OPG

EB-2016-0152

AMPCO Compendium

Panel 3B

UNDERTAKING JT2.14

Undertaking

TO UPDATE REFERRED TABLE TO REFLECT P-50 CONFIDENCE LEVEL SCHEDULE FOR DARLINGTON REFURBISHMENT PROJECT

Response

The updated table reflecting a P-50 confidence level schedule for Darlington Refurbishment is attached. The cells in the table in Attachment 1 that have been changed are highlighted in yellow.

The P-50 confidence level schedule moves the end date for Unit 2 refurbishment from February 14, 2020 to November 15, 2019 (see Ex. L-4.5-5 CCC-022 Attachment 1 page 6 and 7, Tables 3 and 4) and has cascading impacts on other refurbishment and post refurbishment mini-outages. The Unit 3 refurbishment starts one month after the Unit 2 returns to service.

The net impacts to the forecast of generation in the test period by using a P-50 schedule for Darlington Refurbishment versus a P-90 schedule are as follows:

Gain of approximately 0.6TWh in 2019.

Loss of approximately 1.3TWh in 2021.

Total impact would be a loss of production of approximately 0.7TWh during the test period.

Please note that the formulas used to calculate total production and total revenue impacts for Darlington in 2020 were incorrect in Ex. L-5.1-5 CCC-024 and have been corrected in the updated table. The corrected formulas result in total 2020 production increasing from 14.8TWh to 18.1TWh. To be clear, however, there is no change in total production impact and revenue impact in 2020 as a result of updating the table to reflect a P-50 confidence level schedule for Darlington Refurbishment.

Year		Outage	Unit Affected	Description	Outage Duration (days)	Forecast Production (TWh) Impact Due to Outage	Revenue Impact of Outage ($M)
2017	Pickering	P1711	Unit 1	Planned Outage	204.9	2.6	168.0
		P1742	Unit 4	Mid-Cycle Outage	43.0	0.5	35.2
		P1751	Unit 5	Planned Outage	160.7	2.0	132.0
		P1761	Unit 6	Planned Outage	133.0	1.7	109.2
		Total			**541.6**	**6.8**	**444.4**
	Darlington	D1711	Unit 1	Planned Outage	108.4	2.3	152.9
		DNRU2	Unit 2	Refurbishment Outage	365.0	7.8	514.8
		D1731-PD	Unit 3	Planned Derate	2.5	0.1	3.5
		D1732	Unit 3	PHT Pump Motor Outage	20.0	0.4	28.2
		D1741-PD	Unit 4	Planned Derate	2.5	0.1	3.5
		D1742	Unit 4	PHT Pump Motor Outage	20.0	0.4	28.2
		Total			**518.4**	**11.1**	**731.2**
Total 2017					**1,060.0**	**17.9**	**1,175.6**
2018	Pickering	P1812	Unit 1	Mid-Cycle Outage	43.0	0.5	39.1
		P1841	Unit 4	Planned Outage	144.1	1.8	131.2
		P1871	Unit 7	Planned Outage	193.5	2.4	176.4
		P1881	Unit 8	Planned Outage	150.2	1.9	136.9
		Total			**530.8**	**6.6**	**483.6**
	Darlington	D1811	Unit 1	PHT Pump Motor Outage	20.0	0.4	31.3
		DNRU2	Unit 2	Refurbishment Outage	365.0	7.8	571.4
		D1831	Unit 3	Planned Outage	103.3	2.2	161.7
		D1841	Unit 4	PHT Pump Motor Outage	20.0	0.4	31.3
		Total			**508.3**	**10.9**	**795.8**
Total 2018					**1,039.1**	**17.5**	**1,279.4**
2019	Pickering	P1911	Unit 1	Planned Outage	128.5	1.6	129.8
		P1942	Unit 4	Mid-Cycle Outage	43.0	0.5	43.4
		P1951	Unit 5	Planned Outage	165.6	2.1	167.6
		P1961	Unit 6	Planned Outage	180.1	2.2	182.3
		Total			**517.2**	**6.5**	**523.1**
	Darlington	D1911	Unit 1	PHT Pump Motor Outage	20.0	0.4	34.8
		D1912-PD	Unit 1	Planned Derate	2.5	0.1	4.3
		DNRU2	Unit 2	Refurbishment Outage	318.5	6.8	553.5
		DNRU3	Unit 3	Refurbishment Outage	17.0	0.4	29.5
		P1931-PD	Unit 3	Planned Derate	2.5	0.1	4.3
		D1941	Unit 4	Planned Outage	99.1	2.1	172.2
		Total			**459.6**	**9.9**	**798.7**
Total 2019					**976.8**	**16.3**	**1,321.8**
2020	Pickering	P2012	Unit 1	Mid-Cycle Outage	43.0	0.5	48.2
		P2041	Unit 4	Planned Outage	164.5	2.0	184.4
		P2071	Unit 7	Planned Outage	102.5	1.3	115.1
		P2081	Unit 8	Planned Outage	188.9	2.4	212.2
		Total			**498.9**	**6.2**	**560.0**
	Darlington	D2011	Unit 1	Planned Outage	108.2	2.3	208.7
		DNRU2	Unit 2	Refurbishment Outage	0.0	0.0	0.0
		D2022-PD	Unit 2	Planned Derate	2.5	0.1	4.8
		D2021	Unit 2	Post Refurb Mini Outage	55.0	1.2	106.1
		DNRU3	Unit 3	Refurbishment Outage	366.0	7.8	706.0
		D2042-PD	Unit 4	Planned Derate	2.5	0.1	4.8
		D2041	Unit 4	PHT Pump Motor Outage	20.0	0.4	38.6
		Total			**554.2**	**11.9**	**1069.1**
Total 2020					**1,053.1**	**18.1**	**1,629.1**
2021	Pickering	P2111	Unit 1	Planned Outage	150.5	1.9	187.3
		P2141	Unit 4	Vacuum Building Outage	30.0	0.4	37.3
		P2151	Unit 5	Planned Outage	179.7	2.2	224.1
		P2161	Unit 6	Planned Outage	112.6	1.4	140.4
		P2162	Unit 6	Vacuum Building Outage	30.0	0.4	37.4
		P2171	Unit 7	Vacuum Building Outage	30.0	0.4	37.4
		P2181	Unit 8	Vacuum Building Outage	30.0	0.4	37.4
		Total			**562.8**	**7.0**	**701.3**
	Darlington	DNRU1	Unit 1	Refurbishment Outage	261.0	5.6	558.9
		D2121	Unit 2	Post Refurb Mini Outage	31.2	0.7	66.8
		D2122-PD	Unit 2	Planned Derate	2.5	0.1	5.4
		DNRU3	Unit 3	Refurbishment Outage	365.0	7.8	781.6
		D2142-PD	Unit 4	Planned Derate	2.5	0.1	5.4
		D2141	Unit 4	PHT Pump Motor Outage	20.0	0.4	42.8
		Total			**682.2**	**14.6**	**1,460.8**
Total 2021					**1,245.0**	**21.6**	**2,162.1**

SEC Interrogatory #49

Issue Number: 5.1
Issue: Is the proposed nuclear production forecast appropriate?

Interrogatory

Reference:
[E2/1/1]

For each 6 month delay in refurbishment of Darlington unit 2, please provide the revised production forecast per year. Please also provide the change in proposed payment amounts as a result.

Response

The production impact of a 6-month delay in the refurbishment of Darlington Unit 2 would not affect the production forecast in 2017, 2018 or 2019. The impact of a 6-month delay on the production forecast in 2020 and 2021 is based on the assumption that the delay would push the start of refurbishment of Unit 3 back by the same amount. Such a delay would result in the first mini post commissioning outage of 55 days being delayed from 2020 into 2021 and the second mini post commissioning outage of 31 days being delayed from 2021 outside the rate period. The estimated production impact would be a gain of production of 55 days in 2020, representing about 1.1 TWh, and a corresponding loss of production of 24 days in 2021, representing about -0.5TWh.

The resulting changes in payment amounts cannot be provided, as they would depend on the specific causes of the assumed 6-month delay and the actions taken to address them. Any attempt to develop 6-month delay scenarios and quantify the range of potential impacts on the payment would be completely speculative, depending entirely on the assumptions made about the causes of the delay and OPG's responsive actions.

Witness Panel: Nuclear Operations and Projects

APPENDIX 5: Nuclear Financial Plan, Operational Targets, and Initiatives

Financial Plan

	Actual	Business Plan			Projection		
(in millions of dollars)	2015	2016	2017	2018	2019	2020	2021
OM&A							
Base	1,157	1,180	1,192	1,210	1,232	1,247	1,259
Outage Incremental	316	332	390	372	343	327	326
Project Portfolio	115	94	111	91	82	82	87
Pickering Continued Operations Enabling Costs	-	15	26	55	107	104	-
Darlington Refurbishment Project	2	1	42	14	4	48	20
Nuclear New Build	1	1	1	1	1	1	1
Total Nuclear OM&A	**1,591**	**1,624**	**1,762**	**1,744**	**1,769**	**1,809**	**1,693**
Capital							
Project Portfolio (including Spares and Minor Fixed Assets)*	315	353	279	258	282	278	199
Darlington Refurbishment Project (excluding Support Services)	681	1,189	1,063	1,094	951	833	1,170
Total Nuclear Capital	**996**	**1,542**	**1,342**	**1,352**	**1,234**	**1,111**	**1,369**
Provision Expenditures							
ONFA Funded	61	104	140	150	206	260	256
Internally Funded - Base	96	104	109	116	118	120	123
Internally Funded - Projects	40	39	39	40	40	40	40
Internally Funded - Darlington Refurbishment Waste Containers	6	56	32	43	30	33	26
Total Nuclear Provision Expenditures	**203**	**303**	**320**	**348**	**394**	**453**	**445**
Fuel Expense (Pickering and Darlington)	**244**	**261**	**220**	**222**	**233**	**228**	**213**

*In 2019, includes $15M related to the load of new fuel bundles into the refurbished Darlington Unit 2

Operational Targets

The key 2016-2018 targets for the Nuclear business unit are set out below. These targets are informed by the latest industry benchmarks and are designed to drive continuous performance improvement.

			Pickering				Darlington			
Metric	NPI Max	Industry Best Quartile	2015 Actual	2016 Annual Target	2017 Annual Target	2018 Annual Target	2015 Actual	2016[1] Annual Target	2017[1] Annual Target	2018[1] Annual Target
All Injury Rate (#/200k hrs worked)	N/A	0.66	0.44	0.24	0.24	0.24	0.22	0.24	0.24	0.24
Collective Radiation Exposure (person-rem/unit)	80.00	42.25	100.90	111.50	126.90	137.30	73.72	65.00	87.80	72.10
Unit Capability Factor (%)	92.0	89.4	79.4	77.6	71.5	72.0	76.9	91.1	85.1	86.0
Forced Loss Rate (%)	1.00	1.03	2.89	5.00	5.00	5.00	4.86	1.00	1.00	1.00
On-line Corrective Maintenance Backlog (work orders/unit)	N/A	11	125	56	28	28	24	20	15	10
WANO NPI (Index)	N/A	92.9	68.5	72.3	71.1	71.1	83.7	87.3	84.3	93.0
Human Performance Error Rate	N/A	0.0020	0.0055	0.0030	0.0030	0.0030	0.0031	0.0030	0.0020	0.0020
Total Generating Cost per MWh[2]	N/A	$38.71	$64.00	$71.09	$76.46	$75.32	$52.40	$47.35	$47.85	$48.68

[1] Darlington targets reflect the impact of the Unit 2 Refurbishment starting in October of 2016, where applicable.

[2] Metrics exclude centrally-held Pension and OPEB costs and asset service fees. Targets may change subject to allocations and assumptions being finalized. Darlington metrics have been normalized after 2016 for generation forgone during the Unit 2 refurbishment. The non-normalized Darlington target for 2017 is $63.76/MWh and 2018 is $63.50/MWh.

Green = Max NPI Points Achieved (if applicable) or Best Quartile Performance
White = 2nd Quartile Performance
Yellow = 3rd Quartile Performance
Red = 4th Quartile Performance

Darlington Refurbishment Project Targets

Milestone	Target Completion Date
Unit 2 Execution Estimate Complete	August 15, 2016
Unit 2 Refurbishment Start (Breaker Open)	October 15, 2016
Unit 2 Reactor Defueling Complete	February 2017
Heavy Water Storage & Drum Handling Facility In-Service	May 2017
Unit 2 Reactor Component Removals Complete	April 2018
Unit 2 Calandria Tube Installation Complete	September 2018
At least 284 Unit 2 Fuel Channels Installed	December 31, 2018

Initiatives

The following initiatives are aimed at closing performance gaps in order to achieve targeted results for the Nuclear business unit:

- **Workforce Planning & Resourcing Initiative:** This initiative focuses on developing and implementing the resourcing strategy to support the safe operation of the plants and successful completion of the Darlington refurbishment, while minimizing disruption and costs associated with the Pickering end of commercial operations. A dedicated team will optimize workforce planning strategies across the Nuclear business and provide oversight on the resourcing approval process.
- **Outage Performance:** This initiative focuses on delivering predictable outage performance through improved planning and execution of outage work to meet planned outage day targets. Areas for improvement include: model work order development and utilization; outage schedule and resource planning quality; implementation of a long-term purchased services agreement to optimize contracted work and improve quality of supplemental staff execution; inspection and maintenance execution improvements; Life Cycle Management Plan development improvements; and completing a feasibility study for placing the Pickering station on a 30-month outage cycle.
- **Equipment Reliability:** This initiative aims to improve equipment reliability, improve effectiveness of the maintenance program and reduce equipment failures to meet forced loss rate targets.
- **Human Performance:** This initiative focuses on: 1) Behaviours associated with procedural use and adherence; 2) Leadership accountability whereby leaders understand and model the behaviours expected from all staff; and 3) Supervisor effectiveness whereby supervisors set and communicate clear expectations to positively influence behaviours.
- **Parts Improvement Project:** This initiative focuses on obtaining the right parts on time, reducing churn in the work management system, and ultimately improving equipment reliability through the completion of 19 cross-functional sub-initiatives across the Engineering, Supply Chain, Fleet Operations & Maintenance, and Work Management functions.
- **Inventory Reduction Initiative:** This initiative is to develop a strategy to optimize inventory levels and reduce costs by targeting half the historical growth rate for 2016. The 2016 growth rate would be lower than benchmark.

APPENDIX 4: NUCLEAR FINANCIAL PLAN, OPERATIONAL TARGETS, AND INITIATIVES

Financial Plan

	Forecast	Business Plan			Projection	
(in millions of dollars)	2016	2017	2018	2019	2020	2021
OM&A						
Base*	1,172	1,196	1,215	1,254	1,263	1,281
Outage Incremental	319	392	373	343	328	322
Project Portfolio	94	111	91	82	82	87
Pickering Continued Operations Enabling Costs	15	26	55	107	104	-
Darlington Refurbishment Project	3	49	16	7	52	26
Nuclear New Build	1	2	7	10	11	11
Total Nuclear OM&A	**1,605**	**1,776**	**1,758**	**1,803**	**1,841**	**1,727**
Capital						
Project Portfolio (including Spares and Minor Fixed Assets)**	291	322	319	299	289	244
Darlington Refurbishment Project (excl. Support Services)	1,008	1,119	1,084	1,082	1,019	1,035
Total Nuclear Capital	**1,299**	**1,441**	**1,403**	**1,381**	**1,308**	**1,279**
Provision Expenditures						
ONFA Funded	85	150	147	206	264	325
Internally Funded - Base	101	115	115	122	125	127
Internally Funded - Projects	54	49	70	45	45	40
Internally Funded - Darlington Refurbishment Waste Containers	31	44	45	45	38	19
Total Nuclear Provision Expenditures	**272**	**358**	**377**	**418**	**471**	**511**
Fuel Expense (Pickering and Darlington)	**263**	**223**	**220**	**228**	**217**	**198**

* Includes an estimated $4M to $5M per year for work in support of the RG&PM business unit

** In 2019, includes $16M related to the load of new fuel bundles into the refurbished Darlington Unit 2

Operational Targets

The key 2017-2019 targets for the Nuclear business unit are set out below. These targets reflect the operating environment of the nuclear fleet, including refurbishment activities at the Darlington station and continuing work on fuel channel inspections at the Pickering station.

			Pickering					Darlington[1]				
Metric	NPI Max	Industry Best Quartile	2016 Target	2016 Forecast	2017 Target	2018 Target	2019 Target	2016 Target	2016 Forecast	2017 Target	2018 Target	2019 Target
All Injury Rate[2] (#/200k hrs worked)	N/A	0.69	0.24	0.49	0.24	0.24	0.24	0.24	0.23	0.24	0.24	0.24
Collective Radiation Exposure (person-rem/unit)	80.00	38.17	111.50	104.50	126.90	137.30	153.30	65.00	80.90	111.90	82.70	78.40
Unit Capability Factor (%)	92.0	91.3	77.6	75.3	71.5	72.0	72.6	91.1	90.0	85.1	86.0	87.8
Forced Loss Rate (%)	1.00	0.38	5.00	4.37	5.00	5.00	5.00	1.00	1.93	1.00	1.00	1.00
On-line Corrective Maintenance Backlog (work orders/unit)	N/A	7	55	80	28	28	28	20	20	15	10	7
WANO NPI (Index)	N/A	93.5	72.3	75.6	69.7	67.2	65.9	87.3	85.5	83.1	90.7	91.0
Human Performance Error Rate	N/A	0.0010	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0053	0.0020	0.0020	0.0020
Total Generating Cost per MWh[3]	N/A	$38.93	$71.09	$72.46	$78.83	$80.09	$81.49	$47.35	$46.46	$49.75	$49.54	$52.33

[1] Darlington targets reflect the impact of the Unit 2 Refurbishment starting in October of 2016, where applicable.

[2] Also applies to Darlington Refurbishment Project and Contractors.

[3] Metrics exclude centrally-held Pension and OPEB costs and asset service fees. Targets may change subject to allocations and assumptions being finalized. Darlington metrics have been normalized after 2016 for generation forgone during the Unit 2 refurbishment.

Initiatives

The following initiatives represent the focus areas of the Nuclear business unit aimed at closing performance gaps in order to achieve targeted results:

- **Outage Execution:** This initiative focuses on delivering predictable outage performance through improved planning and execution of outage work to meet planned outage day targets. Areas for improvement include: outage schedule and resource planning quality; implementation of a long-term purchased services agreement to optimize contracted work and improve quality of supplemental staff execution; inspection and maintenance execution improvements; Life Cycle Management Plan development improvements; and studying the option of moving Pickering to a 30-month outage cycle.
- **Workforce Planning & Resourcing Initiative:** This initiative focuses on implementing the resourcing strategy to support the safe operation of the plants and successful completion of the Darlington refurbishment, while minimizing disruption and costs associated with the Pickering end of commercial operations. A dedicated team provides oversight on the resourcing strategies and resourcing approval process.
- **Equipment Reliability:** This initiative aims to improve equipment reliability, improve effectiveness of the maintenance program and reduce equipment failures to meet forced loss rate targets.
- **Project Excellence Initiative:** This initiative supports the corporate-wide initiative focused on implementing a standard scalable project delivery model throughout OPG via the established Project Management Centre of Excellence, in order to increase project predictability and successful project outcomes.
- **Parts Improvement Sustainment:** This initiative aims to sustain and continuously improve on the results of the 19 completed sub-initiatives of the overall Parts Improvement Project. The focus of the Parts Improvement Project has been on obtaining the right parts on time, reducing churn in the work management system, and ultimately improving equipment reliability through the completion of the 19 cross-functional sub-initiatives across the Engineering, Supply Chain, Fleet Operations & Maintenance, and Work Management functions.
- **Human Performance:** This initiative focuses on: 1) Behaviours associated with procedural use and adherence; 2) Leadership accountability whereby leaders understand and model the behaviours expected from all staff; and 3) Supervisor effectiveness whereby supervisors set and communicate clear expectations to positively influence behaviours.

2015 Plant Level Performance Summary

Metric	NPI Max	2015 Actuals			
		Best Quartile	Median	Pickering	Darlington
Safety					
All Injury Rate (#/200k hours worked)		0.69	N/A[1]	0.44	0.22
Rolling Average[2] Industrial Safety Accident Rate (#/200k hours worked)	0.20	0.00	0.00	0.05	0.08
Rolling Average[2] Collective Radiation Exposure (Person-rem per unit)	80.00	38.17	48.53	97.72	79.55
Airborne Tritium Emissions (Curies) per Unit[3]		1,192	1,784	2,409 ⇩	1,313
Fuel Reliability Index (microcuries per gram)	0.000500	0.000001	0.000001	0.000421 ⇧	0.000122
2-Year Reactor Trip Rate (# per 7,000 hours)	0.50	0.00	0.06	0.17	0.13
3-Year Auxiliary Feedwater System Unavailability (#)	0.0200	0.0000	0.0050	0.0116	0.0000
3-Year Emergency AC Power Unavailability (#)	0.0250	0.0006	0.0041	0.0030	0.0000
3-Year High Pressure Safety Injection Unavailability (#)	0.0200	0.0000	0.0000	0.0000	0.0000
Reliability					
WANO NPI (Index)		93.5	89.4	68.5	83.7 ⇩
Rolling Average[2] Forced Loss Rate (%)	1.00	0.38	1.46	6.85	3.65
Rolling Average[2] Unit Capability Factor (%)	92.0	91.31	88.05	77.32	83.96 ⇩
Rolling Average[2] Chemistry Performance Indicator (Index)	1.01	1.00	1.00	1.06 ⇩	1.00
1-Year On-line Deficient Maintenance Backlog (work orders per unit)		116	160	351 ⇩	174 ⇩
1-Year On-line Corrective Maintenance Backlog (work orders per unit)		7	15	125	24 ⇩
Value for Money					
3-Year Total Generating Cost per MWh ($ per Net MWh)		38.93	44.38	67.36	44.38 ⇩
3-Year Non-Fuel Operating Cost per MWh ($ per Net MWh)		22.60	25.89	56.49	33.19 ⇩
3-Year Fuel Cost per MWh ($ per Net MWh)		7.97	8.73	5.71	5.18
3-Year Capital Cost per MW DER (k$ per MW)		47.33	63.63	33.86	43.52
Human Performance					
18-Month Human Performance Error Rate (# per 10k ISAR and contractor hours)		0.00100	0.00300	0.00550 ⇧	0.00310

Notes
1. No median benchmark available.
2. Indicates a 2-Year Rolling Average for Pickering and a 3-Year Rolling Average for Darlington.
3. 2014 data is used because 2015 results were unavailable at the time of benchmarking.

Green = maximum NPI results achieved or best quartile performance

White = 2nd quartile performance

Yellow = 3rd quartile performance

Red = 4th quartile performance

⇩ Declining Benchmark Quartile Performance vs. 2014

⇧ Improving Benchmark Quartile Performance vs. 2014

Numbers may not add due to rounding.

Table 2
Capital Expenditures Summary - Nuclear Operations ($M)

Line No.	Category	2013 Actual	2014 Actual	2015 Actual	2016 Budget	2017 Plan	2018 Plan	2019 Plan	2020 Plan	2021 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
	Portfolio Projects (Allocated)									
1	**Darlington NGS**	76.4	164.2	194.4	212.7	176.6	140.9	88.6	37.4	30.2
2	**Pickering NGS**	90.6	96.1	93.4	89.7	23.0	2.4	0.0	0.0	0.0
3	**Nuclear Support Divisions**	24.0	9.5	4.6	14.2	4.6	0.2	0.0	0.0	0.0
4	**Subtotal Portfolio Projects (Allocated)**	191.0	269.8	292.5	316.5	204.2	143.4	88.6	37.4	30.2
5	**Portfolio Projects (Unallocated)**	0.0	0.0	0.0	5.5	48.8	94.6	159.4	221.6	149.8
6	**Subtotal Project Capital (Portfolio)**	191.0	269.8	292.5	322.0	253.0	238.0	248.0	259.0	180.0
7	**Darlington New Fuel**	0.0	0.0	0.0	0.0	0.0	0.0	15.3	0.0	0.0
8	**Minor Fixed Assets**	10.2	22.9	22.3	31.0	26.0	20.0	19.1	19.5	19.3
9	**Total Nuclear Operations Capital**	201.2	292.7	314.8	353.0	279.0	258.0	282.4	278.5	199.3

Numbers may not add due to rounding.

Table 1
Capital Project Listing - Nuclear Operations Facility Projects
Projects ≥ $20M Total Project Cost[1]

Line No.	Facility	Project Name	Project Number	Category	Start Date	Final In-Service Date	Total Project Cost[2] ($M)	Partial/Devmt Release ($M)	Initial Full Release ($M)	Superseding Full Release ($M)	In-Service 2016 ($M)	In-Service 2017 ($M)	In-Service 2018 ($M)	In-Service 2019 ($M)	In-Service 2020 ($M)	In-Service 2021 ($M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
		ONGOING PROJECTS FROM EB-2013-0321														
1	DN	Operations Support Building Refurbishment[3]	25619	Sustaining	Mar-09	Oct-15	62.7		53.0	62.7	3.6	0.0	0.0	0.0	0.0	0.0
2	DN	Class II Uninterruptible Power Supply Replacement[4]	31412	Sustaining	Jan-11	Jun-25	55.1	31.1			7.0	6.5	9.4	6.5	1.6	7.6
3	DN	Fukushima Phase 1 Beyond Design Basis Event Emergency Mitigation Equipment[4,5]	31508	Regulatory	Sep-11	Sep-17	52.9	51.8			17.0	13.8	0.0	0.0	0.0	0.0
4	DN	Improve Maintenance Facilities at Darlington	31717	Sustaining	Aug-07	Oct-13	43.2		43.2		0.8	0.0	0.0	0.0	0.0	0.0
5	DN	Secondary Control Area Air Conditioning Unit Replacement[4]	33621	Sustaining	Feb-09	Apr-17	28.3	25.8			10.3	6.1	0.0	0.0	0.0	0.0
6	DN	Chiller Replacement to Reduce CFC Emissions	33631	Regulatory	Jan-04	Jan-13	30.0		30.0		0.0	1.2	0.0	0.0	0.0	0.0
7	DN	Major Pump-sets Vibration Monitoring System Upgrades[4]	33818	Sustaining	Mar-06	Jul-21	23.8	9.6			0.0	0.0	5.2	4.6	4.5	4.4
8	DN	Shutdown System Computer Aging Management[4]	33955	Sustaining	Nov-06	May-16	30.3		20.3		2.0	0.0	0.0	0.0	0.0	0.0
9	DN	Standby Generator Controls Replacement	33973	Sustaining	Dec-06	May-17	38.6	32.4			17.9	8.7	0.0	0.0	0.0	0.0
10	DN	Digital Control Computer Replacement / Refurbishment / Upgrades	33977	Sustaining	Sep-03	Dec-18	24.8		22.8	24.8	0.0	2.0	1.8	0.0	0.0	0.0
11	DN	Auxiliary Heating System[3]	34000	Regulatory	Mar-06	Apr-16	99.5		98.5		94.2	0.1	0.0	0.0	0.0	0.0
12	DN	Primary Heat Transport Pump Motor Capital Spares[4]	36001	Sustaining	Sep-11	May-15	30.8		12.0	30.8	0.0	0.0	0.0	0.0	0.0	0.0
13	PN	Unit 1 & 4 Fuel Channel East Pressure Tube Shift/Reconfigure[6]	41023 48247	Sustaining	Nov-09	Mar-16	38.6		28.8	38.6	17.0	0.0	0.0	0.0	0.0	0.0
14	PN	Pickering A Fuel Handling Single Point of Vulnerability Equipment Reliability Improvement	46634	Sustaining	Feb-11	Mar-16	27.3		27.3		3.8	2.5	0.0	0.0	0.0	0.0
15	PN	Fukushima Phase 1 Beyond Design Basis Event Emergency Mitigation Equipment[4,5]	49158 49299	Regulatory	Sep-11	Aug-16	56.0	47.2			21.0	10.5	0.5	0.0	0.0	0.0
16	SEC	Physical Barrier System	25609	Regulatory	Nov-05	Dec-13	67.2		49.5	67.2	0.5	0.0	0.0	0.0	0.0	0.0
17		Subtotal					702.2				195.1	51.5	16.9	11.2	6.0	12.0
		COMPLETED/DEFERRED/CANCELLED FROM EB-2013-0321														
18	PN	PS Standby Generator Governor Upgrade	49109	Sustaining	Oct-05	Jan-15	22.8		22.3		0.0	0.0	0.0	0.0	0.0	0.0
19	PN	Modify/Replace Fiber Reinforced Plastic Components During 2010 Vacuum Building Outage	49285	Sustaining	Nov-09	Jun-10	17.7		12.8	24.5	0.0	0.0	0.0	0.0	0.0	0.0
20	ENG	Feeder Repair by Weld Overlay	62568	Value Enhancing	May-09	Deferred	0.0		53.2		0.0	0.0	0.0	0.0	0.0	0.0
21		Subtotal					40.5				0.0	0.0	0.0	0.0	0.0	0.0
		PROJECTS NOT IN EB-2013-0321														
22	DN	Restore Emergency Service Water and Firewater Margins	31516	Sustaining	Dec-12	Sep-16	47.1	28.4			2.1	0.0	33.8	0.0	0.0	0.0
23	DN	Station Roofs Replacement	31524	Sustaining	Nov-12	Deferred	36.3	0.8			0.0	15.5	8.0	0.1	0.0	0.0
24	DN	Powerhouse Water Air Conditioning Units Replacement	31532	Sustaining	Oct-12	Dec-19	20.0	11.3			0.0	4.8	3.8	3.0	5.2	0.2
25	DN	Water Treatment Plant Replacement	31535	Sustaining	Oct-12	Deferred	57.8	5.2			0.0	0.0	0.0	48.9	0.5	0.0
26	DN	Transformer Multi-Gas Analyzer Installation	31542	Sustaining	Oct-12	Mar-18	22.7		22.7		6.0	3.5	1.8	0.1	0.0	0.0
27	DN	Radiation Detection Equipment Obsolescence	31544	Sustaining	Jan-14	Dec-21	46.9	1.2			0.0	6.6	10.2	9.5	1.7	0.8
28	DN	Condenser Circulating Water and Low Pressure Service Water Travelling Screens Replacement	31552	Sustaining	May-13	Jun-18	37.6	27.5			10.6	8.4	7.2	0.1	0.0	0.0
29	DN	Shutdown Cooling Heat Exchanger Replacement	31710	Sustaining	Nov-12	May-19	56.1	38.8			15.8	9.9	14.3	0.9	0.0	0.0
30	DN	Neutron Over-Power & Ion Chamber Amplifier Replacement (Reactor Regulating System, Shutdown System 1 & Shutdown System 2)	31716	Sustaining	Jul-13	Jul-22	17.7	5.5			0.0	0.0	0.0	1.0	2.3	0.0
31	DN	Zebra Mussel Mitigation Improvements	38848	Sustaining	Nov-12	Jul-16	21.5		21.5		18.9	1.0	0.0	0.0	0.0	0.0
32	DN	Holt Road Interchange Upgrade	73706	Value Enhancing	Nov-13	Dec-16	28.6		31.0		22.4	0.0	0.0	0.0	0.0	0.0
33	DN	CH180 Aging Management Hardware Installation	80022	Sustaining	Dec-14	Dec-22	47.2	1.4			0.0	0.0	7.9	5.7	5.5	5.6
34	DN	Digital Control, Common Process and Sequence of Events Monitoring Computer Aging Management	80078	Regulatory	Nov-15	Jun-25	47.3	1.7			0.0	0.0	0.0	0.0	1.6	6.0
35	DN	Generator Stator Core Spare	80111	Sustaining	Sep-15	Jul-19	35.0		35.0		0.0	0.0	0.0	32.0	0.0	0.0
36	DN	Vault Cooling Coil Replacement	82816	Regulatory	Dec-15	Sep-20	26.3	11.8			6.9	2.4	1.3	3.8	2.9	0.0
37	DN	Primary Heat Transport Pump Motor Replacement/Overhaul[7]	73566 80144	Sustaining	May-15	Dec-22	129.5	53.8			14.8	11.0	13.0	17.0	19.2	0.0
38	PN	Pickering B Fuel Handling Reliability Modifications	40978	Sustaining	Aug-12	Jul-17	37.3	30.9			11.5	7.9	4.2	0.0	0.0	0.0
39	PN	Fukushima Phase 2 Beyond Design Basis Event Emergency Mitigation Equipment	41027	Regulatory	Oct-12	Jun-17	46.3	5.8			7.3	22.5	0.0	0.0	0.0	0.0
40	PN	Machine Delivered Scrape	66600	Value Enhancing	Feb-14	May-17	24.9	14.1	0.0	0.0	18.9	1.5	0.0	0.0	0.0	0.0
41		Subtotal					788.0				135.1	95.0	105.3	123.1	38.9	12.6
42		Total									330.2	146.5	122.2	134.3	44.9	24.6
		DIVISION TOTALS:														
43		Darlington									250.2	101.5	117.5	134.3	44.9	24.6
44		Pickering									79.4	45.0	4.7	0.0	0.0	0.0
45		Nuclear Support Divisions									0.5	0.0	0.0	0.0	0.0	0.0
46		Total									330.2	146.5	122.2	134.3	44.9	24.6

Notes:
1 Projects with expenditures during Test Period OR In-Service Amounts in Bridge or Test Period, AND Completed/Deferred Projects (from EB-2013-0321 or subsequent).
2 Total Project Cost reflects BCS amounts, with the exception of Completed/Deferred/Cancelled Projects (for which actual costs are shown).
3 Projects from Ex. D2-2-1 Table 7 in EB-2013-0321.
4 Projects from Ex. D2-1-3 Table 2 in EB-2013-0321.
5 Projects 31508, 49158 and 49299 are combined in a single Business Case Summary.
6 Projects 41023 and 48247 are combined in a single Business Case Summary. Project 48247 is from Ex. D2-1-3 Table 2 in EB-2013-0321
7 Projects 73566 and 80144 are combined in a single Business Case Summary

Numbers may not add due to rounding.

Table 2a
Capital Project Listing - Nuclear Operations Facility Projects
Projects $5M - $20M Total Project Cost[1]

Line No.	Facility	Project Name	Project Number	Category	Project Description	Start Date	Final In-Service Date	Total Project Cost[2] ($M)	In-Service 2016 ($M)	In-Service 2017 ($M)	In-Service 2018 ($M)	In-Service 2019 ($M)	In-Service 2020 ($M)	In-Service 2021 ($M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
		ONGOING PROJECTS FROM EB-2013-0321												
1	DN	DN Passive Auto-Catalytic Recombiners	31306	Regulatory	Install passive auto-catalytic recombiners for long-term post-accident hydrogen mitigation.	Dec-09	Jun-16	5.8	1.7	0.0	0.0	0.0	0.0	0.0
2	DN	DN Active Liquid Waste System Upgrade	31403	Regulatory	Add aeration and chemical addition to the active liquid waste management system to ensure compliance with discharge criteria.	Nov-09	Dec-17	12.1	1.5	1.0	0.0	0.0	0.0	0.0
3	DN	DN Pressurizer Heaters & Controllers Replacement Project	31422	Sustaining	Replace electrical heaters in pressurizers that are at the end of their expected life.	Apr-11	Dec-18	14.5	3.2	2.5	0.0	0.0	0.7	0.0
4	DN	DN F/H Inverter Replacement	31426	Sustaining	Replace obsoleter inverters providing power to operate critical fuel handling components.	Nov-11	Dec-18	14.4	2.6	5.3	2.6	0.0	0.0	0.0
5	DN	DN Replacement of EPS Uninterruptible Power Supply	33258	Sustaining	Replace life-expired uninterruptible power supplies to the emergency power system.	Feb-10	Nov-17	16.6	1.7	3.4	2.3	0.0	0.0	0.0
6	DN	Replacement of Obsolete Computer Components	33509	Sustaining	Replace obsolete components of the digital control computers.	Jun-00	Jul-16	9.1	0.4	0.3	0.0	0.0	0.0	0.0
7	DN	DN Installation of partial discharge monitors	33823	Sustaining	Provide a means of assessing stator winding conditions in the Main Generator and Primary Heat Transport Pump Motors.	May-07	Jan-14	7.1	0.1	0.0	0.0	0.0	0.0	0.0
8	DN	FH Computer Replacement	33815	Sustaining	Replace obsolete components of the fuel handling system control computers.	Aug-05	Nov-17	14.8	1.1	1.2	1.1	0.0	0.0	0.0
9	DN	DN MOT Capital Spares	36002	Sustaining	Mitigate the risk of a forced outage due to Main Output Transformer failure by acquiring two spare transformer phases to facilitate a planned refurbishment programme.	Aug-11	Jul-16	8.3	7.6	0.0	0.0	0.0	0.0	0.0
10	IMS	OPGN Pressure Tube to Calandria Tube Gap	66255	Value Enhancing	Develop capability to directly measure the gap between the pressure tube and the calandria tube.	Feb-10	Sep-14	17.5	0.0	0.0	0.0	0.0	0.0	0.0
11	IMS	IMS CIGAR Gap System and Drive Reliability	66594	Sustaining	Improve the reliability, operability and functionality of CIGAR (Channel Inspection and Gauging Apparatus for Reactors) system.	Jun-12	Jun-17	11.7	4.5	4.8	0.0	0.0	0.0	0.0
12	PN	PB Main Generator AVR and Protective Relay Upgrade	40680	Sustaining	Replace analog automatic voltage regulator and electromechanical protective relays with new digital devices.	Feb-10	Jun-15	18.8	0.1	0.0	0.0	0.0	0.0	0.0
13	PN	PB EPG Protective Relays	40691	Sustaining	Replace obsolete Emergency Power Generator protective relays with new digital relays to improve availability.	Feb-12	May-19	11.0	4.4	1.0	2.5	2.7	0.0	0.0
14	PN	Standby Generator Reliability	40972	Sustaining	Improve reliability and availability of the unit 012/034 Standby Generators (SG) by addressing obsolescence, lack of spare parts, maintenance and performance issues.	Apr-12	Nov-17	13.8	5.8	5.9	0.0	0.0	0.0	0.0
15	PN	PA Passive Auto-Catalytic Recombiners	46605	Regulatory	Install passive auto-catalytic recombiners for long-term post-accident hydrogen mitigation.	Jan-10	May-14	14.4	0.1	0.0	0.0	0.0	0.0	0.0

Table continues on Ex. D2-1-3 Table 2b

Notes:
1 Projects with expenditures during Test Period OR In-Service Amounts in Bridge or Test Period, AND Completed/Deferred Projects (from EB-2013-0321 or
2 "Total Project Cost" reflects BCS amounts, with the exception of Completed/Deferred Projects (for which actual costs are shown).

Numbers may not add due to rounding.

Table 2b
Capital Project Listing - Nuclear Operations Facility Projects
Projects $5M - $20M Total Project Cost[1]

Line No.	Facility	Project Name	Project Number	Category	Project Description	Start Date	Final In-Service Date	Total Project Cost[2] ($M)	In-Service 2016 ($M)	In-Service 2017 ($M)	In-Service 2018 ($M)	In-Service 2019 ($M)	In-Service 2020 ($M)	In-Service 2021 ($M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
		ONGOING PROJECTS FROM EB-2013-0321 (Continued from Ex. D2-1-3 Table 2a)												
16	PN	PB SG/EPG Fire Detection Upgrade and CO2 Suppression Removal	49116	Sustaining	Ensure fire compliance for the Standby Generator, Standby Generator Oil Pump and Emergency Water & Power System buildings including a reliiable and maintainable fire detection system.	Feb-10	Jul-16	10.7	1.2	0.2	0.0	0.0	0.0	0.0
17	PN	PB RBSW Dechlorination & MISA Cleanup	49132	Regulatory	Replace temporary dechlorination system for the Reactor Building Service Water discharge with a permanent system with improved sampling points.	May-11	Oct-16	14.1	13.5	0.6	0.0	0.0	0.0	0.0
18	PN	PB Replacement of Containment Box-up Monitors	49134	Sustaining	Replace obsolete ventilation exhaust radioactivity monitors	Dec-10	May-15	8.8	0.2	0.0	0.0	0.0	0.0	0.0
19	PN	PN Fire Code Compliance for Relocatable Structures in Un-Zoned Area for Pickering Station	49146	Regulatory	Ensure compliance with Canadian Standards Association N293-07 Fire Protection for CANDU Nuclear Plants for relocatable structures in the unzoned area.	Dec-11	Jul-16	16.0	12.4	0.3	0.0	0.0	0.0	0.0
20	PN	PB LP Spindles Refurbishment Cap Spares	49150	Sustaining	Refurbish existing Pickering A low pressure spindles to allow use in Pickering B and support turbine maintenance strategy through 2020.	Aug-11	Aug-14	4.3	0.0	0.0	0.0	0.0	0.0	0.0
21	PN	PB Replacement of Obsolete Instrumentation and Control Equipment	49154	Sustaining	Replace critical obsolete instrumentation and control equipment.	Aug-11	Jun-18	6.8	1.0	1.2	0.3	0.0	0.0	0.0
22	PN	PN Standby Boiler Capacity Improvement	49267	Regulatory	Provide reliable backup heating steam.	Dec-08	Nov-15	6.4	0.1	0.0	0.0	0.0	0.0	0.0
23	PN	PN Administration Building Rehab	49284	Sustaining	Complete rehabilitation of the Administration Building to support operations and post-operations activities.	Oct-09	Nov-14	19.4	0.3	0.0	0.0	0.0	0.0	0.0
24	PN	PA Class II Emergency Lighting	49296	Regulatory	Upgrade emergency lighting to meet electrical codes and address employee safety concerns.	Aug-11	Jul-15	6.1	0.1	0.0	0.0	0.0	0.0	0.0
25		**Subtotal**						282.7	63.8	28.0	8.8	2.7	0.7	0.0
	Table continues on Ex. D2-1-3 Table 2c													

Notes:
1 Projects with expenditures during Test Period OR In-Service Amounts in Bridge or Test Period, AND Completed/Deferred Projects (from EB-2013-0321 or subsequent).
2 "Total Project Cost" reflects BCS amounts, with the exception of Completed/Deferred Projects (for which actual costs are shown).

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Table 2c
Capital Project Listing - Nuclear Operations Facility Projects
Projects $5M - $20M Total Project Cost[1]

Line No.	Facility	Project Name	Project Number	Category	Project Description	Start Date	Final In-Service Date	Total Project ($M)	In-Service 2016 ($M)	In-Service 2017 ($M)	In-Service 2018 ($M)	In-Service 2019 ($M)	In-Service 2020 ($M)	In-Service 2021 ($M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
		COMPLETED/CANCELLED PROJECTS FROM EB-												
26	DN	DN F/H RAB Independent Power and Control System	31426	Sustaining	Provide independent power and control to the Reactor Area Bridge to increase opportunities to perform fuel handling system maintenance.	Dec-11	Jul-13	5.5	0.0	0.0	0.0	0.0	0.0	0.0
27	DN	FH Power Track Improvement	31438	Sustaining	Install a video surveillance system to monitor operation and condition of the fuel handling power track system	May-07	Nov-12	16.2	0.0	0.0	0.0	0.0	0.0	0.0
28	DN	DN Suit and Maintenance Communication Replacement	34006	Sustaining	Replace the suit and maintenance communication system, which provides multi-party voice communication for personnel working in clean and radioactive areas.	Feb-11	Cancelled	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	DN	DN Feeder Replacement ALARA/Optimization	34008	Sustaining	Provide tooling and capability to optimize feeder replacements, fuel channel reconfiguration and single fuel channel replacements while minimizing dose.	Aug-09	Jan-14	14.0	0.0	0.0	0.0	0.0	0.0	0.0
30	DN	RM Replacement Tooling (Transfer to MFA when project complete)	34111	Sustaining	Develop tooling for the replacement of reactivity mechanisms.	Oct-01	Mar-12	8.5	0.0	0.0	0.0	0.0	0.0	0.0
31	IMS	Upper Feeder Cabinet Inspection Robot	66266	Sustaining	Develop robotic tooling to perform visual inspections in the feeder insulation cabinets.	Jun-06	Apr-11	5.0	0.0	0.0	0.0	0.0	0.0	0.0
32	IMS	ANDE/CIGAR Hybrid	66423	Sustaining	Increase the speed of fuel channel inspections by integrating the ANDE (Advanced Non-Destructive Examination) probe with the CIGAR (Channel Inspection and Gauging Apparatus for Reactors) delivery system.	Apr-09	Nov-13	9.9	0.0	0.0	0.0	0.0	0.0	0.0
33	IMS	Multiple Simultaneous Inspections for Feeders	66533	Value Enhancing	Develop tooling to perform thickness measurements on multiple feeders concurrently with less passes to reduce the amount of time required to perform inspections.	Dec-10	Cancelled	0.5	0.0	0.0	0.0	0.0	0.0	0.0
34	PN	PB Airlocks System Relief Valve Replacements for Regulatory Compliance	40873	Sustaining	Replace obsolete airlock relief valves with new seismically qualified valves and add an alternative air supply to ensure containment is maintained.	Sep-09	Aug-12	8.5	0.0	0.0	0.0	0.0	0.0	0.0
35	PN	PA ECI Strainer Capacity Margin (Capital)	40984	Regulatory	Improve capacity of the emergency coolant injection system strainers to improve design margins.	May-12	May-13	5.3	0.0	0.0	0.0	0.0	0.0	0.0
36	PN	Pickering 1&4 Turbine Governor System Upgrade	41013	Sustaining	Replace the existing turbine mechanical governors with new hydraulic pressure converters including new auxiliary components for turbine monitoring and control.	Jun-12	Cancelled	17.5	0.0	0.0	0.0	0.0	0.0	0.0
37	PN	PB EPG Control Upgrade	49110	Sustaining	Replace obsolete emergency power generator controls to ensure availability.	Mar-06	Dec-11	15.9	0.0	0.0	0.0	0.0	0.0	0.0
38	PN	PB Powerhouse Office Facilities (Capital)	49126	Sustaining	Upgrade offices inside the powerhouse to meet HVAC (heating, ventilation and air conditioning), building and fire codes.	May-09	Cancelled	6.7	0.0	0.0	0.0	0.0	0.0	0.0
39	PN	Pickering VBO Valve Replacement Program	49137	Sustaining	Replace life-expired negative pressure containment and emergency coolant injection valves during the Vacuum Building Outage.	Jun-10	Jun-10	7.9	0.0	0.0	0.0	0.0	0.0	0.0
40	PN	Pickering Fish Diversion System	49280	Regulatory	Install full barrier screen in Pickering inlet channel to divert fish and reduce fish mortality per CNSC requirements.	Feb-09	Jul-11	10.5	0.0	0.0	0.0	0.0	0.0	0.0
41	PN	PA Fixed Area Gamma Monitor Replacements	49282	Sustaining	Replace obsolete fixed area gamma monitors.	Nov-09	Dec-12	8.1	0.0	0.0	0.0	0.0	0.0	0.0
42	PN	PA PH Emerg Vent Syst Long Term Fix	49283	Sustaining	Replace obsolete progammable logic controllers and revise logic.	Jun-07	Dec-11	4.4	0.0	0.0	0.0	0.0	0.0	0.0
43	PN	PB Radioactive Emission Reduction (EV-005)	79140	Sustaining	Improve the radioactive emissions monitoring and control performance per CNSC Power Reactor Operating License requirements.	Mar-99	Jun-12	10.6	0.0	0.0	0.0	0.0	0.0	0.0
44		Subtotal						151.0	0.0	0.0	0.0	0.0	0.0	0.0

Table continues on Ex. D2-1-3 Table 2d

Notes:
1 Projects with expenditures during Test Period OR In-Service Amounts in Bridge or Test Period, AND Completed/Deferred Projects (from EB-2013-0321 or
2 "Total Project Cost" reflects BCS amounts, with the exception of Completed/Deferred Projects (for which actual costs are shown).

Table 2d
Capital Project Listing - Nuclear Operations Facility Projects
Projects $5M - $20M Total Project Cost[1]

Line No.	Facility	Project Name	Project Number	Category	Project Description	Start Date	Final In-Service Date	Total Project Cost[2] ($M)	In-Service 2016 ($M)	In-Service 2017 ($M)	In-Service 2018 ($M)	In-Service 2019 ($M)	In-Service 2020 ($M)	In-Service 2021 ($M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
		PROJECTS NOT IN EB-2013-0321												
45	DN	DN Dryer PLC Replacement	31420	Sustaining	Replace obsolete programmable logic controllers	Feb-14	Mar-22	12.2	0.0	0.0	2.7	0.0	2.6	1.1
46	DN	DN Containment Button-up Activity Monitors Replacement	31432	Regulatory	Replace aging and obsolete radioactivity monitors used to button up the Negative Pressure Containment System on high activity.	Nov-13	Oct-19	8.0	0.0	1.2	1.8	2.8	0.8	0.0
47	DN	DN Computer Upgrade for HWMS (TRF/SUP)	31436	Sustaining	Upgrade obsolete Heavy Water Management System computers that control Tritium Removal Facility and Station Upgrader operations.	Oct-12	Feb-16	5.9	3.7	0.0	0.0	0.0	0.0	0.0
48	DN	DN Replacement of Obsolete Online Chemistry Analysers	31520	Sustaining	Replace obsolete online chemistry analysers	Oct-12	Nov-17	10.6	4.3	4.3	0.0	0.0	0.0	0.0
49	DN	DN RRS Logic Module Redesign	31534	Sustaining	Redesign the Regulator Regulating System logic modules to address spurious rod movements as well as addressing obsolescence of current modules.	Dec-13	May-26	9.9	0.0	0.0	0.0	0.0	0.0	5.3
50	DN	DN Feedwater Chemistry Control Improvements	31548	Sustaining	Install improved feedwater chemistry monitoring and connections for portable filtration.	Nov-13	Nov-22	10.3	0.0	2.2	1.8	2.1	0.0	0.0
51	DN	DN Fukushima Phase 2 Beyond Design Basis Event Emergency Mitigation Equipment	32202	Regulatory	Provide capability to respond to Beyond Design Basis Events following the events at Fukushima Daiichi Nuclear Power Plant.	Sep-11	Dec-17	28.0	8.9	7.8	0.1	0.0	0.0	0.0
52	DN	DN EPG Power Turbine Capital Spare	36004	Regulatory	Purchase a spare Emergency Power Generator power turbine to mitigate risk of engine failure.	May-13	Mar-17	8.1	0.0	4.5	0.0	0.0	0.0	0.0
53	DN	DN CSA Sewage Line and Sump Emergency Connections	38466	Sustaining	Replace corroded and degraded sewage piping from Central Services Area and add emergency connections to allow sewage truck to empty sump in emergencies.	Jul-13	Dec-17	7.9	0.0	6.4	0.1	0.0	0.0	0.0
54	DN	DN ESW Pipe and Component Replacement	73397	Sustaining	Replacement of degraded Emergency Service Water piping, valves and tanks during the 2015 Vacuum Building Outage.	Feb-14	Sep-15	6.7	0.3	0.0	0.0	0.0	0.0	0.0
55	DN	DN Large Steam Generator LCV Replacement	80023	Sustaining	Install new large Steam Generator level control valve actuators, valve trims and positioners to address operational and maintenance issues with current valves.	Jan-15	Oct-22	18.3	0.0	0.0	2.7	2.5	2.6	0.0
56	DN	DN R22 Refrigerant ACU Replacement	80036	Regulatory	Replace 51 air conditioning/dehumidifying units containing refrigerant R22 with units using approved non-ozone depleting refrigerant.	Jan-16	Oct-21	14.9	0.0	0.0	3.9	4.1	3.8	0.0
57	DN	DN Feeder Scanner Replacement (CMFA)	80070	Sustaining	Replace permanent feeder scanner equipment with portable system that can be setup outside of containment prior to use.	May-14	Mar-19	8.0	0.0	1.8	1.8	3.4	0.0	0.0
58	DN	DN FHA and FSSA Modifications	80151	Regulatory	Implement modifications required for compliance to Canadian Standards Association N293-07 Fire Protection for Nuclear Power Plants identified in the updated Fire Hazard Assessment and Fire Safe Shutdown Analysis prepared during the Integrated Safety Review and committed in the Integrated Implementation Plan	Nov-15	Jan-19	6.8	0.0	0.0	0.5	4.7	0.0	0.0
59	DN	DN Irradiated Fuel Discharge Mechanism Major Component Replacement	82841	Sustaining	Replace the shuttle cylinders and other major components of the Irradiated Fuel Discharge system which are approaching end of design life.	Nov-15	Dec-22	5.9	0.0	0.0	0.0	0.0	0.0	5.2
		Table continues on Ex. D2-1-3 Table 2e												

Notes
1 Projects with expenditures during Test Period OR In-Service Amounts in Bridge or Test Period, AND Completed/Deferred Projects (from EB-2013-0321 or
2 "Total Project Cost" reflects BCS amounts, with the exception of Completed/Deferred Projects (for which actual costs are shown).

Numbers may not add due to rounding

Table 2e
Capital Project Listing - Nuclear Operations Facility Projects
Projects $5M - $20M Total Project Cost[1]

Line No.	Facility	Project Name	Project Number	Category	Project Description	Start Date	Final In-Service Date	Total Project Cost[2] ($M)	In-Service 2016 ($M)	In-Service 2017 ($M)	In-Service 2018 ($M)	In-Service 2019 ($M)	In-Service 2020 ($M)	In-Service 2021 ($M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)
		PROJECTS NOT IN EB-2013-0321 [Continued from Ex. D2-1-3 Table 2d]												
60	DN	DN Station Lighting Retrofit	31516	Sustaining	Replace obsolete fluorescent lighting in powerhouse with new efficient LED lights	Dec-12	Deferred	11.4	0.0	0.0	0.0	0.0	0.0	0.0
61	DN	DN T/G Lube Oil Purifier Replacement	31536	Sustaining	Replace obsolete turbine lubricating oil purifier used to remove contaminants and metal from lubricating oil during operation	Nov-12	Apr-17	7.0	2.0	1.0	0.0	0.0	0.0	0.0
62	DN	DN TRF CRS TOSS/Turbine Replacement	31701	Sustaining	Replace the Tritium Removal Facility Cryogenic Refrigeration System turbine oil supply system and hydrogen expander turbine with a dynamic gas bearing (oil-free) turbine	Jan-14	May-17	7.9	0.0	7.0	0.0	0.0	0.0	0.0
63	DN	DN Vapour Recovery Button-Up Valve Replacements	31706	Sustaining	Replace aging vapour recovery containment button-up valves with new design less prone to passing	Dec-13	Jun-18	13.2	0.0	2.6	5.1	2.6	0.0	0.0
64	DN	TRF Tritium Emissions Reduction Project	38942	Sustaining	Install an adsorbent dryer system and improved stack monitoring to reduce tritium emissions	Oct-12	Jun-17	7.1	0.0	5.5	0.0	0.0	0.0	0.0
65	DN	DN Standby Generators Protective Relay Replacement	80063	Sustaining	Replace 51 air conditioning/dehumidifying units containing refrigerant R22 with units using approved non-ozone depleting refrigerant.	-	Jun-21	9.9	0.0	0.0	0.0	1.8	3.7	1.8
66	DN	DN X-750 Spacer Retrieval CMFA	82949	Regulatory	Develop tooling for the retrieval of fuel channel spacers during unit refurbishment.	Sep-15	Nov-18	6.4	5.5	0.1	0.0	0.0	0.0	0.0
67	PN	PB Machine Guarding Improvement on Low Risk Equipment (Capital)	40983	Regulatory	Install machine guarding on equipment to comply with Ministry of Labour requirements.	Nov-12	Dec-16	8.1	0.9	0.0	0.0	0.0	0.0	0.0
68	PN	PN Replacement of Obsolete Online Chemistry Analysers	40985	Sustaining	Replace obsolete online chemistry analyzers.	Oct-12	Jun-17	18.5	6.1	6.0	0.5	0.0	0.0	0.0
69	PN	Pickering PDM Program Review Project (Capital)	41030	Sustaining	Install predictive maintenance monitoring equipment and cabling on critical equipment to improve reliability.	Jan-13	Dec-18	10.6	0.0	4.4	3.3	0.1	0.0	0.0
70	PN	PN Emergency Power Generator Engine Replacement	41043	Sustaining	Replace the Emergency Power Generator gas turbine engines.	Dec-14	Jun-17	18.3	6.5	5.0	0.1	0.0	0.0	0.0
71	PN	PA SG Protective Relay Upgrade	41044	Sustaining	Replace obsolete electromechanical protective relays with digital units.	Jan-14	May-17	7.7	4.2	1.8	0.4	0.0	0.0	0.0
72	PN	PB Screenhouse Trash Bar Screen Replacement	49140	Sustaining	Upgrade trash bar screens to handle the debris currently experienced from Lake Ontario.	Mar-11	Jun-15	7.7	0.3	0.0	0.0	0.0	0.0	0.0
73	PN	PA Replacement of U1, U4 and IFB-A Stack Monitors	49298	Sustaining	Replace obsolescent stack monitors with monitors used in Pickering B.	Nov-12	Dec-17	9.8	4.5	2.4	0.0	0.0	0.0	0.0
74	PN	PA Firewater Buried Ring Header Replacement	80069	Sustaining	Proactively replace buried sections of the Pickering Units 1 to 4 fire water header subject to frequent failures due to poor material selection	Nov-14	Dec-17	12.0	5.1	5.2	0.7	0.0	0.0	0.0
75	SEC	Security Project A	25918	Regulatory	Security Protected	Oct-15	Jul-16	9.9	8.8	0.0	0.0	0.0	0.0	0.0
76	SEC	SES Station Personnel Emergency Accounting	80027	Regulatory	Install automated emergency personnel accounting systems in Darlington and Pickering	Dec-14	Dec-16	9.0	2.9	0.0	0.0	0.0	0.0	0.0
77		**Subtotal**						331.7	61.9	68.8	25.5	24.1	13.5	13.3
78		**Total**						765.3	125.6	96.8	34.3	26.8	14.2	13.3
		DIVISION TOTALS:												
79		**Darlington**							42.5	57.8	26.5	23.9	14.2	13.3
80		**Pickering**							66.9	34.1	7.8	2.8	0.0	0.0
81		**Nuclear Support Divisions**							16.2	4.9	0.0	0.0	0.0	0.0
82		**Total**							125.6	96.8	34.3	26.8	14.2	13.3

Notes:
1 Projects with expenditures during Test Period OR In-Service Amounts in Bridge or Test Period, AND Completed/Deferred Projects (from EB-2013-0321 or subsequent)
2 "Total Project Cost" reflects BCS amounts, with the exception of Completed/Deferred Projects (for which actual costs are shown)

Numbers may not add due to rounding.

Table 3
Capital Project Listing - Nuclear Operations Facility Projects
Projects < $5M Total Project Cost[1]

Line No.	Sponsoring Division	Number of Projects	Total Project Cost ($M)	Average Cost Of All Projects ($M)	In-Service 2016 ($M)	In-Service 2017 ($M)	In-Service 2018 ($M)	In-Service 2019 ($M)	In-Service 2020 ($M)	In-Service 2021 ($M)
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
1	**Darlington NGS**	28	96.4	3.4	38.7	22.1	8.0	4.2	0.8	0.7
2	**Pickering NGS**	30	81.5	2.7	18.5	6.9	3.3	0.0	0.0	0.0
3	**Nuclear Support Divisions[2]**	13	10.4	0.8	0.4	2.0	3.6	0.0	0.0	0.0
4	**Total**	71	188.2	2.7	57.6	31.0	14.9	4.2	0.8	0.7

Notes:
1 Projects with expenditures during Test Period, or In-Service Amounts in Bridge or Test Period.
2 Nuclear Support Divisions with capital projects includes Engineering, Inspection and Maintenance Services, and Security & Emergency Services.

Table 6
Capital Projects - Nuclear Operations
Listing of Business Case Summaries Filed

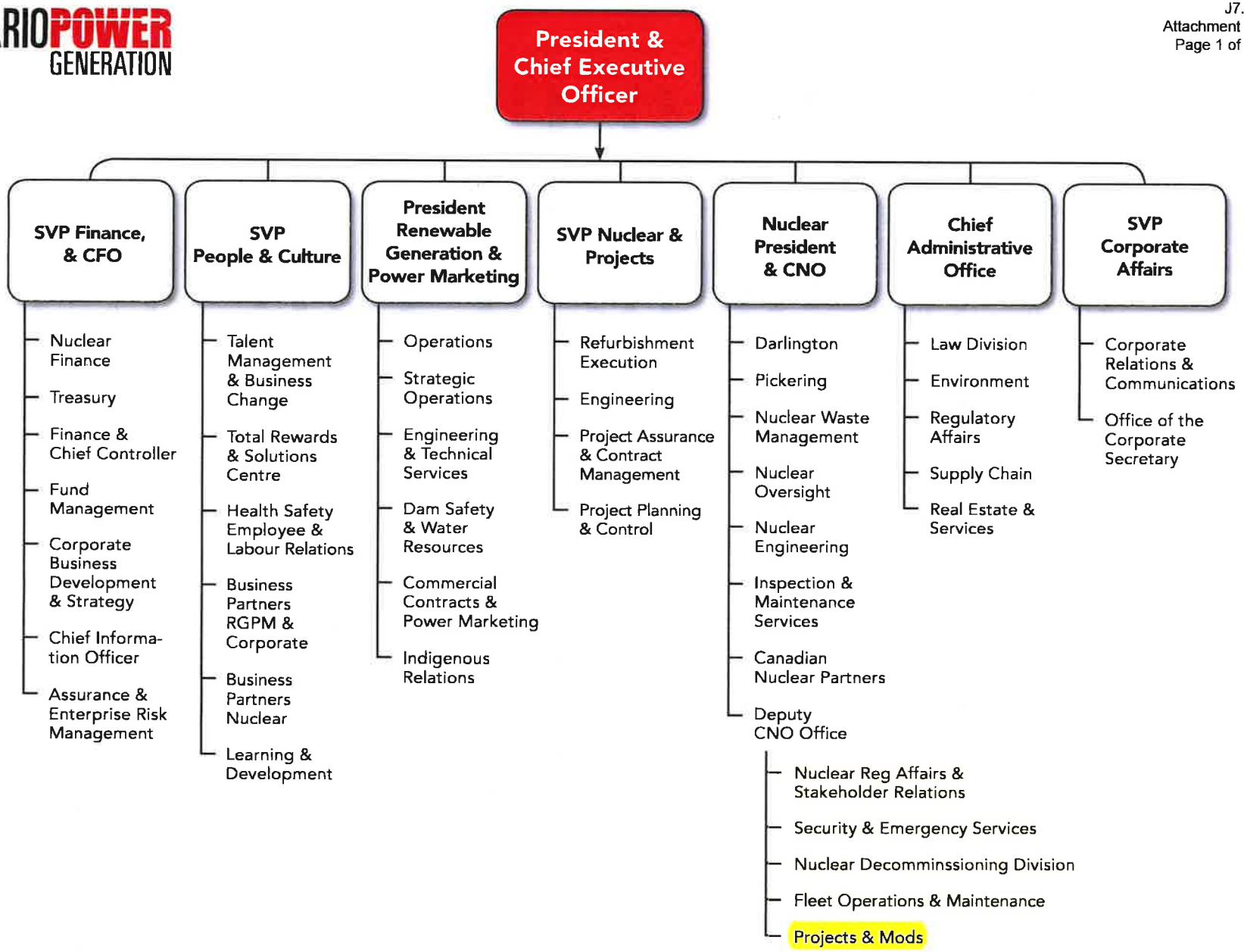
Line No.	Facility	Business Case Summary (BCS) Title	Project Number	BCS Approval Date	Project Stage	BCS Status	BCS Status in EB-2013-0321
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
		ONGOING PROJECTS FROM EB-2013-0321					
1	DN	Operations Support Building Refurbishment	25619	Aug-15	Execution	Full	Definition Full
2	DN	Class II Uninterruptible Power Supplies Replacement	31412	Sep-15	Execution	Partial	Definition Full
3	DN PN	Fukushima Phase 1 Beyond Design Basis Event Emergency Mitigation Equipment	31508 49158 49299	May-15	Execution	Partial	Execution Partial
4	DN	Improve Maintenance Facilities	31717	Mar-12	Execution	Full	Execution Partial
5	DN	Secondary Control Area Air Conditioning Unit Replacement	33621	Aug-15	Execution	Partial	Execution Partial
6	DN	Chiller Replacement to Reduce CFC Emissions	33631	Sep-10	Execution	Full	Execution Full
7	DN	Major Pump-sets Vibration Monitoring System Upgrades	33819	Oct-15	Execution	Partial	Execution Partial
8	DN	Shutdown System Computer Aging Management	33955	Feb-15	Execution	Superceding	Execution Full
9	DN	Standby Generator Controls Replacement	33973	May-15	Execution	Partial	Execution Partial
10	DN	Digital Control Computer Replacement / Refurbishment / Upgrades	33977	Jun-13	Execution	Superceding	Execution Full
11	DN	Auxiliary Heating System	34000	Jul-15	Execution	Partial	Execution Partial
12	DN	Primary Heat Transport Pump Motor Capital Spares	36001	May-13	Execution	Superceding	Execution Full
13	PN	Unit 1 & 4 Fuel Channel East Pressure Tube Shift Reconfigure	41023 49247	Sep-14	Execution	Superceding	N/A
14	PN	Pickering A Fuel Handling Single Point of Vulnerability Equipment Reliability Improvement	46634	May-12	Execution	Full	Execution Partial
		COMPLETED/DEFERRED/CANCELLED FROM EB-2013-0321					
15	PN	Pickering B Standby Generator Governor Upgrade	49109	Mar-07	Execution	Full	Execution Full
16	PN	Modify/Replace Fiber Reinforced Plastic Components During 2010 Vacuum Buiding Outage	49285	Apr-10	Complete	Complete	Superceding
17	ENG	Feeder Repair by Weld Overlay	62568	May-09	Deferred	Full (OM&A)	Full (OM&A)
		PROJECTS NOT IN EB-2013-0321					
18	DN	Restore Emergency Service Water and Firewater Margins	31518	Feb-14	Definition	Full	N/A
19	DN	Station Roofs Replacement	31524	Nov-12	Deferred	Partial	N/A
20	DN	Powerhouse Water Air Conditioning Units Replacement	31532	Feb-15	Definition	Partial	N/A
21	DN	Water Treatment Plant Replacement	31535	Oct-12	Definition	Full	N/A
22	DN	Transformer Multi-Gas Analyzer Installation	31542	May-15	Execution	Full	N/A
23	DN	Radiation Detection Equipment Obsolescence	31544	Jan-14	Definition	Partial	N/A
24	DN	Condenser Circulating Water and Low Pressure Service Water Travelling Screens Replacement	31552	Jun-15	Execution	Partial	N/A
25	DN	Shutdown Cooling Heat Exchanger Replacement	31710	Apr-14	Execution	Partial	N/A
26	DN	Neutron Overpower & Ion Chamber Amplifier Replacement (Reactor Regulating System, Shutdown System 1 & Shutdown System 2)	31716	Oct-15	Definition	Partial	N/A
27	DN	Zebra Mussel Mitigation Improvements	38948	Oct-15	Execution	Partial	N/A
28	DN	Highway 401 and Holt Road Interchange	73706	Nov-13	Execution	Full	N/A
29	DN	OH180 Aging Management Hardware Installation	80022	Dec-14	Definition	Full	N/A
30	DN	Digital Control, Common Process and Sequence of Events Monitoring	80078	Nov-15	Definition	Partial	N/A
31	DN	Generator Stator Core Spare	80111	Sep-15	Execution	Full	N/A
32	DN	Vault Cooling Coil Replacement	82816	Dec-15	Execution	Partial	N/A
33	DN	Primary Heat Transport Pump Motor Replacement/Overhaul[7]	73566	Jul-15	Execution	Partial	N/A
34	PN	Pickering B Fuel Handling Reliability Modifications	40976	Jun-15	Execution	Partial	N/A
35	PN	Fukushima Phase 2 Beyond Design Basis Event Emergency Mitigation Equipment	41027	Aug-15	Execution	Partial	N/A
36	IMS	Machine Delivered Scrape	66600	Jul-15	Execution	Partial	N/A

for steam generators and fuel channels), engineering programs, selected systems (such as real-time process computers and security), chemistry, cyber security, human factors engineering, plant information systems, and administration of the nuclear research and development program.

- Design Engineering provides design services such as, preparation of modifications; parts procurement support; and expert-level support on nuclear industry codes and standards for the nuclear stations and the Decommissioning and Nuclear Waste Management organization.
- Engineering Strategy provides strategic support to Nuclear Engineering long range planning, develops international relationships and provides strategic advice on matters relating to CANDU technology, represents OPG Nuclear with international nuclear industry bodies and oversees Nuclear Engineering projects.
- Nuclear Safety provides oversight of technical support provided to the stations by the Reactor Safety Engineering Departments, and specialized services in the areas of Fuel, Nuclear Safety Analysis and Probabilistic Risk Assessment.
- Nuclear Waste provides engineering strategies for the efficient and effective management of used fuel and Low and Intermediate Level Waste ("L&ILW"), and safety assessments of Nuclear Waste Management facilities and transportation systems.
- Station Engineering is responsible for specifying engineering requirements, concurrence to schedule and acceptance of engineering products and services provided to support safe operation of the plant. It also ensures the Safety Operating Envelope and the Design and Licensing Basis for the plant are maintained by exercising prescriptive authority for the definition of operating and outage scope of work associated with these basis documents.

Projects and Modifications is accountable for executing or managing the execution of the majority of project work carried out at the generating stations and associated sites. Project work (in contrast to base OM&A work) is discussed in Ex. D2-1-1. While the Projects and Modifications function is primarily funded by project OM&A and capital (Ex. F2-3-1 and Ex.

ONTARIO POWER GENERATION



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Numbers may not add due to rounding.

Table 4
Comparison of In-Service Capital Additions - Nuclear Operations ($M)

Line No.	Business Unit	2013 Budget	(c)-(a) Change	2013 Actual	(g)-(c) Change	2014 OEB Approved	(g)-(e) Change	2014 Actual	(k)-(g) Change	2015 OEB Approved	(k)-(i) Change	2015 Actual
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
1	Darlington NGS	89.9	(10.0)	79.9	(48.8)	43.8	(12.8)	31.1	75.9	7.7	99.3	107.0
2	Pickering NGS	53.6	41.3	94.9	(26.2)	48.8	19.9	68.7	3.0	12.5	59.1	71.7
3	Nuclear Support Divisions[1]	17.4	10.2	27.6	(1.6)	6.4	19.6	26.0	(22.9)	0.7	2.4	3.1
4	Subtotal	160.8	41.6	202.4	(76.7)	99.1	26.7	125.7	56.0	20.9	160.9	181.8
5	Supplemental In-Service Forecast[2]	0.0	0.0	0.0	0.0	37.9	(37.9)	0.0	0.0	99.1	(99.1)	0.0
6	Total Portfolio In-Service Forecast	160.8	41.6	202.4	(76.7)	137.0	(11.3)	125.7	56.0	120.0	61.7	181.8
7	Minor Fixed Assets	19.9	(9.7)	10.2	12.6	21.3	1.6	22.9	(0.5)	21.7	0.6	22.3
8	Total In-Service Capital Additions	180.7	31.9	212.6	(64.0)	158.3	(9.7)	148.6	55.5	141.7	62.4	204.1

Line No.	Business Unit	2015 Actual	(c)-(a) Change	2016 Budget	(e)-(c) Change	2017 Plan	(g)-(e) Change	2018 Plan	(j)-(g) Change	2019 Plan	(k)-(i) Change	2020 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
9	Darlington NGS	107.0	224.5	331.4	(150.1)	181.3	(29.4)	152.0	10.4	162.4	(102.4)	60.0
10	Pickering NGS	71.7	93.2	164.9	(78.9)	86.0	(70.2)	15.8	(13.0)	2.8	(2.8)	0.0
11	Nuclear Support Divisions[1]	3.1	13.9	17.1	(10.1)	6.9	(3.3)	3.6	(3.6)	0.0	0.0	0.0
12	Subtotal	181.8	331.6	513.4	(239.1)	274.3	(102.9)	171.4	(6.2)	165.2	(105.3)	60.0
13	Supplemental In-Service Forecast[2]	0.0	(47.4)	(47.4)	136.1	88.7	35.1	123.8	(68.8)	55.0	150.7	205.7
14	Total Portfolio In-Service Forecast	181.8	284.3	466.0	(103.0)	363.0	(67.7)	295.2	(75.0)	220.2	45.4	265.6
15	Darlington New Fuel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.3	15.3
16	Minor Fixed Assets	22.3	8.7	31.0	(5.0)	26.0	(6.0)	20.0	(0.9)	19.1	0.4	19.5
17	Total In-Service Capital Additions	204.1	292.9	497.0	(108.0)	389.0	(73.7)	315.2	(75.9)	239.3	61.1	300.4

Line No.	Business Unit	2020 Plan	(c)-(a) Change	2021 Plan
		(a)	(b)	(c)
18	Darlington NGS	60.0	(21.3)	38.7
19	Pickering NGS	0.0	0.0	0.0
20	Nuclear Support Divisions[1]	0.0	0.0	0.0
21	Subtotal	60.0	(21.3)	38.7
22	Supplemental In-Service Forecast[2]	205.7	(48.0)	157.6
23	Total Portfolio In-Service Forecast	265.6	(69.3)	196.3
24	Darlington New Fuel	15.3	(15.3)	0.0
25	Minor Fixed Assets	19.5	(0.1)	19.3
26	Total In-Service Capital Additions	300.4	(84.8)	215.6

Notes:
1 Includes Engineering, Inspection and Maintenance Services, and Security & Emergency Services.
2 Supplemental forecast to reconcile BCS in-service estimates to final business plan (see Ex. D2-1-3, Section 4.0).

values are rolled forward based on a forecast of in-service additions (including adjustments to ARC, if any), retirements/transfers, and depreciation/amortization on these assets.

Exhibits D2-1-3 Table 4, Ex. D2-2-10 Table 5, and Ex. D3-1-2 Table 4 summarize the forecast in-service additions for all nuclear operations, DRP, and support services, respectively. Exhibit D3-1-2 Table 5 separately presents forecast support services in-service additions that are included in total regulated rate base, and those that impact the asset service fees and therefore are not included in rate base.

A summary of the forecast nuclear in-service additions for 2016 to 2021 is provided below in Chart 1.

Chart 1

Forecast Nuclear In-service Capital Additions* ($M)

*Amounts may not add due to rounding.

	Reference	2016	2017	2018	2019	2020	2021
Nuclear operations capital projects	Ex. D2-1-3 Table 4, line 17 & 26	497.0	389.0	315.2	239.3	300.4	215.6
Darlington Refurbishment Program	Ex. D2-2-10 Table 5, line 12 & 17	350.4	374.4	8.9	0.0	4,809.2	0.4
Support services capital projects entering rate base	Nuclear Portion of Ex. D3-1-2 Table 5, lines 7,9,13 & 15	10.5	8.1	18.0	5.0	5.0	5.0
Total nuclear in-service additions, excluding ARC	Ex. B3-3-1 Table 1 & 2, col. (b)	**857.9**	**771.5**	**342.1**	**244.3**	**5,114.7**	**221.1**

The depreciation/amortization forecasts for 2016 to 2021 are determined by applying the estimated service lives and depreciation/amortization policy to the opening in-service fixed/intangible asset values and planned additions during the year. These depreciation/amortization forecasts are presented in Ex. F4-1-1 Table 2. The depreciation/amortization policy is described in Ex. F4-1-1.

PROJECT AND PORTFOLIO MANAGEMENT - NUCLEAR

1.0 PURPOSE

This evidence provides an overview of the nuclear operations project portfolio and other related project work. The project portfolio includes project OM&A, which forms part of the overall OM&A amounts in the revenue requirement, and project capital which is included in rate base when projects are completed and placed into service. This evidence also discusses the process for managing this portfolio and the forecast level of nuclear capital and project OM&A expenditures (excluding the Darlington Refurbishment Program ("DRP")) in the test period.

2.0 NUCLEAR OPERATIONS PROJECT PORTFOLIO

OPG Nuclear employs a portfolio management approach to assess and prioritize all nuclear operations projects (both project OM&A and capital). The portfolio management approach (e.g., project prioritization, project phases, approval processes, and the role of the Asset Investment Screening Committee ("AISC")) is discussed in section 3.0 below and is unchanged from that presented in EB-2013-0321.

OPG Nuclear projects within this portfolio are developed to meet regulatory commitments (e.g., from the Canadian Nuclear Safety Commission), increase system or unit reliability, address system obsolescence, or optimize station generation. Since 2010, expenditures on major capital spares have also been considered part of the capital project portfolio, due to their role in supporting system or unit reliability.

As shown in Chart 1, starting in 2014, actual and forecast nuclear operations project portfolio spending (i.e., annual capital expenditures and project OM&A) increased beyond the range of $250M to $300M (or $25M to $30M per nuclear unit) which OPG had historically targeted for project portfolio expenditures:

Chart 1

Nuclear Operations Project Portfolio Expenditures

Line No.	Category	2013 Actual	2014 Actual	2015 Actual	2016 Budget	2017 Plan	2018 Plan	2019 Plan	2020 Plan	2021 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
1	Project Portfolio - Capital	190.9	269.8	292.5	322.0	253.0	238.0	248.0	259.0	180.0
2	Project Portfolio- OM&A	87.4	80.8	100.7	78.2	98.9	90.4	81.7	83.0	86.8
3	Total Nuclear Portfolio	278.3	350.6	393.2	400.2	351.9	328.4	329.7	342.0	266.8

Overall, total average annual portfolio spending in the period 2017-2021 is $323.8M ($32.4M per unit). In conjunction with this increase in capital expenditures, various initiatives are being undertaken by OPG to improve project management, as described in section 3.2 below.

Key drivers of the changes in nuclear operations project portfolio expenditures over the 2013-2021 period are addressed in Ex. D2-1-2 (Capital Expenditures) and Ex. F2-3-1 (Project OM&A).

In addition to the nuclear project portfolio, there may also be the following capital and project OM&A expenditures:

- Capital expenditures on Minor Fixed Assets (see Ex. D2-1-2);
- Capital and project-related OM&A expenditures on special, non-recurring projects that are managed outside of the project portfolio, referred to as "Non-portfolio projects" (see Ex. D2-1-2 and Ex. F2-3-1); and,
- Capitalization of Darlington new fuel (see Ex. F2-5-1 section 2.0).

3.0 NUCLEAR PROJECT MANAGEMENT PROCESSES

3.1 Overview

The OPG corporate investment and project approval processes are outlined in Ex. A2-2-1, with further detail on asset management and project review provided in Ex. A2-2-1 Attachment 4. The nuclear project management processes are developed within that framework.

The OPG Board of Directors approves the annual nuclear projects portfolio budget during the business planning process. The annual nuclear projects portfolio budget is administered by the AISC, which determines project prioritization and allocates portfolio funding to specific projects. A separate process is used to approve a Business Case Summary ("BCS") based on the recommended projects which the AISC has prioritized and for which budgets have been allocated. The AISC consists of members from Nuclear Engineering, stations and Finance. This committee has the mandate to review project recommendations and evaluate acceptance of new projects to be added into the nuclear project portfolio from an OPG nuclear fleet perspective. The AISC evaluates the project value, relative priorities, schedules, and cost estimates of the submitted projects along with the resourcing constraints on the organization as a whole. If the AISC supports the proposal, the applicable BCS will be routed as per the Organizational Authority Register for approval of the associated funding (see Ex. A2-2-1, Attachment 4, section 3.0 for a description of OPG's approval process for BCSs and the Organizational Authority Register).

Each project BCS includes contingency in the cost estimate. However, the AISC project portfolio annual budgets do not contain contingencies. OPG expects the AISC to fully utilize the annual portfolio budgets. When a project requires contingency funds contained within the BCS approved release, a request is made by the project manager to the AISC for additional funding. If additional funding is approved, the AISC will re-allocate funding to attempt to stay within the overall project portfolio annual budget. For example, such a request could be accommodated by other projects that are completed under budget, by delaying or deferring other projects, or from AISC budget funds not yet allocated.

There are fives phases to the life cycle of a nuclear project, as follows:

(i.) Project Identification – The objective of the identification phase is to build the initial business need for the project, including an assessment of the business need, gap or opportunity. This work is funded from base OM&A. Potential projects are generally identified by Engineering through system health reviews, component condition assessments, and the life cycle plans that are prepared for major systems. Component condition assessments are continuous or periodic inspections of the condition of a

specific component so as to determine the need for preventive or remedial action. Other drivers include new or revised regulatory requirements, spare parts obsolescence, an opportunity to improve reliability based on forced loss rate analysis, or security needs. Projects with an anticipated benefit for multiple sites may be identified and sponsored by the support divisions. Station screening committees review potential projects and forward their recommendations to the AISC for approval based on the net benefit documented in business cases.

(ii.) Project Initiation – The purpose of the initiation phase is to evaluate viable alternatives and identify the initial project scope, schedule, conceptual funding and applicable stakeholders for the preferred alternative. If the review concludes that undertaking a project is the recommended solution, the next step for most projects is completion of a definition phase BCS. This phase is generally funded from the project OM&A budget. Potential projects are screened and success at this phase will lead to an allocation of future funding from either the project portfolio capital or project OM&A budget.

(iii.) Project Definition – The goal of the definition phase is to further define the project and demonstrate readiness for execution, including completion of sufficient engineering to determine bulk material requirements, development of the project cost estimate and execution plan, assessment of risk and development of mitigating plans, identification of and application for any requirements for regulatory approvals, and procurement of engineered equipment. A full release or partial release execution phase BCS is usually developed at this stage.

(iv.) Project Execution – The execution phase includes completion of detailed engineering, procurement (if not completed in the definition phase), and detailed construction/installation planning and/or physical execution of the project and commissioning work.

(v.) Project Close-out and Post-implementation Review – The close out phase is the last phase in the project life cycle and includes preparation of a project close out report and Post-Implementation Review to document final costs and lessons learned.

A project's movement through these five phases is monitored by the AISC to ensure that periodic and systematic reviews are conducted, and to provide the opportunity to redirect or

cancel the project as it is defined (in accordance with OPG's project management process) before proceeding to the next phase.

Given the amount of assessment and engineering work that is completed at each phase of a project life cycle, OPG seeks to ensure that project scope is appropriately defined prior to proceeding to the next stage in the process. A project is generally approved for execution only after project engineering, scope definition and planning execution is sufficiently complete. The scoping process, combined with the ongoing AISC review and BCS approval processes, enhances OPG's ability to bring projects to completion within budget and schedule.

3.2 Initiatives to Improve Project Management within OPG

OPG continuously seeks to improve the performance of its project management function. In 2012, OPG implemented an Engineering, Procurement and Construction ("EPC") contracting strategy with its vendors. This model established a single point of accountability for design, procurement and construction of a designated portion of a project, while OPG maintains exclusive oversight. Prior to implementing the EPC model, OPG had relied upon differerent vendors or internal resources for each of the three components. Reliance upon a single vendor responsible for all three components was expected to facilitate on-time and on-budget delivery of projects as it allows for proper adherence to procedures and schedules and reduces delays or conflicts that may occur among vendors and/or OPG during handoffs along the three stages. An EPC contracting strategy was also expected to increase OPG's project execution capabilities, allowing additional project work to be undertaken within the nuclear project portfolio to meet the station needs for regulatory and reliability improvements. Adopting an EPC contracting strategy was consistent with OPG's workforce plan for staff reductions through natural attrition by allowing OPG to optimize its resources and efforts on project oversight. Through the primary competitive process that selected vendors, OPG achieved reduction in trade labour rates and improved contract terms and conditions prior to proceeding.

In 2012, a competitive process was used to select two vendors to enter into Extended Services Master Services Agreements ("ESMSA") for EPC services. These agreements extablished a set of terms and conditions in advance, such that the procurement cycle for

executing new EPCs or any combination of engineering, procurement or construction would be significantly shortened. A summary of the ESMSA contracts is provided in Ex. D2-2-3 Attachment 5 and the contract is provided in Ex. D2-2-3 Attachment 10.

At the same time as the EPC contracting strategy was being implemented, OPG began an ambitious program to complete major prerequisite projects (Facilities and Infrastructure Projects ("F&IP")) in advance of the Darlington Refurbishment Program. These projects consisted of either new facilities and infrastructure or upgrades to the existing facilities and infrastructure. The F&IP projects included major, one-time complex undertakings such as the D2O Storage Facility and the Auxiliary Heating System ("AHS") projects and were managed by the Projects and Modifications ("P&M") organization. Despite reduced resources resulting from OPG's workforce reductions, P&M also retained its accountability for its assigned Nuclear Operations portfolio projects while undertaking the F&IP.

Projects within the nuclear project portfolio traditionally involve in-plant modifications of existing systems, new equipment installation and upgrades to existing facilities. The initial outcome from implementation of ESMSA agreements for EPC services for projects within the nuclear project portfolio saw improvements such as reduced procurement cycle time. However, as discussed extensively in EB-2013-0321, the contracting strategy using the ESMSA agreements for the larger F&IP projects proved challenging, pointing to weaknesses in project oversight and to contractor issues related to planning, scope, cost estimating, subcontractor management, and risk management. Some of these projects, including the AHS, exceeded the original cost estimates and schedules. OPG's experience with the AHS project as well as others has been used as a source of lessons learned, which have been applied to the ongoing management of these projects and also as input for continuous improvement initatives in project management within OPG Nuclear (the AHS project is discussed further in Ex. D2-1-3 section 3.4).

The five main continous improvement initiatives in project management underway are as follows:

1) Centre of Excellence for project management: OPG is currently centralizing the standards for project planning and controls, risk management, and other project management functions for all nuclear projects through the establishment of a Centre of Excellence that supports all Nuclear projects and ensures consistent deployment of the same tools, standards, processes and practices.
2) Identification of appropriate contracting strategy: OPG will pursue various contracting strategies depending on the project. OPG will consider factors such as project cost estimates, unique risks or risks that can be effectively transferred, and contactor capability/specialization or project complexity, to determine if a project specific contract agreement is needed. Where appropriate, OPG will also consider entering into other contracting agreements such as a Design Engineering Services Agreement ("DESA"), separate from the construction and execution contract. OPG will continue to use ESMSA contracting strategies where suitable. Use of project specific agreements or DESAs will allow OPG to select a contractor best suited for unique projects, optimize risk transfer, and leverage specific performance incentives to increase the probability of the project meeting cost and schedule expectations.
3) Implementing new approaches to improve ESMSA vendor project execution performance: This intiative has various components as follows:
   - OPG has added another ESMSA vendor to mitigate contractor capacity and capability risk for the projected work program.
   - OPG has implemented a Collaborative Front End Planning program that will allow more intrusive and real time oversight by OPG through collaborative planning between the vendor and OPG to ensure there is a common understanding of the project requirements and that the proposed solutions meet those requirements.
   - OPG will be physically embedding engineering resources with the contractor providing enginering services under an ESMSA agreement. This is viewed as an opportunity to provide enhanced oversight as well as reducing review cycles to shorten timelines and help mitigate risk.
4) Improving OPG's staff project management and oversight capabilities: OPG's capability to collaborate with, provide direction to, and challenge vendors to ensure projects are delivered on budget and on schedule requires a well trained and

sufficiently staffed workforce. OPG will be undertaking improvements in project management and contractor oversight training. In addition, in conjunction with the ongoing workforce planning and resource initiative, OPG will address any staffing gaps within P&M to ensure that it has sufficient resources to manage and oversee its projects.

5) Improving project cost and schedule predictability: There are two main components in this initiative, as follows:
   - Implementing a revised approval process for the Nuclear Operations project portfolio. The intent is to ensure sufficient project work has been completed to provide confidence in cost and schedule, including risk identification and contingencies for the next planned project phase. The reviews offer management an opportunity to challenge the project manager on readiness and confidence in project estimates and schedules before progressing.
   - Improved estimating of project cost and schedules by establishing common estimating practices including standardized estimating templates and checklists for preparation of project estimates, and incorporating lessons learned from previous projects. The amount of conceptual funding (funded from Base OM&A) at the project initiation phase has also been increased, consistent with industry practice, in order to improve initial estimates.

SEC Interrogatory #48

Issue Number: 4.4
Issue: Are the proposed test period in-service additions for nuclear projects (excluding those for the Darlington Refurbishment Program) appropriate?

Interrogatory

Reference:
[D2/1/3, Attach 1, Tab 1]

With respect to the Operations Support Building Refurbishment project?

a. Who was the EPC contractor for the project?

b. Why was the contract not a fixed price?

c. Please provide the original Business Case Summary.

Response

a) The EPC contractor for the project was Black & McDonald.

b) The Operations Support Building Refurbishment contract was issued following the request for proposals (RFP) and evaluation process. The RFP requested fixed price proposals. Through evaluation of the proposals submitted, OPG selected the alternative ES-MSA target price performance fee as providing best value as the fixed price proposals contained significant cost premiums.

c) See Attachment 1 which includes confidential content as marked.

The original Business Case Summary reflects the estimates in the first Execution Phase Business Case. Per OPG-STD-0017 Organizational Authority Register and OPG-STD-0076 Developing and Documenting Business Cases, OPG does not commit to the full estimated cost of a project until the first Execution Phase business case at which point most of the detailed engineering and planning is complete and procurement of engineered equipment is underway.

Witness Panel: Nuclear Operations and Projects

AMPCO Interrogatory #17

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-3 Attachment 1 Page 2 Nuclear Business Case Summary Index

Please complete the attached excel spreadsheet prepared by AMPCO.

Response

In the attached spreadsheet (Attachment 1), the values for Original Total Project Estimate, except where noted, reflect the estimates in the first Execution Phase Business Case Summary ("BCS"). Per OPG-STD-0076 Developing and Documenting Business Cases, OPG does not commit to the full estimated cost of a project until the first Execution Phase BCS at which stage most of the detailed engineering and planning is complete and procurement of engineered equipment is underway.

For reference purposes, Chart 1 lists BCS' that have been filed as attachments in response to interrogatories.

Chart 1

Project No.	BCS Title	Interrogatory
25619	Operations Support Building Refurbishment	Ex. L-4.4-15 SEC-48 Attachment 1
33955	Shutdown System Computer Aging Management	Ex. L-4.4-15 SEC-46 Attachment 1
34000	Auxiliary Heating System	Ex. L-4.4-15 SEC-46 Attachment 2
31532	Powerhouse Water Air Conditioning Units Replacement	Ex. L-4.2-1 Staff-28 Attachment 1
82816	Vault Cooling Coil Replacement	Ex. L-4.2-1 Staff-40 Attachment 1
73566 80144	Primary Heat Transport Pump Motor Replacement/ Overhaul	Ex. L-4.2-1 Staff-41 Attachment 1
66600	Machine Delivered Scrape	Ex. L-4.2-1 Staff-43 Attachment 1

Witness Panel: Nuclear Operations and Projects

4.2-AMPCO-17

Ref: D2-1-3 Attachment 1 Page 2 Nuclear Operations Facility Tier 1 Projects (>$20 million)

Tab No.	Project No.	Business Case Summary (BCS) Title	Original In-service Date[4]	Updated In-service Date[5]	Variance Months	Original Total Project Estimate[4]	Total Project Estimate Last BCS	Total Project Estimate Current BCS[5]	Variance $ h to f	Variance $ h to g
(a)	(b)	(c)	(d)	(e)		(f)	(g)	(h)		
		Projects in EB-2013-0321								
1	25619	**Operations Support Building Refurbishment**	30/Oct/15	01/Oct/15	-1	53.0	53.0	62.7	9.7	9.7
2	31412	DN Class II Uninterruptible Power Supply Replacement	01/Jun/19	01/Jun/25	72	38.4	55.1	55.1	16.7	0.0
3	31508 49158 49299	Fukushima Phase 1 Beyond Design Basis Event Emergency Mitigation Equipment	01/Aug/16	01/Dec/17	16	70.0	111.0	115.6	45.6	4.6
4	31717	Improve Maintenance Facilities at Darlington[2]	01/May/13	01/Oct/13	5	49.8	49.8	35.6	-14.2	-14.2
5	33621	Secondary Control Area Air Conditioning Unit Replacement[1]	01/Oct/14	01/Apr/17	30	12.3	19.1	28.3	16.0	9.2
6	33631	Chiller Replacement to Reduce CFC Emissions	01/Jun/09	01/Dec/17	102	14.9	14.9	30.0	15.1	15.1
7	33819	Major Pump-sets Vibration Monitoring System Upgrades	01/Apr/17	01/Jul/21	51	12.8	12.8	23.0	10.2	10.2
8	33955	Shutdown System Computer Aging Management[1]	13/Nov/16	01/Nov/15	-12	17.2	20.3	20.4	3.2	0.1
9	33973	Standby Generator Controls Replacement[1]	01/Oct/13	01/May/17	43	21.8	39.6	43.5	21.7	3.9
10	33977	Digital Control Computer Replacement / Refurbishment / Upgrades	01/Dec/10	31/Dec/18	97	22.1	22.1	24.9	2.9	2.9
11	34000	**Auxiliary Heating System**	01/Dec/15	01/Oct/17	22	45.6	99.5	107.1	61.5	7.7
12	36001	Primary Heat Transport Pump Motor Capital Spares	01/Apr/12	01/May/15	37	12.0	30.8	28.9	16.9	-1.9
13	41023 49247	Unit 1 & 4 Fuel Channel East Pressure Tube Shift/Reconfigure	01/Jan/16	01/Mar/16	2	29.3	28.8	38.6	9.3	9.8

14	46634	Pickering A Fuel Handling Single Point of Vulnerability Equipment Reliability Improvement	01/Dec/12	01/Jun/18	66	27.0	27.0	27.3	0.3	0.3
15	49109	PB Standby Generator Governor Upgrade[2]	01/Apr/08	01/Jan/15	81	22.1	23.3	22.8	0.6	-0.6
16	49285	Modify/Replace Fiber Reinforced Plastic Components During 2010 Vacuum Buiding Outage[2]	01/Jun/10	10/Jun/10	0	12.8	24.5	17.7	4.9	-6.8
17	62568	Feeder Repair by Weld Overlay	01/Jul/11	Deferred		53.2	53.2	53.2	0.0	0.0
	New Projects (Not in EB-2013-0321)									
18	31518	Restore Emergency Service Water and Firewater Margins	01/Sep/16	TBD		47.1	47.1	47.1	0.0	0.0
19	31524	Station Roofs Replacement		TBD		36.3	36.3	36.3	0.0	0.0
20	31532	Powerhouse Water Air Conditioning Units Replacement[1]	01/Jan/23	**01/Jan/23**	0	26.6	26.6	**26.6**	0.0	0.0
21	31535	Water Treatment Plant Replacement	01/Nov/16	Deferred		57.8	57.8	57.8	0.0	0.0
22	31542	Transformer Multi-Gas Analyzer Installation	01/Dec/17	01/Mar/18	3	15.2	26.7	22.7	7.6	-4.0
23	31544	Radiation Detection Equipment Obsolescence[3]	01/Dec/21	**01/Dec/22**	12	46.9	46.9	**46.9**	0.0	0.0
24	31552	Condenser Circulating Water and Low Pressure Service Water Travelling Screens Replacement	01/Nov/19	01/Jun/18	-17	24.4	24.4	37.6	13.3	13.3
25	31710	Shutdown Cooling Heat Exchanger Replacement	01/May/19	01/Sep/18	-8	56.1	56.1	56.1	0.0	0.0
26	31716	Neutron Over-Power & Ion Chamber Amplifier Replacement (Reactor Regulating System, Shutdown System 1 & Shutdown System 2)[3]	01/Jul/22	01/Jul/22	0	17.7	17.7	17.7	0.0	0.0
27	38948	Zebra Mussel Mitigation Improvements	01/Jul/16	30/Aug/17	14	21.5	21.5	29.3	7.8	7.8
28	73706	**Holt Road Interchange Upgrade**	01/Dec/15	01/Aug/16	8	31.0	31.0	24.6	-6.4	-6.4
29	80022	OH180 Aging Management Hardware Installation[3]	01/Dec/22	01/Oct/22	-2	47.2	47.2	47.2	0.0	0.0
30	80078	Digital Control, Common Process and Sequence of Events Monitoring Computer Aging Management[3]	01/Jun/25	01/Jun/25	0	47.3	47.3	47.3	0.0	0.0
31	80111	Generator Stator Core Spare	01/Jul/19	01/Jul/19	0	35.0	35.0	35.0	0.0	0.0
32	82816	Vault Cooling Coil Replacement[1]	01/Jul/20	01/Sep/20	2	26.3	26.3	18.8	-7.6	-7.6
33	73566 80144	**Primary Heat Transport Pump Motor Replacement/Overhaul**	01/Jun/22	01/Dec/19	-30	129.5	129.5	124.0	-5.5	-5.5
34	40976	Pickering B Fuel Handling Reliability Modifications[1]	01/Dec/15	01/Dec/18	36	29.0	37.3	43.0	14.0	5.7
35	41027 32202	Fukushima Phase 2 Beyond Design Basis Event Emergency Mitigation Equipment	01/Dec/17	01/Dec/17	0	74.3	74.3	75.5	1.2	1.2
36	66600	Machine Delivered Scrape	01/Jun/17	01/Jun/17	0	24.9	24.9	26.1	1.2	1.2

	629	1308	1498	1554	246.0	55.6
Variance	52				18.8%	3.6%
Less Deferred Projects &Definition Phase BCS Projects	619	955	1145	1201	25.8%	4.6%

Notes:

1. Current values reflect the amounts in the BCS approved subsequent to the filing.
2. Current values reflect the amouns in the Project Closure Report
3. Original and Current values reflect amounts in the Defintion Phase BCS and do not reflect committed values.
4. Original values reflect the amounts in the First Execution Phase BCS, except where noted.
5. Updated values reflect the current BCS, except where noted.

Red Highlighted Projects - Reclassified from DRP

AMPCO Interrogatory #20

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-3 Table 1

a) Of the nineteen Tier 1 projects listed in Table 1 as new Tier 1 projects that have been approved for execution since EB-2013-0321, please provide a listing of all of the projects that have a total project estimate that has increased in this Business Case Summary (BCS) compared to the last BCS and include the variance. For example, for the Powerhouse Water ACU Replacements project (#31532, BCS Tab 18), the last BCS total project estimate was $9.693 million, whereas this BSC indicates a total project estimate of $20.045 million.

b) For some of the projects on Table 1, the Final In-service Date is shown as 2016 or earlier but in-service additions are shown in 2016 and beyond. Please explain by project. For example, for Project #31317, the in-service date is October 2013 and $0.8 million is recorded as an in-service addition in 2016.

c) For each of the projects that have been deferred, please provide the total project estimate, the total amount spent to date and the total amount to be deferred.

d) Line 19 Project #49285: For this completed project, please explain why the Total Project Cost reflects BCS amounts and not actual amounts.

e) Column (f) Final In-service date – please provide an update to the in-service dates.

Response

a) See Ex. L-4.2-2 AMPCO-17 for the basis of comparison used in this response.

The new Tier 1 projects whose total project estimate has increased compared to the first Execution Phase BCS are shown in Chart 1.

Chart 1

Project No.	Project Name	Total Project Estimate - Last BCS (M$)	Total Project Estimate - Current BCS (M$)	Variance (M$)
31552	Condenser Circulating Water and Low Pressure Service Water Travelling Screens Replacement	24.4	37.6	13.3
40976	Pickering B Fuel Handling Reliability Modifications	37.3	43.0	5.7
66600	Machine Delivered Scrape	24.9	26.1	1.2

b) The reasons for the in-service amounts that are shown after the final in-service dates are common for all projects. The final in-service date quoted in Ex. D2-1-3 Table 1 represents the date at which the project is installed, commissioned and accepted by the operating authority at the final Available For Service Meeting. At that point, the project enters the close-out phase where the project team completes the following activities:

i) Revision of engineering drawings to reflect new configuration;
ii) Revision of design and operating manuals;
iii) Preparation of lessons-learned reports;
iv) Completion of actions identified at the Available For Service meeting;
v) Procurement and placement of spare parts in inventory;
vi) Transfer of quality records to storage;
vii) Close-out of purchase orders, and,
viii) Preparation and approval of project closure documentation.

Completion of this work typically takes about a year from the in-service date. Upon completion and approval of the project closure documentation, the cost incurred completing the above activities is transferred from construction-in-progress to fixed assets, i.e., placed in service.

c) The total project estimate, life-to-date spending and total amount deferred for the deferred projects are shown in Chart 2.

Chart 2

Project No.	Project Name	Total Project Estimate (M$)	Total Amount Life-to-Date (M$)	Total Amount Deferred (M$)
62568	Feeder Repair by Weld Overlay	53.2	0.0	53.2
31524	Station Roofs Replacement	36.3	0.8	35.4
31535	Water Treatment Plant Replacement	57.8	0.5	57.3

d) The Total Project Cost of $17.7M for project # 49285 in Ex. D2-1-3 Table 1 column (g) was the actual amount, not the BCS amount (see footnote 2 of Ex. D2-1-3 Table 1).

e) See column (e) in Ex. L-4.2-2 AMPCO-17 Attachment 1 for all projects except project # 25609 Physical Barrier. Project # 25609 was declared in-service in December 2013.

AMPCO Interrogatory #26

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-1

a) Please provide a summary of OPG's key project management performance metrics and discuss performance trends over the past five years and forecast for the test period.

Response

Key project management performance metrics used over the past five years relate to Safety, Project Schedule, and Project Cost.

The Safety metrics are All Injury Rate ("AIR") and High Maximum Reasonable Potential for Harm ("HMRPH").

The AIR metric is measured as total medical treatment plus lost time injuries/200,000 hours worked. The safety trend for OPG project staff, based on AIR, is excellent and consistently below corporate targets. The AIR target is expected to remain better than target through the test period.

The safety metric for contactor staff working on projects is HMRPH. This metric shows an increasing, (i.e., negative) trend. OPG and its contractor partners view HMRPH events as serious because even though no direct injury may have occurred, the potential for serious harm was present. OPG has actions to address this adverse HMRPH trend and expects over the test period to reverse the increasing trend.

The Project Schedule performance metric is an integrated project schedule performance index ("SPI"), which shows a declining (i.e., negative) trend. This is the result of some key projects taking longer to execute along with a significant increase in volume of project work being executed by Projects and Modifications in support of preparation for Darlington Refurbishment (see Ex. D2-2-10). Over the test period, SPI is expected to improve as lessons learned are applied, the addition of a third ES-MSA contractor is utilized, and improved project scheduling standards are implemented.

Project cost performance trend is measured using an integrated cost performance index ("CPI") across the portfolio of projects. This metric has remained constant, slightly above

target. However, there a few projects that exceeded the full BCS release and the number of projects requiring a superseding release has increased over the past five years. The project management improvement initiatives (see Ex. D2-1-1), while not expected to eliminate superseding releases, will reduce the number of projects requiring a superseding release and the magnitude of the additional budget required to complete the project.

SEC Interrogatory #48

Issue Number: 4.4
Issue: Are the proposed test period in-service additions for nuclear projects (excluding those for the Darlington Refurbishment Program) appropriate?

Interrogatory

Reference:
[D2/1/3, Attach 1, Tab 1]

With respect to the Operations Support Building Refurbishment project?

a. Who was the EPC contractor for the project?

b. Why was the contract not a fixed price?

c. Please provide the original Business Case Summary.

Response

a) The EPC contractor for the project was Black & McDonald.

b) The Operations Support Building Refurbishment contract was issued following the request for proposals (RFP) and evaluation process. The RFP requested fixed price proposals. Through evaluation of the proposals submitted, OPG selected the alternative ES-MSA target price performance fee as providing best value as the fixed price proposals contained significant cost premiums.

c) See Attachment 1 which includes confidential content as marked.

The original Business Case Summary reflects the estimates in the first Execution Phase Business Case. Per OPG-STD-0017 Organizational Authority Register and OPG-STD-0076 Developing and Documenting Business Cases, OPG does not commit to the full estimated cost of a project until the first Execution Phase business case at which point most of the detailed engineering and planning is complete and procurement of engineered equipment is underway.

Witness Panel: Nuclear Operations and Projects

Table 1
Operating Costs Summary - Nuclear ($M)

Line No.	Cost Item	2013 Actual	2014 Actual	2015 Actual	2016 Budget	2017 Plan	2018 Plan	2019 Plan	2020 Plan	2021 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
	OM&A:									
	Nuclear Operations OM&A									
1	**Base OM&A**	1,127.7	1,127.1	1,159.6	1,201.8	1,210.6	1,226.0	1,248.4	1,264.7	1,276.3
2	**Project OM&A**	105.7	101.9	115.2	98.2	113.7	109.1	100.1	100.2	86.8
3	**Outage OM&A**	277.5	221.3	313.7	321.2	394.6	393.8	415.3	394.4	308.5
4	**Subtotal Nuclear Operations OM&A**	1,510.8	1,450.3	1,588.5	1,621.3	1,718.9	1,728.9	1,763.8	1,759.4	1,671.6
5	**Darlington Refurbishment OM&A**	6.3	6.3	1.6	1.3	41.5	13.8	3.5	48.4	19.7
6	**Darlington New Nuclear OM&A**[1]	25.6	1.5	1.3	1.2	1.2	1.2	1.2	1.3	1.3
7	**Allocation of Corporate Costs**	428.4	416.2	418.8	442.3	448.9	437.2	442.7	445.0	454.1
8	**Allocation of Centrally Held and Other Costs**[2]	413.5	416.9	461.0	331.9	80.2	118.2	108.3	91.1	81.3
9	**Asset Service Fee**	22.7	23.3	32.9	28.4	27.9	27.9	28.3	22.9	20.7
10	**Subtotal Other OM&A**	896.5	864.1	915.5	805.0	599.7	598.3	584.1	608.6	577.1
11	**Total OM&A**	2,407.3	2,314.5	2,504.0	2,426.3	2,318.6	2,327.1	2,347.9	2,368.0	2,248.7
12	**Nuclear Fuel Costs**	244.7	254.8	244.3	264.8	219.9	222.0	233.1	228.2	212.7
	Other Operating Cost Items:									
13	**Depreciation and Amortization**	270.1	285.3	298.0	293.6	346.9	378.7	384.0	524.9	338.1
14	**Income Tax**	(76.4)	(61.5)	(31.8)	(18.7)	(18.4)	(18.4)	(18.4)	51.2	51.7
15	**Property Tax**	13.6	13.2	13.2	13.5	14.6	14.9	15.3	15.7	17.0
16	**Total Operating Costs**	2,859.3	2,806.2	3,027.8	2,979.4	2,881.6	2,924.4	2,961.9	3,187.9	2,868.2

Notes:

1 Nuclear Operations expenditures to maintain the Nuclear New Build option. In addition there are allocated corporate costs (included in line 7) for Nuclear New Build of $0.8M in 2016, $1.1M in 2017, $0.2M in 2018, $0.5M in 2019, $0.5M in 2020 and $0.5M in 2021.

2 Comprises centrally-held costs from Ex. F4-4-1 Table 3 and amounts of approximately $1M-$6M per year for machine dynamics and performance testing services provided by Hydro Thermal Operations in support of Nuclear Operations.

Numbers may not add due to rounding.

Table 1
OM&A Project Listing - Nuclear
Projects ≥ $20M Total Project Cost[1]

Line No.	Facility	Project Name	Project No.	Category	Start Date	Final Completion Date	Total Project Cost[2] ($M)	Partial/Devmt Release ($M)	Initial Full Release ($M)	Superceding Full Release ($M)	2013 Actual ($M)	2014 Actual ($M)	2015 Actual ($M)	2016 Budget ($M)	2017 Plan ($M)	2018 Plan ($M)	2019 Plan ($M)	2020 Plan ($M)	2021 Plan ($M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)	(s)
		ONGOING PROJECTS FROM EB-2013-0321																	
1	DN	Primary Heat Transport Liquid Relief Valve Modifications	38933	Regulatory	Dec-08	Jul-24	25.8	13.2	0.0	0.0	1.8	1.9	2.3	0.0	0.2	3.7	0.0	0.0	0.0
2	ENG	Fuel Channel Life Management	62444	Sustaining	Aug-09	Jun-16	54.1	0.0	54.1	0.0	9.2	8.3	2.3	0.4	0.0	0.0	0.0	0.0	0.0
3	PN	Locking Tabs - Boiler Divider Plate (Pickering 1 & Pickering 4)	49248	Sustaining	Jun-07	Dec-18	23.9	14.4	0.0	0.0	(0.6)	0.3	(0.0)	0.0	0.0	8.2	0.0	0.0	0.0
4	ENG	Fuel Channel Life Extension	80014	Value Enhancing	Nov-13	Jun-18	105.8	41.2	0.0	0.0	0.0	4.9	10.0	15.6	12.3	0.7	0.0	0.0	0.0
5		**Subtotal**					209.5												
		COMPLETED PROJECTS FROM EB-2013-0321																	
6	DN	DN EQ Component Replacements	38457	Regulatory	Oct-04	Jun-14	59.9	0.0	63.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	ENG	Probabilistic Risk Assessment Upgrade	62440	Regulatory	Jan-09	Jun-14	50.1	0.0	51.1	0.0	8.8	4.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
8	PN	PB Steam Generator Locking Tab Replacement	40641	Sustaining	Mar-07	Sep-12	35.2	0.0	20.5	39.4	(0.2)	(0.1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9		**Subtotal**					145.2												
		PROJECTS NOT IN EB-2013-0321																	
10	DN	Irradiated Fuel Bay Stacking Frame Replacement	80067	Sustaining	Dec-14	Dec-22	33.0	9.4	0.0	0.0	0.0	0.0	2.5	3.5	3.3	3.2	3.2	0.0	0.0
11		**Subtotal**					33.0												

Notes:
1 Projects with expenditures during Test Period AND Completed/Deferred Projects (from EB-2013-0321 or subsequent).
2 "Total Project Cost" reflects BCS amounts, with the exception of Completed/Deferred Projects (for which actual costs are shown).

Table 5
OM&A Projects - Nuclear Operations
Listing of Business Case Summaries Filed

Line No.	Project Number	Business Case Summary (BCS) Title	BCS Approval Date	Project Stage	BCS Status	BCS Status in EB-2013-0321
	(a)	(b)	(c)	(d)	(e)	(f)
		ONGOING PROJECTS FROM EB-2013-0321				
1	38933	Primary Heat Transport Liquid Relief Valve Modifications	Feb-14	Execution	Partial	Partial
2	62444	Fuel Channel Life Management	Oct-12	Execution	Full	Partial
3	49248	Locking Tabs - Boiler Divider Plate (Pickering 1 & Pickering 4)	Dec-11	Execution	Partial	Partial
4	80014	Fuel Channel Life Extension	Nov-13	Execution	Partial	N/A
		COMPLETED PROJECTS FROM EB-2013-0321				
5	38457	DN EQ Component Replacements	Jan-08	Complete	Full	Full
6	62440	Probabilistic Risk Assessment Upgrade	Apr-12	Complete	Full	Full
7	40641	PB Steam Generator Locking Tab Replacement	Dec-10	Complete	Superceding	Superceding
		PROJECTS NOT IN EB-2013-0321				
8	80067	Irradiated Fuel Bay Stacking Frame Replacement	Dec-14	Execution	Partial	N/A

OM&A PURCHASED SERVICES
NUCLEAR OPERATIONS

1.0 PURPOSE

This evidence presents the purchases of OM&A services for nuclear operations (excluding Darlington Refurbishment) that meet the threshold of one per cent of the OM&A expense before taxes, consistent with OEB filing guidelines.

2.0 OVERVIEW

This evidence supports the approval sought for the purchased services portion of nuclear OM&A costs. An overview of OPG's procurement process which is applicable to the nuclear facilities is presented in Ex. F3-3-1.

The nuclear operations OM&A expense before taxes is equal to the sum of nuclear base, project and outage OM&A. This sum is $1,718.9M in 2017, $1,728.9M in 2018, $1,763.8M in 2019, $1,760.9M in 2020, and $1,671.6M in 2021 as presented in Ex. F2-1-1 Table 1. For the nuclear facilities the threshold of one per cent of the operations OM&A expense before taxes is, therefore approximately $17M.

Information on vendor contracts for nuclear operations purchased services for nuclear base, outage and project OM&A expenditures at or above the $17M threshold for 2013-2015 is presented in Chart 1.

Total purchases for the vendors listed in Chart 1 are $136.2M in 2013, $129.4M in 2014, and $166.7M in 2015.

Chart 1
Purchase of Services - Nuclear Operations Contracts

Vendor Name	Description/Nature of Activities	Tendering Process		Justification, if not Competitive
		Competitive	Single Source	
Black & McDonald Ltd.	Provider of general construction and Engineering-Procurement-Construction ("EPC") services in 2013-2015 (see Ex. D2-2-3 Section 3.6)	X	X	In 2012, a competitive process was used to select Black & McDonald and ES Fox to enter into an Extended Service-Master Service Agreement for EPC services. Individual work packages are issued to these vendors to obtain competitive bids. In limited circumstances, consistent with OPG policies and procurement governance, work packages may be single sourced.
ES Fox Ltd.	Provider of general construction and Engineering-Procurement-Construction ("EPC") services in 2013-2015	X	X	
AMEC-NSS	Provider of engineering services, safety analysis services and specialized code development and maintenance.	X	X	A mix of sole source and competitive bid. Nuclear safety analysis work is primarily sole source, reflecting their unique skill set in the marketplace. Work packages are competitively bid where competition is available.

Vendor Name	Description/Nature of Activities	Tendering Process		Justification, if not Competitive
		Competitive	Single Source	
Candu Owners Group	The CANDU Owners Group Inc. is a not-for-profit organization which provides programs for the support, development, operation and maintenance of CANDU reactor technology. All CANDU Operators in the world are members of the CANDU Owners Group Inc.		X	Not applicable due to the nature of the services provided

1

AMPCO Interrogatory #114

Issue Number: 6.1
Issue: Is the test period Operations, Maintenance and Administration budget for the nuclear facilities (excluding that for the Darlington Refurbishment Program) appropriate?

Interrogatory

Reference:
Ref: F2-6-1

a) Please provide the forecast and actual purchases by vendor for the years 2013 to 2015.

b) Please provide the OM&A Purchased Services Nuclear Operations forecast for 2016 to 2021.

Response

a) OPG did not forecast purchases of OM&A services for nuclear operations by vendor for the period 2013-2015. Four vendors were identified in Chart 1 in Ex. F2-6-1, pp. 2-3 as having provided services in excess of a $17M threshold over the period 2013-2015. These vendors are AMEC-NSS, Black & McDonald Ltd., ES Fox Ltd. and Candu Owners Group. Aggregated amounts were provided in Ex. F2-6-1. Chart 1 below sets out the actual purchases over the period 2013-2015 by vendor. For confidentiality reasons, the vendors have been identified as A, B, C and D. Please note that the correct 2014 total amount is $129.4M as shown in Chart 1 below; the total amount for 2014 shown in Ex. F2-6-1, page 1, line 24 is incorrect.

Chart 1 ($M)

Line No.	Vendor	2013	2014	2015
	(a)	(b)	(c)	(d)
1	A	45.0	46.2	65.2
2	B	44.4	42.8	75.7
3	C	23.4	23.5	25.9
4	D	23.4	16.8	n/a
5	**Total**	**136.2**	**129.4**	**166.7**

b) Chart 2 below shows the Nuclear Operations OM&A Purchased Services forecast for each year from 2016-2021.

Chart 2 ($M)

Line No.		2016 Budget	2017 Plan	2018 Plan	2019 Plan	2020 Plan	2021 Plan
		(a)	(b)	(c)	(d)	(e)	(f)
1	**Total OM&A Purchased Service**	365.3	446.8	466.0	486.8	515.6	498.0

ONTARIO POWER GENERATION

Nuclear Oversight - 889 Brock Road, Pickering, ON L1W 3J2

MEMORANDUM

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DATE: March 13, 2015

File No: N-REP-01070-0535240 T06

DISTRIBUTION:

Audit OPGN NO-2015-022
Project Management

Nuclear Oversight conducted a performance based audit of the Project Management program implemented by the Projects and Modifications organization at Darlington, Pickering and Nuclear Waste over the period from January 26 to February 12, 2015. The objective of this performance based audit was to determine whether the project management requirements defined in governance have been met and effectively implemented to support safe and reliable operation. The focus areas of the audit were project oversight including contract management and field engineering.

CONCLUSIONS: The audit determined that performance of the managed system controls for the Project Management Program is not fully effective (audit rated Yellow). The audit identified 3 Findings.

Finding 1: Deficiencies in the Execution of Project Management Oversight

Finding 2: Deficiencies in Projects & Modifications Staff Qualifications and Requirements

Finding 3: Deficiencies in Project Management Program Governance and Supporting Documents

One audit insight was provided and 3 SCRs were initiated during the audit.

A copy of the audit report is attached. Please contact either me at 702-5400 or Russ Gomme 702-5452 if you have any questions.

Regards,

Art Maki
Director
Nuclear Oversight
P82-6

AM/

Enc

ONTARIO POWER GENERATION

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Nuclear Oversight Audit Report – Project Management

OPGN NO-2015-022 T6

Objective and Scope

Nuclear Oversight conducted a performance based audit of the Project Management program implemented by the Projects and Modifications organization at Darlington, Pickering and Nuclear Waste over the period January 26 to February 12, 2015. The objective of this performance based audit was to determine whether the project management requirements defined in governance have been met and effectively implemented to support safe and reliable operation. The focus areas of the audit were project oversight including contract management and field engineering.

Overall Assessment

This performance based audit of the Project Management Program has identified that the managed system controls are not fully effective (audit rated Yellow). The rating for this audit is based on the ongoing issues related to project oversight execution and the lack of mandatory training and qualifications for the Project Managers which are among the contributing factors to performance deficiencies and projects being overspent and behind schedule. In addition, inconsistent work practices were evident which can be attributed to a simplified program governance structure and a perceived optional application of supporting desktop documents.

Project Management program execution is not in alignment with INPO Performance Objective and Criteria CO.5:9: "*Corporate managers establish, communicate, and implement a structured project management process to select, plan, and implement projects with predictable quality, scope, schedule, and cost performance.*"

With respect to the Nuclear Safety Traits, program performance reflected weakness in "*Leadership Safety Values and Actions*" in the area of "*Resources*" (i.e. procedures and personnel training) and strength in "*Problem identification & resolution"* in the area of "*Trending*".

The audit identified the following three findings:

- Finding 1: Deficiencies in the Execution of Project Management Oversight
- Finding 2: Deficiencies in Projects & Modifications Staff Qualifications and Requirements
- Finding 3: Deficiencies in Project Management Program Governance and Supporting Documents

One audit insight was provided based on feedback from the Nuclear Industry Exchange Program audit Subject Matter Expert from [redacted] who supported the audit for one week during the conduct.

Audit Title: Project Management	Page: 2 of 74

1.0 Findings

1.1 Finding 1: Deficiencies in the Execution of Project Management Oversight

The Projects and Modifications (P&M) organization is not effectively executing key project management oversight activities. These deficiencies are evident in the Project Management, Contract Management Organization (CMO), and Field Engineering organizations at PNGS, DNGS, and Nuclear Waste. Unclear guidance (Finding 3) and deficiencies in project management training (Finding 2) are some of the causes of these deficiencies. These deficiencies are among the contributors to project delays, cost over-runs, quality issues, and some safety concerns.

Supporting facts: (Additional supporting facts are shown in Appendix B)

1) Project Management oversight is not fully effective at controlling costs, schedule, quality, and potential safety issues.
   a) Safety:
      i) Project 10-73164 DR Irradiated Fuel Bay Heat Exchanger Replacement: OPG's Design Engineering review was not obtained for the engineered scaffolding and lifting beam as required per the Contractor/Owner Interface agreement.
   b) Cost and Schedule Quality:
      i) Project 13-40985, Replacement of Obsolete Online Chemistry Analyzers: Key performance indicators are red, (Cost Performance Indicator (CPI) is 0.47 and Schedule Performance Indicator (SPI) is 0.64). Cost has increased significantly from 2.5M to 15M. There are many SCRs for schedule delays and missed milestones as well as significant issues with vendor quality, which led to contract termination.
      ii) Project 16-34000 DN Auxiliary Heating Steam: The scope was expected to be complete in April 2015 per the PMP NK38-PLAN-73110-0495234 at a cost of $28.5M; however, the new projected completion date is October 2015 with an estimated completion cost of $85M.
2) Some Project Management oversight activities are not performed as required per the Project Oversight Plan (POP) and N-INS-09701-10007 R000, *Project Oversight Planning and Implementation* and other supporting documents (N-MAN, N-GUID).
   a) Project Management Plan (PMP) Issues: The PMP was not revised to reflect changes to contract strategy which affects adherence to QA requirements. (e.g. Project 10-73164)
   b) POP Issues:
      i) Some POPs only contain general guidelines for the required activities without providing specific oversight activities for critical evolutions, project milestones, or strategic oversight (i.e. higher risk elements), with the appropriate frequency. For example in Project 13-49140, the activities for lifting and hoisting the trash screen in-place, were not captured in the POP as a "strategic" oversight requirement during the Execution Phase. However, the lift did require the completion of a Complex Lift Plan (NK30-REF-71120-0507806) during actual execution.
      ii) The POP is not treated as a living document and revised to include additional oversight as the project evolves or negative trends appear that indicate risks or poor performance. Revisions were not implemented following changes to contractor,

Audit Title: Project Management	Page: 3 of 74

contracting strategy, scope changes, repeat design quality issues, significant cost increases, changes to risks and recurring schedule delays (most projects reviewed).

iii) The POP is not utilized as a tool to manage the project since some POP activities are not performed. Examples are actions to control costs, no oversight reports for relevant in-line/in-process, routine and oversight activities (most projects reviewed).

iv) The POPs are approved by the Section Manager and not the Project Manager (PM) as required by the N-INS. POPs are usually prepared by the person acting in the PM role. There is some hesitation from staff to embrace the role of PM and the responsibility that goes with it.

c) Oversight reports for activities in the POP are not prepared by all work groups and stored in a common data base per N-INS; consequently, the PM may not be aware and subsequently may miss issues that could impact the project (all projects reviewed).

i) Only Field Engineering is using the Oversight Reporting System (ORS) database. Although, ORS has the capability, it is not used by other organizations identified in the POP (project management, contract management, engineering/design, procurement / warehousing, safety compliance). No oversight reports were found for these groups.

d) Project Kick-Off/Orientation Meeting with the Contractors and other applicable OPGN stakeholders, for development of the oversight plan and review of Human Performance and Work expectations, are not consistently performed. (e.g. 16-34000, 13-49116)

e) Documentation Issues: Documents required per the PMP have not been issued, PMPs and POPs are only in draft form, some documents were not filed in Asset Suite and some do not show OPG acceptance (most projects reviewed).

f) Other issues:

i) The PMP identified Risk Monitoring and Control activities which were not performed. (e.g. Project 10-73398)

ii) Software qualifications for project 16-33258 were not requested and therefore may not meet the required QA requirements.

iii) The Contractors alert group was not set up to allow input of SCRs to document issues related to safety, configuration management, delays etc.. (e.g. 16-33258)

3) Some Contract Management Oversight activities are not being completed or performed effectively.

a) Activities not performed:

i) Project 13-49140: Safety Certification of Contractors Equipment – N-FORM-11482, was not utilized to document OPG acceptance of Vacuum Trucks brought on site by the contractor. In response to the audit the CMO initiated SCR N-2015-03616.

ii) Contractor qualifications are not checked as described in Section 4.1.1 of N-GUID-00120-10008. CMO Line stated "*there is a robust process in place for ES MSA contract staff that ensures that qualifications for all contract staff are properly maintained,...*"; however, it is not documented in N-GUID. (most projects reviewed)

iii) Construction Quality Assurance (QA) Plan is missing OPG's acceptance signature as required by the Contractor Owner Interface agreement (Project 13-40985).

iv) Per review of the completed Daily Logs in the Contract Management SharePoint site, there are numerous records of project delays that were not escalated through the SCR program. Per the Contract Administrator, the contractor is accountable to submit SCRs but none were found. (e.g. Project 13-40985)

b) Records:
   i) Contract Management Plans (CMP) do not exist (most projects reviewed).
   ii) Daily Logs do not contain oversight records for activities defined in the POP (most projects reviewed).
   iii) The Contract Management forms for the project are not consistently used and not issued in Asset Suite as required (e.g. Contract management template, Contractor work release, Contract Inspection Check list, Safety Certification of Contractors equipment). (e.g 16-33258, 13-4910)

c) Meetings:
   i) The Mark-Up meeting which is used to determine jurisdiction of building trades union work is not consistently performed and/or there is no evidence that the meeting took place. (e.g. 13-49140, 16-34000)
   ii) Contract Administrators are not always invited to or take part in any oversight strategy meetings as required in N-STD-AS-0030 to ensure stakeholder input and buy-in to project objectives. (e.g. 13-40985)

4) Some Field Engineering (FE) Oversight activities are not completed or performed effectively as documented in requirements. As a result, the completion of oversight activities and frequencies are left to the discretion of FE staff and what they consider to be adequate.

a) Construction oversight:
   i) Project 13-49140: Some of the applicable construction oversight elements applicable to FE (per Appendix D of N-INS-09701-10007) were not performed by OPG.
      (1) Prior to fabrication and installation:
         (a) Review and acceptance of Work Plans, Vendor's QA/QC staff training and qualification, Foreign Material Exclusion (FME) plan reviews, tooling / rental equipment (e.g. a vacuum truck and spreader bar for hoisting the screen into place).
         (b) Welding procedures reviewed by OPG welding engineering. Per feedback from FE line, FE staff from Pickering (and DNGS) do not provide any oversight on welding activities as none of the FE staff are qualified to perform oversight / Quality Surveillance functions in that specialty area. In addition, Project Oversight Plans do not provide enough clarity on the accountability to perform oversight on welding/Non-destruction Examination activities.
      (2) Off-site fabrication: Oversight reports applicable to off-site fabrication of guardrail and base plates were not identified or completed.

b) Deficiencies identified in the FE oversight reports are not documented and addressed per the process required by N-INS-09701-10007-R000, *Project Oversight Planning and Implementation*. It is difficult to know how, or if, these deficiencies were addressed.

Audit Title: Project Management	Page: 5 of 74

c) No documentation exists to show that the Design Engineering organization has verified the welding packages. There is no design weld detail for the rewelding of the 4" guard pipe fittings that are being cut. (Project 10-73360)

SCR N-2015-06123 was initiated to identify the finding. Director, Pickering & NWMD Projects agreed to be the EO for this SCR at significance level 2. Supported by other P&M Directors.

AMPCO Interrogatory #135

Issue Number: 6.6
Issue: Are the test period human resource related costs for the nuclear facilities (including wages, salaries, payments under contractual work arrangements, benefits, incentive payments, overtime, FTEs and pension costs, etc.) appropriate?

Interrogatory

Reference:
Ref: F4-3-1 Page 13

a) Please provide the range of premiums paid for overtime.

b) Please explain the reasons for the higher overtime amounts in 2013 and 2015.

c) Please provide the budgeted overtime for the years 2013 to 2016 in terms of $ and hours.

d) Please explain any variances greater than 10%, comparing overtime budget to actuals for the years 2013 to 2016.

e) Please provide the forecast of overtime hours for the years 2017 to 2021.

f) Please provide the percentage of overtime paid at double time for the years 2013 to 2015 and the assumptions for 2016 to 2021.

g) Please provide the percentage of overtime paid at more than double time for the years 2013 to 2015 and the assumptions for 2016 to 2021.

h) Please provide the budget and actual overtime amounts for the DRP to date.

i) Please provide the forecast overtime budget for the DRP for the years 2017 to 2021.

j) For the PWU skilled trades, please discuss the types of work shifts, the hours in a work week and the number of hours worked before an employee is eligible for overtime. Please discuss when and how different overtime rates are applied.

k) For the PWU clerical, semi-skilled trades and general trades, please discuss the type of work shifts, the hours in a work week and number of hours worked before an employee is eligible for overtime. Please discuss when and how different overtime rates are applied.

l) Please provide contractor overtime amounts (budgeted and actual) for the years 2010 to 2016 and forecast for 2017 to 2021.

Witness Panel: Corporate Groups, Compensation
Darlington Refurbishment Program
Nuclear Operations and Projects

m) Please provide any recent changes to OPG's work shifts, overtime policies and management of overtime in order to minimize overtime of its employees and contractors.

Response

a) Payments for overtime range from 1.5 times normal pay to 2.5 times normal pay with most overtime being paid 2.0 times normal pay.

b) Please see L-06.6-1 Staff-145.

c) & d):

Total Nuclear	Acutal ($M) (a)	Budget ($M) (b)	Variance ($M) (c) = (a)-(b)	Variance (d) = (c)/(b)
2013	159.2	127.0	32.2	25.3%
2014	117.6	109.3	8.2	7.5%
2015	132.1	122.3	9.7	7.9%
2016 YTD Sept (Actual and Budget)	102.3	86.6	15.7	18.2%

Overtime is budgeted on dollar basis only.

The following are the major variance drivers in years where overtime variance is greater than 10% of budget:

i. In 2013 the overtime variance of 25.3% from budget was largely due to:
   - Use of overtime to complete work programs due to regular labour resources being under complement.
   - Completing outage work primarily due to forced extension to Darlington's two planned outages.

ii. As of September 2016, year-to-date overtime variance of 18.2% is largely due to use of overtime to complete work programs due to regular labour resources being under complement.

e) Overtime is not forecasted on an hourly basis.

Witness Panel: Corporate Groups, Compensation
Darlington Refurbishment Program
Nuclear Operations and Projects

Board Staff Interrogatory #145

Issue Number: 6.6
Issue: Are the test period human resource related costs for the nuclear facilities (including wages, salaries, payments under contractual work arrangements, benefits, incentive payments, overtime, FTEs and pension costs, etc.) appropriate?

Interrogatory

Reference:

Ref: Exh F4-3-1 pages 12-13
The evidence states that overtime expenses are expected to fall by approximately 50% from 2013 to 2021.

a) Given the relatively stable FTE numbers over this period, how will OPG manage to reduce overtime expenses by 50%?

b) Figure 9 shows that the projected overtime costs are essentially stable from 2014 through 2019, and then fall significantly in 2020 and 2021. Why is there a significant drop-off in 2020 and 2021?

Response

a) As noted in the evidence reference provided, OPG plans to continue its efforts to control overtime expenditures over the IR period by requiring pre-approvals of overtime use in non-emergency situations, regular monitoring of overtime by executives and finance staff and conducting periodic reviews to assess overtime usage. OPG also plans to manage overtime costs by increased reliance on external resources, where cost-effective and consistent with outage requirements and its collective agreements.

The number of nuclear FTEs does not drive changes in overtime over the period 2013 to 2021. Rather, changes in overtime are driven primarily by the mix of resources used to address OPG's outage work programs, the number of outages, the duration of outages, the scope and complexity of outage activity. For example, overtime costs were relatively high in 2013 because Darlington executed two outages in that year based on its three-year outage cycle. However, Darlington is expected to have one large outage per year during the rate-setting period while one unit is in refurbishment, which results in reduced overtime costs during the rate-setting period.

b) The reasons for overtime costs being variable are outlined in part a). In addition, there is no scheduled planned outage in Darlington in 2021, as explained at Ex. F2-4-2, pp. 2-3.

Witness Panel: Nuclear Operations & Nuclear Projects

UNDERTAKING J7.3

Undertaking

To provide a copy of the report ARC 2016 Q1: Project Controls - Projects & Modifications ("P&M") Group, if possible before Panel 3A appears.

Response

The Project Controls Audit – Projects & Modifications Group Internal Audit report is filed as Attachment 1. In addition, consistent with OPG's response to L-4.3-1 Staff-072, please see Attachment 2 for a summary of the findings and the associated status of the management action plans.

ONTARIO POWER GENERATION

Internal Audit

Project Controls Audit - Project & Modifications Group

March 9, 2016

Report Rating: **Requires Improvement**

Distribution:

Dietmar Reiner
SVP, Nuclear Projects

Art Rob
VP, Projects & Modifications

cc:		
	Jeffrey Lyash	President & Chief Executive Officer
	Glenn Jager	Chief Nuclear Officer
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	Riyaz Habib	Director, Contract Mgmt. & Project Control Office
	Sabine Parks	Director, Nuclear Finance
	Janice Ding	Director Internal Audit
	Art Maki	Director Nuclear Oversight

Table of Contents

1.0 EXECUTIVE SUMMARY

1.1 Summary of Internal Audit Findings

Report Rating: **Requires Improvement**

No.	Finding	Risk Type	Risk Rating[1]		
			High	Moderate	Low
1	Project estimates are not at a sufficient level of accuracy prior to the execution phase.	Financial	x		
2	Cost and Schedule Control Baselines ("CSCB's") are not keeping pace with approved project changes.	Operational		x	
3	A Gating Process for AISC Portfolio Projects has not been formally implemented.	Operational		x	
4	Governance and Procedures specific to AISC projects require improvement.	Operational			x
Total			**1**	**2**	**1**

1.2 Background

The Projects and Modifications ("P&M") Group, part of the Nuclear Projects Organization, is responsible for the management and execution of Operations, Maintenance and Administration ("OM&A") and Capital Projects supporting the Darlington and Pickering Nuclear Generating Stations and Western Waste Facility. The P&M Group has a total project portfolio of $1.1B over the three year period from 2015 through to 2017. The projects that the Asset Investment Steering Committee ("AISC") manages total $833M, with the remaining portfolio related to projects supporting the Darlington Nuclear Refurbishment ("DNR") Project. DNR Projects are executed using the Nuclear Project's Project Management framework which has different requirements than is currently used on the AISC projects, which follows Finance governance. To address these differences, a "Project Excellence" initiative is now in place and includes the development of a common set of standards for all projects across Nuclear. This initiative had just started at the time of the audit.

The AISC is a committee that meets to review, prioritize and provide budgets for sustaining projects for OPG's Nuclear Generating Stations. The committee works in conjunction with business line sponsors to prioritize and recommend projects for approval in accordance with business objectives.

Given the high value of P&M's AISC project portfolio and the critical role these projects play in OPG's on-going nuclear operations, this audit was performed as part of Internal Audit's ("IA's") cyclical audit program.

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