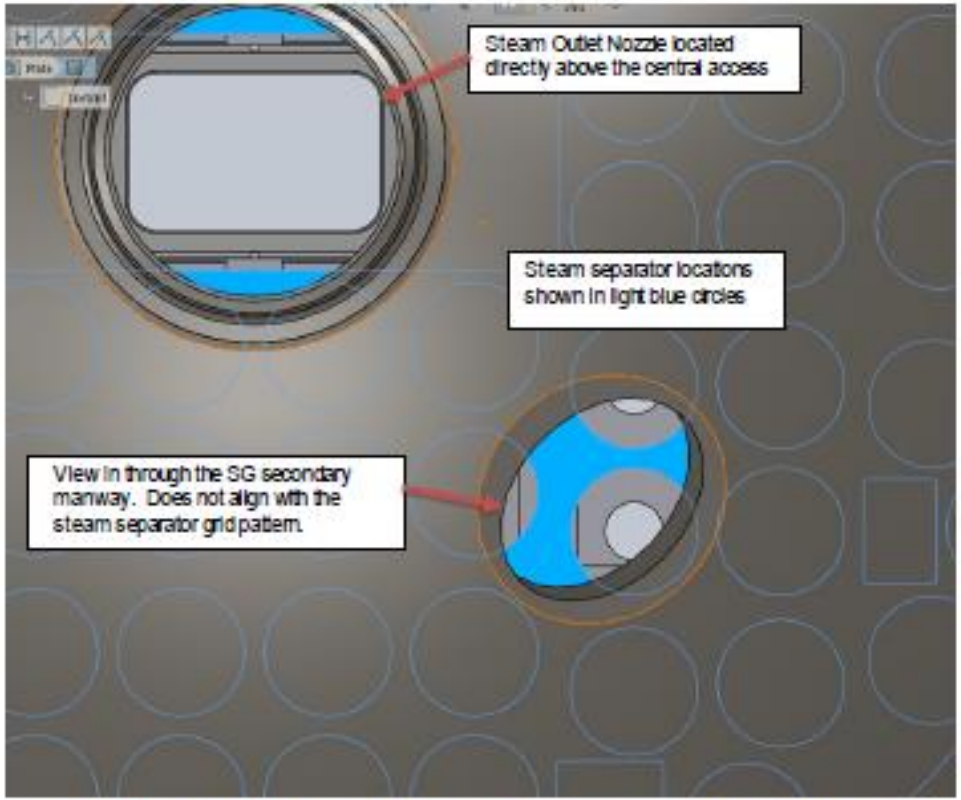
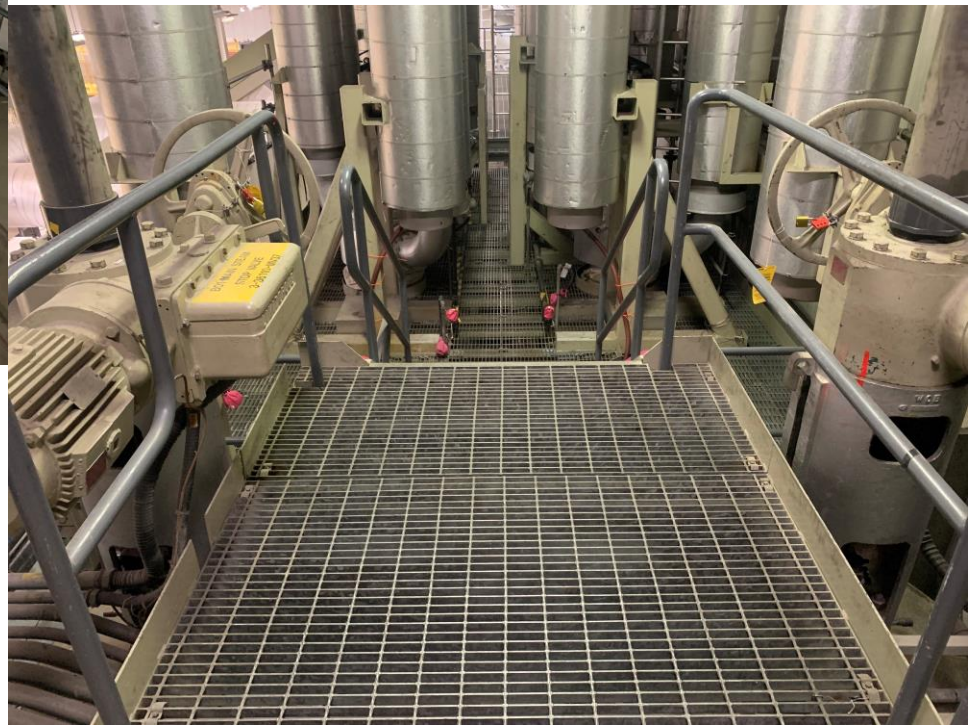
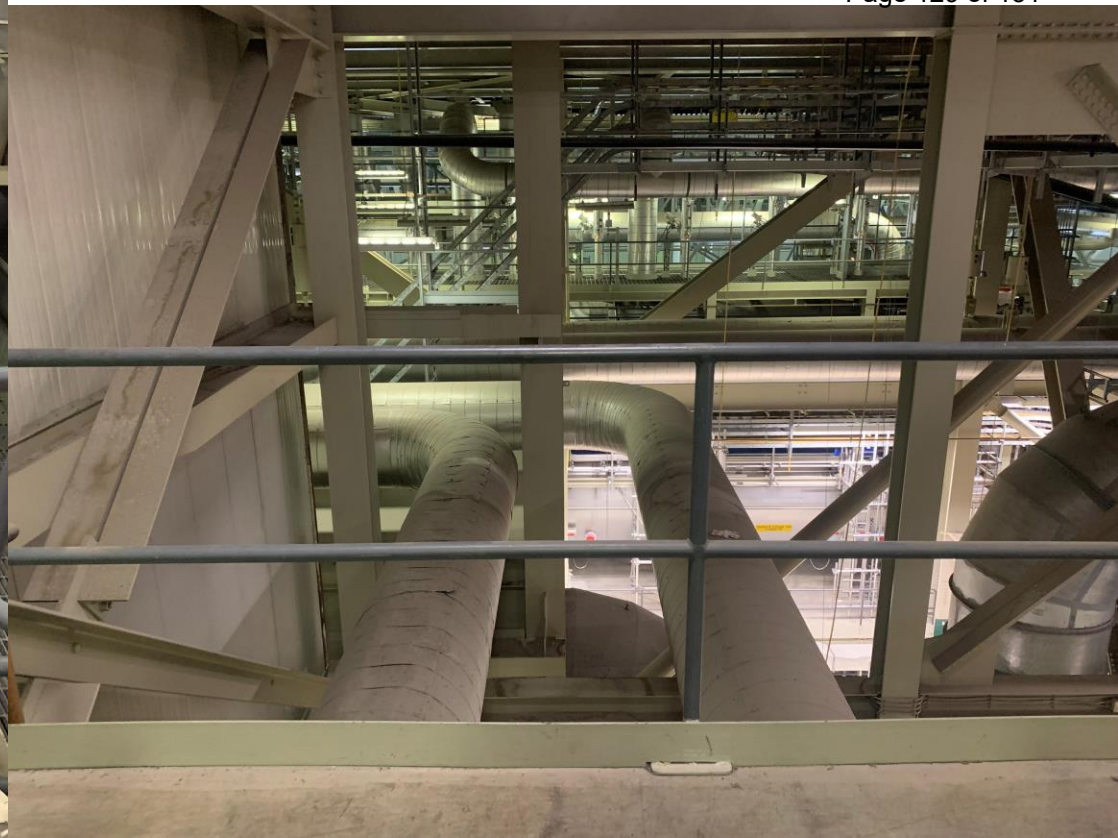
Figure 6: Line-of-Sight Arrangement between Darlington SG Secondary Manway and the Separator Pattern



View is looking straight down onto the steam generator shell from above. View shows access through the steam nozzle if the steam piping were removed.

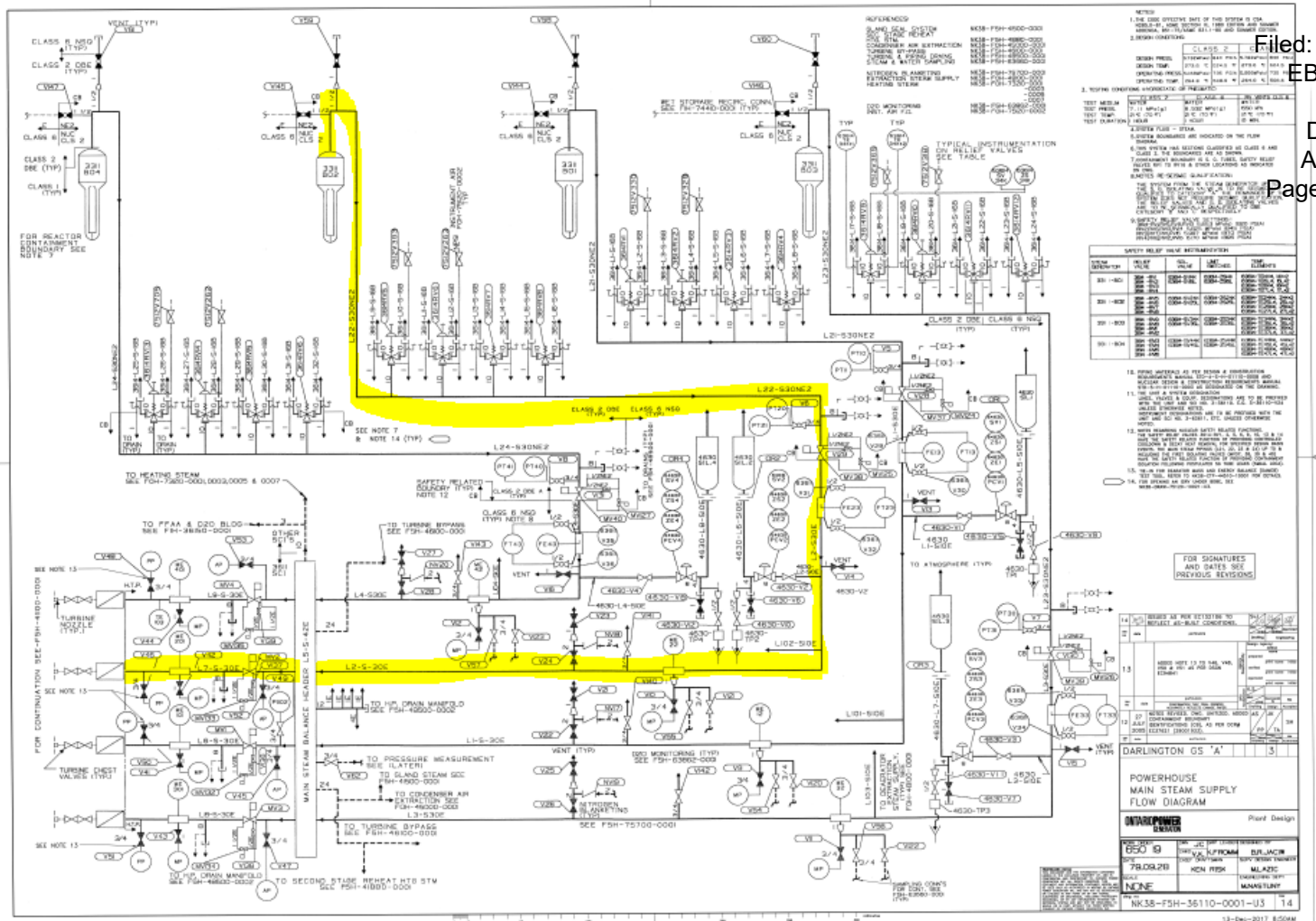




Appendix K

Main Steam Flowsheet

ONTARIO POWER GENERATION


DARLINGTON GS 'A'
POWERHOUSE
MAIN STEAM SUPPLY
FLOW DIAGRAM
Plant Design
NK38-FSH-36110-0001-U3
FOR SIGNATURES AND DATES SEE PREVIOUS REVISIONS
TYPICAL INSTRUMENTATION SEE TABLE
SAFETY RELIEF VALVE INSTRUMENTATION
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Board Staff Interrogatory #091

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 1 / Schedule 3 / Attachment 1 / Tab 45

Preamble:

At Reference 1, OPG states that Project #86910 will replace approximately 14,000 fluorescent lighting fixtures with LED lighting at Darlington at a total project cost of approximately $39.9 million. OPG indicates that annual lighting maintenance costs exceed $1.3 million and identifies a target to reduce annual maintenance costs and energy consumption by 50%.

Question(s):

a) Please confirm whether the stated annual lighting maintenance cost of approximately $1.3 million relates solely to the approximately 14,000 fixtures within the scope of this project.

b) If available, please provide the economic evaluation supporting the project and any sensitivity analysis performed on LED life and failure assumptions.

c) Please explain whether OPG evaluated phased replacement through normal maintenance cycles instead of a concentrated capital program and provide the results of any such evaluation.

Response

a) Confirmed.

b) An economic evaluation and sensitivity analysis were not performed. Project #86910 is a sustaining capital project. As such, an economic evaluation supporting the project is not required.

c) OPG did not evaluate phased replacement through normal maintenance cycles instead of the preferred alternative to replace the remaining LED lights, as phased replacement was not a viable alternative from a safety perspective. As OPG discovered through its regular maintenance program, the rate of fluorescent bulb failure exceeded OPG's ability to replace them, resulting in areas of poor illumination and increasing risk to plant operations and personnel safety. Moreover,

replacement fluorescent lamps/ballasts were not commercially available and conversion from obsolete fluorescent lamps/ballasts to LED fixtures required plant modification.

Board Staff Interrogatory #092

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 1 / Schedule 3 / Table 1c
Ref 2: Exhibit D2 / Tab 1 / Schedule 3 / Attachment 1 / Tab 51

Preamble:

At Reference 1, OPG presents Project #89281 with a total project cost of approximately $350 million and forecast in-service amounts during the IR term. However, at Reference 2, the Business Case Summary (BCS) identifies the total project cost as "TBD."

Question(s):

a) Please clarify the extent to which stator rewind for units 1 through 4 were, at any time, part of the Darlington Refurbishment Program (DRP) scope and $12.8 billion DRP Program budget. If they were not part of the program scope at any time, please explain why.

b) Please reconcile the approximately $350 million total project cost presented in the D2 tables with the "TBD" total project cost shown in the BCS. What is the current approved total project cost for this project?

c) Please identify:
   i. The estimate class associated with the approximately $350 million figure
   ii. The confidence range for that estimate
   iii. The current BCS phase, including whether First Execution BCS approval has been obtained.

d) Please provide a latest BCS if available.

Response

a) The generator stator rewinds for Darlington Unit 1 and 2 were never part of the Darlington Refurbishment Program ("DRP") $12.8B budget and scope. The generator stator rewinds for Darlington Units 3 and 4 were included in the DRP $12.8B budget and scope. Refer to Ex. D2-1-3, pp. 15-16 for an explanation of why Unit 1 and 2 were excluded from the DRP.

b) The $350M total project cost shown at Reference 1 is consistent with the total project cost range of $312M to $420M included in the most recent Gate 2 (Definition Phase) Business Case Summary ("BCS") for the Darlington Unit 1 and 2 Generator Stator Rewind project, which is provided in Attachment 1 (confidential). As per OPG's phase gate process, a total project cost is not required within the Gate 1 (Development) BCS.

c)

i. The estimate class associated with the $350M figure is Class 4 as shown in Attachment 1.

ii. The expected accuracy range for an estimate class is defined as per the Association for the Advancement of Cost Engineering International recommended practice, which is included in Ex. D2-1-1, Attachment 1, p. 2, Figure 1.

iii. Gate 3 (Execution Phase) BCS has not been obtained. The first execution BCS will be obtained upon completion of the current Gate 2 (Definition Phase).

d) The Gate 2 BCS for the Darlington Unit 1 and 2 Generator Stator Rewind project is enclosed as Attachment 1 (confidential).

Business Case Summary

Project #	89281	**BCS Document Number**	NK38-BCS-42100-1677340
Project Title	**89281 - DN STA**TOR REWIND-U1 U2-42100		
Facility	D - DARLINGTON NGD	**Investment Classification**	Sustaining
Project Level (Scalability)	A	**Financial Classification**	17553 - CAPITAL - GENERATING FACILITIES
Release: Gate and Project Phase	G2 - Definition - (Full)	**Target Project Completion Date**	2031-Jan-31
Estimate Class (Current Request)	Class 3	**Estimate Class (Overall Project)**	Class 4

Recommendation

We recommend a release of $286,100 K, including [redacted] of contingency.
This will bring the total released-to-date to $313,102 K, including [redacted] of contingency
The estimated total project cost range is between $312 M and $ 420 M.

This project will rewind the generator stators in Units 1 and 2 of DNGS to ensure safe and efficient operation until the station's end of life. The stator insulation ages due to thermal, electrical, ambient and mechanical factors. Failure of the stators would result in an extended unplanned outage and severely impact Darlington's generating output.

This release will fund;
- Purchasing of a U2 Stator Rewind Kit
- Procurement of equipment and materials for Unit 1 & 2
- OPG & Design Services Provider (DSP) engineering support
- OPG & Vendor project management
- Vendor installation in future U1 and U2 outages

Investment Cash Flows

Project Number	89281 - DN STATOR REWIND-U1 U2-42100					**FAC**	17553 - CAPITAL - GENERATING FACILITIES		
$K	**LT YE last year**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Future**	**Total**
Previous releases	0	7,474	10,094	2,793	6,641				27,002
Currently Requested	0	20,288	44,979	9,000	98,520	25,449	87,583	281	286,100
Total released to date	0	27,762	55,073	11,793	105,161	25,449	87,583	281	313,102
Future required	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Total Project Cost	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Ongoing Costs	0								0

Total OAR Approval	313,102.0

Approvals	**Signatures**	**Date**
The recommendation, including the identified ongoing costs, if any, represents the best option to meet the validated business need.		
Recommended by: Direct Report of Line Approver : Shelley Babin Chief Operations Officer Chief Operations Officer	Shelley Babin	2025-08-28

Business Case Summary

I concur with the business decision as documented in this BCS.		
Finance Approval : **Aida Cipolla** **CFO & CAO**	Aida Cipolla	2025-08-28
I confirm that this investment/project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.		
Line Approval per OAR : **OAR Element : 1.1** **Nicolle Butcher** **President & Chief Executive Officer**	Nicolle Butcher	2025-08-28

EXECUTIVE SUMMARY – Project Overview

The generator stator function is to convert the rotating magnetic field from the rotor into alternating current through its copper windings to generate electricity. Thermal, electrical, ambient, and mechanical stresses contribute to the aging of stator insulation. There is also a risk of damaging the stator core asset if insulation degrades and multiple short-circuiting occurs. Failure of the stators would result in an extended unplanned outage and severely impact Darlington's generating output.

Based on inspections and condition assessments, the Darlington Refurbishment scope included a full stator rewind for Units 3 and 4, while Units 1 and 2 were determined to be at low risk of requiring a rewind to Darlington second end of life. Further outage inspections showed signs of insulation degradation in Unit 1, that resulted in a full re-wedge. Due to the same design, operating conditions and age, there is also a concern that insulation issues will also develop in Unit 2. In addition, particulate issues originating from the copper hollow conductors have led to cooling flow problems in both units. As a result of these indications and aging mechanisms, OPG has determined that the generator stators in Unit 1 and Unit 2 have reached end of life and will require an in-situ rewind to ensure their continued viability through to the end of commercial operations in 2055. An in-situ rewind was not an option at the time of scoping Unit 1 and Unit 2 for refurbishment as [redacted] was unable to provide this procedure. However, [redacted] and was able to provide different recommendations such as in-situ stator rewinds. Unit 1 and Unit 2 will require an in-situ rewind to ensure their continued viability through to the end of commercial operations in 2055. This scope was previously performed in U3 and U4 and the project is leveraging lessons learned to derisk the overall execution.

Project Status:
The previous Development Phase release (Gate 1) funded the purchase of the U1 Stator Rewind Kit with the Original Equipment Manufacturer. It also funded OPG project management, and preliminary engineering efforts.

This Definition Phase release (Gate 2) will cover the cost required to purchase the second stator rewind kit for U2, complete the remainder of the purchase of materials required, as well as any engineering and installation planning required. OPG design engineering will provide oversight to the Design Services Provider (DSP) as there are no changes to the technical requirements (like-for-like).

Future releases will include:
The Execution Phase release (Gate 3) will fund the installation for Units 1 and 2, commissioning and project close out.

Key project risk includes:
The primary risk to the project is the possibility that the stator rewind kit may not be delivered before the start of the D2811 outage, which could delay project execution beyond 2028. To mitigate this risk, the Major Components group is evaluating whether the outage window start date can be adjusted. Meanwhile, the project team is actively working with the vendor to expedite delivery of the stator rewind kit, which is currently scheduled for February 2028.

Business Need

For Project Level A or B

Thermal, electrical, ambient, and mechanical stresses contribute to the aging of stator insulation. There is a risk of damaging the stator core asset if insulation degrades and multiple short-circuiting occurs. Failure of the stators would result in an extended unplanned outage and severely impact Darlington's generating output.

Loose end wedges and slot exits in the stator windings of DNGS generators can lead to degradation and potential failures. Thermal, electrical, ambient, and mechanical stresses contribute to the aging of stator insulation, with specific failure mechanisms including abrasion near slot exits, which can cause flashover or damage to insulation and anti-corona paint. These flashovers could lead to potential explosions if they encounter low-purity hydrogen. While the likelihood of such an event is very low, the consequences of a hydrogen gas explosion would be severe. There is also a risk of damaging the stator core asset if insulation degrades and multiple flashovers occur, rendering it unusable.

In addition, Operational issues such as copper oxide buildup in the stator cooling water system can also reduce cooling efficiency, necessitating frequent filter replacements and potential chemical cleanings, thereby increasing maintenance complexity and costs. There is a chance of significant losses resulting from a forced outage due to generator burnout. If burnout occurs, OPG would need to rewind the windings as a reactive measure as opposed to the recommended preventative measure, which may result in the units being offline for a significant period. The reactive measure is also not ideal as it could potentially damage the equipment even further.

Outage inspections showed signs of insulation degradation in Unit 1, that resulted in a full re-wedge. Due to the same design, operating conditions and age, there is also a concern that insulation issues will also develop in Unit 2. In addition, particulate issues originating from the copper hollow conductors have led to cooling flow problems in both units. As a result of these indications and aging mechanisms, OPG has determined that the generator stators in Unit 1 and Unit 2 have reached end of life and will require an in-situ rewind to ensure their continued viability through to the end of commercial operations in 2055.

Market analysis indicates unprecedented growth in global demand for turbine stators due to rising electrical demand. The global demand is fueling cost escalation and long lead times for turbine stators resulting in premium pricing.

Preferred Alternative:	Overhaul Unit 1 & Unit 2 Stator	For Project Level A, B or C

Description of Preferred Alternative

The preferred alternative is to rewind the U1 & U2 stators during future planned outages, currently planned for D2811 and D3021 (respectively). This scope was previously performed in U3 and U4 and the project is leveraging lessons learned to derisk the overall execution.

The rewinding will allow for high voltage testing to detect any aging or defects, and a new wedge design will be implemented. The new design allows for tightening without removing the outer wedges, representing an improvement over the previous design, which required outer wedge removal to access and tighten the inner wedges. Additionally, the process will replace copper hollow conductors with stainless steel ones, which is expected to eliminate the need for chemical cleanings and lower maintenance costs related to filter and strainer replacements. As a result, the Unit 1 and Unit 2 generators will benefit from renewed stator life, enabling reliable operation through to the station’s end of life with minimal risk of burnout.

Deliverables:

Previous Release:

Deliverable Type	*Milestones*	*Associated Milestones (if any):*	*Target Date*
BCS for Gate 1 OAR Approved	Gate G1 Approval	89281M0010	2025-02-28

Current Release:

Deliverable Type	*Milestones*	*Associated Milestones (if any):*	*Target Date*
BCS for Gate 2 OAR Approved	Gate G2 Approval	89281M0030	2025-09-15
Preliminary Design Complete	Preliminary Design Complete	89281M0020	2025-09-15
Long Lead Materials Identified	LLM_Contract Awarded PO Issued	89281M0160	2025-09-15
Detailed Design Complete	Detailed Design Complete	89281M0120	2026-07-15

Future Release:			
Deliverable Type	*Milestones*	*Associated Milestones (if any):*	*Target Date*
BCS for Gate 3 OAR Approved	Gate G3 Approval	89281M0110	2026-06-30
Start of Installation (SOI) Unit 1	Start of Installation	89281M0380	2028-01-10
Available for Service (AFS) Unit 1	Available for Service and/or Ready For Service Completed	89281M0350	2028-05-09
Start of Installation (SOI) Unit 2	Start of Installation	89281M0300	2030-01-10
Available for Service (AFS) Unit 2	Available for Service and/or Ready For Service Completed	89281M0400	2030-05-09
Project Closeout	Project Close Out Completed	89281M0360	2031-12-31

Alternative 2:	**Base Case - No Project**	For Project Level A, B or Value-Enhancing

Not Recommended:
This alternative is not recommended as loose end wedges and slot exits in the stator windings of DNGS generators can lead to degradation and potential failures. Thermal, electrical, ambient, and mechanical stresses contribute to the aging of stator insulation, with specific failure mechanisms including abrasion near slot exits, which can cause flashover or damage to insulation and anti-corona paint. These flashovers could lead to potential explosions if they encounter low-purity hydrogen. While the likelihood of such an event is very low, the consequences of a hydrogen gas explosion would be severe. There is also a risk of damaging the stator core asset if insulation degrades and multiple flashovers occur, rendering it unusable. In addition to this large potential financial impact, Stator Cooling Water (SCW) filters could regularly become clogged prior to cleaning, leading to increased costs to address these issues. There is a chance of significant losses resulting from a forced outage due to generator burnout. If burnout occurs, OPG would need to rewind the windings as a reactive measure as opposed to the recommended preventative measure, which may result in the units being offline for a significant period. The reactive measure is also not ideal as it could potentially damage the equipment even further.

Alternative 3:	**Delay Work**	For Project Level A, B or Value-Enhancing

Not Recommended:
Delaying the rewind increases the likelihood of further insulation deterioration, which could result in a stator ground fault and unit trip. Operational issues such as copper oxide buildup in the stator cooling water system can also reduce cooling efficiency, necessitating frequent filter replacements and potential chemical cleanings, thereby increasing maintenance complexity and costs. A forced outage caused by stator failure could lead to financial losses of approximately $2 million per day, further compounded by potential delays in sourcing new stator bars and assembling a qualified installation crew on short notice. To mitigate some of the risks associated with delaying the scope into D3111, proactive measures must be taken such as: reinstating partial discharge data collection every 6 months, monitoring stator cooling water flow and temperature trends, and ensuring readiness for online and offline chemical cleaning. Market analysis indicates unprecedented growth in global demand for turbine stators due to rising electrical demand. The global demand is fuelling cost escalation and long lead times for turbine stators resulting in premium pricing.

Alternative 4:		For Project Level A, B

N/A

Business Case Summary

Key Risk Assessment			For Project Level A, B or C
Risk Class	**Description of Risk**	**Response Type / Actions / Final TCD**	**Residual Ranking**
Project Management	OEM has indicated that they may not be able to deliver the stator rewind kit to meet OPG's outage milestone	Mitigate Major Components is doing evaluations to determine if we can adjust the outage window start time. In the meantime, working with the vendor to improve the delivery date and working towards executing in D2811. Also, explored storage options until next outage (D3111) at additional costs. 6/30/2026	Medium
Project Management	Execution schedule may extend beyond allowable outage maintenance window leading to potential for outage schedule extension or execution schedule compression	Mitigate 71437 - Advance subsequent unit procurement planning and schedule activities prior to next contract release 6/30/2026	Medium
Project Management	Detailed schedule integration not fully developed as there could be a potential schedule and resource issue due to overlap of the generator stator rewind project and the turbine spindle replacement project	Mitigate 71438 -Advance subsequent unit procurement planning and schedule activities prior to next contract release 6/30/2026	Low

Financial Evaluation		For Project Level A, B (with multiple feasible alternatives) or Value-Enhancing			
$K	**Alternative**	**Base Case (No Project)**	**Delay Work**	**Alternative 4**	**Alternative 5**
N/A					
Analysis of Financial Evaluation – Key Assumptions and Key Results:					
Financial Evaluation is not required for Sustaining Projects					

Post Implementation Review (PIR) Plan (refer to OPG-GUID-00120-0007)				
Is PIR Required?	Yes		**PIR Completion Date**	2032-01-31
PIR KPI's	**Current Baseline**	**Target Result**	**How to Measure?**	**Who will measure?**
To be developed for Execution Phase (Gate 3)				

Business Case Summary

APPENDICES

Appendix A1: Summary of Estimate

Project Number	89281 - DN STATOR REWIND-U1 U2-42100						FAC	17553 - CAPITAL - GENERATING FACILITIES		
$K	LT YE last year	2025	2026	2027	2028	2029	2030	Future	Total	%
0 - Cost Management		150	263						413	0
1 - Project Management	[redacted]									
2 - Inspection										
3 - Engineering										
4 - Procurement										
5 - Construction										
6 - Commissioning										
Closeout										
Subtotal										
Outside WBS										
Contingency										
Subtotal w/ Contingency										
Interest										
Other										
Total		27,762	55,073	11,793	105,161	25,449	87,583	281	313,102	100
Removal Costs (incl. above)										0

Appendix A2: Summary of Estimate – Notes

Escalation Rate	2.93	Interest Rate (going-forward)	4.67

Appendix A3: Summary of Estimate - In-Service Estimates

$K	Only applicable to capital projects. In-Service amount shall include interest but exclude removal costs.			
Project#	**Date**	**Description**	**Amount**	**%**
89759				
		Total:		

Prepared by		Reviewed and Endorsed by (Execution Authority)	
Archun Aranan Project Leader TG Projects 6.2.1	2025-08-18	Subo Sinnathamby Chief Projects Officer Enterprise Projects	2025-08-26

Board Staff Interrogatory #093

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 1 / Schedule 3 / Attachment 1 / Tab 49

Preamble:

At Reference 1, OPG states that stress corrosion cracking has been detected in low-pressure (LP) rotors of all Darlington units and that engineering projections indicate rotor replacement will be required prior to station end of life. OPG also states that advancement of LP replacements is not technically necessary based on crack projections but is being pursued to mitigate supply chain and manufacturing risks. The preferred alternative includes replacement of both LP and high-pressure (HP) turbines and acquisition of a spare LP rotor.

Question(s):

a) Please clarify the extent to which the Darlington Turbine Rotors Replacement was, at any time, part of the Darlington Refurbishment Program (DRP) scope and $12.8 billion DRP budget. If it was not part of the program scope at any time, please explain why.

b) Please provide the projected year in which each LP rotor would reach critical crack depth based on current crack growth models and quantify the safety margin remaining relative to the planned replacement outages.

c) Given that advancement of LP replacements is stated to be not technically necessary, please quantify to the extent possible:
   i. The expected cost impact of deferring procurement by five years to the next IR term 2032-2036.
   ii. The probability-weighted schedule delay risk associated with not securing original equipment manufacturing slots at this time.

d) For the HP turbines, please provide:
   i. The incremental capital cost attributable to inclusion of HP turbine replacement.
   ii. The standalone economic analysis supporting HP replacement (including next present value (NPV) and assumptions underlying the ~$70/MWh levelized cost of energy (LCOE) estimate).
   iii. Confirmation of whether the incremental 21.6 Mwe per unit is reflected in forecast production or revenue assumptions.

e) Please provide a summary of any internal trending or engineering reports relating to the turbine rotors that were presented at any engineering or site management meetings form the 2017 to 2025.

Response

a) Turbine rotor replacements were never part of the Darlington Refurbishment Program ("DRP") $12.8B budget and scope. Inspections of the Low-Pressure ("LP") turbine rotors prior to unit refurbishments did not identify any concerning trends indicating stress corrosion cracking ("SCC") and the need for this emergent work was established subsequently, as discussed in Ex. D2-1-3, pp. 16-17.

b) Chart 1 provides the safety margin relative to planned replacement outages in the last column, along with other pertinent information below. OPG has not projected the year in which each LP rotor would reach critical crack depth ("CCD") as there is insufficient inspection data available to develop this projection. To develop certain information in Chart 1, OPG has assumed an estimated crack growth rate of 1 mm per year based on industry operating experience ("OPEX").

In addition to the safety margin to CCD at replacement outage, Chart 1 shows, for each Darlington unit, the maximum repairable crack depth ("MRCD"), beyond which remedial machining is not an allowable repair strategy per the original equipment manufacturer ("OEM"); the repair margin consumed as of the inspection during the DRP; the planned replacement outage year, which reflects the earliest possible planned outage to execute the work; the projected crack depth at replacement outage; the projected repair margin at replacement outage; and, the CCD, which was assessed by an industry expert, and represents the depth at which the turbine will likely catastrophically fail.

Crack repair can be performed with remedial machining; however, this consumes repair margin in relation to MRCD. When the repair margin exceeds the MRCD, the OEM recommends that the turbine be replaced, although the equipment is expected to remain operable for a limited period of time.

Chart 1
LP Turbine Crack Depth Information by Unit

Unit	Max. Repairable Crack Depth (mm)	Repair Margin Consumed at DRP Inspection (mm)	Planned Replacement Outage Year	Projected Crack Depth at Replacement Outage (mm)	Projected Repair Margin at Replacement Outage (mm)	Critical Crack Depth (mm)	Projected Safety Margin to CCD at Replacement Outage (mm)
(a)	(b)	(c)	(d)	(e)	(f) = (b) – (c) – (e)	(g)	(h) = (g) – (c) – (e)
1	10	3.5	2031	7	-0.5	26	15.5
2	10	2.5	2030	9	-1.5	26	14.5
3	10	3	2029	5	2	26	18
4	10	2	2032	6	2	26	18

c) OPG has not quantified the cost impact of deferring procurement to the following IR term or calculated the probability-weighted schedule delay risk associated with not securing the manufacturing slots given the technical necessity of replacing the LP turbines at the earliest possible planned outage, as discussed in part b).

Contrary to the premise of the question, OPG has indicated that there is a technical need for the work to be done, and for that work to occur during planned outages during the IR term, as discussed in Ex. D2-1-3, pp. 16-17, and in the Business Case Summary ("BCS") at Ex. D2-1-3, Attachment 1, Tab 49. The statement at page 5 of the BCS "Advancement of the LP Replacements is not necessary (based on crack projections for each unit)," refers to an option that was explored previously to advance this work to an earlier planned outage in relation to the current plan. However, procurement timelines did not support this option, and it was not pursued further.

d)

i. The incremental capital cost attributable to inclusion of HP turbine replacement is $360M, which represents 14% of the estimated total project cost.

ii. Chart 2 provides the assumptions underpinning the $70/MWh levelized cost of energy ("LCOE") estimate for high pressure ("HP") turbines.

Chart 2
HP Turbine LCOE Estimate Assumptions

Item	Assumption
1	Unit 1 In-Service Date of June 2031 Unit 2 In-Service Date of December 2030 Unit 3 In-Service Date of December 2029 Unit 4 In-Service Date of June 2032 Refer to Ex. D2-1-3, Table 1c, line 51
2	Capacity factor of 88% Refer to EB-2016-0152, Ex. D2-2-8, Attachment 1, p. 17
3	Capital cost of HP turbines $360M
4	Incremental capacity for HP turbine MW/unit is 12.2 MWe Refer to Ex. D2-1-3 Attachment 1, Tab 49 p.3
5	Assumed 30-year service life for each unit
6	Tax rate is 25% Refer to Ex. F4-2-1 Table 3d, line 33
7	8% CCA rate
8	7% discount rate
9	Escalation rate is 2%

iii. Confirmed. The incremental 21.6 MWe is the total increase for each unit from both the LP and HP turbines and is reflected in the forecast production and revenue projections during the IR term.

e) Chart 3 provides a summary of engineering reports relating to the turbine rotors that were presented at engineering or site management meetings between 2017-2025.

Chart 3
Summary of Key Turbine Rotor Reports Presented at Engineering or Site Management Meetings 2017-2025

Year	Details/Summary
2017	A report prepared by the OEM identifying the crack issue and repair considerations.
2018	Analysis established generic SCC propagation mechanisms.
2024	OEM feasibility study assessed four options (LP like-for-like; LP+HP; LP uprate; LP+HP uprate). OEM confirmed like-for-like not feasible due to manufacturing limitations (original configuration/weight).

Board Staff Interrogatory #094

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 1 / Schedule 3 / Attachment 1 / Tab 52

Preamble:

At Reference 1, OPG proposes a full secondary side chemical cleaning of Darlington steam generators at an estimated total project cost of $77.9 million (range $60 million–$90 million), including a pilot in Unit 3 prior to full implementation. OPG states that sludge and deposits have accumulated despite routine water lancing and that cleaning is required to preserve long-term fitness-for-service.

Question(s):

a) Please clarify the extent to which Darlington Steam Generator Soft Chemical Cleaning project was, at any time, part of the Darlington Refurbishment Program (DRP) scope and $12.8 billion DRP budget. If it was not part of the program scope at any time, please explain why.

b) Please quantify the current extent of sludge and deposit accumulation for each unit and provide the projected year at which fitness-for-service limits would be approached without chemical cleaning.

c) Provide the historical trend in deposit accumulation and explain, with quantitative support, why continued water lancing is insufficient to maintain long-term performance.

d) Provide the anticipated corrosion allowance and expected material loss associated with the soft chemical cleaning process and identify any benchmarking from comparable units demonstrating long-term integrity impacts.

e) What improvement to the level of estimate accuracy does OPG expect the Unit 3 pilot will provide?

Response

a) The Darlington Steam Generator (“SG”) Soft Chemical Cleaning project was never part of the Darlington Refurbishment Program (“DRP”) $12.8B RQE budget and scope.

b) As discussed in Ex. D2-1-3, Attachment 1, Tab 52, p. 2, the Darlington SGs were not replaced during refurbishment and are expected to safely, reliably, and economically perform their design function for the next 30 years post-refurbishment. The project is being done proactively following the first available outage after refurbishment to reduce deposit build up and enhance the performance and life of the SGs.

c) There is no method available to quantify current sludge loading on boilers in a unit that is online. As a result, the year at which fitness-for-service limits would be approached without chemical cleaning cannot be projected. Most of the sludge transport typically happens during a unit restart evolution when corrosion products from the secondary side get transported to the boiler. Sludge amounts are expected in every outage based on past inspections and the results of waterlancing campaigns.

The historical trends of sludge and deposit accumulation have been relatively consistent in all Darlington units, in the range of 15-25 kilograms per outage.

Waterlancing is insufficient to maintain long-term SG performance as it is limited to the immediate area at the top of the tubesheet. Waterlancing does not access all other areas of the steam generator (e.g., tube surfaces, supports, support crevices, preheater region, and all upper bundle regions). Waterlancing also is not fully effective at removing hard sludge, which poses a higher risk of tube stress corrosion cracking and denting in the centre of the tube bundle. The soft chemical clean accesses the complete boiler and therefore better mitigates regions inaccessible to waterlancing. Waterlancing and chemical cleaning are complimentary activities, and both are identified in the Major Component Steam Generator life cycle plan. While the limitations of waterlancing are understood qualitatively as described above, such limitations cannot be easily translated into quantitative data to support why waterlancing is insufficient on its own.

d) The laboratory tests performed on Darlington materials of construction as a part of the qualification of the chemical cleaning prior to field execution measured an average carbon steel corrosion of 50 micrometer and negligible (i.e., less than 0.1) micrometer corrosion of tubing and stainless-steel support structures. Over the last 20-25 years, the advanced soft chemical clean agent has been successfully executed in over 60 nuclear plants worldwide, with no operating experience concerning corrosion limits exceeding the values demonstrated by the qualifications.

e) The level of estimate accuracy will improve from a Class 4 for the overall project to Class 3. The pilot installation on Unit 3 will provide better cost certainty based on a refined execution schedule and duration and incorporation of lessons learned from

discovery issues. It would be difficult to achieve a Class 3 estimate without the pilot, as OPG required the pilot to determine key parameters for the cleaning. Therefore, OPG expects the level of estimate accuracy to increase to Class 3, following the completion of the Unit 3 pilot. As described in Ex. D2-1-3, p. 23, lines 23-27, a pilot increases project definition and reduces uncertainty in execution approach, risk, and cost.

Board Staff Interrogatory #095

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 1 / Schedule 3 / Attachment 1 / Tab 50

Preamble:

At Reference 1, OPG proposes installation of 37 sensor integration scope elements at Darlington at an estimated total cost of $51.0 million (range $38 million–$58 million) to support equipment reliability improvements, transition to condition-based maintenance, and optimization of manual rounds. The project includes pilot installations and does not identify Post-Implementation Review Key Performance Indicators (PIR KPI).

Question(s):

a) Please quantify the baseline and projected reduction associated with this project for: Forced Loss Rate (FLR), annual maintenance labour hours, and manual operator round hours. Please identify which of these reductions are expected to result in measurable cost savings versus redeployment of resources.

b) The project includes pilot installations covering approximately 7% of scope. Please explain how pilot results will refine total project costs and scope and identify the potential variance in total project cost following pilot completion.

c) Given that no PIR KPI has been identified, please explain how OPG will measure and validate realization of the projected reliability and maintenance benefits.

Response

a) OPG has not quantified a baseline and projected reduction for FLR, annual maintenance labour hours, or manual operator round hours in connection with the Darlington SmartOps Sensor Integration project. While sensor integration is intended to provide earlier identification of degrading conditions that would require mitigating actions and could result in a forced outage or a forced power reduction, as discussed in Ex. L-D2-Staff-086, individual projects collectively support the achievement of annual FLR targets and no individual project is tied to specific FLR reduction targets. Instead of reducing hours and corresponding costs for annual maintenance labour and manual operator rounds, the project will result in an overall

effort reduction for maintaining affected pieces of equipment and/or systems, allowing for more effective resource utilization.

b) As described in Ex. D2-1-3, p. 23, lines 23-27, the use of pilots increases project definition and reduces uncertainty in execution approaches, risk, and cost. For this project, the pilot provides an opportunity for installation of Category 2 scope of work elements (non-intrusive scope as defined in Reference 1). While this scope will provide valuable lessons learned and initial operating experience to inform downstream designs and corresponding costs, the potential impact to total project costs following pilot completion is unknown, as the pilot is still in progress.

c) In the current partial definition phase (Gate 2A), the PIR plan and KPIs are being defined. As noted in the Business Case Summary at Ex. D2-1-3, Attachment 1, tab 50, p. 8, PIR KPIs will be determined prior to the execution phase (Gate 3) and the PIR will be performed when the project is completed.

Board Staff Interrogatory #096

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 3 / Schedule 1 / pp. 3-4
Ref 2: Exhibit F4 / Tab 1 / Schedule 1 / pp. 16-17

Preamble:

At Reference 1, OPG states that the Pickering Refurbishment Program (PRP) Release Quality Estimate (RQE) total $26.84 billion, inclusive of contingency, interest and escalation, and as approved by OPG's Board of Directors in November 2025. The RQE includes $4.05 billion of interest.

At Reference 2, OPG states that for Pickering Units 5-8 OPG implemented a change to extend the accounting end-of-life date assumption for Pickering Units 5-8 to December 31, 2070, effective December 31, 2023, based on the expectation of their refurbishment.

Question(s):

a) Please confirm whether the extension of the accounting end-of-life date for the PRP to 2070 has resulted in any change to the:
   i. PRP Scope;
   ii. The RQE total capital cost estimate;
   iii. The PRP capital expenditure timing for 2027-2031
   iv. If yes to any of i-iii above, please provide a quantitative bridge by year showing the impact of the end-of-life extension. If no, explain why no revision was required.

b) Please confirm whether the RQE and 2027-2031 capital forecast were developed on the basis that:
   i. Operation of refurbished Units 5-8 would extend to 2070; and,
   ii. All life-extension assumptions embedded in depreciation, asset life and nuclear liability modeling are fully aligned with the PRP capital forecast

c) Please confirm whether the $4.05 billion of interest assumes capitalization of any interest on CWIP or if the entirety is assumed as recovery under the concurrent cost recovery (CCR) framework:
   i. Please confirm that no interest amounts are embedded in the RQE as capitalized interest and are also recovered through CCR.

d) Please provide a confirmation that CCR did not alter the total PRP program cost or capital forecast introduced in this application.

Response

a) OPG confirms that the extension of the accounting average station end-of-life date for Pickering Units 5-8 to 2070 did not result in any changes to the PRP scope, the PRP RQE total capital cost estimate or the PRP capital expenditure timing for 2027-2031. No revisions were required, as an accounting end-of-life determination is not a driver of project, operational or business decisions; it is a reflection of them.

b) i) For clarity, OPG adopted December 31, 2070 as the average station end-of-life date for Pickering Units 5-8, for accounting purposes, based on a post-refurbishment target operating period for each unit[1]. OPG confirms that the PRP RQE and the 2027-2031 PRP capital forecast in the Application were developed with these assumptions.

ii) Confirmed.

c) and d)

The $4.05 billion of interest reflected in the PRP RQE assumed that interest would be capitalized (and subsequently reflected in the rate base upon the assets being placed in service), rather than recovered through the CCR mechanism. As explained at Ex. D2-3-8, Section 4.1, as a result of the CCR framework, the requested PRP in-service additions to rate base (Ex. D2-3-8, Tables 2-4) do not include any interest capitalization as of the January 1, 2026 effective date for the CCR mechanism[2]. As shown in Chart 5, Ex. D2-3-8, capitalized interest of $30M is reflected in the requested PRP in-service additions to rate base, being the forecast interest capitalized for these expenditures prior to January 1, 2026. There is therefore no duplication of interest recovery in respect of the PRP between the CCR mechanism and other elements of the proposed revenue requirements. Under this framework, the Applicants expect that the same approach would be followed for the PRP in-service additions that close to rate base subsequent to the 2027-2031 period. As noted at Ex. D2-3-8, Section 4.1, overall PRP cost performance will be tracked inclusive of CCR interest amounts against the RQE of $26.84 billion, which OPG confirms continues to be the total program budget.

[1] Ex. F4-1-1, Attachment 3, p. 6.
[2] Similarly, the PRP capital expenditures shown at Ex. D2-3-8, Table 1 do not include capitalized interest as of January 1, 2026.

Board Staff Interrogatory #097

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 3 / Schedule 3 / p. 8

Preamble:

At Reference 1, OPG states “the Class 3 Definition phase, encompassing the majority of high-value items such as reactor components, boilers, and specialized tooling, was thoroughly evaluated using both industry and DRP RFR Project benchmarks”.

Question(s):

a) Please provide a summary comparison of the Pickering Refurbishment Program (PRP) with the industry and Darlington Refurbishment Program Retube and Feeder Replacement (DRP RFR) project benchmarks that are referenced in the preamble.

b) If the PRP benchmarking comparison was approved by the OPG board, please provide materials that were approved.

Response

a) “Project benchmarks” cited in Reference 1 refer to cost information from industry or the DRP RFR project benchmarks that were available to validate vendor estimates and quotations for the applicable PRP retube, feeder and boiler replacement (“RFBR”) high-value items. Chart 1 provides the requested comparison summary of project benchmarks in relation to the PRP’s reactor components, tooling, and boilers scopes of work.

Chart 1 – Comparison Summary of Project Benchmarks

Component	Comparison summary
Reactor Components	<u>End fittings</u> The cost of end fittings for the PRP was compared to the DRP. Such costs have risen significantly since these components were purchased for DRP more than 10 years ago. To validate the higher pricing of these components, a competitive bidding process was used with multiple vendors. Similar estimates were received in the process providing confidence and validation of the pricing of these components. <u>Closure Plugs</u> The closure plug procurement followed a competitive bid process; estimates were found to be within an acceptable range. <u>Calandria Tubes and Pressure Tubes</u> OPG reviewed the benchmark for the most recent Candu Energy (i.e. for the Candu 6 Refurbishment Project) costs, which showed that PRP costs were reasonable.
Tooling	The PRP RFR Tooling project's $544M cost compares favourably with the DRP's corresponding cost of $680M. This delta accounts for cost savings attributable to PRP being able to leverage the experience and the existing supply chain of tooling from DRP, where technically feasible.
Boilers	The PRP's $17.8M cost per boiler compares favourably with Bruce Power's $36M[1] cost per boiler.

b) OPG's Board of Directors did not approve the PRP benchmarking comparison. While the Board of Directors approved the Release Quality Estimate (refer to Ex. D2-3-8, Attachment 1), which was informed by the benchmarking comparison, Board approval is not required for benchmarking activities.

[1] Reflects escalation to 2025 dollars from 2017 dollars.

Board Staff Interrogatory #098

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 3 / Schedule 3 / p. 11
Ref 2: Exhibit D2 / Tab 3 / Schedule 8 / Chart 3

Preamble:

At Reference 1, OPG states that "where the contractor has less impact on outcomes, OPG has excluded the work from the target pricing structure. Instead, cost plus mark-up pricing is used for Owner Specified Materials as well as for commissioning work."

Reference 2 summarizes the Pickering Refurbishment Program (PRP) Release Quality Estimate (RQE) according to 11 cost categories.

Question(s):

a) Please provide the dollar amount of Owner Specified Materials and commissioning work according to the 11 PRP RQE cost categories as applicable.

b) Please describe how OPG validated the costs of Owner Specified Materials and commissioning work.

c) Please provide the dollar amount of Owner Specified Materials and commissioning work that is included in the total 2023-2031 PRP in-service addition of $9,868 million.

Response

a) Reference 1 relates to the Retube Feeder and Boiler Replacement ("RFBR") commercial agreement and is not applicable to any of the other ten PRP RQE cost categories in Ex. D2-3-8, Chart 3. The dollar amount included in the RQE for RFBR Owner Specified Material ("OSM") is $1,602M.

b) OPG validated the Owner Specified Material costs in part a) above as follows:

RFBR Reactor components:

- Reviewed DRP-issued OSM contracts
- Conducted estimate validation of recent similar purchases for Candu 6 refurbishment projects.

Boilers:
The OSM cost estimate was compared to the cost of the previously manufactured boilers (i.e., Bruce Power) and escalation was added to account for the passage of time.

Commissioning:
As set out at Ex. D2-3-3, p. 11, lines 25-26, commissioning work for RFBR is limited in scope as it is largely managed and executed by OPG, with support as required by the vendors. Therefore, these costs were validated via internal operating experience from past projects.

c) For clarity, the total PRP in-service additions of $9,868M are for the 2026-2031 period, as there are no in-service additions for the 2023-2025 period. The dollar value of RFBR OSM included within these in-service additions is $411M.

Board Staff Interrogatory #099

Interrogatory

Reference:
Ref 1: Exhibit D2 / Tab 3 / Schedule 4 / p. 7

Preamble:

At Reference 1, "A key difference between the PRP and DRP is that PRP will begin with the full station being offline and all four units being refurbished in parallel, creating larger resourcing demands and greater complexity in execution".

Question(s):

a) Please explain why OPG decided to refurbish all units in parallel instead of in sequence like in the Darlington Refurbishment Program (DRP).

b) Did OPG present an analysis of alternative approaches (e.g., refurbishment in parallel, refurbishment in series) and a recommendation to its Board of Directors for approval? If so, please provide the analysis and approval. If not, why not?

c) Please describe the cost implications of OPG's choice to refurbish all units in parallel instead of in sequence like in the DRP. For example, does the refurbishment of all units in parallel increase or decrease costs compared to other alternatives that OPG considered. If so, by how much do costs increase or decrease?

Response

a) and b)

Pickering Units 5-8 are life-limited by fuel channel fitness for service and only authorized by the current operating license to operate through to the end of 2026. As noted in Ex. D2-3-1, p. 1, lines 13-14, without refurbishment, Units 5-8 would cease commercial operation in 2026. As such, no alternative approaches were considered as all units must be taken offline in parallel.

While Units 5-8 will be shut down in parallel, based on lessons learned from DRP, PRP schedule execution has been optimized and sequenced, consistent with the DRP execution strategy for Units 3, 1, and 4 (see Ex. D2-3-8, Attachment 1, p. 12).

c) All units must be taken offline in parallel by the end of 2026, as discussed in parts a) and b) above. Directionally, there would be an overall cost increase if OPG were to refurbish units in sequence, as Pickering units would be idle while extending the overall PRP execution schedule beyond the current eight-year program duration. The impact of such an increase is influenced by multiple factors including direct and indirect costs, including increased maintenance and inspection costs and increased interest cost due to longer program duration.