ONTARIO POWER GENERATION

Records File Information:
See Guidance Section

OPG-FORM-0076-R003*

Type 3 Business Case Summary

Final Security Classification of the BCS: **OPG Confidential**

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

Executive Summary and Recommendations					
Project #:	16-31555	**Title:**	Heavy Water Storage and Drum Handling Project		
Phase:	Execution		**Release:**	Full	
Facility:	Darlington		**Records File:**	N-BCS-00120.3-10022-R000	
Class:	Capital		**Investment Type:**	Value Enhancing	

Project Overview

We recommend the release of $79,085 k ([redacted] base costs plus [redacted] contingency).

Upon approval, the total amount released will be $110,015 ([redacted] base cost plus [redacted] contingency)

Additional heavy water storage capacity is needed to support refurbishment of Darlington. The first unit refurbishment outage is scheduled to begin October 2016. The in-service date for this facility is October 15, 2015, and is one year before the planned start of the first unit refurbishment outage. This lead time is to mitigate the risk of an earlier start of refurbishment, and to perform refurbishment preparation activities, such as detritiation of the units. The need for heavy water management improvements had been approved earlier (2007), but was deferred in 2009 to be consolidated with Refurbishment's need for heavy water storage to achieve economies of scale and reduce overall project costs.

This Full Execution release is required in parallel to the Phase I and Phase II release to allow progression of the construction planning and materials procurement in order to mitigate overall schedule completion risk. Specifically, ordering of non-long lead materials and work planning for the construction of the facility must begin in parallel with the current releases to ensure seamless execution of the project by the Engineer, Procure, and Construct (EPC) vendor.

The project scope is to build a facility for the storage of 2.1 million litres of heavy water in tanks that meet nuclear safety requirements to address the radiological hazard that tritium in the heavy water poses. One such requirement is to have a back-up heating system to ensure the heavy water does not drop below 10°C, which is required to mitigate risk of tritium emissions by avoiding freezing and tank rupture. Heavy water freezes at 4°C. A second key safety requirement is to enclose the tanks in a seismically qualified dike, designed to hold the heavy water in place following a design basis earthquake. The facility will be 30,000 square feet, and will also include a heavy water drum cleaning, testing and handling area, and consolidated office space for the Tritium Removal Facility (TRF) staff. There will be 25 storage tanks, most having a capacity of 100,000 L. Of the 2,100,000 L of storage, 1,700,000 L (or 21 tanks) is mandatory support of core scope for Darlington Refurbishment (a value enhancing project). The appropriate alternative for this scope is the lowest cost feasible alternative. The remaining 400,000 L (or 4 tanks), drum cleaning, testing, and handling area, and the office space provides needed heavy water management operational improvements, and is also value enhancing scope.

This project is currently executing Phase I (Design) and Phase II (Site Preparation, Procurement of Long Lead Materials). Requested now is funding to complete Phase III of the project, and includes completion of construction planning, ordering of non-long lead materials and spare parts, construction, testing and commissioning, training, in-service declaration, and project closeout. Phase I, Design, has a target completion of July 15, 2013 and is currently at risk. Preliminary Engineering was completed on December 21, 2012. This was 2 months behind schedule. This has resulted in compression of the detailed design, and when combined with additional scope items identified during the preliminary engineering phase, has resulted in completion risk for the July 15, 2013 milestone. However, it is not anticipated that a delay of up to 2 months will impact construction of the new facility, as design packages are being completed in sequence as required by construction start dates. Because the project is being executed in this fashion, Phase II, Site Preparation, has already begun. Soil and ground water samples have been taken, and interferences have started to be removed in order to clear the site for construction of the new facility. This work was initially forecasted to be completed by September 2013, however, it was determined that relocation of a low pressure service line must occur during a scheduled TRF outage in October 2013 to avoid potential for increased tritium emissions at the site.

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

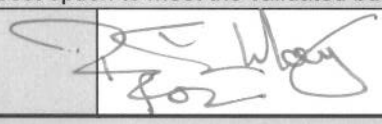
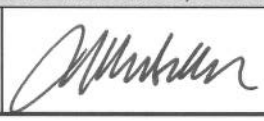
Type 3 Business Case Summary

Project Cash Flows									
k$	LTD	2013	2014	2015	2016	2017	2018	Future	Total
Currently Released	12,683	16,228	2,019						30,930
Requested Now	-	11,766	50,088	17,231					79,085
Future Required	-								
Total Project Cost	12,683	27,994	52,107	17,231	0	0	0	0	110,015
Ongoing Costs	-		638	1,431	664	677	691	3,666	7,766
Grand Total	12,683	27,994	52,745	18,662	664	677	691	3,666	117,781

Estimate Class:	Class 2	**Estimate at Completion:**	$94,824k
NPV:	$67,100 k	**OAR Approval Amount:**	$117,781

Additional Information on Project Cash Flows (optional):

Grand Total includes 10 years of on-going costs (OM&A). NPV is in 2012$. Ongoing costs in year 2015 includes $780k for critical spare parts.

Approvals			
	Signature	**Comments**	**Date**
This BCS represents the best option to meet the validated business need in a cost effective manner.			
Recommended by: Wayne Robbins Project Sponsor			May 2/2013
I concur with the business decision as documented in this BCS.			
Finance Approval: Donn Hanbidge Position per OPG-STD-0076			May 10/13
I confirm this project will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Tom Mitchell Position per OAR, per OAR 1.1			May 14 2013

Final Security Classification of the BCS: **OPG Confidential**

Business Case Summary

Part A: Business Need

Business Need:

Additional heavy water storage capacity is needed to support refurbishment of Darlington. The first unit refurbishment outage is scheduled to begin October 2016. The in-service date for this facility is October 15, 2015, and is one year before the planned start of the first unit refurbishment outage. This lead time is to mitigate the risk of an earlier start of refurbishment, and to perform refurbishment preparation activities, such as detritiation of the units.

During Darlington refurbishment, heavy water storage capacity is needed at the Darlington site. An assessment of existing storage capacity determined that it was insufficient to meet the increased storage needs for refurbishment. Individually, each unit requires 750,000 L of storage for moderator and heat transport heavy water. However, refurbishment will be executed with over-lapping shutdown units, requiring sufficient capacity to store two units worth of heavy water, or 1,500,000 L. In addition refurbishment requires 200,000 L of storage to facilitate flushing and other support operations associated with the preparation of the Darlington units for refurbishment work. This storage is for light water, and must be segregated from reactor grade heavy water. Therefore, this storage requirement is incremental to the 1,500,000 L required. The 200,000 L storage need must be met through additional capacity as the existing Darlington operational storage is required to support the operations of the units across the OPG fleet that remain in service during Darlington refurbishment. Therefore, the total additional heavy water storage capacity required to support refurbishment is 1,700,000 L. It is currently anticipated that the 1,500,000 L of reactor grade storage, which will be surplus storage upon completion of Darlington refurbishment, will be available for the long term storage of heavy water from OPG units.

The second mandate for this project is to improve heavy water management in support of all OPG nuclear units is the result of a previously approved Operational Improvement project which was deferred to be merged with the refurbishment D20 storage project in order to achieve cost efficiencies. The 3 main components of the second mandate are as follows:

1. Additional 400,000 L of permanent storage required to improve utilization of the Darlington Tritium Removal Facility (TRF) and mitigate threats to the achievement of OPG detritiation objectives (before, during and after Darlington refurbishment) due to current storage constraints. The increased storage will address the TRF feed and product storage bottleneck that is a significant challenge to the efficiency of the overall tritium removal process. Improving the efficiency of the TRF will allow increased detritiation efforts to occur, and lower both tritium emissions and employee radiation exposure (aka dose).

2. A new Heavy Water Drum Handling, Cleaning, Testing, and Storage Facility providing services to both Pickering and Darlington stations will centralize drum storage, and provide a means of long term cleaning and disposal of the current inventory of drums. The current large backlog of drums has caused radiological and conventional safety concerns, injuries, and significant operational burden due to storing drums throughout the Heavy Water Management Building (HWMB). The facility will also provide the ability to support any refurbishment activities requiring drum cleaning/disposal, and expedite commercial shipments.

3. New consolidated office space for TRF staff. Construction of the new Heavy Water Storage and Drum Handling Facility will require demolition of existing permanent office trailers, so new replacement office space for these operations staff is required, including interim accommodations. As well, there are currently numerous staff located in nonstandard offices throughout the TRF/HWMB. In addition, managers will be relocated to the central offices, improving communication, oversight, and time in the field. There will also be increased efficiencies associated with consolidating the TRF operations, maintenance, and management team in one area. The office requirements are for 9 staff, including 1 conference room.

The improvements to the TRF operations and OPG Heavy Water Management are summarized below:

• Improve tritium removal capability within OPG by providing scheduling flexibility and reducing detritiation management dependency on TRF availability

- Improve utilization efficiency of available TRF capacity by providing storage for high Curie input feed, thereby maximizing tritium removal
- Improve operational flexibility and ability to segregate different heavy water streams to support Darlington operation and outage scenarios, such as unit, station containment, and vacuum building outages
- Eliminate the backlog of heavy water in drums that needs to be processed through the heavy water Cleanup System
- Rectify long standing problem of unconsolidated and nonstandard work locations with new offices

Part B: Preferred Alternative

Description of Preferred Alternative: Build 2,100,000 L of Heavy Water Storage and a Drum Handling Facilty, with additional office space

Construction of a new 2,100,000 L heavy water storage and drum handling facility (as an extension to the existing Heavy Water Management Building, HWMB) is recommended because it is the lowest cost option that meets both the mandate to support Darlington Refurbishment and the need for OPG heavy water management operational improvements.

The major components of this option are as follows:

(a) **Facility:** The preferred alternative requires the design and construction of a multistory building, adjacent to the existing Heavy Water Management Building (HWMB) within the protected area of the Darlington station. To prepare the site for the new facility, interferences with existing station systems (such as buried piping & electrical cable ducts, over ground structures such as bulk gases tanks, temporary trailers etc) will need to be removed and/or relocated using the engineering change control process while minimizing impact on safe plant operations.

(b) **Building:** The facility will house the heavy water storage tanks (see details below) in the basement on a seismically qualified foundation/dyke which would be built on bedrock to ensure prevention of egress of heavy water to the environment in the unlikely event of failure of all tanks (for example, a design basis seismic event). The basement would also contain a slightly negative pressure HVAC and filtering systems. There is a requirement to have a back-up heating system to ensure the heavy water does not drop below 10°C, which is required to mitigate risk of tritium emissions by avoiding freezing and tank rupture.

A new vapour recovery system consisting of dryers would be installed to remove tritiated vapour to minimize leakage of radiation to the environment and reduce radiological hazards to personnel. Thick concrete (shielding) floor and walls would be provided for personnel protection in office areas and to staff working in the drum handling area. The building (with the exception of the offices) would be classified as radiological Zone 3 (highest radiological zone), and contain appropriate radiation monitoring and handling systems (e.g. stack effluent monitors, personnel and materials monitors, etc.).

(c) **Building Services**: The building electrical loads would be supplied by a new distribution network fed from the Clarington Municipality, and a backup electrical power supply would also be provided to maintain critical loads in service at all times. A new instrument air system would also be installed to support the new facility's process systems. Other support services, such as domestic water, active/inactive drains, steam and condensate systems would be tied in to the existing station systems.

(d) **Process and Tie-ins:** 25 tanks of various sizes, to contain the heavy water from Moderator, Heat Transport, Cleanup system etc would be designed and built as per applicable nuclear codes and standards (CSA N285). Support equipment such as piping, valves, pumps, instrumentation & controls designed to same standards would be provided to monitor and operate the facility. Tie ins to existing Heavy Water Management Building tanks, and to the Darlington units and TRF facility for heavy water transfer capability would be provided. All this work would be coordinated and planned to ensure minimal impact on station operations.

For refurbishment to be successful, the new facility must provide sufficient heavy water storage at the Darlington site for the heavy water from two units prior to start of refurbishment, a requirement of the Darlington refurbishment project. This option meets this requirement and has been assessed to be the lowest cost option available. In addition, by increasing the operational storage, this option would enable more efficient utilization of the Darlington TRF and mitigate threats to the achievement of OPG detritiation objectives (before, during and after Darlington refurbishment) due to current heavy water storage constraints. Lastly, this option facilitates the current TRF/Heavy

Water Management Life Cycle Management plan to 2055, thus reducing the risk of requiring a costly refurbishment of the existing TRF, or construction of a new TRF facility.

The execution of this work has been divided into 3 Phases:

Phase I, Detailed Design, June 2012 – July 2013 (Already Released)

This work is underway under the Full Definition Release approved in June 2012 for $12,793 k. Due to additional scope (vapour recovery system, and instrument air/service air) and delays during the Preliminary Design, completion by July 2013 is currently at risk and a recovery plan is being executed. Should final design completion be delayed, it is not forecasted to adversely affect the construction schedule, as individual design packages are currently forecasted to be completed well ahead of construction need.

Phase II, Site Preperation, September 2012 – September 2013 (Already Released)

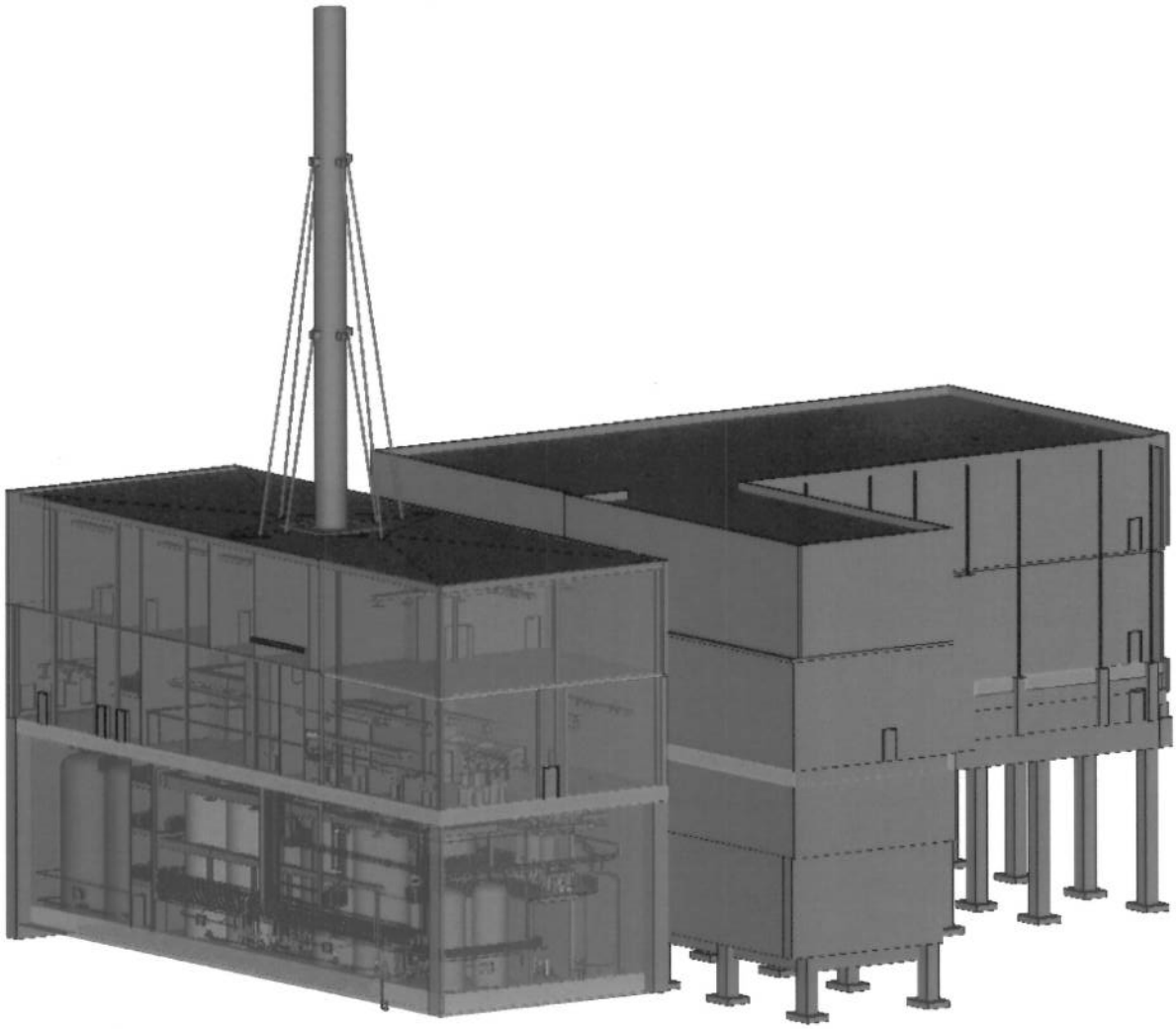
This work is for site preparation, construction planning, and procurement of Long Lead materials. This work is underway under the Partial Execution Release approved in August 2012 for $7,544k. Site preparation activities include demolition of TRF trailers, relocation of existing and buried services, start of excavation, and miscellaneous civil substructures. Long lead material purchase orders have been awarded as scheduled, including a purchase order for the 25 heavy water storage tanks. Site preparation is underway, and forecasted to be completed by November 2013. This work was originally scheduled to be completed by September 2013, but upon re-assessment of some critical services, it was decedied to relocate a critical service water line during the TRF outage T1301 in Q3 2013 to mitigate nuclear safety risk. It is not anticipated that this change will impact overall project cost or schedule. The final work in this phase will be completed during the outage window starting in October 2013.

Phase III, Full Execution, September 2013 – April 2016 (Requested Now)

Completion of the caisson work and excavation, completion of construction planning, foundation pouring, installation of the tanks, construction of facility, and tie-in to existing station.

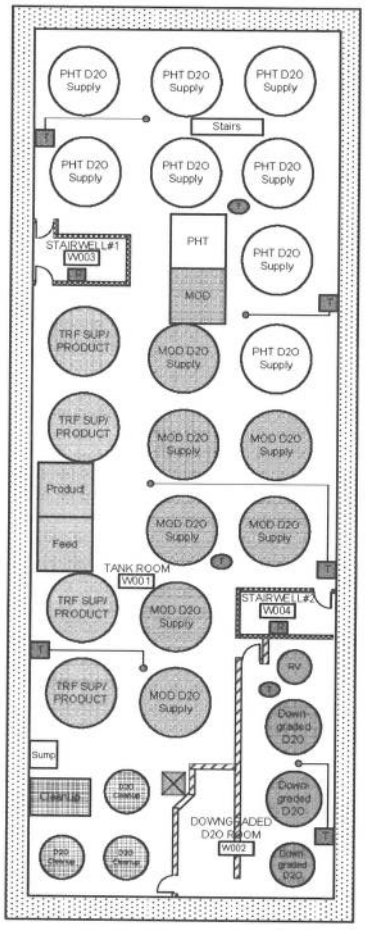
The project has negotiated a performance based target price for an engineer, procure, and construct (EPC) contract to complete this work. A portion of the performance target price for the whole project is a fixed price contract to complete Phase I, Detailed Engineering. The fixed price portion and the overall target price are the basis of the design and construction costs. The OPG costs are associated with the required nuclear oversight to mitigate safety, schedule, and quality risks to ensure safe and timely completion of this prerequisite project for Darlington Refurbishment.

The image below shows a cut-away of the new Heavy Water Storage Facility. Behind the new facilty is the existing Tritium Removal and Heavy Water Management Facility

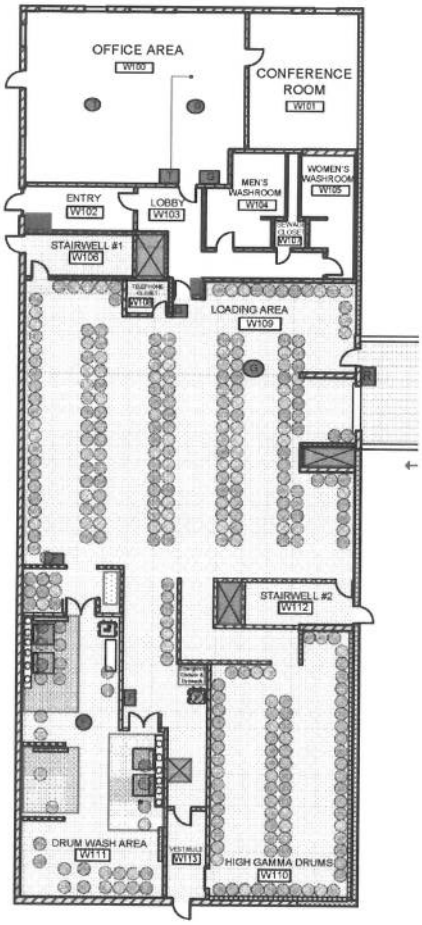


Type 3 Business Case Summary

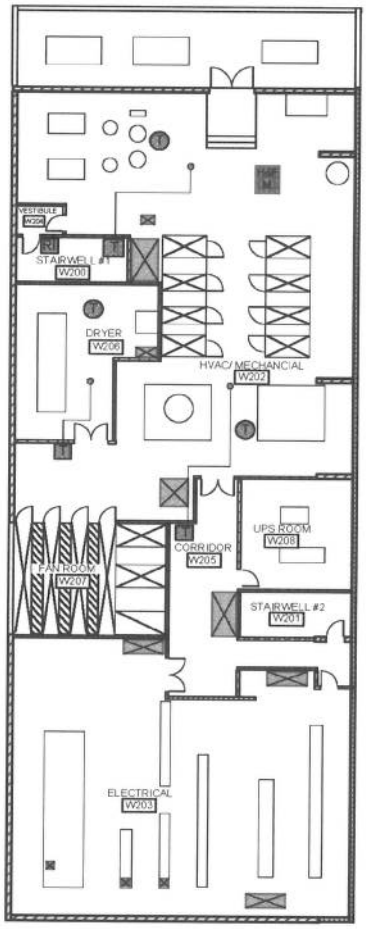
Below are current, not-finalised design layouts for the 3 different floors of the facility. A side view is provided at the bottom of this page.



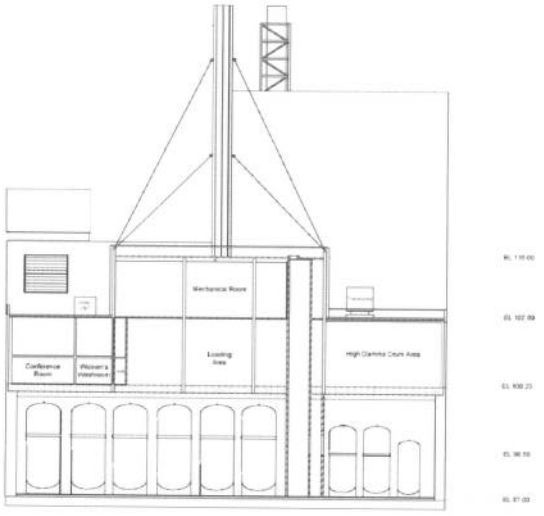
Basement layout



Ground floor layout



Second floor layout



Side view of new facility

Deliverables:	Associated Milestones (if any):	Target Date:
The following are deliverables committed to under both the Full Definition Release, Partial Execution Release, and this Full Execution Release.		
Complete - Partial Execution BCS (Under previous release)	Partial Execution BCS Approved	14-Sep-12
Complete - Preliminary Design Complete (Under previous release)	Preliminary Design Complete	29-Oct-12
Complete - Award Phase II of EPC Contract (Under previous release)	EPC Phase II Installation Contract Awarded	15-Jan-13
Complete - Award Long Lead Material Contracts (Under previous release)	All Long Lead Time Materials Contracts Awarded	28-Mar-13
At Risk - Detailed Design Packages (Under previous release)	Design Documents Approved and Issued	15-Jul-13
On Track - Full Execution BCS (Under this BCS)	Full Execution Release Approved	16-Sep-13
EPC Phase III Installation Contract Awarded (Under this BCS)	EPC Phase III Installation Contract Awarded	23-Sep-13
Start of Installation (Under this BCS)	Start of Installation	16-Oct-13
Final In-service Declaration Complete (Under this BCS)	Avaliable for Service	15-Oct-15
Project Close-out Complete (Under this BCS)	Project Close out	15-Apr-16

Part C: Other Alternatives

Base Case: Status Quo – No Project

The do nothing option is not viable and therefore has not been assessed because this option does not meet the Darlington Refurbishment mandate. Work must be undertaken to address the 1,700,000 L storage requirements to support refurbishment.

Alternative 2: Build "drum warehouse" inside the Protected Area to store 1,700,000 L of D2O for Refurbishment in drums, and build a smaller D2O Facility for the Operational Improvements

This option for the Refurbishment heavy water storage is not viable because of the impact to the refurbishment outage critical path. It has been determined that 2 months of round the clock drumming would be required to drain the primary heat transport (PHT) system and moderator in this fashion. As well, it would require 2 months of round the clock drum purging to re-fill the PHT system and moderator post-refurbishment. This would be required for each refurbished unit, with a previously estimated total lost generation revenue of approximately $290,000 k (2012$ PV).

An estimated 7200 drums at a cost of $1000/drum would also be required to implement this option. This solution would still require a building with similar requirements of the proposed solution, and therefore would still result in the need to design, procure, and construct a new heavy water facility. Thus this option does not avoid much of the cost associated with the preferred option. The station would also be required to address an increased environmental risk of heavy water spills. The existing backlog of drums have caused radiological and conventional safety concerns, injuries, and significant operational burden.

An economic analysis was previously completed for the heavy water operational improvements scope of work with an NPV of $59,900k (2012$).

Alternative 3: Delay Work- Building 1,700,000 L for Refurbishment now, and Operational Improvement portion 3 years later

This option does not meet the operational improvement requirements. The Operational Improvement portion of this work was previously approved in 2006. However, it was deferred to be merged with the refurbishment D20 scope in order to achieve cost savings, estimated at $20 M to $30 M, by realising efficiencies of completing the two mandates together as one project. Completing two different projects and time periods eliminates any cost savings even after factoring in the time value of money. There is high demand for detritiation services particulary in the period 2016 – 2020 as a result of the need to detritiate Pickering units prior to shutdown and to detritiate the heavy water drained from the Darlington units during refurbishment.

An economic analysis was previously completed for the heavy water operational improvements scope of work with an NPV of $64,200k (2012$).

Alternative 4: Do Less – Build 1,700,000 L of Storage for Refurbishment needs only

This option does not meet the operational improvement requirements. There is high demand for detritiation services particulary in the period 2016 – 2020 as a result of the need to detritiate Pickering units prior to shutdown and to detritiate the heavy water drained from the Darlington units during refurbishment.

The 400,000 L of incremental storage is required to improve the efficiency and effectiveness of the TRF operation. Optimization of the TRF is required to improve its overall ability to manage its heavy water inventories to support continuous station operations before, during and after the refurbishment period.

During the refurbishment period the 1,700,000 L will be utilized to drain the units, and will have limited capability of increasing the TRF's reliability. It is currently anticipated that the 1,500,000 L of reactor grade storage, which will be surplus storage after Darlington refurbishment, will be available for the long term storage of heavy water from OPG units. Therefore, the operational improvements are still required to improve the efficiency and effectiveness of the TRF operation and minimize threats to OPG's detritiation objectives from 2015 to 2055.

Since this alternative does not meet the needs of OPG, a financial evaluation has not been completed for it.

Alternative 5: Build 2,100,000 L of Heavy Water Storage outside the Protected Area

This option is not recommended as it is not viable. This option requires additional regulatory approvals from the CNSC and Ministry of Environment which would result in a significant delay to the project that would not meet Refurbishment's schedule. Heavy water is classified as nuclear material due to the tritium concentrations, and as a result, building a new facility outside the protected area would require a new protected area to be zoned and then built. Although technically feasible, the additional costs and time required to secure all regulatory approvals (such as evaluation of impact to the exclusion and protected zones), re-zone land for creation of a new protected area, and connecting interfacing systems at the current Heavy Water Management Building would not meet the Darlington refurbishment program needs and would result in significant risk to delaying the start of refurbishment. As this option is not a viable alternative, a financial evaluation has not been completed for it.

Part D: Project Cash Flows

k$	LTD	2013	2014	2015	2016	2017	20	Future	Total
Currently Released	12,683	16,228	2,019						30,930
Requested Now	-	11,766	50,088	17,231					79,085
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Grand Total	12,683	27,994	52,745	18,662	664	677	691	3,666	117,781

Estimate Class:	Class 2	**Estimate at Completion:**	$94,824 k	**OAR Approval Amount:**	$117,781k

Additional Information on Project Cash Flows (optional):

Grand Total includes 10 years of on-going costs (OM&A). NPV is in 2012$. Ongoing costs in year 2015 includes $780k for critical spare parts.

Part E: Financial Evaluation

k$	Base Case	Preferred Alternative	Refurb Drum Storage	Delay Ops improvement 3 years	Refurb Storage Only
Project Cost	N/A	110,015	48,600	119,000	84,300
NPV (after tax)	0	67,100	59,900	64,200	N/A
Other (e.g., LUEC)					

Summary of Financial Model Key Assumptions (see Guidance on this Type 3 BCS Form):

1. Project Costs shown are incremental (going forward) costs.
2. NPV values are for the Heavy Water Management Operational Improvements scope of work.
3. The interest has been included in the total project cost above, but has not been included for the NPV evaluation.
4. Alternative 4 & 5 do not meet the business need and therefore is not evaluated.
5. Assumptions used to calculate the NPV include:
    1. Operational improvements result in more efficient utilization of the Darlington TRF and improved heavy water management (e.g. decreased impact from TRF outages, potential for 3rd party heavy water sales, dose savings at OPG stations)
    2. Operational improvements reduces probability of refurbishing existing TRF, or construction of a new TRF facility due to ability to stock pile low curie heavy water
    3. Between 2 and 4 staff (depending on which alternative) are required to support operation of the new facility

Part F: Qualitative Factors

Other qualitative factors associated with this project are as follows:

Citizenship & Regulatory

- Reduce tritium emissions throughout Ontario through improved efficiency for the detritiation of OPG and Bruce Power heavy water inventory
- Reduce risk of infringing on tritium emission regulatory limits
- Reduce risk of infringing on OPG's Operating Policies and Principles limits through maintenance of unit tritium levels in the moderator and primary heat transport below required limits

Customer Relations

- Increasing OPG's capability and flexibility to process heavy water will improve customer relations by providing flexibility in meeting contractual obligations with Bruce Power for detritiation services and provide the ability to increase detritiation services to third parties.

Health and Safety

- Reduced tritium levels due to increased TRF efficiency will reduce worker dose
- Additional drum storage will improve housekeeping and reduce drum handling requirements, thereby reducing the related health and safety concerns
- Reduce operator work around and extra operation actions that are required to maneuver various grades of heavy water into unconventional storage arrangements

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	Potential for tritium or conventional contaminants present in ground water and soil resulting in higher cost due to tritiated groundwater and soil disposal, and possible schedule delays.	Preliminary soil & groundwater condition has been assessed under Project 16-38940. Additional boreholes will be used by EPC Contractor to further characterize soil conditions. Based on results, the Contractor will develop and own final soil management & dewatering plan. This plan is likely to include contingency plans to temporarily store soil on Darlington site for drying, as discussed with Director of Environment, until it can be disposed in nonhazardous landfill. Water risk is planned to be mitigated by proactively pumping out the local box drain sump with a flow path for dewatering through CCW, approved by MOE/CNSC.	High	Medium
Scope	Risk that connections to service, demin, fire water, air systems etc are more complicated and costly than anticipated, or existing systems do not have adequate capacity.	An internal review of interfacing systems was conducted and recommendations provided in the CDR as the basis for the performance fee contract. Capacity of station services is being verified in detailed design. This risk has been triggered already via the addition of vapour recovery system, and instrument air/service air compressors.	Medium	Medium
Schedule	Limited vehicle access to site due to limited Sally port (security screening) throughput rate.	Initiate a project to extend Sally port security screening area to increase throughput capacity and increase vehicle access to site.	High	Medium
Resources	Risk of insufficient qualified construction resources to execute this project.	A portion of this risk is transferred to the EPC Contractor as nonperformance affects the performance fee. The remainder, considered low risk, is accepted in order to meet the project schedule.	Low	Medium
Quality/ Performance	Cost and schedule impacts due to relatively new contract strategy and new processes to manage the transition to EPC management and oversight model.	An integrated project oversight plan is prepared that incorporates OPEX, in consultation with all stakeholders, that addresses EPC contract oversight.	Low	Medium
Technical	Long lead materials (LLM) must be ordered prior to final drawings approved to meet schedule. Therefore, risk of ordering LLM without approved code classification from CNSC, based on preliminary drawings.	A portion of this risk is transferred to the EPC Contractor as nonperformance affects the performance fee. The remainder, considered low risk, is accepted in order to meet the project schedule.	Low	High

Cost	Electrical power supply from the DN Electrical Upgrade Project will be available Oct 15, 2014, 6 months prior to the completion of the project. If this power supply is not available as scheduled, use of portable power will be required at additional cost. Schedule may also be impacted.	Substation location and schedule has been confirmed. Coordinate closely with DN Electrical Upgrade project and escalate any schedule issues to senior management.	Low	Medium
Schedule	Delays to project schedule due to regulatory approvals / permits taking longer than anticipated.	Project has identified which regulatory approvals are required, and is currently actively pursuing early submission to ensure sufficient time for regulatory review.	Medium	High
Schedule	The HWMB loading dock has two active barn swallow nests which are an at-risk species and construction work may be subject to federal regulations. Installation of caissons in 2013 is at risk.	For the two active nests on the Bldg 42 loading dock, this risk must be accepted as the permit process is beyond the project's control. It is understood however that this issue may be expedited with the MNR from the senior executive level. For the TRF trailers and plywood trailer, mitigating measures may involve putting up exclusion material (netting etc) if these trailers cannot be removed prior to April 15, 2013.	Low	Medium

Additional Risk Analysis:

As per N-GUID-00120-10003 Project Risk Management Guide, the Extensive Risk Management process was applied to this release. Risk workshops were used to identify risks and determine the risk exposure. In addition to the Most Likely costs for the risk impact estimates, the Minimum (optimistic) and Maximum (pessimistic) costs were identified. All risks were evaluated as documented in the Risk Register.

The location of the new facility has groundwater contaminated with tritium from the 2009 Injection Water Storage Tank spill. The latest geotechnical and environment sampling reports do not indicate a significant level of soil contamination; however, the groundwater is contaminated with low concentrations of tritium. Disposal costs for both the soil and contaminated ground water are included in the total project cost estimate. The risk remains that the tritium contamination is greater than the geotechnical investigation currently indicates, or that other conventional contaminats may be present, or lowest cost disposal options will not be feasible. Therefore, the risk of additional disposal costs to dispose of contaminated groundwater and/or soil due to larger than anticipated contamination, are captured as a specific item in the risk management plan for this project.

The table below illustrates the updated contingency cashflows going forward.

	2013 ($k)	2014 ($k)	2015 ($k)	Total ($k)
Specific Contingency Cashflows	[redacted]			
General Contingency Cashflows				
Total Contingency Cashflows				

Part H: Post Implementation Review (PIR) Plan				
Type of PIR		**Target Project In Service Date**		**Target PIR Completion Date**
Comprehensive		2015-10-15		2016-10-15
Measurable Parameter	**Current Baseline**	**Target Result**	**How will it be measured?**	**Who will measure it? (person/group)**
Heavy water storage volume to meet needs of Refurb. Project	No refurbishment storage	1,700,000 L heavy water storage for Refurb project	Storage volume available in time for Refurb schedule	Refurb Prog – Project and Controls
Heavy water storage volume for TRF Operations	Insufficient storage to support optimal TRF operations	400,000 L provided for improved TRF operation	Storage volume for operational improvements	TRF Manager
Amount of drum Handling, Cleaning and Testing Facility at DNGS	No capability to clean and test drums in-house	Ability to clean and test 100/drums per year	Amount of drum cleaning and testing.	TRF Manager
Consolidated office space & conference room for TRF staff.	No consolidated office space or conference room.	9 Offices and 1 conference room.	Number of offices and conference rooms.	TRF Manager

Part I: Definitions and Acronyms

AACE – The Association for the Advancement of Cost Estimating
BCS – Business Case Summary
CDR – Conceptual Design Report
CNSC – Canadian Nuclear Safety Commission
D_2O – Deuterium oxide, aka heavy water
DNGS – Darlington Nuclear Generating Station
EPC – Engineer, Procure, Construct
HVAC – Heating, Ventilation, Air Conditioning
HWMB – Heavy Water Management Building
l - litres
LLM – Long Lead Materials
MOE – Ministry of Environment
OPG – Ontario Power Generation
PDRI – Project Definition Rating Index
PIR – Post Implementation Review
PNGS – Pickering Nuclear Generating Station
PO – Purchase Order
TRF – Tritium Removal Facility
TSSA – Technical Standards and Safety Authority
T&C – Terms and Conditions

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For Internal Project Cost Control

Type 3 Business Case Summary

Appendix A: Summary of Estimate										
Project Number:	16-31555		**Facility:**	Darlington						
Project Title:	D2O Storage And Drum Handling Project									
Estimated Cost in k$										
	LTD	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Future**	**Total**	**%**
OPG Project Management	[redacted]									
OPG Engineering										
Permanent Materials										
Design and Construction										
Consultants										
Other Contracts/Costs										
Interest										
Subtotal										
Contingency										
Total	12,683	27,994	52,107	17,231					110,015	100%
Removal Costs Included		650							650	

Notes			
Project Start Date	2006-11-11	**Project Completion or In-Service Date**	15-Oct-15
Interest Rate	5.0%	**Escalation Rate**	2.0%
Definition Cost Included	$16,393 k	**Estimate at Completion**	$94,824 k

Prepared by:	Approved by:
Ramesh Solanki ~~Julian Read~~ Project Manager APRIL/30/2013	Dragan Popovic Project Director May 01, 2013

Type 3 Business Case Summary

Appendix B: Comparison of Total Project Estimates										
Phase	Release	Date (YYYY-MM-DD)	Total Project Estimate in k$ (by year including contingency)						Later	Total Project Estimate
			2010	2011	2012	2013	2014	2015		
Definition	Partial	2006-10-22	20,845	14,938	600					36,383
Definition	Full	2012-06-14	0	3,034	10,779	38,411	41,298	14,595	31	108,148
Execution	Partial	2012-07-18	0	3,034	10,688	38,782	40,880	14,667		108,051
Execution	Full	2013-04-19	0	3,044	9,649	27,994	52,107	17,231		110,015

Project Variance Analysis					
Estimated Cost in k$					
k$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management	[redacted]				OPG Project Management and OPG Engineering costs have changed as a result of the updated graded approach to providing Oversight. Materials costs have increased due to the inclusion of added scope in this BCS, and directed change scope additions (such as Vapour Recovery System) and risks being triggered (instrument air/service air, etc). For the same reasons, EPC Design and Construction costs have also increased. Other contract/costs updated to reflect new work break down coding system and include funds shifted out of OPG engineering, based on work done during the initial developmental release.
OPG Engineering					
Permanent Materials					
Design and Construction					
Consultants					
Other Contracts/Costs					
Interest					
Subtotal					**Additional scope, further definition of execution requirements, and risks triggered during the detailed design phase and site preparation phase have resulted in increased base project costs.**
Contingency					Risk register has been re-run and contingency requirements to complete the project (all phases) has been updated.
Total	**12,683**	**108,051**	**110,015**	**1,964**	
Removal Costs Included	-	650	650	-	Project includes removal of services and structures, such as TRF Trailers.

Appendix C: Financial Evaluation Assumptions

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

Project Cost:

(1) A fixed price has been provided for Phase I, and a second performance target price has been provided to include both Phase II and Phase III. These performance target prices are the basis of the design and construction costs.

Financial:

(1) 2% escalation
(2) 7% discount rate

Project Life:

(1) 2016 to 2055 for HEAVY WATER Operational Improvements Storage Tanks
(2) 2016 – 2024 for Refurbishment HEAVY WATER Storage tanks

Energy Production:

(1) Alternative 2 (Drum warehouse for Refurbishment HEAVY WATER) – 2011 update for System Economic Values (energy + capacity) used to calculate value of 4 month critical path outage extension of unit refurbishment outage.

Operating Cost:

(1) For the Preferred Alternative, the following incremental staff requirements were assumed to be required for the life of the new facility: Operator – 2 FTE, Control Maintainer – 0.5 FTE, Mechanical Maintainer – 0.5 FTE, Engineer – 0.5 FTE

Other:

Benefits for Operational Improvements

1. Avoids capital cost of refurbishing TRF or new TRF facility in 2035. Assume cost of $532M (2012$) and 30% probability
2. Reduces impact of an unplanned TRF outages on OPG ability to manage heavy water inventories. Assume 50% probability of saving $7.2M/yr (2012$) during 2025-2055
3. Improves ability to achieve incremental third party HEAVY WATER sales. Assume 50% probability of $3.1M/yr during 2016-2043
4. OPG achieves dose savings during outages. Assume $450k/year (2012$) from 2016 to 2055
5. Reduces risk of need to detritiate primary heat transport HEAVY WATER after storage in moderator S&I tanks during a Vacuum Building Outage/Station Containment Outage. Assume one occurrence eliminated saving $3.6M (2012$) and modeled as $600k (2012$) every 6 years
6. Elimination of Kinetrics Drum Handling Contract (pressure test. Assume saving of $30k/yr (2012$) from 2016 - 2055
7. Avoids risk of downgrading reactor grade HEAVY WATER during acute recovery events or SUP outage. Assume savings of $0.9M (2012$) over 40 years, or $22k/yr

Note: For alternative 3, these benefits were started in 2018 when the HEAVY WATER Operational Improvements were put in service.

Benefits for Building Refurbishment Tank Storage (1,700,000 L)

1. Avoid capital cost of building storage for Darlington HEAVY WATER as part of decommissioning in 2055. Assume $78M (2012$)

Attach further detail as appropriate from the Financial Evaluation spreadsheet.

The following is the breakdown of released funds, including contingency, following approval of this BCS.

	$k
Developmental Release	[redacted]
Full Definition Release Project Costs	
Full Definition Contingency	
Partial Execution Release Project Costs	
Partial Execution Release Contingency	
Sub-Total (Previously Released)	*$30,930*
Full Execution Release Project Costs	[redacted]
Full Execution Release Contingency	
TOTAL	*$110,015*

Appendix D: References

DNGS D_2O Storage and Drum Handling Project Developmental BCS, D-BCS-38000-10001-R001
Project Charter, N-PCH-09701-10001
Adverse Trend for Drum Handling Issues, SCR D-2012-04114
OPEX review of Drum Handling Issues, NK38-REF-38000-0427531
Project 16-31555: Office Space Requirements Within The New D_2O Storage Facility, NK38-CORR-38000-0400715
Long Term Strategy for D_2O Storage Upon Station Shutdown, N-REP-03800-10004 (Pickering Shutdown)

This Guidance section should be deleted prior to submission of the BCS.

Guidance for Completing this Type 3 Form:

Always use the latest revision of the Form! Verify this is the latest revision through PowerSearch, or Finance BCS Toolkit intranet website.

Final Security Classification

Determine the Final Security Classification of the BCS from the drop-down list before both the Executive Summary and Recommendations and Part A. Refer to OPG-STD-0030 Classification, Protection and Release of Information.

Executive Summary and Recommendations

Records File Information

Refer to OPG-PROC-0019, Records and Document Management for the requirements and expectations of record filing after the BCS is submitted.

The SCI used for record filing should be:

- *00120.3* for Nuclear BCSs.
- *08707.021* for BCSs of all other business units and corporate groups.

Submitted BCSs shall also be filed according to local BU governance, which may require different SCIs.

Project Overview

State the following:

- What needs to be done and why it needs to be done.
- When the investment/project will be completed.
- Key business objectives.
- Expected benefits of the investment/project.
- Whether the investment/project is within the original scope as specified in the approved Business Plan and/or Life Cycle Plan.
- Brief history of previous releases.
- Level of confidence for current request.
- If critical to the decision, any constraints on the investment/project or its timing.

Project Cash Flows

This table in the Executive Summary and Recommendations section is the same as the table in Part D: Project Cash Flows. See guidance for Part D: Project Cash Flow.

Approvals

Provide the title and name of the individuals making the three required signatures: the Project Sponsor, the individual providing Finance Approval, and the Approver of the BCS per the OAR. The Comments cell is to allow brief hand-written comments. For example, "see comment on Part D", which would refer to a hand-written comment later in the BCS document. These comments would be minor in nature; otherwise a reviewer would require revisions to the BCS before signing the document.

Business Case Summary

Part A: Business Need

This section describes the business needs or opportunities that gave rise to the investment. It provides background and context for the investment including: the investment's purpose, what's driving the investment, why the investment needs to be addressed now, what are the impacts of not proceeding, key assumptions, identification of any subsequent commitments or obligations, and the benefits or constraints that the investment will create. Provide studies, experience or lessons learned from similar investments, if available. If this submission relates to a subsequent approval, provide a quick overview of investment history.

If the investment is a subset of a program, or if the issue to be addressed is symptomatic of a broader issue that requires additional response, provide the context and identify the related response, whether planned or anticipated.

Part B: Preferred Alternative

This section describes expected business results and objectives, including resourcing requirements, when the investment will be completed, and any major milestones. The proposal section must put the investment into the proper context by providing the link between the investment and the business strategy for the asset and/or other planned investments in that asset.

Describe the link between this investment and business strategy or other investments. Disclose if the resourcing is in place. Alternatively, if the investment is not in the business plan, or if the scope has changed relative to the Business Plan, reasons for the change(s) must be provided.

State the expected benefits and what is being delivered, without specifying vendor name(s). Describe briefly project execution strategy, regulatory approvals, third party agreements, project management, and basis for the cost and schedule contingencies, if applicable. Highlight any constraints on the investment or on its timing, and any constraints or obligations created by the investment.

Deliverables

In the Deliverables section, list the project deliverables and target completion dates, including associated milestones (such as unit in-service dates and external or regulatory milestones).

Part C: Other Alternatives

This section describes viable alternatives considered, including associated risks. At minimum, include a Base Case: Status Quo – No Project. Other alternatives may include:

- Deferring the project.
- Different means to meet the same business need.
- Completing partial scope.
- Alternatives with additional scope.

Part D: Project Cash Flows

This table in Part D: Project Cash Flows is very similar to the table under Project Cash Flows in the Executive Summary and Recommendations section.

This table provides a yearly breakdown of estimated project costs, including amounts currently released from earlier BCSs if applicable, the new amounts being requested now in this BCS, and estimated future requirements not currently requested. Contingency shall be included in these amounts.

The new amounts being requested are for actual work to be completed and for any costs that will be committed to through that work. For example, if an equipment purchase is bundled with a maintenance contract for a committed period, the committed payments under the maintenance contract must be included in the current request. Ongoing Costs include any costs related to the investment that would not be part of the project budget, including ongoing incremental operating costs, and acquisition of inventory.

The Future column is the sum of expected future cash flows beyond the last year shown in the table.

Estimate Class

Estimate Class is a cost estimate classification system developed by the Association for the Advancement of Cost Engineering International (AACE) which defines the estimate "quality" based on the input information used and the project's stage of development. AACE uses five estimate classes with Class 5 being the least accurate, and Class 1 being the most accurate.

Estimate Class	Class 5	Class 4	Class 3	Class 2	Class 1
Phase	Identification	Initiation	Definition	Execution	Execution
Level of Project Definition (%)	0% to 2	1 to 15	10 to 40	30 to 75	65 to 100
Expected Accuracy Range (%)	-50 to +100	-30 to +50	-20 to +30	-15 to +20	-10 to +15

OAR Approval Amount

For BCSs up to and including Definition Phase work, the OAR Approval Amount is the cumulative total actual and committed cost to date, not the estimated total investment/project cost. For Execution Phase BCSs or BCSs that cover multiple phases including Execution, the OAR Approval Amount is the estimated total investment/project cost, including cumulative cost to date.

Additional Information on Project Cash Flows (optional)

Relevant information such as the delta between approved business plan cash flows and requested release, may be entered into this open-field table cell.

Part E: Financial Evaluation

This section describes and compares the key alternatives considered. Only the most relevant alternatives shall be listed in this table for comparison. The analysis includes financial evaluations, economic analysis, and comparisons of the alternatives based on total project cost, after-tax NPV, and any other financial metric deemed appropriate by the project sponsor (e.g., IRR, discounted payback, etc.) The BCS Financial Evaluation Model is available on the Finance website and is updated periodically to help facilitate financial analysis. Attach further detail as appropriate from the Financial Evaluation spreadsheet.

Summary of Financial Model Key Assumptions

List key assumptions used in the Financial Evaluation. For Part E, provide a brief summary of the most important assumptions that are listed in Appendix C.

Part F: Qualitative Factors

Qualitative factors gained (or lost) from the investment and how an initial specification will be measured within the post implementation review (to the extent feasible). Qualitative factors could include: sustainable energy development impacts; community, government, and customer relations; staff relations issues, technical or operational considerations, reliability, health and safety issues, and other intangibles.

Part G: Risk Assessment

This section identifies the risks associated with the investment and the plans to manage or mitigate these risks. Refer to OPG-STD-0062, Project Risk Management Standard and local business unit standards for guidance on completing and documenting risk assessments. Each BU can add risk areas specific to its business.

Extra Risk Classes may be added by changing "Other" to a specific risk class and/or inserting extra rows to the table.

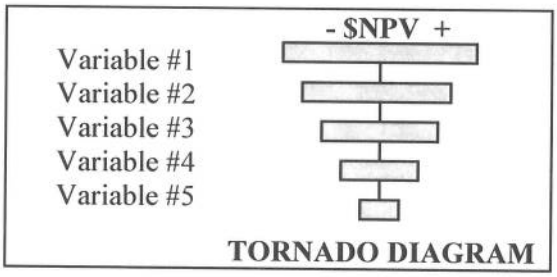
The Risk Analysis section discusses, as appropriate for the project, quantitative risk factors that relate to the project financial evaluation, including considerations such as:

- Present and discuss material impacts/consequences of variations in the basic assumptions, e.g., price of electricity used for revenue, sales forecast, service life, etc. Discuss likelihood of occurrence.

- Based on risks identified and mitigation measures implemented, indicate whether the financial analysis completed for the recommended alternative includes the contingency required for OPG residual risks, and their impact on the estimated in-service date.

- The extent of the risk assessment and the risk analysis techniques employed should be commensurate with the magnitude of the cash flows and the degree of uncertainty associated with the critical assumptions upon which the investment is based.

- For Major Projects, the risk analysis section will typically include sensitivities of the investment to various risk factors or scenarios, and a discussion of their likelihood of occurrence. A convenient way of presenting the results of the risk assessment on the variability of the NPV to changes in the critical variable is to include a graph or tornado diagram as shown below.



- For larger investments, more advanced risk analysis techniques such as Monte Carlo may be suitable. These techniques require analysts with appropriate training; contact your local Finance support to discuss applicability and to arrange Finance analytical support if required. The limitations of Monte Carlo or any other risk assessment technique must be considered in their application, and require a time commitment from the project team and stakeholders to develop and estimate model inputs.

Part H: Post Implementation Review (PIR) Plan

PIR plan is a succinct description of the project benefits using measurable parameters. The PIR plan should clearly specify what is to be measured, who is responsible for measuring it, and when the measurement should take place, along with any requirements for establishing pre-project baseline information for comparison purposes.

Extra PIR metrics may be added by inserting extra rows to the table.

The PIR plan should contain the following five main elements:

- What: Key deliverables or benefits of the project clearly defined in measurable parameters, including a clear description of the reference or baseline from which the incremental benefits or changes due to the project are to be measured.

- How: A brief description of how each parameter is going to be measured.

- Who: The name of the group, department, or individual that will be measuring the benefits.

- When: When the measurement of the benefits will take place.

In addition, the Project Sponsor and key stakeholders may specify other items such as the types of lessons learned and recommendations to be captured during the execution of the PIR.

Part I: Definitions and Acronyms

Define key technical terms and list acronyms to assist reviewers of the document.

Appendix A: Summary of Estimate

Note: All content from Appendix A onwards, including this Guidance section, contains a level of detail that is intended for OPG internal use only and should be removed before a copy of a BCS is released to an external party.

To assist the reviewer in understanding the cost estimate in the BCS, this table provides a breakdown of various cost components by year, with explanatory notes as appropriate.

Note: The label "Project Completion or In-Service Date" is intended to provide flexibility for projects that do not have a specific "In-Service Date", such as engineering studies in future decisions or for future regulatory documents.

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

This section provides the history of past releases and their associated estimates, with explanations of changes as appropriate.

Appendix C: Financial Evaluation Assumptions

This section is intended to provide a reviewer with an overall understanding of the key assumptions used in the financial evaluation, to help a reviewer confirm that relevant drivers and appropriate assumptions were used in the analysis. The main considerations in the economic evaluation of the alternatives are outlined below:

Cost and Schedule Estimates

The work breakdown structure (WBS) of the project usually provides detailed information on the cost of the project and should be referred to while estimating the costs and schedule. Best practices in project cost and schedule estimating should be applied wherever possible including using lessons from similar experiences and benchmarks. Requests for quotations from competitive sources are another option to obtain detailed estimates. Schedule and cost estimates must obtain stakeholders' inputs and be reviewed by the key stakeholders of the project before being finalized.

Taxes

All investments must be assessed on an after-tax basis. Users will be required to properly classify the capital assets for Capital Cost Allowance (CCA) purposes. The financial evaluation model provided on the Finance website will compute the initial income tax impacts for most types of investments; the model also contains the latest CCA rates for most types of investments. For further information on CCA, sales taxes and tax shields, please contact your local Finance support group.

Cost of Capital

An appropriate cost of capital or discount rate must be used to ensure that an adequate return is provided to shareholders. For investments related to the manufacturing and processing of electricity for regulated nuclear and base-loaded hydroelectric facilities, the discount rate is generally lower than for unregulated facilities. This is partly due to regulated assets having a more predictable revenue stream, and hence lower risk than unregulated generation facilities.

For projects and business opportunities that are clearly outside of OPG's core business, or are not related to the manufacturing and processing of electricity, the project's cost of capital should be used, instead of OPG's cost of capital. Updated rates for OPG's core business are posted in the BCS Financial Evaluation Model. Contact Investment Planning for assistance.

Revenue Forecasts

The revenue forecast from generation assets must be based on the OPG System Economic Values (SEVs). The appropriate SEVs for the applicable time frame are selected based on the characteristics of the generation asset being evaluated (e.g., peaking vs. baseload). Contact your local Finance support group for further guidance on using SEVs.

Appendix D: References

The reference documentation and attachments contain the detailed numbers, calculations, and any other analysis done probing the need and substantiating the justification for the investment. This documentation includes: cost estimates, financial evaluation sheets, risk assessment tables, modeling assumptions, project execution plan, technical studies, and any other specific studies related to the investment.

Additional Attachments

Additional documents be prepared as separate documents and enclosed with the BCS for reviews and approvals (e.g., multiple file attachments to e-mails).

The final signed version of the BCS may then be combined with all the attachments in a single PDF file.