

SEC Interrogatory #1

Interrogatory

Reference: [H1-1-1, Table 7b]

Question:

With respect to the 2017-2021 in-service additions eligible for inclusion in the CRVA for regulated hydroelectric:

- a. Please explain the difference between 'Total Project Cost' and '1st Execution Business Case costs.
- b. For each project that had a final in-service date after 2021, please provide the Total Project Costs and 1st Execution Business Case forecast for the equivalent scope of work that involved in-service additions between 2018 and 2021.
- c. For all projects whose final in-service date is after 2021, please provide the final total in-service costs.
- d. For all projects with a total forecast cost above \$10M, please provide a copy of the following documents:
 - i. 1st Execution Business Case
 - ii. Any subsequent Business Cases
 - iii. A copy of all internal audits, reviews (internal or external), or similar documents discussing project performance.
- e. Have any of the projects increased hydroelectric generating capacity? If so, please provide details including the actual increase.

Response

- a. "First Execution Business Case" cost represents the total project cost estimate provided in the First Execution Business Case Summary ("BCS"), which, under OPG's current project management standards, would occur when a Class 3 estimate has been determined.¹ "Total Project Cost" refers to the total actual cost of a completed project, subject to any future close out costs that have not yet been incurred.

In the course of preparing the response to this interrogatory, OPG identified that the First Execution Business Case estimates for several projects presented in Ex. H1-1-1, Table 7b, col. (c) incorrectly utilized the Full Execution BCSs as the

¹ As explained in Ex. L-H-Staff-07 part a), for certain Execution BCSs pre-dating the implementation of standardized project management tools across the company, the cost estimates developed at the time may be considered to be of a less accurate Class under OPG's current project management standards.

reference point for the “First Execution Business Case”. For these projects, which includes the Sir Adam Beck I Generating Station – Unit G5 Major Overhaul project, there was a Partial Execution BCS that preceded the Full Execution BCS.

OPG will file an updated version of Ex. H1-1-1, Table 7b and any necessary changes to Ex. H1-1-1, Attachment 4 to correct the First Execution Business Case cost estimates for these projects.

- b. There are no separate First Execution Business Case cost estimates for the equivalent scopes of work comprising actual in-service additions between 2018 and 2021 for the projects identified in Ex. H1-1-1, Table 7b whose final in-service date is listed as after 2021.

Total Project Costs for the scopes of work that involved the above in-service additions are represented by the amounts of these in-service additions, as summarized in Chart 1 below.

Chart 1

Project	Total In-Service Amounts 2018-2021 (\$M)	Reference (Ex. H1-1-1, Table 7b, sum of cols. (e) to (h))
Aguasabon GS – Surge Tank Replacement	23.1	Line 14b
Abitibi Canyon GS – Unit G5 Stator Winding Replacement	8.1	Line 15b
Caribou Falls GS – Auto Sluice System Replacement	14.6	Line 16b
Sir Adam Beck I GS – Units G1, G2 Replacement	11.6	Line 17b
Ranney Falls GS G3	53.7	Line 18b

- c. For all projects identified in Ex. H1-1-1, Table 7b whose final in-service date is listed as after 2021, Chart 2 provides the total in-service costs, subject to final project close out where it had not yet occurred at the time of this application.

Chart 2

Project	Total In-Service Amount (\$M)
Aguasabon GS – Surge Tank Replacement	24.5
Abitibi Canyon GS – Unit 5 Stator Winding Replacement	8.5
Caribou Falls GS– Auto Sluice System Replacement	15.9
Sir Adam Beck I GS – Units G1, G2 Replacement	112.9
Ranney Falls GS G3	74.5

d. Consistent with OPG's Filing Guidelines,² OPG is providing Business Case Summaries and project performance reviews for projects with a Total Project Cost above \$20M:

i. and ii. Business Case Summaries:

Chart 3

Project	Total Project Cost³ (\$M)	Documentation Provided
Sir Adam Beck I GS – Unit G10 Major Overhaul and Upgrade	30.8	<p>Attachment 1 (confidential): First Execution BCS (June 21, 2014)</p> <p>Attachment 2 (confidential): Execution BCS (January 13, 2015)</p> <p>Attachment 3 (confidential): Superseding BCS (August 31, 2016)</p>

² EB-2011-0286, Filing Guidelines for Ontario Power Generation Inc., November 11, 2011, p. 14.

³ Total Project Costs shown above include removal costs expensed to OM&A and the capital costs associated with the project. Some BCSs also contain estimates for non-standard OM&A projects undertaken at the same facility in addition to the capital project. Non-standard OM&A projects are managed and funded as separate scopes of work and are excluded from the Total Project Costs shown above. OPG has not recorded any costs for non-standard OM&A projects in the CRVA.

DeCew Falls II GS – Unit G2 Overhaul and Upgrade	35.5	Attachment 4: First Execution BCS (April 20, 2016)
Manitou Falls GS – Auto Sluice System Replacement	25.3	Attachment 5: First Execution BCS (November 27, 2018) Attachment 6: Project Over Variance Approval (November 17, 2021)
Sir Adam Beck I GS – Unit G5 Major Overhaul	44.7	Attachment 7: First Execution BCS (August 30, 2018) Attachment 8 (confidential): Execution BCS (November 26, 2018) Attachment 9: Project Over Variance Approval (March 22, 2021) Attachment 10 (confidential): Superseding BCS (September 17, 2021)
Aguasabon GS – Surge Tank Replacement	26.4	Attachment 11: First Execution BCS (November 19, 2019) Attachment 12 (confidential): Execution BCS (February 05, 2020) Attachment 13: Project Over Variance Approval (December 07, 2021)
Sir Adam Beck I GS – Units G1, G2 Replacement	122.8	Attachment 14 (confidential): First Execution BCS (October 23, 2019) Attachment 15: Project Over Variance Approval (October 07, 2020)

Ranney Falls GS G3	74.5	Attachment 16: First Execution BCS (March 14, 2017)
Sir Adam Beck Pump GS – Reservoir Replacement	48.7	Attachment 17: First Execution BCS (August 18, 2015)

iii. Project Performance Reviews (see Note):

Chart 4

Project	Total Project Cost (\$M)	Documentation Provided
Sir Adam Beck I GS – Unit G10 Major Overhaul and Upgrade	30.8	Attachment 18: PCR (December 21, 2018)
DeCew Falls II GS – Unit G2 Overhaul and Upgrade	35.5	Attachment 19: PCR (October 4, 2023)
Manitou Falls GS – Auto Sluice System Replacement	25.3	Project closeout in progress, no PCR
Sir Adam Beck I GS – Unit G5 Major Overhaul	44.7	PCR and PIR in progress
Aguasabon GS – Surge Tank Replacement	26.4	Attachment 20: PCR (December 8, 2023)
Sir Adam Beck I GS – Units G1, G2 Replacement	122.8	Attachment 21: PCR (October 13, 2023) Attachment 22: IA Report (February 28, 2020)
Ranney Falls GS G3	74.5	Attachment 23: IA Report (November 23, 2018) Attachment 24 (confidential): PCR (November 2, 2023)

Sir Adam Beck Pump GS – Reservoir Replacement	48.7	Attachment 25: PCR (January 30, 2018) Attachment 26 (confidential): PIR (January 31, 2018)
---	------	---

Note:
PCR: Project Closure Report
PIR: Post-Implementation Report
IA: Internal Audit

- e. Chart 5 sets out regulated hydroelectric projects with actual in-service additions between 2017 and 2021 that have increased hydroelectric generating capacity:

Chart 5

Project	Maximum Continuous Rating (MCR) Increase (MW)
Sir Adam Beck I GS – Unit G10 Major Overhaul and Upgrade	45.9 to 55.0
Sir Adam Beck I GS – Unit G5 Major Overhaul	53.1 to 58.0
Sir Adam Beck I GS – Units G1, G2 Replacement	0 to 57.5 per unit
Ranney Falls GS G3	0.8 to 10

Refer to Ex. H1-1-1, Attachment 4 for further project details.

Type 2 Business Case Summary

To be used for investments/projects meeting Type 2 criteria in OPG-STD-0076.

Project Information			
Project #:	SAB10050	Document #:	
Project Title:	G10 Major Overhaul & Upgrade		
Class:	<input type="checkbox"/> OM&A <input checked="" type="checkbox"/> Capital <input type="checkbox"/> Capital Spare <input type="checkbox"/> MFA <input type="checkbox"/> CMFA <input type="checkbox"/> Provision <input type="checkbox"/> Others:	Investment Type:	Sustaining
Phase:	Execution	Release:	Partial
Facility:	SAB1 (NF20)	Target In-Service or Completion Date:	Aug 2016

Project Overview
<p>We recommend the release of \$1,500k, including \$55k of contingency. The estimated total project cost is \$ 27,000k, including \$ 2,427k of contingency. The quality of the estimate for this release is Class 3, and for the total project is Class 3.</p> <p>This release will fund the following scope of work. It does not commit OPG to further investment on this project.</p> <ul style="list-style-type: none"> Purchase the runner prior to full execution release due to the long lead time required for design and manufacture. <p>An Initiation and Definition BCS was approved October 18, 2013 to complete a Technical Specification and update analysis of critical components and complete the RFP process.</p>

Part A: Business Need				
<p>Execution of this project will ensure availability and reliability of SAB1 G10 for 25-30 years and also ensure that Hydro-Thermal Operations maintains and develops hydro resources.</p> <p>Sir Adam Beck G.S. #1 (SAB1) G10 was originally placed in-service in 1930 as a 25Hz unit rated for 45MVA then converted to 60Hz in 1956. The last major overhaul completed on the unit was in 1986. During the upcoming overhaul, the opportunity exists to execute additional work which would increase the capacity and efficiency of G10 and allow Niagara Operations to better utilize the water available to the station. The recommended alternative upgrades the current rating of the unit to the following capabilities:</p>				
	Turbine		Generator	
	Efficiency (%)	Power (MW)		Rating parameters
		Best	Full Load	MVA MW
Existing Unit		43.0	57.0	55 55
Upgraded Unit		55.0	59.0	63 59
Improvement		+12.0	+2.0	+8 +4
<p>A Life Cycle Plan (LCP) for SAB1 (R-NF20-01556-0002) was approved July 2008. The recommended alternative was an eight unit station (G3-G10) which included overhaul and upgrade of G10. This project is also included in the 2014-16 Business Plan.</p>				

Part B: Preferred Alternative: Perform Major Overhaul and Upgrade Unit to 55MW, 63MVA
<p>Description of Preferred Alternative</p> <p>The project would execute a complete refurbishment of the generator stator and rotor including a rewind, and replacement of all supporting electrical auxiliaries. A major overhaul of the turbine would be completed, including installation of a new runner, headcover, and wicket gates. Further investigation and possible repair would be done on the penstock and scrollcase, including completion of a load carrying capacity analysis.</p> <p>A Definition Project Charter (NPG-00121.2-0055) was approved October 2, 2013 which includes a detailed scope of work based on actual work completed on G7, G8, and G3.</p>

Internal Use Only
OPG-FORM-0075-R004

Type 2 Business Case Summary

Project #: SAB10050
Project Title: G10 Major Overhaul & Upgrade, <Partial> <Execution> Release

Document #:

Part B: Preferred Alternative: Perform Major Overhaul and Upgrade Unit to 55MW, 63MVA

Description of Preferred Alternative

An equipment supply agreement between OPG and American Hydro Corp (now Weir) was signed Feb 2007 for the supply of runners for G3-G10. The runner for G10 will be purchased under the terms of this agreement. The decision to purchase 8 runners and the SAB1 overhaul program were recommended and supported by the 2008 LCP for SAB1.

The execution strategy is to award a single contract to a general contractor. A Technical Specification is under development (95% complete) which will specify equipment and components proven and existing on previous SAB1 upgrades. The general contractor will be responsible for completing the installation design (mechanical, electrical, civil), manufacture of parts, supply of equipment (except the runner), removal of existing equipment, and installation of new and/or refurbished equipment. This strategy will reduce the cost of re-engineering equipment, lower the contract cost, and reduce the duplication of spare parts.

An Initial Project Execution Plan (PEP) and Risk Analysis have been drafted.

The unit will be overhauled during a Planned Outage from August 2015 to July 2016.

This alternative is recommended since it will address availability and reliability concerns, has the highest NPV, and lowest risk profile. It is also consistent with Hydro-Thermal Operations mandate to maintain and develop hydro resources.

Deliverables:	Associated Milestones (if any):	Target Date:
Purchase new runner	PBCS approved	July 4, 2014
	PO issued	July 11, 2014
	EBCS approved	Sept 30, 2014
Main contract for General Contractor	RFP start	July 2014
	Award main contract	Oct 2014
	Runner arrive at site	Aug 2015

Part C: Other Alternatives

Summarize all viable alternatives considered, including pros and cons, and associated risks. Other alternatives may include different means to meet the same business need, and a reduced or increased scope of work, etc.

Alternative 2: Base Case – No Project

Do nothing, continue with the existing LEM program for the unit and corrective maintenance on an ad hoc basis.

Based on its current condition, G10 could likely run without major investment until 2018, at which time the turbine is expected to have reduced reliability and the transformer is expected to reach end-of-life. If left unaddressed, an eventual failure will result in a forced outage during either the Nuclear Refurbishment, SAB2 Overhaul Program, or the later stages of the SAB1 Overhaul Program.

Therefore, this alternative is not recommended.

Alternative 3: Perform a Minor Overhaul for 10 Years of Operation at 45.9MW

Maintain the current rating of the generator. The scope of work would be largely focussed on cleaning, testing and repair of existing equipment, including removal of the generator rotor for cleaning and a flux test. Also included is the purchase and installation of a new transformer.

This alternative has the worst NPV due to its investment requirements and expected outcome of reliability, and the fact that the next overhaul will occur in the middle of the Nuclear Refurbishment & SAB2 Overhaul Programs.

Therefore, this alternative is not recommended.

Alternative 4: Perform Major Overhaul to Ensure 15-20 Years of Operation at 45.9MW

Maintain the current rating of the generator. The project would execute a complete refurbishment of the generator stator and rotor, including a rewind, and replacement of all supporting electrical auxiliaries. A major overhaul of the turbine would be completed including weld repair of the runner, installation of new wicket gates and potential install of a new headcover.

This alternative provides for low technical risk, but is not recommended due to its lower NPV.

Internal Use Only
OPG-FORM-0075-R004

Type 2 Business Case Summary

Project #: SAB10050
Project Title: G10 Major Overhaul & Upgrade, <Partial> <Execution> Release

Document #:

Alternative 5: Upgrade the Unit to 81MW, 88MVA

The scope of work for this alternative is very similar to that of the preferred alternative, with the significant difference being the purchase and installation of a new generator and all of the associated work required to the superstructure to accommodate the unit.

Due to a less favourable NPV and increased technical risk with the expanded scope, this alternative is not recommended.

Part D: Project Cash Flows, NPV, and OAR Approval Amount

k\$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released		100	700						800
Requested Now		890	610						1,500
Future Required			12,300	12,400					24,700
Total Project Cost		990	13,610	12,400					27,000
Ongoing Costs									
Grand Total		990	13,610	12,400					27,000

Estimate Class:	Class 3	Estimate at Completion:	\$27,000k
NPV:	\$43.9M	OAR Approval Amount:	\$1,500k

Additional Information on Project Cash Flows (optional):

(k\$)	LTD	2014	2015	2016	2017	Total
BP 2014-16	0	100	10,000	15,400		25,500
Summary of Estimate	0	990	13,610	12,400		27,000
Variance	0	890	3,610	(3,000)		1,500

Approval has been requested for Niagara's 2014 annual Capital forecast; changes will be managed within the revised budget envelope.

Part E: Financial Evaluation

M\$	Upgrade to 55MW, 63MVA	Base Case No Project	Minor Overhaul	Major Overhaul	Upgrade to 61MW, 68MVA
Project Cost	27.0	N/A	7.1	20.3	38.5
NPV (after tax)	27.0	24.3	19.6	19.6	23.1

Summary of Financial Model Key Assumptions or Key Findings:

Energy projections per the SAB1 LCP are still valid.

Project costs based on actual costs from G7, G9, and G3 overhauls/upgrades.

The potential for a higher MCR during the Darlington refurbishment program has not been included.

Part F: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	Costs higher than expected	Release amount requested for purchase of runner only has sufficient contingency of 9%.	Low	Low
Scope	N/A – supply of runner only			
Schedule	Runner not delivered in time, delaying the start of the execution phase	Order the runner as soon as possible. Monitor progress of supplier.	Medium	Low

Internal Use Only
 OPG-FORM-0075-R004

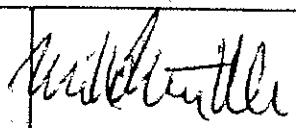


Type 2 Business Case Summary

Project #: SAB10050
 Project Title: G10 Major Overhaul & Upgrade, <Partial> <Execution> Release

Document #:

Part F: Risk Assessment				
Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
Resources	Required resources are identified as per the project charter. No additional resources are anticipated.	Accept the risk.	Low	Low
Quality/ Performance	Due to volume of work and consolidation of engineering packages, technical specs and RFP package may contain errors.	Peer reviews will be used when appropriate to ensure accuracy of documentation.	Low	Low
Technical	Runner does not meet performance requirements.	Runner design based on uprate study and modeling which has been completed.	Low	Low
Other	This is a large multifaceted project with a variety of risks which may contribute to poor execution.	Niagara Operations recently completed overhauls on three other SAB1 units. Lessons learned and PIRs will be used to ensure strong project delivery.	Low	Low

Part G: Post Implementation Review (PIR) Plan				
<input type="checkbox"/> It is determined appropriate that only a Project Closure Report (PCR) is needed as the PIR for this project, due to its straight forward deliverables, which do not require any measures other than confirmation of completion or delivery.				
Type of PIR Report	Target In-Service or Completion Date	Target PIR Completion Date		
N/A				
Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
PIR requirements are not included in this release as they will be identified in the BCS for Full Release of funds.				

Approvals			
	Signature	Comments	Date
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by (Project Sponsor): Mike Martelli SVP HTO			18 JUN 14
I concur with the business decision as documented in this BCS.			
Finance Approval: Robin Heard SVP & CFO per OPG-STD-0076			18 JUN 14
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Tom Mitchell President & CEO per OAR 1.1			21 JUN 14

Internal Use Only
 OPG-FORM-0075-R004

Type 2 Business Case Summary

Project #: SAB10050
 Project Title: G10 Major Overhaul & Upgrade, <Partial> <Execution> Release

Document #:

Appendix A: Summary of Estimate										
Project Number:	SAB10050									
Project Title:	G10 Major Overhaul & Upgrade									
k\$	LTD	2014	2015	2016	2017	2018	2019	Future	Total	%
OPG Project Management		140	620	625					1,385	5.1
OPG Engineering (including Design)			120	120					240	0.9
OPG Procured Materials		485	720	170					1,375	5.1
OPG Other										
Design Contract(s)										
Construction Contract(s)			10,970	10,180					21,150	78.3
EPC Contract(s)										
Consultants		120							120	0.4
Other Contracts / Costs										
Interest		76	105	122					303	1.1
Subtotal		821	12,535	11,217					24,573	91.0
Contingency		169	1,075	1,183					2,427	9.0
Total		990	13,610	12,400					27,000	100.0

Notes			
Project Start Date	Aug-2016	Total Definition cost (excludes unspent contingency for Nuclear)	
Target In-Service (or AFS) Date	Jul-2016	Contingency included in this BCS (Nuclear only)	
Target Completion Date		Total contingency released plus contingency in this BCS (Nuclear only)	
Escalation Rate	1.7%	Total released plus this BCS without contingency (Nuclear only)	
Interest Rate	5.0%	Total released plus this BCS with contingency (Nuclear only)	
Removal Costs	See note	Estimate at Completion (includes only spent contingency for Nuclear)	\$27,000k

Note: Removal Costs are included in the Summary of Estimate, however they haven't been fully identified at this time. They will be broken out as part of the RQE for the Full Execution BCS.

Prepared by:	Approved by:
Alan Lansbury Project Leader Date 2014-06-04	Ken Prince Section Manager - Projects Date 2014-06-04

Document #:

Appendix B: Comparison of Total Project Estimates and Project Variance Analysis

[illegible]

Project Variance Analysis					
Choose an item.	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management		n/a	1,385		The last BCS did not have a breakdown of costs as that was not required for a Type 2 BCS at that time.
OPG Engineering (Including Design)		n/a	240		
OPG Procured Materials		n/a	1,375		
OPG Other		n/a			
Design Contract(s)		n/a			
Construction Contract(s)		n/a	21,150		
EPC Contract(s)		n/a			
Consultants		n/a	120		
Other Contracts / Costs		n/a			
Interest		n/a	303		
Subtotal		n/a	24,573		
Contingency		n/a	2,427		
Total		n/a	27,000		



Records File Information:
 Records SCI/USI Retention
 - See Guidance Section

Internal Use Only
 OPG-FORM-0076-R005*

Type 3 Business Case Summary

To be used for investments/projects meeting Type 3 criteria in OPG-STD-0076.

Executive Summary and Recommendations

Project Information			
Project #:	SAB10050	Document #:	NF20-BCS-08707 021-XXXX
Project Title:	G10 Major Overhaul and Upgrade		
Class:	<input type="checkbox"/> OM&A <input checked="" type="checkbox"/> Capital <input type="checkbox"/> Capital Spare <input type="checkbox"/> MFA <input type="checkbox"/> CMFA <input type="checkbox"/> Provision <input type="checkbox"/> Others:	Investment Type:	Sustaining
Phase:	Execution	Release:	Full
Facility:	SAB1	Target In-Service or Completion Date:	July 2018

Project Overview
<p>We recommend the release of \$24.7M, including \$2,427K of contingency. The estimated total project cost is \$27M, including \$2,427K of contingency. The quality of the estimate for this release is Class 3, and for the total project is Class 3.</p> <p>This release will fund the following scope of work:</p> <ul style="list-style-type: none"> • Generator end Stator rewind and Electrical auxiliaries, new main transformer and static excitation. • New upgraded runner and major overhaul of the turbine components. • New PTFE thrust bearing. <p>The rehabilitated G10 unit is expected to produce 59 GWh annually, including an incremental increase of 13 GWh due to the installation of higher capacity stator windings, more efficient runner and transformer.</p> <p>This sustaining investment is consistent with the approved Life Cycle Plan (LCP) for SAB1 and OPG's objective of continuing to increase clean, renewable generation from its existing fleet of hydroelectric assets.</p> <p>Problem Statement/Business Need:</p> <p>Execution of this project will ensure availability and reliability of SAB1 G10 for 25-30 years and also ensure that Hydro-Thermal Operations maintains and develops hydro resources.</p> <p>Summary of Preferred Alternative:</p> <p>The project would execute a complete refurbishment of the generator stator and rotor including a rewind, and replacement of all supporting electrical auxiliaries. A major overhaul of the turbine would be completed, including installation of a new runner, modified head cover, and new wicket gates. Further investigation and possible repair would be done on the penstock and scroll case, including completion of a load carrying capacity analysis.</p> <p>A Definition Phase Charter (NEQ 00121.2-0355) was approved October 2, 2013 which includes a detailed scope of work based on actual work completed on G7, G9, and G3.</p> <p>This alternative is recommended since it will address availability and reliability concerns, has the highest NPV, and lowest risk profile. It is also consistent with Hydro-Thermal Operations mandate to maintain and develop hydro resources.</p> <p>History of BCS releases and project cost estimates:</p> <p>The project cost estimate of \$27M has been consistent through all releases.</p> <ul style="list-style-type: none"> • Init/Def BCS approved Oct. 18/13 to complete Technical specification and Update Study. • Partial BCS approved June 21/14 to purchase a new upgraded Runner <p>History of scope and schedule changes:</p> <p>The scope and schedule have not changed from the previous BCS's</p>

*Associated with OPG-STD-0076, Developing and Documenting Business Cases

Internal Use Only
 OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: SAB10050
 Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Document #: NF20-BCS-08707.021-xxxx

Project Overview

Key Assumptions and Risks:

The project will be executed by a single main contractor. All equipment and manpower, except for the runner purchase, will be included in the scope of work for the contractor.

Project Cash Flows, NPV, and OAR Approval Amount

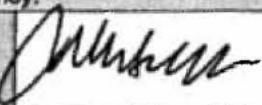
k\$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released		990	1,310						2,300
Requested Now	-		12,300	12,400					24,700
Future Required	-								
Total Project Cost		990	13,610	12,400					27,000
Ongoing Costs	-								
Grand Total	-	990	13,610	12,400					27,000

Estimate Class:	Class 3	Estimate at Completion:	27,000
NPV:	26,951	OAR Approval Amount:	27,000

Additional Information on Project Cash Flows (optional):

The 2014 cashflow will be managed within the Niagara Operations budget envelope.

Approvals

	Signature	Comments	Date
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by (Project Sponsor): Mike Martelli SVP HTO			19 Dec 14
I concur with the business decision as documented in this BCS.			
Finance Approval: Beth Summers SVP & CFO per OPG-STD-0076			22 Dec 14
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Tom Mitchell President & CEO per OAR 1.1			13 Jan 15



Records File Information:
 Records SCI/USI Retention
 - See Guidance Section

Internal Use Only
 OPG-FORM-0076-R005*

Type 3 Business Case Summary

Project #: SAB10050
 Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Document #: NF20-BCS-08707.021-xxxx

Business Case Summary

Part A: Business Need

Execution of this project will ensure availability and reliability of SAB1 G10 for 25-30 years and also ensure that Hydro-Thermal Operations maintains and develops hydro resources.

A generator rewind and an upgraded runner will result in improved unit efficiency and a maximum continuous rating (MCR) increase of approximately 9 MW. This project is a sustaining investment required to ensure continued reliable operation of G10 and to maximize the use of water available from the Niagara River new third tunnel.

Sir Adam Beck GS #1 (SAB1) G10 was originally placed in-service in 1930 as a 25Hz unit rated for 45MVA then converted to 60Hz in 1956. The last major overhaul completed on the unit was in 1986. During the upcoming overhaul, the opportunity exists to execute additional work which would increase the capacity and efficiency of G10 and allow Niagara Operations to better utilize the water available to the station. The recommended alternative upgrades the current rating of the unit to the following capabilities:

	Turbine		Generator		
	Efficiency (%)	Power (MW)		Rating parameters	
		Best	Full Load	MVA	MW
Existing Unit		43.0	57.0	55	55
Upgraded Unit		55.0	59.0	63	59
Improvement		+12.0	+2.0	+8	+4

A Life Cycle Plan (LCP) for SAB1 (R-NF20-01556-0002) was approved July 2008. The recommended alternative was an eight unit station (G3-G10) which included overhaul and upgrade of G10. This project is also included in the 2015-17 Business Plan.

The project cost estimate of \$27M has been consistent through all releases.

- Init/Def BCS (NPG-08707.021-0127) approved Oct. 18/13 to complete Technical specification and Uprate Study.
- Partial BCS (NPG-08707.021-0141) approved June 21/14 to purchase a new uprated Runner.

Part B: Preferred Alternative: Perform Major Overhaul and Upgrade unit to 55 MW, 63 MVA

Description of Preferred Alternative

The project would execute a complete refurbishment of the generator stator and rotor including a rewind, and replacement of all supporting electrical auxiliaries. A major overhaul of the turbine would be completed, including installation of a new runner, modified head cover, and new wicket gates. Further investigation and possible repair would be done on the penstock and scrollcase, including completion of a load carrying capacity analysis.

A Definition Phase Charter (NPG-00121.2-0055) was approved October 2, 2013 which includes a detailed scope of work based on actual work completed on G7, G9, and G3.

An equipment supply agreement between OPG and American Hydro Corp (now Weir) was signed Feb 2007 for the supply of runners for G3-G10. The runner for G10 will be purchased under the terms of this agreement. The decision to purchase 8 runners and the SAB1 overhaul program were recommended and supported by the 2008 LCP for SAB1.

The execution strategy is to award a single contract to a general contractor. A Technical Specification has been developed which will specify equipment and components proven and existing on previous SAB1 upgrades. The general contractor will be responsible for completing the installation design (mechanical, electrical, civil), manufacture of parts, supply of equipment (except the runner), removal of existing equipment, and installation of new and/or refurbished equipment. This strategy will reduce the cost of re-engineering equipment, lower the contract cost, and reduce the duplication of spare parts.

An Initial Project Execution Plan (PEP) with Risk Analysis (NPG-00121.1-0025) was approved June 25, 2014 and is attached below.

The unit will be overhauled during a Planned Outage from August 2015 to July 2018.

This alternative is recommended since it will address availability and reliability concerns, has the highest NPV, and lowest risk profile. It is also consistent with Hydro-Thermal Operations mandate to maintain and develop hydro resources.

*Associated with OPG-STD-0076, Developing and Documenting Business Cases

Internal Use Only
OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: SAB10050

Document #: NF20-BCS-08707.021-xxxx

Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Deliverables:	Associated Milestones (if any):	Target Date:
Purchase new runner	PBCS approved	July 4, 2014
	PO issued	July 16, 2014
Main contract for General Contractor	RFP start	Sept 18 2014
	Full BCS Approval	Jan 2015
	Award main contract	Jan 2015
	Construction Start	Aug 2015
	Equipment in Service	July 2016



PEP SAB10050 r0
APPROVED.pdf

Part C: Other Alternatives

Summarize all viable alternatives considered, including pros and cons, and associated risks. Other alternatives may include different means to meet the same business need, and a reduced or increased scope of work, etc.

Alternative 2: Base Case – No Project

Do nothing, continue with the existing LEM program for the unit and corrective maintenance on an ad hoc basis.

Based on its current condition, G10 could likely run without major investment until 2018, at which time the turbine is expected to have reduced reliability and the transformer is expected to reach end-of-life. If left unaddressed, an eventual failure will result in a forced outage during either the Nuclear Refurbishment, SAB2 Overhaul Program, or the later stages of the SAB1 Overhaul Program.

Therefore, this alternative is not recommended.

Alternative 3: Perform a Minor Overhaul for 10 Years of Operation at 45.9 MW

Maintain the current rating of the generator. The scope of work would be largely focussed on cleaning, testing and repair of existing equipment, including removal of the generator rotor for cleaning and a flux test. Also included is the purchase and installation of a new transformer.

This alternative has the worst NPV due to its investment requirements and expected outcome of reliability, and the fact that the next overhaul will occur in the middle of the Nuclear Refurbishment & SAB2 Overhaul Programs.

Therefore, this alternative is not recommended.

Alternative 4: Perform Major Overhaul to Ensure 15-20 Years of Operation at 45.9 MW

Maintain the current rating of the generator. The project would execute a complete refurbishment of the generator stator and rotor, including a rewind, and replacement of all supporting electrical auxiliaries. A major overhaul of the turbine would be completed including weld repair of the runner, installation of new wicket gates and potential install of a new headcover.

This alternative provides for low technical risk, but is not recommended due to its lower NPV. It also does not take advantage of the opportunity to increase capacity and efficiency to make better use of the available water.

Alternative 5: Upgrade the Unit to 61 MW, 68 MVA

The scope of work for this alternative is very similar to that of the preferred alternative, with the significant difference being the purchase and installation of a new generator and all of the associated work required to the superstructure to accommodate the unit.

Due to a less favourable NPV and increased technical risk with the expanded scope, this alternative is not recommended.

Internal Use Only
 OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: SAB10050
 Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Document #: NF20-BCS-08707.021-xxxx

Part D: Project Cash Flows, NPV, and OAR Approval Amount

k\$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released		990	1,310						2,300
Requested Now	-		12,300	12,400					24,700
Future Required	-								
Total Project Cost		990	13,610	12,400					27,000
Ongoing Costs	-								
Grand Total		990	13,610	12,400					27,000
Estimate Class:	Class 3			Estimate at Completion:		27,000			
NPV:	26,951			OAR Approval Amount:		27,000			

Additional information on Project Cash Flows (optional):

(k\$)	LTD	2014	2015	2016	2017	Total
BP 2015-17	0	990	13,610	12,400	0	27,000
Summary of Estimate	0	990	13,610	12,400	0	27,000
Variance (SoE - BP)	0	0	0	0	0	0

The 2014 cashflow will be managed within the Niagara Operations budget envelope.

Part E: Financial Evaluation

M\$	Upgrade to 55 MW, 63 MVA	Base Case No Project	Minor Overhaul	Major Overhaul	Upgrade to 61 MW, 68 MVA
Project Cost	27.0	N/A	7.1	20.3	38.5
NPV	27.0	24.3	19.6	19.6	23.1
Incremental NPV	2.7	N/A	(4.7)	(4.7)	(1.2)

Summary of Financial Model Key Assumptions or Key Findings:

Energy projections per the SAB1 LCP are still valid.

Project costs based on actual costs from G7, G9, and G3 overhauls/upgrades.

The potential for a higher MCR during the Darlington refurbishment program has not been included.



NPV SAB10050 G10
 Overhaul & Upgrade

Part F: Qualitative Factors

Sustainable Development

Since hydroelectric generation is a renewable source of energy, the loss of a hydroelectric generating unit will increase the environmental impact of meeting Ontario's electricity demands. This will potentially necessitate the supply of energy from other less sustainable sources; therefore, increasing the reliability and production of SAB1 will potentially reduce the environmental impact of meeting Ontario's electricity demands.

Station Enhancement

Upgrades performed on the unit such as the modernization of the excitation system, unit protections and controls will improve the unit response and ensure compliance with Electricity market rules. This will enhance the overall station performance.

Health and Safety

The work will be completed in a manner that ensures G10 and associated equipment will be compliant with current corporate and provincial health and safety standards. Efforts will also be made to ensure that any new equipment installed is ergonomic. Enhancements such as upgraded lighting will improve the work environment and reduce health and safety risks to workers.

Type 3 Business Case Summary

Project #: SAB10050

Document #: NF20-BCS-08707.021-xxxx

Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Part F: Qualitative Factors

Environmental

An Environmental Assessment is not required for this project as the scope of this upgrade does not extend the operational parameters for SAB1 past the parameters associated with the original 10 unit station configuration.

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	Costs higher than expected	Cost based on recent G7, G9 and G3 projects. A contingency allowance is included in the estimate (9%)	Low	Low
Scope	Planned Execution Phase not complete. Discovery Work	A very comprehensive and detailed scope has been developed, with lessons learned from previous unit scope and as-found extra work detailed in the scope.	Low	Low
Schedule	Delay in completion of construction will result in lost generation revenue.	Preliminary estimates of hours required to complete the work are based on recent G3, G7 and G9 projects.	Low	Low
Resources	Insufficient OPG resources (PES, PWU) to support the work	Required resources have been committed to per the PEP. Contract additional resources as required.	Low	Low
Quality/Performance	Due to volume of work and consolidation of engineering packages, functional specs and RFP packages may contain errors.	Peer reviews have been used to ensure accuracy of documentation.	Low	Low
Technical	Unit does not meet performance requirements	G10 is a repeat of G3 with very minor differences.	Low	Low

Additional Risk Analysis:

G3 project was managed with multiple contractors and purchase orders which created many issues. G10 will be managed by a single main contractor with only two purchase orders. The technical specification is very specific and has reduced engineering design. Lessons learned from previous projects were analysed and included in the project.

Part H: Post Implementation Review (PIR) Plan

Type of PIR Report	Target In-Service or Completion Date		Target PIR Completion Date	
Simplified PIR	September 2016		September 2017	
Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
MCR	45.9 MW	55 MW	Unit Metering	SAB1 Production
Apparent Power	55 MVA	63 MVA	Unit Metering	SAB1 Production
Runner Efficiency at best efficiency point.	1986 Gibson Test		Gibson Test	Tech Supp Erg HTO / P&T
Runner Cavitation	N/A	As per model testing results (cavitation guarantee is 59 MW)	Visual Inspection	NPG Asset/Projects

Internal Use Only
OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: SAB10050

Document #: NF20-BCS-08707.021-xxxx

Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Part i: Definitions and Acronyms

BP	Business Plan
HTO	Hydro-Thermal Operations
LEM	Leading Edge Maintenance
LCP	Life Cycle Plan
MCR	Maximum Continuous Rating
MW	Megawatts
MVA	Megavolt Ampere (a unit of measure of apparent power)
NPG	Niagara Plant Group (now Niagara Operations)
NPV	Net Present Value
P&T	Performance & Testing
PES	Plant Engineering Services
PTFE	Polytetrafluoroethylene - a synthetic polymer with numerous applications. The best known brand name is Teflon.
PWU	Power Workers Union
RQE	Release Quality Estimate
RFP	Request for Proposal
SAB	Sir Adam Beck

Internal Use Only
OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: SAB10050

Document #: NF20-BCS-08707.021-xxxx

Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

This page is intentionally left blank

Internal Use Only
OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: SAB10050

Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Document #: NF20-BCS-08707.021-xxxx

For Internal Project Cost Control

Type 3 Business Case Summary

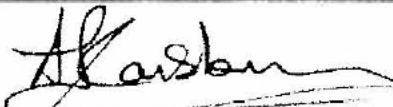

Document #: NF20-BCS-08707.021-xxxx

Project #: SAB10050

Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Appendix A: Summary of Estimate										
Project Number:	SAB10050									
Project Title:	G10 Major Overhaul and Upgrade									
k\$	LTD	2014	2015	2016	2017	2018	2019	Future	Total	%
OPG Project Management	34	106	620	625					1,385	5.1
OPG Engineering (including Design)			120	120					240	0.9
OPG Procured Materials		485	720	170					1,375	5.1
OPG Other										
Design Contract(s)										
Construction Contract(s)			10,970	10,180					21,150	78.3
EPC Contract(s)										
Consultants		120							120	0.4
Other Contracts / Costs										
Interest		76	105	122					303	1.1
Subtotal	34	787	12,535	11,217					24,573	91.0
Contingency	0	169	1,075	1,183					2,427	9.0
Total	34	956	13,610	12,400					27,000	100.0

Notes			
Project Start Date	Aug-2015	Total Definition cost (excludes unspent contingency for Nuclear)	34
Target In-Service (or AFS) Date	Jul-2016	Contingency included in this BCS (Nuclear only)	N/A
Target Completion Date	July -2018	Total contingency released plus contingency in this BCS (Nuclear only)	N/A
Escalation Rate	1.7%	Total released plus this BCS without contingency (Nuclear only)	N/A
Interest Rate	5.0%	Total released plus this BCS with contingency (Nuclear only)	N/A
Removal Costs		Estimate at Completion (includes only spent contingency for Nuclear)	27,000

Prepared by:	Approved by:
	
Alan Lansbury Project Leader	Ken Prince Section Manager - Projects
Date 2014-11-27	Date 2014-12-03

Internal Use Only
 OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: SAB10050
 Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Document #: NF20-BCS-08707.021-xxxx

Appendix A: Summary of Estimate

Project Number:	SAB10050									
Project Title:	G10 Major Overhaul and Upgrade									
k\$	LTD	2014	2015	2016	2017	2018	2019	Future	Total	%
OPG Project Management	34	106	620	625					1,385	5.1
OPG Engineering (including Design)			120	120					240	0.9
OPG Procured Materials		485	720	170					1,375	5.1
OPG Other										
Design Contract(s)										
Construction Contract(s)			10,970	10,180					21,150	78.3
EPC Contract(s)										
Consultants		120							120	0.4
Other Contracts / Costs										
Interest		76	105	122					303	1.1
Subtotal	34	767	12,536	11,217					24,573	91.0
Contingency	0	169	1,075	1,183					2,427	9.0
Total	34	936	13,610	12,400					27,000	100.0

Notes

Project Start Date	Aug-2015	Total Definition cost (excludes unspent contingency for Nuclear)	34
Target In-Service (or AFS) Date	Jul-2016	Contingency included in this BCS (Nuclear only)	N/A
Target Completion Date	July -2016	Total contingency released plus contingency in this BCS (Nuclear only)	N/A
Escalation Rate	1.7%	Total released plus this BCS without contingency (Nuclear only)	N/A
Interest Rate	5.0%	Total released plus this BCS with contingency (Nuclear only)	N/A
Removal Costs		Estimate at Completion (includes only spent contingency for Nuclear)	27,000

Prepared by:

Approved by:

Alan Lansbury
 Project Leader

Date
 2014-11-27

Ken Prince
 Section Manager - Projects

Date
 2014-12-03

Internal Use Only
OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: SAB10050

Document #: NF20-BCS-08707.021-xxxx

Project Title: G10 Major Overhaul and Upgrade, <Full> <Execution> Release

Appendix C: Financial Evaluation Assumptions

Key assumptions used in the financial model of the Project are (complete relevant assumptions only):

Project Cost:

1. Overall project cost estimates were heavily based on G3, G7 and G9 rehabilitations
2. Costs for components and labour were based on costs for similar work carried out in the past with appropriate escalators applied
3. Cost reduction by reducing engineering design by using proven designs from previous units

Financial:

1. The new generator and associated equipment will have a useful service life of 50 years
2. Increased capacity will generate higher revenue
- 3.

Project Life:

1. The project can start immediately after approval
2. The project can be completed and the generator can be commissioned by the end of Q4 2016
- 3.

Energy Production:

1. Energy forecasts were based on Niagara River flow models
2. Generation at the Beck plants can be maximized while adhering to the market dispatches
3. Historical forced outage rates will be typical in the future

Operating Cost:

1. There will be minimal incremental operating costs associated with the upgraded G10 unit
- 2.
- 3.

Other:

- 1.
- 2.
- 3.

List further detail below as appropriate from the Financial Evaluation:

Appendix D: References

SAB1 Life Cycle Plan (R-NF20-01556-0002) dated December 2007
Business Plan 2015-2017
Release Quality Estimate
Initial Project Execution Plan (NPG-00121.1-0025) approved June 25, 2014
Definition Phase Charter (NPG-00121.2-0055) approved October 2, 2013

Type 3 Business Case Summary

To be used for investments/projects meeting Type 3 criteria in OPG-STD-0076.

Executive Summary and Recommendations

Project Information			
Project #:	BK180649 (SAB10050)	Document #:	NIAG-REP-08707.021-0201
Project Title:	G10 Major Overhaul and Upgrade		
Class:	<input type="checkbox"/> OM&A <input checked="" type="checkbox"/> Capital <input type="checkbox"/> Capital Spare <input type="checkbox"/> MFA <input type="checkbox"/> CMFA <input type="checkbox"/> Provision <input type="checkbox"/> Others:	Investment Type:	Sustaining
Phase:	Execution	Release:	Superseding
Facility:	SAB1	Target In-Service or Completion Date:	April 2017

Project Overview
<p>We recommend the release of an additional \$6.14M, including \$1M of contingency. The project was originally released at \$27M including \$2.4M contingency, which will be consumed by cost variances as explained below. The revised estimated total project cost is \$33.14M, including \$1M of contingency. The quality of the estimate for this release is Class 1 (+15%), and for the total project is Class 1 (+15%).</p> <p>This is accompanied by a shift of the in-service date from July 2016 to April 2017..</p> <p>This release will provide additional funding to complete the following scope of work:</p> <ul style="list-style-type: none"> Stator windings, electrical auxiliaries, new main transformer, static excitation and controls installation. New upgraded runner, headcover and bottom ring and overhauled turbine components installation. Start-up and commissioning. <p>The rehabilitated G10 unit is expected to produce 59 GWh annually, including an incremental increase of 13 GWh due to the installation of higher capacity stator windings, more efficient runner and transformer.</p> <p>This sustaining investment is consistent with the approved Life Cycle Plan (LCP) for SAB1 and OPG's objective of continuing to increase clean, renewable generation from its existing fleet of hydroelectric assets.</p> <p>Reasons for Variance:</p> <ol style="list-style-type: none"> PWU support costs (\$1,853): The PWU support costs for contract monitoring and site preparation were not covered in the original EBCS; the project team initially planned to execute as an Owner Only contract at lower cost, but this did not transpire and the costs were not accounted for in the RQE. EPC contract pricing (\$1,375): The lowest contract bid price was significantly higher than the RQE allowance. It included higher than expected risk cost associated with an all-inclusive contract, which is the preferred contracting strategy as it shifts resource demand and performance liability to the contractor. New head cover and bottom ring (\$1,100): Based on emergent information from G9, a decision was made to procure a new head cover and bottom ring; these costs were not included in the original RQE or EBCS. Grit-blasting and lead abatement (\$975): A change in work method was requested to significantly improve containment of fugitive lead paint particulate, improving cleanliness in the powerhouse from a Health & Safety standpoint, thereby increasing execution cost. Interest Costs (\$610): Higher than expected EPC contract cost, combined with an overall nine month delay in the completion date contributed to higher than estimated interest costs. Runner currency exchange and escalation allowance (\$450): The value of the Canadian dollar declined significantly during execution; there was no allowance for escalation from the original blanket purchase order, in the original RQE or EBCS. Moody cone tip and stainless steel draft tube extension scope changes (\$418): Based on recent discovery of cavitation on G9, it was decided to change the draft tube extension material to stainless steel at an increased cost. In addition, after disassembly, the Moody Cone tip was discovered to be missing. A new tip was fabricated and installed to preserve runner performance guarantees. Windings delayed delivery (Schedule impact): The EPC contractor experienced quality issues during fabrication of the generator windings which will result in an approximate nine month delay to the in-service date. Although the Contractor mitigated schedule impact where possible, this will result in carrying cost to OPG. Liquidated damages

*Associated with OPG-STD-0076, Developing and Documenting Business Cases

Internal Use Only

OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: BK180649 (SAB10050)

Document #: NIAG-REP-08707.021-0201

Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

Project Overview

recovery will be negotiated but are not included in this estimate due to remaining schedule uncertainty.

9. **Other additional scope and discovery work (\$786):** Major contributors - discovery work (\$257) - penstock bulge injection /Moody Cone install/lower fan repair/thrust bearing/shaft steel replacement, Schedule delays (\$220k) – Andritz mobilization was impacted by IESO and Powerhouse Crane not available early in the project. [REDACTED]

Key Assumptions and Risks:

The project, except for the runner supply, is being executed under a single, well-qualified EPC contractor, mitigating the risk to OPG associated with coordinating multiple contractors and suppliers. The unusually complex G10 stator winding configuration resulted in significant manufacturing challenges which have now been resolved through dedicated process improvements.

Project Cash Flows, NPV, and OAR Approval Amount

k\$	LTD	2016	2017	2018	2019	2020	2021	Future	Total
Currently Released	14,600	12,400							27,000
Requested Now	-	4,816	1,324						6,140
Future Required	-								
Total Project Cost	14,600	17,216	1,324						33,140
Ongoing Costs	-								
Grand Total	14,600	17,216	1,324						33,140
Estimate Class:	Class 1			Estimate at Completion:		33,140			
NPV:				OAR Approval Amount:		33,140			

Additional Information on Project Cash Flows:

The 2016 cash flow is being managed within the Niagara Operations budget envelope; the 2017 cash flow will be incorporated in the 2017 Business Plan.

Internal Use Only



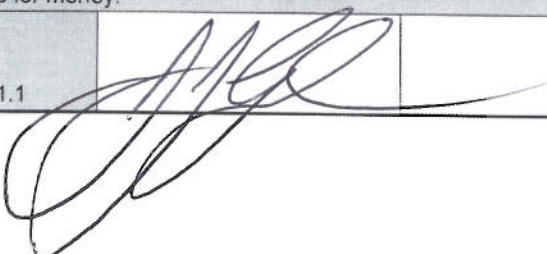
OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: BK180649 (SAB10050)

Document #: NIAG-REP-08707.021-0201

Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

Approvals			
	Signature	Comments	Date
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by (Project Sponsor): Mike Martelli President, RG&PM			26 AUG 16
I concur with the business decision as documented in this BCS.			
Finance Approval: Ken Hartwick SVP & CFO per OPG-STD-0076			Aug 27, 2016
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Jeff Lyash President & CEO per OAR 1.1			Aug 31, 2016

Type 3 Business Case Summary

Project #: BK180649 (SAB10050)

Document #: NIAG-REP-08707.021-0201

Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

Business Case Summary

Part A: Business Need

Execution of this project will ensure availability and reliability of SAB1 G10 for 25-30 years and also ensure that Renewable Generation and Power Marketing maintains and develops hydro resources.

A generator rewind and an upgraded runner will result in improved unit efficiency and a maximum continuous rating (MCR) increase of approximately 9 MW. This project is a sustaining investment required to ensure continued reliable operation of G10 and to maximize the use of water available from the Niagara River new third tunnel.

Sir Adam Beck GS #1 (SAB1) G10 was originally placed in-service in 1930 as a 25Hz unit rated for 45MVA then converted to 60Hz in 1956. The last major overhaul completed on the unit was in 1986. During the upcoming overhaul, the opportunity exists to execute additional work which would increase the capacity and efficiency of G10 and allow Niagara Operations to better utilize the water available to the station. The recommended alternative upgrades the current rating of the unit to the following capabilities:

	Turbine			Generator		MCR (MW)
	Efficiency (%)	Power (MW)		Rating parameters		
		Best	Full Load	MVA	MW	
Existing Unit		43.0	57.0	55	55	45.9
Upgraded Unit		55.0	59.0	63	59	55
Improvement		+12.0	+2.0	+8	+4	9.1

A Life Cycle Plan (LCP) for SAB1 (R-NF20-01556-0002) was approved July 2008. The recommended alternative was an eight unit station (G3-G10) which included overhaul and upgrade of G10. This project is also included in the 2015-17 Business Plan.

- Init/Def BCS (NPG-08707.021-0127) approved Oct. 18/13 to complete the Technical Specification and Upgrade Study.
- Partial BCS (NPG-08707.021-0141) approved June 21/14 to purchase a new upgraded runner.

Part B: Preferred Alternative: Perform Major Overhaul and Upgrade unit to 55 MW, 63 MVA

Description of Preferred Alternative

The project is executing a complete refurbishment of the generator stator and rotor including a rewind, and replacement of all supporting electrical auxiliaries. A major overhaul of the turbine has been undertaken, including installation of a new, uprated runner, headcover, lower ring and new wicket gates. Inspection of the penstock, Johnson valve and scroll case has revealed the need for significant repair and polyurethane injection.

A Definition Phase Charter (NPG-00121.2-0055) was approved October 2, 2013 which included a detailed scope of work based on actual work completed on G7, G9, and G3.

An equipment supply agreement between OPG and American Hydro Corp (now WAH) was signed Feb 2007 for the supply of runners for G3-G10. The runner for G10 was purchased under the terms of this agreement. The decision to purchase 8 runners and the SAB1 overhaul program was recommended and supported by the 2008 LCP for SAB1. The G10 RQE failed to allow for escalation and exchange rate fluctuation, as provided for in the WAH agreement.

The Technical Specification covering equipment and components which was based on previous SAB1 upgrades has stood up well during execution of the main EPC contract. That general contractor is responsible for completing the design (mechanical, electrical, civil), manufacture of parts, supply of equipment (except the runner), removal of existing equipment, and installation of new and/or refurbished equipment and installation of all of equipment and materials. It is believed that his strategy has reduced the execution cost and the associated risk to OPG, over what it would be under a multiple contracts scenario.

An Initial Project Execution Plan (PEP) with Risk Analysis (NPG-00121.1-0025) was approved June 25, 2014 and is attached below.

The unit is being overhauled during a Planned Outage from October 2015 extended to February, 2017.

This approach was recommended since it addresses availability and reliability concerns, had the highest NPV, and lowest risk profile. It is also consistent with Renewable Generation and Power Marketing mandate to maintain and develop hydro resources.

Internal Use Only
OPG-FORM-0076-R005

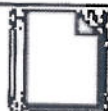
Type 3 Business Case Summary

Project #: BK180649 (SAB10050)

Document #: NIAG-REP-08707.021-0201

Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

Deliverables:	Associated Milestones (if any):	Target Date:
This phase of the project will: Complete the mechanical and electrical installation and commissioning work.	Equipment in Service	Feb 2017



EBCS BK180649
(SAB10050) G10 Majo

Part D: Project Cash Flows, NPV, and OAR Approval Amount									
k\$	LTD	2016	2017	2018	2019	2020	2021	Future	Total
Currently Released	14,600	12,400							27,000
Requested Now	-	4,816	1,324						6,140
Future Required	-								
Total Project Cost	14,600	17,216	1,324						33,140
Ongoing Costs	-								
Grand Total	14,600	17,216	1,324						33,140
Estimate Class:	Class 1				Estimate at Completion:		33,140		
NPV:					OAR Approval Amount:		33,140		
Additional Information on Project Cash Flows (optional):									
The 2016 cash flow will be managed within the Niagara Operations budget envelope; the 2017 cash flow will be incorporated in the 2017 Business Plan.									

Part E: Financial Evaluation (Revised to reflect current approval request)					
M\$	Upgrade to 55 MW, 63 MVA	Base Case No Project	Minor Overhaul	Major Overhaul	Upgrade to 61 MW, 68 MVA
Project Cost	33.1	N/A	7.1	22.3	44.6
NPV	22.0	21.9	18.3	17.5	19.5
Incremental NPV	0.1	N/A	(3.6)	(4.4)	(2.4)

Summary of Financial Model Key Assumptions or Key Findings:

Energy projections per the SAB1 LCP are still valid.

Project costs are based on actual costs and current projections of work to complete.

The potential for a higher MCR during the Darlington refurbishment program has not been included.



VPV SAB10050 G10
Overhaul & Up...

Internal Use Only

OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: BK180649 (SAB10050)

Document #: NIAG-REP-08707.021-0201

Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

Part F: Qualitative Factors

Sustainable Development

Since hydroelectric generation is a renewable source of energy, the loss of a hydroelectric generating unit will increase the environmental impact of meeting Ontario's electricity demands. This will potentially necessitate the supply of energy from other less sustainable sources; therefore, increasing the reliability and production of SAB1 will potentially reduce the environmental impact of meeting Ontario's electricity demands.

Station Enhancement

Upgrades performed on the unit such as the modernization of the excitation system, unit protections and controls will improve the unit response and ensure compliance with Electricity market rules. This will enhance the overall station performance.

Health and Safety

The work will be completed in a manner that ensures G10 and associated equipment will be compliant with current corporate and provincial health and safety standards. Efforts will also be made to ensure that any new equipment installed is ergonomic. Enhancements such as upgraded lighting will improve the work environment and reduce health and safety risks to workers.

Environmental

An Environmental Assessment is not required for this project as the scope of this upgrade does not extend the operational parameters for SAB1 past the parameters associated with the original 10 unit station configuration.

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	Costs higher than expected	Allowances have been made for the expected spending trends to the end of the project. A contingency is also included consistent with the Estimate Class. Although it is possible for additional problems to arise during commissioning, Niagara has had recent success with the Weir runner/Andritz overhaul combination. The rewind portion of the contract will be transitioned to Owner Only.	Medium	Medium
Scope	Planned Execution Phase not complete. Discovery Work	The odds of there being significant additional discovery work are reduced at this point.	Low	Low
Schedule	Delay in completion of construction will result in lost generation revenue. Potential risk to coil manufacturing.	Newly qualified fabrication process has been developed with a firm delivery date. Although it is possible for additional problems to arise during commissioning, Niagara has had recent success with the Weir runner/Andritz overhaul combination.	Medium	Low
Resources	Insufficient OPG resources (PES, PWU) to support the work	Required resources committed to date have been sufficient.	Low	Low
Quality/ Performance	Due to volume of work and consolidation of engineering packages, functional specs and RFP packages may contain errors.	Confidence has been established that we will receive high quality coils based on extensive work by Andritz at the expense of a schedule delay. The prototype coils successfully passed testing requirements and will continue to be spot checked.	Low	Low
Technical	Unit does not meet performance requirements	G10 is a repeat of G3 with some additions.	Low	Low

Additional Risk Analysis:

Type 3 Business Case Summary

Project #: BK180649 (SAB10050)

Document #: NIAG-REP-08707.021-0201

Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

Additional Risk Analysis:

G3 project was managed with multiple contractors and purchase orders which created many issues. G10 is being executed by a single general contractor under only two purchase orders. Site execution to date has been very good. Major additional work items that were not captured in the specification have been identified and addressed.

Part H: Post Implementation Review (PIR) Plan

Type of PIR Report	Target In-Service or Completion Date	Target PIR Completion Date
Simplified PIR	February 2017	February 2018

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
MCR	45.9 MW	55 MW	Unit Metering	SAB1 Production
Apparent Power	55 MVA	63 MVA	Unit Metering	SAB1 Production
Runner Efficiency at best efficiency point.	1986 Gibson Test		Gibson Test	Tech Supp Eng HTO / P&T
Runner Cavitation	N/A	As per model testing results (cavitation guarantee is 59 MW)	Visual Inspection	NPG Asset/Projects

Part I: Definitions and Acronyms

BP	Business Plan
HTO	Hydro-Thermal Operations
LEM	Leading Edge Maintenance
LCP	Life Cycle Plan
MCR	Maximum Continuous Rating
MW	Megawatts
MVA	Megavolt Ampere (a unit of measure of apparent power)
NPG	Niagara Plant Group (now Niagara Operations)
NPV	Net Present Value
P&T	Performance & Testing
PES	Plant Engineering Services
PTFE	Polytetrafluoroethylene - a synthetic polymer with numerous applications. The best known brand name is Teflon.
PWU	Power Workers Union
RQE	Release Quality Estimate
RFP	Request for Proposal
SAB	Sir Adam Beck

Type 3 Business Case Summary

Project #: BK180649 (SAB10050)

Document #: NIAG-REP-08707.021-0201

Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

This page is intentionally left blank

Type 3 Business Case Summary

Project #: BK180649 (SAB10050)

Document #: NIAG-REP-08707.021-0201

Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

For Internal Project Cost Control

Type 3 Business Case Summary

Project #: BK180649 (SAB10050)

Document #: NIAG-REP-08707.021-0201

Project Title: G10 Major Overhaul and Upgrade, <Superseding> <Execution> Release

Appendix A: Summary of Estimate (Revised)										
Project Number:	BK180649 (BK180649 (SAB10050))									
Project Title:	G10 Major Overhaul and Upgrade									
k\$	LTD	2016	2017	2018	2019	2020	2021	Future	Total	%
OPG Project Management	340	695	142						1,177	3.6
OPG Engineering (including Design)	67	291	50						408	1.2
OPG Procured Materials	1,698	545							2,243	6.7
OPG Cnst Labour	368	1,245	240						1,853	5.6
Design Contract(s)										
Construction Contract(s)	14,654	9,414	572						24,640	74.3
EPC Contract(s)										
Consultants	182	79	0						261	.8
Other Contracts / Costs										
Interest	160	633	120						913	2.8
Subtotal	17,469	12,902	1,124						31,495	95.0
Removal Costs	645								645	1.9
Contingency	0	800	200						1,000	3.1
Total	18,114	13,702	1,324						33,140	100.0

Notes			
Project Start Date	Oct-2015	Total Definition cost (excludes unspent contingency for Nuclear)	34
Target In-Service (or AFS) Date	February-2017	Contingency included in this BCS (Nuclear only)	N/A
Target Completion Date	February -2017	Total contingency released plus contingency in this BCS (Nuclear only)	N/A
Escalation Rate	1.7%	Total released plus this BCS without contingency (Nuclear only)	N/A
Interest Rate	5.26%	Total released plus this BCS with contingency (Nuclear only)	N/A
Removal Costs	\$645k	Estimate at Completion (includes only spent contingency for Nuclear)	33,140

Prepared by:		Approved by:	
Rick Comacchio Project Leader		Ken Prince Section Manager - Projects	
Date 2016-05-27		Date 2016-05-27	

Type 3 Business Case Summary

To be used for investments/projects meeting Type 3 criteria in OPG-STD-0076.

Executive Summary and Recommendations

Project Information			
Project #:	DQ280851 (Capital)	Document #:	NIAG-REP-08707.021-0189 R00
Project Title:	G2 Overhaul & Upgrade		
Class:	<input type="checkbox"/> OM&A <input checked="" type="checkbox"/> Capital <input type="checkbox"/> Capital Spare <input type="checkbox"/> MFA <input type="checkbox"/> CMFA <input type="checkbox"/> Provision <input type="checkbox"/> Others:	Investment Type:	Sustaining
Phase:	Execution	Release:	Full
Facility:	Decew Falls (NF23)	Target In-Service or Completion Date:	FEB 14-2018

Project Overview
<p>We recommend the release of \$37,350k, including \$5,440k of contingency. The estimated total project cost is \$38,100k, including \$5,560k of contingency.</p> <p>The quality of the estimate for this release, and for the total project is AACE Class 3.</p> <p>This release will fund the following scope of work:</p> <ul style="list-style-type: none"> • A new reliable 90 MVA Generator and overhauled Turbine, producing 72 MW MCR. • Upgrade of relevant downstream electrical equipment and protections as required, to ensure G2 generator output is safely and reliably delivered to the grid. • Removal of the current operating 9MW unit de-rating. <p>Problem Statement/Business Need:</p> <p>The unit is currently de-rated, experiencing increased outages, and has a potential risk of generator failure. This project is necessary to ensure safe and reliable operation of the unit capable of meeting Independent Electricity System Operator ("IESO") committed Mega Watts ("MW"). As per the Risk Treatment Plan (NF23-PLAN-09823-0001) this project eliminates the very-high financial risk identified in the 2015 ERAP.</p> <p>Summary of Preferred Alternative:</p> <ul style="list-style-type: none"> • Replace the generator with one that is appropriately sized to keep future options open. The project is based on accommodating operation of G2 at its maximum runner capability of ~76 MWe. Maximum Continuous Rating ("MCR") will remain at 72 MW. • Replace the turbine shaft with one that is appropriately designed to keep future options open and provides an adequate safety factor. The same diameter is expected and a new head cover will not be required. • Re-use the existing runner and include cavitation repairs to the runner and draft tube (overhaul turbine). • Upgrade of electrical equipment such as breaker and switchgear, transformer cooling, full static excitation system and unit controls and instrumentation. <p>For detailed scope of work for this alternative refer to NIAG-REP-00121.2-0002</p>

Type 3 Business Case Summary

Project #: DQ280851 (Capital)

Document #: NIAG-REP-08707.021-0189 R00

Project Title: G2 Overhaul & Upgrade, <Full> <Execution> Release

Project Overview**History of BCS releases and project cost estimates:**

Definition BCS release was approved on Feb. 6, 2015 for \$750k which has covered costs for Scope Definition, creation of the Technical Specification and creating the Request for Proposals documents.

The 2015-17 Business Plan included \$44,430 (CAP), based on a scope that included a new runner as well as powerhouse movement mitigation measures.

The revised project estimate based on mid-range contractor bids proposals is \$38,100k encompassing Alt. 1 scope which includes; a new generator, overhauled turbine, and replacement of all necessary components. This alternative re-uses the existing runner.

History of scope and schedule changes:

Initial Scope was for a New Stator only (Initiation Phase Charter and Business Plan 2014-16).

Scope developed in the Definition Phase was for a New Upgraded Generator, New Turbine Shaft, and a Turbine Overhaul. Including a new runner in the scope was discussed and evaluated during the Definition Phase, but was not the preferred alternative.

Key Assumptions and Risks:

The development of this project will be expedited to the extent possible, recognizing the increasing risk of failure as the unit continues to operate.

Project Cash Flows, NPV, and OAR Approval Amount

k\$	LTD	2016	2017	2018	2019	2020	Future	Total
Currently Released	750							750
Requested Now	-	10,829	25,730	791				37,350
Future Required	-							
Total Project Cost	750	10,829	25,730	791				38,100
Ongoing Costs	-							
Grand Total	750	10,829	25,730	791				38,100
Estimate Class:	Class 3			Estimate at Completion:		38,100		
NPV:	284,690			OAR Approval Amount:		38,100		

Additional Information on Project Cash Flows (optional):

(k\$)	2015	2016	2017	2018	Total
BP 2016-18	250	11,740	25,625	0	37,615
Summary of Estimate	222	11,357	25,730	791	38,100
Variance (SoE – BP)	(28)	(383)	105	791	485

The current Summary of Estimate is slightly higher than BP 2016-18; changes will be managed within the revised budget envelope.

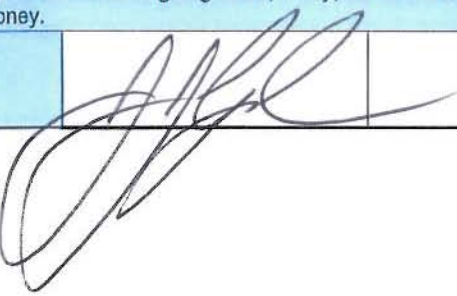
Internal Use Only
 OPG-FORM-0076-R005

Type 3 Business Case Summary

Document #: NIAG-REP-08707.021-0189 R00

Project #: DQ280851 (Capital)

Project Title: G2 Overhaul & Upgrade, <Full> <Execution> Release

Approvals			
	Signature	Comments	Date
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by (Project Sponsor): Allan Reid Plant Manager, Niagara Operations			April 6/16
I concur with the business decision as documented in this BCS.			
Finance Approval: Ken Hartwick SVP Finance, Strategy, Risk & CFO per OPG-STD-0076			Apr 15, 2016
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Jeff Lyash President and CEO per OAR 1.1			April 20, 2016

Type 3 Business Case Summary

Project #: DQ280851 (Capital)

Document #: NIAG-REP-08707.021-0189 R00

Project Title: G2 Overhaul & Upgrade, <Full> <Execution> Release

Business Case Summary**Part A: Business Need**

The unit is currently de-rated, experiencing increased outages, and has a potential risk of generator failure. This project is necessary to ensure safe and reliable operation of the unit capable of meeting Independent Electricity System Operator ("IESO") committed Mega Watts ("MW").

Background of Issues:

On November 13, 2012, a loud, low frequency hum was discovered by an Asset Engineer and recognized as a possible indicator of loose stator components. Preliminary investigation revealed severe fretting at the upstream split in the sectional stator, cracks in key-bar brackets, and other issues in this area of the stator core.

Plant Engineering Services ("PES") conducted a root cause technical investigation ([R-NF23-42120--0003](#)) on G2 stator failure which identified 2 main causes:

- Apparent overloading of the unit for the last six or more years (due to unrecognized design differences between G1 and G2)
- The opening of the stator core split in the upstream area (although this was the design philosophy of the original generator, it is recognized as a weak design today)

To conclude this project addresses G2's emergent generator issues: shortened life compared to design life, lower output, higher maintenance costs and longer outage duration. Completion of this project will restore lost revenue potential and mitigate the risk of unplanned generator outages.

Part B: Preferred Alternative: Upgrade Generator, Replace Turbine Shaft, and Turbine Overhaul**Description of Preferred Alternative**

- Replace the generator with one that is appropriately sized to keep future options open (i.e. future runner replacement and associated draft tube re-profiling)
- Replace the turbine shaft with one that provides an adequate safety factor. The same diameter shaft is expected and a new head cover will not be required.
- Re-use the existing runner and repair cavitation on the runner and draft tube (overhaul turbine).
- A comprehensive look at the units' power equipment and condition to ensure all systems are sized to meet the units' current and expected future rating.
- This alternative produces the highest Net Present Value (see Part E), and is recommended as it provides an expedited schedule with fewer component interdependencies (co-ordinating generator design with runner design). A conservative approach is preferred given the current state of the unit and potential for generator failure.

Deliverables:	Associated Milestones (if any):	Target Date:
Present to Asset Management Committee		March 21, 2016
BCS Approval		April 15, 2016
NF23 G2 Outage Start		Nov. 7, 2016
Contractor Substantial Completion		Dec. 13, 2017
Planned Unit in Service		Feb. 14, 2018
Project Closure Report Complete		Aug. 30, 2018

Type 3 Business Case Summary

Project #: DQ280851 (Capital)

Document #: NIAG-REP-08707.021-0189 R00

Project Title: G2 Overhaul & Upgrade, <Full> <Execution> Release

Part C: Other Alternatives

Summarize all viable alternatives considered, including pros and cons, and associated risks. Other alternatives may include different means to meet the same business need, and a reduced or increased scope of work, etc.

Alternative 2: Upgraded Generator & New Runner

- There exists a limit on the water that can be discharged by the Decew facility into the 12 Mile Creek. The water is currently portioned between ND1 (Decew GS #1 G5, G6, G7, G8) and NF23 (Decew GS #2 G1 and G2). The older ND1 station has a historically favourable GRC arrangement which negates efficiency gains that could be made by diverting more water through NF23. As such, a new runner would not be able to take advantage of higher throughput until water is available from ND1. This would happen when ND1's favourable arrangement expires.
- A new runner would improve cavitation performance to the extent possible, but would also require re-profiling the draft tube to realize efficiency gains.
- Replace the turbine shaft with one that provides an adequate safety factor. The same diameter is expected and a new head cover will not be required.
- This is not the recommended alternative as the schedule risks associated with the new runner were found to be intolerably high given the risk of generator failure and the gains from the new runner would not be realized until some future date.

Alternative 3: Status Quo (Base Case)

- Continue to operate the unit with regular inspections and repairs. This could include identifying an operating point that would result in minimal vibrations and applying operating restrictions to operate the unit at this point. This unit restriction would result in ongoing economic losses.
- This alternative was rejected as there is still a risk of generator failure (current repairs are expected to be a short term fix) resulting in a long term forced outage while an overhaul is carried out.

Alternative 4: Replace Generator Only

- Replace the generator with a unit that matches the previous 72MW rating.
- Cavitation repairs to the runner and draft tube.
- This alternative was rejected as it would leave a turbine shaft in place with a marginal factor of safety.

Alternative 5: Repair Stator Core

- The repair involves a re-pile of the core.
- This alternative was rejected as; it is difficult to complete without damaging other parts of the unit, the likelihood of a successful repair is low, and the longevity of the repair is probably only a few years.

Type 3 Business Case Summary

Project #: DQ280851 (Capital)

Document #: NIAG-REP-08707.021-0189 R00

Project Title: G2 Overhaul & Upgrade, <Full> <Execution> Release

Part D: Project Cash Flows, NPV, and OAR Approval Amount (duplicate from Overview section)

k\$	LTD	2016	2017	2018	2019	2020	Future	Total
Currently Released	750							750
Requested Now	-	10,829	25,730	791				37,350
Future Required	-							
Total Project Cost	750	10,829	25,730	791				38,100
Ongoing Costs	-							
Grand Total	750	10,829	25,730	791				38,100
Estimate Class:	Class 3			Estimate at Completion:		38,100		
NPV:	168,659			OAR Approval Amount:		38,100		

Additional Information on Project Cash Flows (optional):

(k\$)	2015	2016	2017	2018	Total
BP 2016-18	250	11,740	25,625	0	37,615
Summary of Estimate	222	11,357	25,730	791	38,100
Variance (SoE – BP)	(28)	(383)	105	791	485

The current Summary of Estimate is slightly higher than BP 2016-18; changes will be managed within the revised budget envelope.

Part E: Financial Evaluation

k\$	Preferred Alternative	Alternative 2	Status Quo	Alternative 4	Alternative 5
Project Cost	38,100	41,950	Alternative Rejected	Alternative Rejected	Alternative Rejected
NPV	294,077	291,191			
Incremental NPV		2,886			

Summary of Financial Model Key Assumptions or Key Findings:**Alternative 1 (Replace the Generator & Turbine Shaft, Overhaul the Turbine and Runner)**

- Replace the generator with one that is appropriately sized for a future runner replacement and associated draft tube re-profiling.
- 30 year life, 72 MW Capacity restored from 63 MW de-rating, 80% Capacity Factor.

Alternative 2 (Replace the Generator & Associated Power Equipment, Turbine Shaft & Turbine Runner, Overhaul the Turbine)

- Assumes an increase in efficiency resulting in an additional 1 MW of capacity (MCR 73MW with available water).
- Assumes the Generator Fails before the runner can be delivered (24 month lead time).
- 30 year life, 73MW Capacity, 80% Capacity Factor.

Alternative 3 Status Quo (Overhaul the Generator, Turbine & Turbine Runner, Replace the Turbine Shaft)

- Incremental OM&A is higher only for this option only.
- Minor Overhaul's assumed to gain approximately 10 years.
- Operating De-rate of 9 MW.

Type 3 Business Case Summary

Project #: DQ280851 (Capital)

Document #: NIAG-REP-08707.021-0189 R00

Project Title: G2 Overhaul & Upgrade, <Full> <Execution> Release

Part F: Qualitative Factors

- The station is in the 'work horse' asset category and as such, the operating and maintenance strategy for the station follows a basic preventive maintenance program and sustaining investments receive medium to high priority.
- Alternative 1 is recommended as it has an expedited schedule with fewer component interdependencies (coordinating generator design with runner design).
- A conservative approach is preferred given the current state of the unit and potential for generator failure.

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	Costs higher than expected.	A well-defined scope has been prepared, actual contractor pricing included and appropriate contingency carried.	Medium	Low
Scope	Additional scope discovered during execution	Project is carrying a contingency of ~15%; discovery work will be addressed as it comes up; strategy will be to accept necessary discovery work to ensure a quality product	Medium	Medium
	Powerhouse movement	Movement of the NF23 powerhouse is an ongoing concern and has the potential to impact the new unit's alignment in the future. An adjustable generator sole plate will provide some mitigation for this risk but more significantly, a project (DQ282672) is in development that will further define and implement powerhouse movement mitigation measures, as necessary.	Medium	Low
Schedule	Class EA not received before project start date.	Accept risk. Upfront planning and continual monitoring of status by designated action owners to mitigate risk.	Low	Medium
	CIA and SIA not completed before project end date.	Accept risk. Upfront planning and continual monitoring of status by designated action owners to mitigate risk.	Low	Medium
	The contract award is delayed, which leaves insufficient time for contractor to do adequate engineering, material purchases.	A 15 month outage has been programmed to provide adequate float. The turbine overhaul has been overflowed to BTU to alleviate strain on internal resources.	Medium	Low
Resources	Other outages/overhauls may strain resources. Not enough staff to commission the unit in a timely manner.	Early / quality planning and commitment from Production to prioritise and focus resources on G2.	Low	Low
Quality/ Performance	Unit reliability issues or does not meet performance expectations due to poor quality of workmanship.	QA/QC, ITPs, RFP submittal requirements, peer reviewed specifications based on recent projects and OPG standards.	Low	Medium
Technical	Some embedded parts may not be able to be repaired in place and may require replacement.	Evaluate as soon as unit is dismantled. Carry appropriate contingency.	Medium	Low
	Cast iron head covers have had problems in other plants.	Thorough inspection early, carry estimated contingency for possible repairs if doable. If new head cover required, then accommodate with CCA.	Low	Low

Type 3 Business Case Summary

Project #: DQ280851 (Capital)

Document #: NIAG-REP-08707.021-0189 R00

Project Title: G2 Overhaul & Upgrade, <Full> <Execution> Release

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
Integration	External Stakeholder (Hydro One & Shickluna) may require outages during the duration of the project	Accept risk. Upfront planning and continual monitoring and communication with external stakeholders to ensure minimal disruptions to the project.	Medium	Medium
	Interference or delays from parallel project within the plant group (West Approach Bridge & G2 Penstock Project)	Mitigate through early planning, execution and continual communication with internal stakeholders.	Medium	Low

Additional Risk Analysis:

There is a risk that the unit could prematurely fail prior to the scheduled overhaul. Should this happen the project schedule will be impacted as an accelerated execution will be highly desirable.

Part H: Post Implementation Review (PIR) Plan

Type of PIR Report	Target In-Service or Completion Date	Target PIR Completion Date
Simplified PIR	FEB-14-2018	FEB-28-2019

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Unit In-Service	February 2018	February 2018	Assess at Project Closeout	Project Sponsor
Project Cost	\$38.1M	\$38.1M	Assess at Project Closeout	Project Sponsor
Power Output	72 MW	72 MW	Revenue meter	Asset Technical Engineer
Project Environmental Performance Index	100%	100%	Assess at Project Closeout	Project Sponsor

Type 3 Business Case Summary

Project #: DQ280851 (Capital)

Document #: NIAG-REP-08707.021-0189 R00

Project Title: G2 Overhaul & Upgrade, <Full> <Execution> Release

Part I: Definitions and Acronyms**AACE** – Association for the Advancement of Cost Engineering**BP** – Business Plan**BTU** – Building Trades Union**CAP** – Capital**Cavitation** – The formation of bubbles in a liquid due to pressure fluctuations which when collapsed can cause damage to surfaces due to cyclic stress.**CIA** – Customer Impact Assessment**EA** – Environmental Assessment**IESO** – Independent Electricity System Operator**LTD** – Life to Date**MCR** – Maximum Continuous Rating**MOT** – Main Output Transformer**MVA** – Mega Volt Amp**MW** – Mega Watt**MW_e** – Mega Watt (electrical)**MW_m** – Mega Watt (mechanical)**NPV** – Net Present Value**OPG** – Ontario Power Generation**OM&A** – Operations, Maintenance and Administration**PES** – Plant Engineering Services (OPG Engineering)**PF** – Power Factor**PIR** – Post Implementation Review**SIA** – System Impact Assessment

Type 3 Business Case Summary

Project #: DQ280851 (Capital)

Document #: NIAG-REP-08707.021-0189 R00

Project Title: G2 Overhaul & Upgrade, <Full> <Execution> Release

This page is intentionally left blank

Internal Use Only

OPG-FORM-0076-R005

Type 3 Business Case Summary

Project #: DQ280851 (Capital)

Document #: NIAG-REP-08707.021-0189 R00

Project Title: G2 Overhaul & Upgrade, <Full> <Execution> Release

For Internal Project Cost Control

Type 3 Business Case Summary

Project #: DQ280851 (Capital)

Document #: NIAG-REP-08707.021-0189 R00

Project Title: G2 Overhaul & Upgrade, <Full> <Execution> Release

Appendix A: Summary of Estimate

Project Number:	NIAG-REP-08707.021-0189 R00								
Project Title:	G2 Overhaul & Upgrade								
k\$	LTD	2016	2017	2018	2019	2020	Future	Total	%
OPG Project Management	47	152	120	37				356	0.9%
External Project Management		99	273	50				423	1.1%
OPG Engineering (including Design)	99	475	441	38				1,053	2.8%
OPG Procured Materials		10						10	0.0%
OPG Other (PWU)		139	379					518	1.4%
Design Contract(s)	71							71	0.2%
Construction Contract(s)									0.0%
EPC Contract(s)		7400	18,810	525				26,735	70.2%
Consultants		501	50					551	1.4%
Other Contracts / Costs		111	395	32				538	1.4%
Interest	5	443	1100	37				1,585	4.2%
Removal		400	300					700	1.8%
Subtotal	222	9,730	21,868	719				32,540	85.4%
Contingency		1,627	3,862	72				5,560	14.6%
Total	222	11,357	25,730	791				38,100	100%

Notes

Project Start Date	2016-11-07	Total Definition cost (excludes unspent contingency for Nuclear)	\$222k
Target In-Service (or AFS) Date	2018-02-14	Contingency included in this BCS (Nuclear only)	N/A
Target Completion Date	2018-12-31	Total contingency released plus contingency in this BCS (Nuclear only)	N/A
Escalation Rate	Line specific escalation %	Total released plus this BCS without contingency (Nuclear only)	N/A
Interest Rate	5.26%	Total released plus this BCS with contingency (Nuclear only)	N/A
Removal Costs	\$700k	Estimate at Completion (includes only spent contingency for Nuclear)	\$38,100k

Prepared by:	Approved by:
	
Richard Squires Project Leader	Ken Prince Section Manager - Projects
Date 2016-03-31 YYYY-MM-DD	Date 2016-03-31 YYYY-MM-DD

Document #: NIAG-REP-08707.021-0189 R00

Project Title: G2 Overhaul & Upgrade, <Full> <Execution> Release

[illegible]

k\$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management					Project Variance Analysis Not Applicable; This release represents the first full release for the project execution phase.
OPG Engineering (including Design)					
OPG Procured Materials					
OPG Other					
Design Contract(s)					
Construction Contract(s)					
EPC Contract(s)					
Consultants					
Other Contracts / Costs					
Interest					
Subtotal					
Contingency					
Total					

Type 3 Business Case Summary

Project #: DQ280851 (Capital)

Document #: NIAG-REP-08707.021-0189 R00

Project Title: G2 Overhaul & Upgrade, <Full> <Execution> Release

Appendix C: Financial Evaluation Assumptions

Key assumptions used in the financial model of the Project are (complete relevant assumptions only):

Alternative 1 (Replace the Generator & Turbine Shaft, Overhaul the Turbine and Runner)

- Replace the generator with one that is appropriately sized for a future runner replacement and associated draft tube re-profiling.
- 30 year life, 72 MW Capacity restored from 63 MW de-rating, 80% Capacity Factor

Alternative 2 (Replace the Generator & Associated Power Equipment, Turbine Shaft & Turbine Runner, Overhaul the Turbine)

- Assumes an increase in efficiency resulting in an additional 1 MW of capacity (MCR 73MW with available water).
- Assumes the Generator Fails before the runner can be delivered (24 month lead time)
- 30 year life, 73MW Capacity, 80% Capacity Factor

Alternative 3 Status Quo (Overhaul the Generator, Turbine & Turbine Runner, Replace the Turbine Shaft)

- Incremental OM&A is higher only for this option only
- Minor Overhaul's assumed to gain approximately 10 years.
- De-rate of 9 MW.

Project Cost:

Alt. 1. \$38,100

Alt. 2. \$41,950

Alt. 3. \$60,000 over 3 minor overhauls

Financial (NPV):

Alt 1. \$294,077k

Alt 2. \$291,191k

Alt 3. \$251,851k

Project Life:

Alt 1. 30 years

Alt 2. 30 years

Alt 3. Minor Overhauls every 10 years (compared over 30 year span)

Financial Evaluation As Reported above using SEVs

NF23 G2 BCS with
Hydro FE Models-Aug**Appendix D: References**[R-NF23-42120--0003](#) Root Cause Technical Investigation[NPG-00121.2-0061](#) Terms of Reference[NIAG-CHAR-00121.2-0079](#) Project Charter[NIAG-REP-08707.021-0158](#) Definition Business Case Summary[NIAG-REP-00121.2-0002](#) Scope of Work

Type 2 Business Case Summary

To be used for investments/projects meeting Type 2 criteria in OPG-STD-0076.

Project Information			
Project #:	MAN82940/MANF0065	Document #:	FP2-BCS-08707-0011 R0
Project Title:	Manitou Auto Sluice System Replacement		
Class:	<input type="checkbox"/> OM&A <input checked="" type="checkbox"/> Capital <input type="checkbox"/> Capital Spare <input type="checkbox"/> MFA <input type="checkbox"/> CMFA <input type="checkbox"/> Provision <input type="checkbox"/> Others:	Investment Type:	Sustaining
Phase:	Execution	Release:	Full
Facility:	Manitou GS	Target In-Service or Completion Date:	Oct 2020

Project Overview
<p>To date, 216k has been released for definition phase activities. This is requesting the additional release of \$23,784k to fund the execution phase.</p> <p>The estimated total project cost is \$24,000k with \$2,376k in contingency</p> <p>Total business plan estimate is \$24,684k</p> <p>The quality of the estimate for this release is Class #3, and for the total project is Class #3.</p> <p>This release will fund the following scope of work:</p> <ul style="list-style-type: none"> Engineering, Procurement, and Construction of two replacement, and one new auto-sluicing systems for Manitou GS, including replacement of embedded parts. <p>Problem Statement/Business Need:</p> <p>Typically auto sluice gates have a life expectancy of 40 to 50 years. Auto sluice gates #A and #B are 60 years old, are at end of life and do not meet operational and design requirements. The existing gates increase the risk of dam safety issues due to inadequate auto sluicing capacity and poor reliability. In order to safely pass station flows, the adjacent log sluice will be converted to an auto sluice gate. This will provide OPG with the ability to respond reliably to market conditions, minimize dam safety risks, optimizing water use, minimize financial losses and address end of life infrastructure.</p> <p>Summary of Preferred Alternative:</p> <p>Replacement of the existing auto sluice gates and associated equipment with an upgraded design will maximize operational efficiencies, decrease incremental maintenance requirements, and optimize site conditions to provide for improved reliability and increased frequency of operation. The addition of a 3rd auto sluice gate will relieve dam safety concerns which are present due to the limited forebay storage capacity, which causes water levels to rise rapidly.</p>

Part A: Business Need
<p>The project is intended to provide OPG with reliable sluicing capability, minimize dam safety risks, optimize water use, address end of life infrastructure and reduce OM&A costs associated with operating log sluices.</p> <p>Manitou GS dam is located on the English river system. It is necessary to be able to respond dynamically to Ontario electricity market conditions, which request the station output to be capable to both generate electricity and spill water. In order to optimize our water usage and comply with water flows required by the Lake of the Woods Control Board, both spill flexibility and reliability are critical.</p> <p>Due to present market conditions, the auto-sluice system at Manitou GS is frequently called upon to operate, often multiple times throughout a given day. The operational pattern of stopping and starting has caused the existing gates and screw hoists to experience significant wear resulting in varying failures of equipment (cracked bell housings, failing torque limiters, failed</p>

*Associated with OPG-STD-0076, Developing and Documenting Business Cases

Type 2 Business Case Summary

Project #: MAN82940/MANF0065

Document #: FP2-BCS-08707-0011 R0

Project Title: Manitou Auto Sluice System Replacement, Full Execution Release

Part A: Business Need

heating, leaking gear boxes). These equipment failures have reduced OPG's ability to reliably operate and maintain availability. Ideally, the existing gates would be suitable for up to 10 operations per day; however, they are currently limited to only 3 operations per day to provide a balance between failure rate and operational requirements. Furthermore, the current system is not designed for such frequent usage/maintenance, and thus there is a limited amount of maintenance that can be done on the gates, further limiting its operational capabilities.

In addition to the operational limitations of the auto-sluice system, there are also significant health and safety problems that restrict access and manual operation of the system. During winter months, maintenance personnel are often dispatched to site to manually operate gates or to troubleshoot the system. This typically results in hazards associated with ice falling from the structure. Furthermore, access to the top of the hoist is a significant health and safety risk due to the possibility of falling from the ladder or hoist bridge. The current open style bridge also requires employees to work in difficult elements such as wind, extreme cold and icy conditions. Personnel rescue is difficult due to poor access to the bridge. In addition, the equipment was not designed for current legislative safety requirements (guardrails, tie off points). Access inside the gate to maintain and/or repair the gate heaters is significantly restricted and cumbersome.

The existing auto-sluice system at Manitou GS is approximately 60 years old, and even with minor rehabilitative upgrades completed over the past 25 years, the equipment has reached end-of-life. Both the screw hoists and the gates were evaluated to determine if rehabilitation or replacement were viable, and it has been shown that complete replacement of the system would provide OPG the best value and performance to meet the operational requirements. In addition, the auto sluices have been assessed as a high risk under the Engineering Risk Assessment Program

A dam safety risk is currently present due to the fact that full station flow cannot be quickly transferred to the auto sluice system when needed. This could and has happened when the generating units trip off and they cannot be brought back online remotely or quickly. In addition, the forebay at this station is small which compounds this issue. Converting the adjacent log sluice to an automated gate will minimize these risks as well as reduce OM&A costs by \$9k per year.

Part B: Preferred Alternative: Complete replacement of existing auto-sluicing system

Description of Preferred Alternative

The Preferred alternative consists of the design, manufacture, and installation of a complete new auto-sluicing system. This includes the demolition and removal of the existing gates, superstructure, screw hoists, electrical components, sluiceway gains and embedded parts. Under this alternative, the existing sluiceway gains will be completely replaced which includes new secondary concrete, embedded anchors, roller path and seal path. The adjacent log sluice will also be converted to an automatic sluice gate to minimize dam safety risks, improve reliability and allow OPG to better respond to market conditions. The embedded parts in the 3 sluices will be aligned as well as the sectional gate gains will be replaced and aligned. This is included due to the unknown amount of concrete creep that has occurred within the dam which would ultimately inhibit the use of the sectional gates in the future if left untouched.

In 2015, Plant Engineering Services (PES) completed a project study (File: PES-MECH-2015-015; Report: NWO-REP-29423-0001) providing recommendations as to how North West Operations should approach the Sluiceway Rehabilitation program. The report states that the existing gates and embedded parts are at end of life and should be replaced. The recommendation to replace the auto-sluicing system was chosen after evaluating other options such as refurbishing the gate and existing screw hoists, replacing only the gate, and/or retrofitting the gate and hoist with features to extend the usable life of the system as well as improve operational performance. The preferred alternative offers a longer life expectancy, greater reliability and operability, as well as the best value for money. Budgetary pricing from Andritz Hydro has confirmed that OPG's best solution is to replace the auto sluice gates due to the high costs and limited performance of a gate refurbishment.

The new systems will address the noted health and safety issues by including the following:

- Hoists will be enclosed which will limit exposure to ice build up
- Electrical control panels will have ice shelters constructed to reduce the risk of falling ice
- Enclosed stair access will be installed
- Equipment inside the gate will be much more accessible
- Gates will be equipped with emergency rescue capabilities as well as equipment hoists to aid in work in the gate.

The primary driver to convert the adjacent log sluice to an automatic sluice gate is Dam Safety. This conversion will address the following dam safety concerns at Manitou Falls.

- 1) In the event the units are tripped or forced offline and cannot be brought back online quickly via the NWCC or with local maintenance staff, the forebay will rise rapidly until water can be released. Auto sluice gates are important in this aspect in the event personnel cannot reach the plant to operate log sluices due to weather, road washouts or

Internal Use Only
OPG-FORM-0075-R004

Type 2 Business Case Summary

Project #: MAN82940/MANF0065

Document #: FP2-BCS-08707-0011 R0

Project Title: Manitou Auto Sluice System Replacement, Full Execution Release

Part B: Preferred Alternative: Complete replacement of existing auto-sluicing system

Description of Preferred Alternative

- forest fires. During higher river flows, the added 3rd auto sluice gate would allow the automated gates at the station to pass station unit flow until staff were able to get to site to address any issues.
- 2) Added auto sluicing capacity is also required to maintain river flows as directed by the Lake of the Woods Control board and to ensure compliance with other key stakeholders. This station was originally staffed 24/7 when first built which allowed station staff to make changes to station discharge as required. The station is now managed under the Kénora/Ear Falls Work center, and staff are not always available to operate the manually operated log machine. In some instances such as extreme cold and snow, it is not feasible to operate the log machine at all. Regulatory conditions have also become much more stringent since the station was first built in the 1950's, placing tighter controls on river flows and thus requiring more auto sluicing capacity to support market conditions.
 - 3) Adding a 3rd gate will allow for more flexibility to conduct maintenance on auto sluice gates as well as less impact to dam safety when an auto sluice gate breaks down.
 - 4) In the past, NWCC would force on generating units through the IESO during periods of high flow to pass more water as required. With current market conditions, this is becoming much more difficult, resulting in the need for additional auto sluicing capability.

Deliverables:	Associated Milestones (if any):	Target Date:
Project Conceptual Design Review	OPG to Review/Approve Obtain NPA Permits	Jan 2019
Design Engineering of Gains/Embedded Parts	Approved	Feb 2019
Design Engineering of Gate Hoists and Hoist House	Approved	Feb 2019
Design Engineering of new Gates	Approved	March 2019
Design Engineering of Superstructure	Approved	April 2019
Manufacturing, Fabrication, and Delivery of Equipment	OPG Witness Inspections Delivery to Site Inspections at Site	July 2019 to Aug 2020
Isolation of Spillway by contractor	Turn-over to Contractor All permits obtained	April 2019
Demolition of Existing Sluiceway Systems	One gate to remain fully operational	Commence June 2019
Installation and Construction of Gains/Embedded Parts	Gain Alignment checked and verified	Commence August 2019
Installation of new Gates		Commence September 2019
Installation of Superstructure, Hoist-House, and Hoists		Commence Sept 2019
Dry Commissioning, Wet Testing, and Final Acceptance	Dry Test Passes OPG Requirements Wet Test Passes OPG Requirements OPG Acceptance	Gate A, October 2020 Gate B August 2020, Gate C October 2019

Part C: Other Alternatives

Summarize all viable alternatives considered, including pros and cons, and associated risks. Other alternatives may include different means to meet the same business need, and a reduced or increased scope of work, etc.

Alternative 2: Base Case – Do Nothing

This is not the recommended alternative, as it will continue to limit our ability to meet the current operational requirements and to adequately maintain the sluice gates given the current access issues. Dam safety risks are not mitigated with this option. With the do nothing option the gate performance will continue to degrade and limit our ability to respond to the changing demands.

This is not the recommended alternative.

Internal Use Only
OPG-FORM-0075-R004

Type 2 Business Case Summary

Project #: MAN82940/MANF0065

Document #: FP2-BCS-08707-0011 R0

Project Title: Manitou Auto Sluice System Replacement, Full Execution Release

Alternative 3: Complete refurbishment of existing gate

Previous project budget estimates for refurbishment of Pine Portage GS sluice gates (similar to Manitou) show that it is actually more expensive than a gate replacement and would not operate at the same performance as a new gate. Failures of screw type actuators after refurbishment at other OPG locations in less severe climates have shown that this is not a good long-term solution nor would it meet the operational requirements. Furthermore, it is reiterated that refurbishment would not provide the performance that is required of this equipment in this climate under expected operating conditions. PES project study (File: PES-MECH-2015-015; Report: NWO-REP-29423-0001) outlined the risks associated with completing a refurbishment and how it will likely impact operations. . Refurbishment of the gates themselves was actually more expensive than replacement, while refurbishing the existing hoists would not provide the performance required to meet current operational requirements

This is not the recommended alternative.

Part D: Project Cash Flows, NPV, and OAR Approval Amount

k\$	LTD	2016	2017	2018	2019	2020	2021	Future	Total
Currently Released				216					216
Requested Now	-			154	16,524	7,106			23,784
Future Required									
Total Project Cost				370	16,524	7,106			24,000
Ongoing Costs	-								
Grand Total				370	16,524	7,106			24,000
Estimate Class:	Class 3			Estimate at Completion:		\$24,000k			
NPV:	NA			OAR Approval Amount:		\$24,000k			

Additional Information on Project Cash Flows (optional):

Part E: Financial Evaluation

k\$					
Project Cost					
NPV					
Other (e.g., IRR)					

Summary of Financial Model Key Assumptions or Key Findings:

Part F: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	There is a risk that execution costs will be higher than currently estimated.	Mitigate - Execution costs are based on Contractor bids. Contingency has been carried to cover potential additional	Low	Low

Internal Use Only
OPG-FORM-0075-R004

Type 2 Business Case Summary

Project #: MAN82940/MANF0065

Document #: FP2-BCS-08707-0011 R0

Project Title: Manitou Auto Sluice System Replacement, Full Execution Release

Part F: Risk Assessment				
Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
		scope items that have not been identified. The project includes replacement of the gains, which is a higher cost option, however, it reduces the potential for significant cost overruns and delays associated with a base refurbishment of the gains.		
Scope	There is a risk that site conditions, fixed components and associated equipment could require addition to scope in order to achieve required results.	Mitigate - The project scope has been well defined via project specifications and is well understood with the Contractor. The Contractor has identified in full their plan and methodology to complete the project scope. The Contractor has a full understanding of the operational needs of OPG which has helped define their project scope. Scope will be managed by ensuring the major scope items are accounted for and anything that could be considered as 'nice-to-haves' have been discussed up front. Project scope included for replacement of sectional gate gains, thus reducing risk.	Medium	Medium
Schedule	There is a risk that manufacturing delays could impact the execution schedule. The construction window is based on a specific execution plan as proposed by the Contractor. Changes or delays in the Construction (weather related or Contractor related) could result in the need to extend the completion schedule.	Mitigate - The Contractor has built in time in the manufacturing cycle to allow for the ability to add additional resources (if necessary) to ensure the manufacturing schedule is met. The Contractor is also allowing for a 14/7 on-site shift schedule. Liquidated damages (\$5,000/day/slucose) have been included in the contract to incentivize completion. One gate to remain in service at all times to suit operational requirements of the NWCC. Schedule risk is present with the timelines to install and seal cofferdams. Advanced underwater inspections to be carried out in 2018 ahead of execution.	Medium	Medium
Resources	There is a risk that a lack of resources could impact the schedule. There is also a risk that the current resourcing plan may not be sufficient for the Contractor to complete the construction.	Transfer/Mitigate - The Contractor has 'in-house' engineering and can therefore add additional man-power during engineering and manufacturing to ensure there are no delays getting the material to site. The Contractor has identified sub-contractors to complete specific construction tasks. The selected Contractor is familiar with EPSCA resourcing and labour requirements. 14/7 schedule at site will attract talented trades forces.	Low	Low
Quality/ Performance	There is a risk that the performance and operational requirements will not be met.	Accept - The design of the gate that is being proposed to OPG is based on the extreme environment in which it must	Low	Medium

Internal Use Only
OPG-FORM-0075-R004

Type 2 Business Case Summary

Project #: MAN82940/MANF0065

Document #: FP2-BCS-08707-0011 R0

Project Title: Manitou Auto Sluice System Replacement, Full Execution Release

Part F: Risk Assessment				
Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
		operate. Further, the existing gains and embedded parts are to be replaced which provides the most certainty in ensuring the system meets the operational performance by removing a high risk. The Contractor that has been selected has significant experience in the design, manufacture, and installation of sluice gate systems, which helps to ensure the quality of the system being provided.		
Technical	There is a risk that the system design does not meet OPG performance and technical requirements.	Mitigate – The specifications and technical design are based on proven industry examples in similar conditions. The Contractor selected has significant experience with the design of sluice gate systems. The technical design of the gains/embedded parts is based on a replacement of the gains which reduces the technical risk associated with assumed existing gain conditions, which could lead to cost and schedule delays as well as poor technical performance of the system (i.e. Premature failure, jamming, leakage, etc.)	Low	Medium

Part G: Post Implementation Review (PIR) Plan				
<input type="checkbox"/> It is determined appropriate that only a Project Closure Report (PCR) is needed as the PIR for this project, due to its straightforward deliverables, which do not require any measures other than confirmation of completion or delivery.				
Type of PIR Report	Target In-Service or Completion Date		Target PIR Completion Date	
Simplified PIR	Oct 2020		Oct 2021	
Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Operations per Day	at least 10 operation per day	25 Operations Per day	Post installation testing of Gate operations during winter	Project Department
Adequate gate seal and de-icing	Minimal leakage and free from ice build up	Check for leaks and icing	Post installation testing	Project Department
Reliable Operation	Gate open close as and when required	Gate open close as and when required	Post installation testing	Project Department


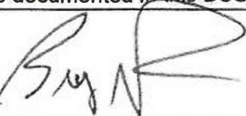
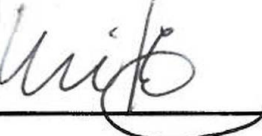
Internal Use Only
OPG-FORM-0075-R004

Type 2 Business Case Summary

Project #: MAN82940MANF0065

Document #: FP 2-BCS-0 8707-0011 R0

Project Title: Manitou Auto Sluice System Replacement, Full Execution Release

Approvals			
	Signature	Comments	Date
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by (Project Sponsor): Brian Dietrich NWO Production Support Manager			Nov. 25, 2018
I concur with the business decision as documented in this BCS.			
Finance Approval: Norma Siroski Director, RG Finance per OPG-STD-0076 <div style="position: absolute; left: 240px; top: 0px;"> Bryan Shaddock Finance Controller </div>		DOA for Norma Siroski	11/26/18
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Mike Martelli President - RG per OAR 1.1			27 NOV 18

Type 2 Business Case Summary



Project #: MAN82940/MANF0065

Document #: FP2-BCS-08707-0011 R0

Project Title: Manitou Auto Sluice System Replacement, Full Execution Release

Appendix A: Summary of Estimate										
Project Number:	MAN82940/MANF0065									
Project Title:	Manitou GS Auto-Sluice System Replacement									
k\$	LTD	2016	2016	2017	2018	2019	2020	Future	Total	%
OPG Project Management					20	74	60		154	0.64
OPG Engineering (Including Design)					30	73	45		148	0.62
OPG Procured Materials					0	0	0		0	0
OPG Other					0	141	120		261	1.09
Design Contract(s)					0	0	0		0	0
Construction Contract(s)					0	0	0		0	
EPC Contract(s)					303	13805	5400		19508	81.28
Consultants					0	325	200		525	2.19
Other Contracts/Costs					0	20	0		20	0.08
Interest					2	305	701		1008	4.2
Subtotal					355	14743	6526		21624	0
Contingency					15	1781	580		2376	9.9
Total					370	16524	7106		24000	100

Notes			
Project Start Date	November 2018	Total Definition cost (excludes unspent contingency for Nuclear)	\$216k
Target In-Service (or AFS) Date	Oct 2020	Contingency Included In this BCS (Nuclear only)	
Target Completion Date	December 2020	Total contingency released plus contingency In this BCS (Nuclear only)	
Escalation Rate	NA	Total released plus this BCS without contingency (Nuclear only)	
Interest Rate	4%	Total released plus this BCS with contingency (Nuclear only)	
Removal Costs	TBD - Included in contract	Estimate at Completion (includes only spent contingency for Nuclear)	\$24,000k

Prepared by:	Approved by:
	
Luciano Da Silva Project Leader	Darryl Flank Section Manager - Projects
Date: November 23, 2018	Date: Nov 23, 2018

Internal Use Only
OPG-FORM-0075-R004

Type 2 Business Case Summary

Project #: MAN82940/MANF0065

Document #: FP2-BCS-08707-0011 R0

Project Title: Manitou Auto Sluice System Replacement, Full Execution Release

Appendix B: Comparison of Total Project Estimates and Project Variance Analysis

Comparison of Total Project Estimates										
Phase	Release	Approval Date	Total Project Estimate In Choose an item (by year including contingency)						Future	Total Project Estimate
			20XX	20XX	20XX	20XX	20XX	20XX		

Project Variance Analysis					
Choose an item	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management					
OPG Engineering (including Design)					
OPG Procured Materials					
OPG Other					
Design Contract(s)					
Construction Contract(s)					
EPC Contract(s)					
Consultants					
Other Contracts/Costs					
Interest					
Subtotal					
Contingency					
Total					

Project Over-Variance Approval

Project #	MAN82940		Controlled Doc #	
Project Title	Sluiceway Replacement			
Facility	Manitou Falls GS		Investment Classification	Sustaining
Project Level (Scalability)	C	Financial Classification	<input type="checkbox"/> OM&A <input checked="" type="checkbox"/> Capital <input type="checkbox"/> Capital Spare <input type="checkbox"/> MFA <input type="checkbox"/> CMFA <input type="checkbox"/> Provision <input type="checkbox"/> Others: [if applicable]	
Release: Gate and Project Phase	<input type="checkbox"/> Over-variance G0: Initiation <input type="checkbox"/> Over-variance G2: Definition <input type="checkbox"/> Over-variance G1: Choose an item. <input checked="" type="checkbox"/> Over-variance G3: Execution			
Estimate Class (overall project)	Class 2		Target Project Completion Date	AUG-2022

Recommendation
<p>We recommend a release of \$2,498 K.</p> <p>This will bring the total released-to-date to \$26,498 K.</p> <p>The estimated total project cost is \$26,498 K.</p> <p>The total project cost is now estimated at \$26,498 K, compared to \$24,000 K in the previous release, including contingency.</p> <p>This release is for additional funding for discovery work not anticipated, contract change orders to address additional scope items not included in the base contract, schedule delays due to COVID-19 and contractor schedule performance. OPG expects to recoup a portion of the contract costs through liquidated damages due to poor contractor schedule performance.</p> <p>Please see below for project variances.</p>

Investment Cash Flows									
\$K	LTD	2021	2022	2023	2024	2025	2026	Future	Total
Previous releases	24,000								24,000
Current request	-	2,398	100						2,498
Total released to date	24,000	2,398	100	-	-	-	-	-	26,498
Future required	-								-
Total Project Cost	24,000	2,398	100	-	-	-	-	-	26,498
Ongoing Costs	-								
					Gate:	G3	OAR Approval:	\$26,498 K	

Project Overview
<p>Auto sluice gates typically have a life expectancy of 40 to 50 years. Auto sluice gates A & B are 60 years old, are at the end of life and do not meet operational and design requirements. The existing gates increase the risk of dam safety issues due to inadequate auto sluicing capacity and poor reliability. In order to safely pass station flows, the adjacent log sluice will be converted to an auto sluice gate. This will provide OPG with the ability to respond reliably to market conditions, minimize dam safety risks, optimizing water use, minimize financial losses and address end of life infrastructure.</p> <p>Replacement of the existing auto sluice gates and associated equipment with an upgraded design will maximize operational efficiencies, decrease incremental maintenance requirements, and optimize site conditions to provide for improved reliability and increased frequency of operation. The addition of a 3rd auto sluice gate will relieve dam safety concerns which are present due to the limited forebay storage capacity, which causes water levels to rise rapidly.</p> <p>Additional funding is requested due to project schedule impacts from COVID-19 along with additional out of scope work required to be completed which was not included in the base contract. Another contributor to the project schedule extension was contractor performance resulting in higher project costs. The project is estimated to be approximately 10% higher than the original approved execution release budget. Please see below for variances.</p>

Project #: MAN82940
Project Title: Sluiceway Replacement
Document #:

OPG Confidential
OPG-FORM-0077-R002

Project Over-Variance Approval

Total Project Estimate Variance Explanation

Project Management / Consultants:

Original BCS: \$679 K
Revised Estimate Including Closeout: \$1,427 K
Variance: \$748 K

Extended construction schedule due to COVID-19 delays and construction impacts resulting in increased costs for site monitor and external inspection consultant.

Engineering:

Original BCS: \$148 K
Revised Estimate including closeout: \$834 K
Variance: \$686 K

Extended construction schedule due to COVID-19 delays and construction impacts resulting in additional resources for engineering.

Procurement:

Original BCS: \$0 K
Revised Estimate: \$125 K
Variance: \$125 K

Insurance purchased by OPG for project along with materials purchased from work centre for commissioning of gates.

Interest:

Original BCS: \$1,008 K
Revised Estimate: \$656 K
Variance: -\$352 K

Interest lower than estimated due to lower interest rates and timing of vendor invoicing.

Other:

Original BCS: \$281 K
Revised Estimate: \$0 K
Variance: -\$281 K

Not required during project.

Construction:

Original BCS Including Contingency: \$21,884 K
Revised Estimate: \$23,456 K
Variance: \$1,572 K

Contract change orders to address additional scope items not included in the base contract:

Repairs to underwater upstream concrete on pier A.

Relocation of the load cells from the original design

Installation of additional cable tray due to electrical load distribution changes

Installation of an electronic transfer switch and changes to 600V distribution

COVID-19 Impacts, suspension of work and associated costs with managing COVID-19

Crack repairs to address existing concrete condition.

Reconstruction of primary concrete columns between the sectional gate and sluice gate gains.


Project #: MAN82940
 Project Title: Sluiceway Replacement
 Document #:

OPG Confidential
 OPG-FORM-0077-R002

Project Over-Variance Approval

Appendix A1: Summary of Estimate - Total Project Cost										
Project Number:	MAN82940									
Project Title:	Sluiceway Replacement									
\$K	LTD	2021	2022	2023	2024	2025	2026	Future	Total	%
Project Mgmt	836	541							1,377	5%
Inspection									-	0%
Engineering	579	205							784	3%
Procurement	84	41							125	0%
Construction	17,184	6,272							23,456	89%
Commissioning									-	0%
Closeout			100						100	0%
Subtotal	18,683	7,059	100	-	-	-	-	-	25,842	98%
Outside WBS									-	0%
Contingency									-	0%
Subtotal w/ Contingency	18,683	7,059	100	-	-	-	-	-	25,842	98%
Interest	511	145							656	2%
Other									-	0%
Total	19,194	7,204	100	-	-	-	-	-	26,498	100%
Removal Costs (incl. above)	1,148								1,148	4%

Appendix A3: Summary of Estimate – In-Service Estimates				
\$K	Only applicable to capital projects. In-Service amount shall include interest but exclude removal costs.			
Project #	Date (YYYY-MM-DD)	Description	Amount	%
MAN82940	6/16/2020	Gate C	8,380	33%
MAN82940	11/27/2020	Gate B	6,450	25%
MAN82940	9/15/2021	Gate A	8,770	35%
MAN82940	8/10/2022	PCR	1,750	7%
Total			25,350	100%

Prepared by:	Reviewed and Endorsed by:
Luciano Da Silva Project Leader NWO Production Support  Date Nov 17, 2021	Darryl Flank Section Manager NWO Production Support Date

Approvals	Signatures	Date
Recommended by: Project Sponsor Brian Dietrich Director Asset Management & Production, Western Region		
Finance Approval: Bryan Shaddock Director Controllershship, RG		
Line Approval per OAR 1.1: Nicole Butcher SVP, RG & Power Marketing		

Internal Use Only
 OPG-FORM-0075-R004

Type 2 Business Case Summary

Project #: BK182777 Cap, BK182199 Non-Std

Document #: NF20-PLAN-08707.021-0006

Project Title: G5 Overhaul – Capital Scope, G5 Overhaul, Partial Execution Release

To be used for investments/projects meeting Type 2 criteria in OPG-STD-0076.

Project Information			
Project #:	BK182777 Cap, BK182199 Non-Std	Document #:	NF20-PLAN-08707.021-0006
Project Title:	G5 Overhaul – Capital Scope, G5 Overhaul		
Class:	<input checked="" type="checkbox"/> OM&A <input checked="" type="checkbox"/> Capital <input type="checkbox"/> Capital Spare <input type="checkbox"/> MFA <input type="checkbox"/> CMFA <input type="checkbox"/> Provision <input type="checkbox"/> Others:	Investment Type:	Sustaining
Phase:	Execution	Release:	Partial
Facility:	SAB1 (NF20)	Target In-Service or Completion Date:	2020-07-29

Project Overview
<p>We recommend the release of \$4,818 k, including \$ 480 k of contingency on the Capital (BK182777) portion of the project. The estimated total project is \$ 24,276 k, including \$ 3,528 k of contingency for both projects. The quality of estimate for this release is Class 3, and for the total project is Class 4.</p> <p>This release will fund the purchase of long lead materials from American Hydro, OPG Project Management, OPG Engineering, Quality Assurance costs, oversight and tooling costs for the generator rim shrink (Andritz) and the fabrication of P&C panels. Appendix C shows list of items to be purchased.</p> <p>This project is included in the approved 2019-23 Business Plan and will be managed within the Niagara Operations Capital Budget Envelope.</p>

Part A: Business Need		
<u>Business Needs</u>		
The business needs of this project are:		
<ol style="list-style-type: none"> 1. Ensure availability, reliability, and continued operation of SAB1 G5 for the next 25-30 years. 2. Enhance the capacity of the generating asset. An opportunity exists to cost effectively increase production of G5 and maximize utilization of available water resources by replacing and upgrading the runner. The recommended alternative upgrades the current rating of the unit to the following capabilities: 		
	Turbine Rating	Generator Mechanical Limit
Pre-Overhaul Ratings	53.1 MW	73 MW
Post-Overhaul Ratings	55.1 MW	73 MW
Improvement	+2.0 MW	-
<u>Background</u>		
<p>Sir Adam Beck 1 (SAB1) G5 was placed into service in 1923 as a 25 Hz unit rated for 45 MVA. It underwent frequency conversion to 60 Hz in 1985 as part of the runner upgrade program. SAB1 G5 has not had a major overhaul since 1985. Hydroelectric units of this type normally require overhauls on a 25-30 year cycle to maintain reliable operation. As a unit approaches end of life, it faces higher potential for production losses due to degraded reliability.</p> <p>G5 has now passed the 25-30 year window (2010-2015) and since 2012 has had a restricted operating window in order to mitigate the effects of high generator rotor vibration. This approach has been used to manage the deterioration of the unit beyond its 30 year major overhaul schedule, due to a heavy overhaul period which began in 2007. For the period from 2007-2018, a primary focus for Niagara Operations has been to overhaul and upgrade SAB1 units as they reached or exceeded the 25-30 year mark in their overhaul cycle. Over this period, G7 was converted to 60 Hz and upgraded (2009), while G9 (2010), G3 (2013) and G10 (2017) underwent major overhauls and runner replacements.</p> <p>There is a risk of failure on the generator due to high mechanical vibration and on the rotor assembly including the generator and turbine shafts. The OEM (Andritz) has asserted that a loose rim would contribute to vibration on the rotor. Their report recommends shrinking the rim to eliminate the vibration caused by a loose rim to minimize eccentricity. This project will implement the proposed remedy to move towards restoration of the unit's full, unrestricted operating window.</p> <p>Replacement of the MOT is recommended as part of all alternatives due to off-gassing.</p>		

Type 2 Business Case Summary

Project #: BK182777 Cap, BK182199 Non-Std

Document #: NF20-PLAN-08707.021-0006

Project Title: G5 Overhaul – Capital Scope, G5 Overhaul, Partial Execution Release

Part A: Business Need

The total required funding for this project is broken down in the following table. (A BP19-23 comparison is shown in Part D.)

k\$	LTD	2018	2019	2020	2021	Future	Total
BK182199 Non-Std	0	0	3,091	1,214	0	0	4,305
BK182777 Cap	0	791	13,546	5,634	0	0	19,971
Total Project Cost	0	791	16,637	6,848	0	0	24,276

The recommended alternative proposed in the Definition Phase Charter (DPC [NF20-PLAN-00121.2-0003](#)) was Alternative 4, to perform a Minor Overhaul during the outage for 2019 and then perform the remainder of the overhaul scope during a planned outage after the BK182198 G1/G2 Frequency Conversion Project. At the time the recommendation was endorsed, there was uncertainty regarding whether the G5 Major Overhaul could be completed without affecting the BK182198 Project. Thus, a decision was made to proceed with the conservative schedule alternative which would only execute the Minor Overhaul scope as the leading alternative. Subsequently, the schedule details for BK182198 have been confirmed and further input from Production has concluded that proceeding with the Major Overhaul and upgrade in advance of BK182198 is the preferred, supported alternative.

Part B: Preferred Alternative: Major Overhaul and Upgrade to a Higher Capacity (25-30 year reliable operation)

Description of Preferred Alternative

The project would execute a complete refurbishment of the unit. High level scope as follows:

- New upgraded turbine runner, wicket gates, scrollcase, draft tube and turbo-venting on draft tube, surface air coolers
- Refurbish servomotors, turbine guide bearing
- Clean/re-wedge generator stator, refurbish generator windings, clean/shrink generator rotor, refurbish field poles
- New MOT, static exciter, bus work, and switches
- Perform further investigation and possible repair on the penstock and scrollcase, including completion of a load carrying capacity analysis

The current strategy is to procure long lead components and provide as owner-supplied materials to the successful Proponent. This strategy will help meet the scheduled execution phase planned for Q2 2019.

Alternative 2 from the DPC is the preferred alternative as it more completely addresses the business needs for sustaining long-term reliable operation and enhance the capacity of the generating asset.

Advantages:

- Addresses generator vibration issues.
- Capacity is enhanced ~2 MW with positive Net Present Value associated with upgrading the runner.
- Reliable operation restored for the next 25 to 30 years.

Disadvantages:

- Higher investment, however has the best NPV

For the detailed scope and further information see Appendix A in the DPC. The outage is planned for May 6, 2019 to Jul 29, 2020. If a Moody Cone is required, it may become the critical path. The project has challenged its engineering resources to find inspection methods to mitigate this risk. An alternative outage plan is also being considered to determine if a second shift can be accommodated.

Contracting Strategy for this Partial Execution Phase Release:

An equipment supply agreement between OPG and American Hydro was signed Feb 2007 for the supply of runners for G3-G10. The runner for G5 will be procured under the terms of this agreement. Runner pricing has been refreshed by the vendor and addressed by Supply Chain based on the 2009 agreement. Other long lead items will be purchased by the OEM from approved vendors.

Protections & Controls (P&C) panels are being designed by Plant Engineering Services (PES) and will be fabricated at the Gravenhurst Work Centre.

Type 2 Business Case Summary

Project #: BK182777 Cap, BK182199 Non-Std

Document #: NF20-PLAN-08707.021-0006

Project Title: G5 Overhaul – Capital Scope, G5 Overhaul, Partial Execution Release

Part B: Preferred Alternative: Major Overhaul and Upgrade to a Higher Capacity (25-30 year reliable operation)

Description of Preferred Alternative

Contracting/Execution Strategy for the Entire Project:

A Functional Specification for an EPC contract to an OEM to engineer, procure components and provide Owner's Representative Services has been developed. The labour determination has been dispositioned with approximately 50% of the work packages going to each of the PWU/BTU trade unions. Both unions' work crews will need to work together on work packages from a work coordination perspective. . As such, OPG acting as Owner-Constructor, will have both unions report to OPG's Union Trades Supervisor up to a Site Project Manager. Delivery of long lead material is scheduled to arrive after disassembly has begun but before the material is required for install in order to advance the outage start.

Environmental Strategy

A Class EA was performed for the BK182198 G1/G2 Frequency Conversion (G1/G2). The Class EA Amendment for G5 will be minor relative to BK182198 as the upgraded capacity of G5 is 2 MW, as compared to 109.6 MW of upgraded capacity for G1/G2. The Site Environmental Advisor is addressing this requirement in alignment with Project timelines.

In summary, Alternative 2 from the DPC is recommended with the above Contracting/Execution strategy which diverges from the strategy proposed at the time that the DPC was written. Engaging the OEM to engineer, procure components and provide Owner's Representation is recommended in light of the condition of the unit, the labour determination, and the schedule constraints/opportunities imposed by the G1/G2 Project.

Deliverables (for the Partial Release):	Associated Milestones (if any):	Target Date:
Prepare a detailed Scope of Work (SoW) form	SoW form Approved	Aug 18, 2018
Partial Release of Funds for procurement of long lead components and remaining definition phase deliverables.	PBCS Approved	Aug 30, 2018
Supply refreshes American Hydro contract and award	Issue PO to American Hydro	Sep 7, 2018
Proposals back from Proponents		Sep 21, 2018
Conduct PDRI and COMES review		Sep 30, 2018
Finalize the L2 schedule, RQE and PEP		Oct 16, 2018
Gate 3 Review for EBCS		Nov 12, 2018
Execution funds released	EBCS Approved	Nov 23, 2018
Select an OEM to Engineer, Procure and be Owner's Rep.	Issue PO	Nov 30, 2018

Part C: Other Alternatives

For the detailed Scope and further information see Appendix A in the DPC (NF20-PLAN-00121.2-0003)

Alternative 1: Base Case – Status Quo (No Project)

G5 would run in the short term without significant rehabilitation or overhaul work but would eventually run to fail. This alternative does not address the potential failure of the generator due to rotor vibration and turbine runner due to vibration-induced cavitation.

This alternative is not recommended because failure of the unit would result in an unplanned outage and reduce OPG's ability to reliably supply power to the grid.

Alternative 3: Major Overhaul (25-30 yr reliable operation)

This alternative has the same scope of work as the preferred alternative except that the runner would be refurbished rather than replaced. Reliability is restored for 25-30 years but there is no increase in capacity.

This alternative has a lower project cost than the preferred alternative but is not recommended because the runner upgrade alternative has the highest NPV.

Type 2 Business Case Summary

Project #: BK182777 Cap, BK182199 Non-Std

Document #: NF20-PLAN-08707.021-0006

Project Title: G5 Overhaul – Capital Scope, G5 Overhaul, Partial Execution Release

Alternative 4: Minor Overhaul (5-10 yr reliable operation)

This alternative we perform the following scope only:

- The generator rotor floating rim is changed to shrunk design removing the vibration issue
- MOT and exciter are replaced.

This alternative is not recommended because the unit would required a subsequent outage within 5 to 10 years.

Part D: Project Cash Flows, NPV, and OAR Approval Amount

k\$	LTD	2018	2019	2020	2021	2022	2023	Future	Total
Currently Released	300	0	0	0	0	0	0	0	300
Requested Now:	-	491	4,327	0	0	0	0	0	4,818
Future Required	-	0	12,310	6,848	0	0	0	0	19,158
Total Project Cost	300	491	16,637	6,848					24,276
Ongoing Costs	-	0	0	0	0	0	0	0	0
Grand Total	300	491	16,637	6,848	0	0	0	0	24,276
Estimate Class:	Class 4				Estimate at Completion:				24,276
NPV:	\$149 M				OAR Approval Amount:				5,118

Additional Information on Project Cash Flows (optional):

- The SoE has increased from the DBCS estimate due to estimates being refined using bid pricing from American Hydro and Andritz
- Based on the labour determination, there is an increase in Project Management, Production, and Engineering resource requirements.

Part E: Financial Evaluation

M\$	Alt2 – Major OH & Upgrade	Alt1 – Status Quo	Alt3 – Major OH Only	Alt4 - Minor OH
Project Cost	23.3	1.2	16.0	7.5
NPV	149	136	144	137

Summary of Financial Model Key Assumptions or Key Findings:

Assumptions

- Evaluated over a 25 year span
- All ongoing OM&A costs (i.e. standard operating expenses) are equivalent for each alternative
- Utilization of Base SEV values and Capacity Credit not used
- Major Overhaul will be taken for each alternative in 25 years (2043)
- Alt 1 Status Quo: Vibration issue requires an outage for Major OH in 2023 (5 years). Operating restrictions are maintained. An unplanned outage would be required circa Oct2023 to Oct 2024 which coincides with PNGS shutdown.
- Preferred Alternative – Alt 2 Major OH & Upgrade: 2 MW increase in capacity achieved with the runner upgrade. Planned outage May 2019 to Jul 2020
- Alt 3 Major OH only: Planned outage May 2019 to Jul 2020
- Alt 4 Minor OH: Planned outage May 2019 to Oct 2019 with another outage within 5 years
- The project will be completed in time to minimize the schedule impacts on BK182198 (G1/G2)

Type 2 Business Case Summary

Project #: BK182777 Cap, BK182199 Non-Std


Document #: NF20-PLAN-08707.021-0006

Project Title: G5 Overhaul – Capital Scope, G5 Overhaul, Partial Execution Release

Part F: Risk Assessment (for Partial Release)				
Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	There is risk of incurring carrying costs and the cost of extending warranty period on the Am. Hydro items if only the Minor OH scope is performed.	The partial BCS has contingency to address unforeseen additional costs. The contract will have a firm fixed price from American Hydro. An allowance for carrying costs and warranty extension has been incorporated into the release request.	Low	Low
Technical	The runner modeling performed (circa 2007) does not meet performance requirements.	Technical review prior to award. Runner design based on uprate study and modeling has been completed and accepted by Engineering.	Low	Low
Schedule	Long lead components not delivered in time, extending the outage period.	Historically, 12 months is required for the longest lead component (runner). This time has been allotted. Liquidated damages will be included in the contract to incentivize the contractor to deliver on time. Order the long lead components as soon as possible. Monitor progress of supplier.	Low	Medium

Note that these risks are for the PBCS only. The complete list of risks for execution will be included in the Risk Register of the PEP and in the EBCS.

Part G: Post Implementation Review (PIR) Plan				
<input type="checkbox"/> It is determined appropriate that only a Project Closure Report (PCR) is needed as the PIR for this project, due to its straight forward deliverables, which do not require any measures other than confirmation of completion or delivery.				
Type of PIR Report	Target In-Service or Completion Date	Target PIR Completion Date		
Simplified PIR				
Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Will be determined as part of the EBCS.				

Approvals			
	Signature	Comments	Date
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by (Project Sponsor): Jessica Polak VP Operations, Niagara Ops	Electronically Approved by POLAK Jessica - OPERATIONS		8/29/2018 8:16 AM
I concur with the business decision as documented in this BCS.			
Finance Approval: Norma Siroski Finance Controller, RG per OPG-STD-0076	Electronically Approved by SIROSKI Norma -FIN & C CTRL		on 8/29/2018 8:25 AM
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Mike Martelli President, RG per OAR 1.1			30 Aug 18

Type 2 Business Case Summary

Project #: BK182777 Cap, BK182199 Non-Std

Document #: NF20-PLAN-08707.021-0006

Project Title: G5 Overhaul – Capital Scope, G5 Overhaul, Partial Execution Release

Appendix A: Summary of Estimate (PBCS)								
Project Number:	BK182777							
Project Title:	G5 Overhaul – Capital Scope							
k\$	LTD	2017	2018	2019	2020	Future	Total	% of Project Total
OPG Project Management			78				78	1.5
OPG Engineering (including Design)			12				12	2.4
Procured Materials			111	3,773			3,884	73.6
OPG Other			235				235	4.6
Design Contract(s)			190				190	3.8
Construction Contract(s)								
EPC Contract(s)								
Consultants								
Other Contracts/Costs			65	90			155	3.0
Interest			21	14			35	0.7
Removal Costs								
Subtotal			712	3,877			4,589	89.7
Contingency			79	450			529	10.3
Total Capital			791	4,327			5,118	100.0

Notes			
Project Start Date	Sep-18-2018	Total Definition cost (excludes unspent contingency for Nuclear)	300
Target In-Service (or AFS) Date	Jul-29-2020	Contingency included in this BCS (Nuclear only)	N/A
Target Completion Date	Jul-29-2021	Total contingency released plus contingency in this BCS (Nuclear only)	N/A
Escalation Rate	NA	Total released plus this BCS without contingency (Nuclear only)	N/A
Interest Rate	4.41%	Total released plus this BCS with contingency (Nuclear only)	N/A
Removal Costs	NA	Estimate at Completion (includes only spent contingency for Nuclear)	24,276

Prepared by:	Approved by:
Michele Sokol Project Leader	Ken Prince Section Manager - Projects
Date	Date

Type 2 Business Case Summary

Project #: BK182777 Cap, BK182199 Non-Std

Document #: NF20-PLAN-08707.021-0006

Project Title: G5 Overhaul – Capital Scope, G5 Overhaul, Partial Execution Release

Appendix A: Summary of Estimate (EBCS – Full Project Capital)								
Project Number:	BK182777							
Project Title:	G5 Overhaul – Capital Scope							
k\$	LTD	2017	2018	2019	2020	Future	Total	% of Project Total
OPG Project Management			78	151	54		283	1.4
OPG Engineering (including Design)			12	158	32		202	1.0
Procured Materials			111	3,773			3,884	19.4
OPG Other			235	1,888	240		2,363	11.8
Design Contract(s)			190				190	1.0
Construction Contract(s)				4,569	4,159		8,728	43.7
EPC Contract(s)								
Consultants				537	146		748	3.4
Other Contracts/Costs			65					
Interest			21	184	103		308	1.5
Removal Costs				436			436	2.2
Subtotal			712	11,696	4,734	0	17,142	85.8
Contingency			79	1,850	900		2,829	14.2
Total Capital			791	13,546	5,634	0	19,971	100.0

Notes			
Project Start Date	Sep-18-2018	Total Definition cost (excludes unspent contingency for Nuclear)	300
Target In-Service (or AFS) Date	Jul-29-2020	Contingency included in this BCS (Nuclear only)	N/A
Target Completion Date	Jul-29-2021	Total contingency released plus contingency in this BCS (Nuclear only)	N/A
Escalation Rate	NA	Total released plus this BCS without contingency (Nuclear only)	N/A
Interest Rate	4.41%	Total released plus this BCS with contingency (Nuclear only)	N/A
Removal Costs	436	Estimate at Completion (includes only spent contingency for Nuclear)	24,276

Prepared by:	Approved by:
Michele Sokol Project Leader	Ken Prince Section Manager - Projects
Date	Date

Type 2 Business Case Summary

Project #: BK182777 Cap, BK182199 Non-Std

Document #: NF20-PLAN-08707.021-0006

Project Title: G5 Overhaul – Capital Scope, G5 Overhaul, Partial Execution Release

Appendix A: Summary of Estimate (EBCS – Full Project Non-Std)								
Project Number:	BK182199							
Project Title:	G5 Overhaul							
k\$	LTD	2017	2018	2019	2020	Future	Total	% of Project Total
OPG Project Management				36	51		87	2.0
OPG Engineering (including Design)				39	34		73	1.7
Procured Materials								
OPG Other				946	256		1,202	27.9
Design Contract(s)								
Construction Contract(s)				1,570	673		2,243	52.1
EPC Contract(s)								
Consultants								
Other Contracts/Costs								
Interest								
Removal Costs								
Subtotal				2,591	1,014		3,605	83.7
Contingency				500	200		700	16.3
Total Non-Std				3,091	1,214		4,305	100.0

Notes			
Project Start Date	Sep-18-2018	Total Definition cost (excludes unspent contingency for Nuclear)	300
Target In-Service (or AFS) Date	Jul-29-2020	Contingency included in this BCS (Nuclear only)	N/A
Target Completion Date	Jul-29-2021	Total contingency released plus contingency in this BCS (Nuclear only)	N/A
Escalation Rate	NA	Total released plus this BCS without contingency (Nuclear only)	N/A
Interest Rate	4.41%	Total released plus this BCS with contingency (Nuclear only)	N/A
Removal Costs	NA	Estimate at Completion (includes only spent contingency for Nuclear)	24,276

Prepared by:	Approved by:
Michele Sokol Project Leader	Ken Prince Section Manager - Projects
Date	Date

OPG-FORM-0075-R004

Document #: NF20-PLAN-08707.021-0006

Document #: NF20-PLAN-08707.021-0006

Document #: NF20-PLAN-08707.021-0006

Appendix B: Comparison of Total Project Estimates and Project Variance Analysis

[illegible]

Note that the DBCS cashflows were based on performing a mini rehab in 2019 and completing the remainder of the work for a major overhaul in 2023/24.

Project Variance Analysis					
k\$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management					A variance analysis cannot be done since the DBCS did not have a breakdown for the entire project.
OPG Engineering (including Design)					
OPG Procured Materials					
OPG Other					
Design Contract(s)					
Construction Contract(s)					
EPC Contract(s)					
Consultants					
Other Contracts/Costs					
Interest					
Subtotal					
Contingency					
Total					

Type 2 Business Case Summary

Project #: BK182777 Cap, BK182199 Non-Std

Document #: NF20-PLAN-08707.021-0006

Project Title: G5 Overhaul – Capital Scope, G5 Overhaul, Partial Execution Release

Appendix C: Project Materials to be purchased with lead times	
Component	Delivery (mths)
New Francis Runner w cowl/skirt	11-12
New Nose Cone	2-3
Turbo-Vent Assembly	3-4
Turbine Shaft Refurb, Runner Shaft Assembly	2
Draft Tube Cone	8-10
P&C Panels	TBD