
**Burrard Generating Station
Unit 1 Generator Rehabilitation
Initiative Assessment**

Business Case

**Power Supply
March 2000**

Executive Summary

On 23 August 1999, while BGS Unit 1 generator (G1) was being returned to service following a major maintenance outage a rapid flame front caused by ignition of a mixture of hydrogen and other gases within the generator enclosure caused significant damage to the generator. The root cause of the failure was investigated and damage to various components of G1 were identified including the rotor, ventilation, stator, casing, seals, and hydrogen coolers.

It was determined that a detailed (“CAR quality”) rehabilitation estimate can only be developed following disassembly of the generator. A tender was prepared to request bids on the disassembly and assessment of the generator components, development of a minimum cost rehabilitation strategy and preparation of an accurate repair cost estimate. An amount of \$350,000 was approved for the failure investigation and to acquire an estimate for generator rehabilitation. The tender contract for the repair estimate was awarded in December 1999 and the final report and cost estimate was received from the contractor on 15 February 2000.

The alternatives considered were:

- Alternative 1 - Do Not Replace BGS G1
- Alternative 2 - Rehabilitate BGS G1
- Alternative 3 - Replace BGS G1

The present value of incremental benefits to be achieved by restoring BGS G1 to its pre-failure condition (75 % availability) is approximately \$27.0 million (not including capital costs), based on the Hysim analysis.

The financial analysis indicates that Alternative 2 (Rehabilitate BGS G1) provides incremental SVA of \$16.9 million. The least cost analysis methodology confirms that Alternative 2 is the preferred alternative.

In addition, this alternative to rehabilitate BGS G1 provides the following benefits:

- Realizes the full “pre-failure” generating capacity of BGS.
- Meets the requirements of the GVRD Air Emission Permit and therefore mitigates risk of reduced permitted output or cancellation of permit.
- Realizes full benefits of the Burrard Upgrade Project (BUP).
- BC Hydro can take full advantage of the transportation agreement with BC Gas.
- Realizes the full benefits in maximizing transmission line capacity (maximizes export capabilities)
- Provides system voltage support to the integrated transmission system.

The Value Based Management initiative score for this project is ~~62.4~~^{49.5}.

It is recommended that this project be approved to proceed with the rehabilitation of the BGS G1.

TABLE OF CONTENTS

1. Project Overview	1
1.1 Background.....	1
1.2 Opportunity Statement.....	1
2. Identification and Analysis of Alternatives.....	2
2.1 Key Assumptions.....	2
2.2 Analysis of Alternatives.....	2
2.2.1 Alternative 1 - Do Not Replace BGS G1	2
2.2.2 Alternative 2 - Rehabilitate BGS G1.....	4
2.2.3 Alternative 3 - Replace BGS G1	5
2.3 Summary of Results	6
3. Recommendation	8
4. Risk	9
5. Project Plan	13
5.1 Project Team	13
5.2 Key Milestones	13
5.3 Deliverables.....	14
6. Project Assessment & VBM Scoring.....	15
6.1 Summary of Value Based Management Results	15
6.2 Strategic Alignment and Impact.....	16
6.3 Financial Benefits.....	21
6.4 Additional Benefits/Impacts.....	21
6.5 Costs	23
6.6 Implementation Risk Factors.....	23

APPENDICES

Appendix A - Project Plan

Appendix B - Detailed Assumptions

Appendix C - Hysim Analysis Results

Appendix D - Summary of Results (Spreadsheets)

1. PROJECT OVERVIEW

1.1 Background

Burrard Generating Station (BGS) is a six-unit gas fired thermal generating station originally constructed by B.C. Electric in the late 1950's. After being taken over by B.C. Hydro in 1962, the plant was expanded in stages with the last unit being commissioned in 1975. In the early 1960's, decisions were made to construct major hydro-electric facilities and BGS' role changed to use as a displaceable, firm energy resource.

On 23 August 1999, while BGS Unit 1 generator (G1) was being returned to service following a major maintenance outage a rapid flame front caused by ignition of a mixture of hydrogen and other gases within the generator enclosure caused significant damage to the generator. The root cause of the failure was investigated with assistance from GEC-Alstom, the original equipment manufacturer, and Pacific Power Consultants (PPC), the engineer of record for the Burrard Upgrade Project. The subsequent investigation report identified damage to various components of G1 including the rotor, ventilation, stator, casing, seals, and hydrogen coolers.

In consultation with GEC-Alstom, PPC and GE Canada, it was determined that a detailed ("CAR quality") rehabilitation estimate can only be developed following disassembly of the generator. A tender was prepared to request bids on the disassembly and assessment of the generator components, development of a minimum cost rehabilitation strategy and preparation of an accurate repair cost estimate. An amount of \$350,000 was approved for the failure investigation and to acquire an estimate for generator rehabilitation. The tender contract for the repair estimate was awarded in December 1999 and the final report and cost estimate was received from the contractor on 15 February 2000.

1.2 Opportunity Statement

BGS G1 has failed and cannot be immediately returned to service. This failure provides an opportunity to evaluate alternatives for restoring G1 back to service, to determine and compare the financial benefits and to identify the system impacts of BGS G1 operation.

2. IDENTIFICATION AND ANALYSIS OF ALTERNATIVES

2.1 Key Assumptions

The key assumptions used in the analysis are as follows:

- The Hysim model is the accepted model for simulation of BC Hydro’s system operations. For the Hysim analysis results, “operating cost” is defined as the production cost corresponding to the energy dispatch less export revenues.¹
- The analysis incorporates the February 2000 BC Hydro nominal price forecast for electricity and the December 1999 Confer price forecast for gas.
- The analysis is conducted in nominal dollars using nominal discount rates and B.C. CPI (inflation) rates consistent with Corporate 2000/01 Business Planning rates.¹
- The initial cost to not return BGS G1 back to service (including costs to decommission and remove G1) is estimated at \$3 million (direct).
- The total capital cost to replace G1 is estimated at \$25 million (direct).
- The generator rehabilitation cost estimate provided for budgeting purposes is within +/- 10% of the final cost. The total direct capital cost to rehabilitate G1 is \$14.5 million.
- BGS Unit 1 availability is assumed to be 75% after the generator is rehabilitated or replaced, which represents the level in effect immediately prior to failure of the generator (the “pre-failure” condition). The availability of the other BGS units are assumed to be their availability at the time of the BGS G1 failure.¹
- The analysis expressly excludes any impacts of the Burrard Upgrade Project.
- The analysis excludes the write-off of the existing Unit 1 equipment. The net book value of Unit 1 is estimated at \$15 million, consisting mainly of the recently installed SCR equipment. The analysis also excludes the cost of decommissioning Unit 1 equipment, the removal of remaining asbestos and GVRD Air Emission Permit costs of non-compliance.
- Used equipment for the rehabilitation of G1 is not considered a reasonable alternative.¹
- All the analyses of the costs and benefits for each alternative use a ten-year economic life from the project in-service date, which follows the Corporate Business Case Requirements.
- Final CAR approval by BC Hydro’s Board of Directors is 17 April 2000.

2.2 Analysis of Alternatives

2.2.1 Alternative 1 - Do Not Replace BGS G1

This alternative represents taking G1 out of service permanently. BGS will be operated with five units instead of six.

If G1 is taken out of service permanently, the following major work will be required:

¹ Further detailed assumptions are located in Appendix B.

- Decommission and dismantle the Unit 1 boiler.
- Remove and dispose the remaining asbestos.
- Dispose the turbine.
- Salvage the Unit 1 equipment.
- Perform miscellaneous civil work.

The costs to perform this work are difficult to determine as they depend on numerous market conditions and additional costs will be incurred just to acquire estimates. The total cost to perform the above work is estimated to be in the order of \$3-5 million. An estimate of \$3 million (direct) is used in the analysis.

The primary benefit of this alternative is the avoided capital costs to rehabilitate or repair the unit. However, there will be a number of issues which result from not returning G1 to service, including:

- Impact on Generating Capacity
BGS G1 can provide approximately 162 MW (nameplate) of generation. This capacity would be lost if G1 is taken out of service.
- GVRD Air Emission Permit
BGS has an Air Emission Permit from the Greater Vancouver Regional District (GVRD) which restricts the permitted output from Burrard. The Air Emission Permit requires that one Selective Catalytic Reducer (SCR) be installed annually until six BGS units are equipped with SCR's. If G1 is taken out of service, BC Hydro would fail to meet this condition of the Emission Permit. This would result in a risk that the permitted output of the plant may be permanently reduced by 17% (one-sixth) and that the GVRD may re-negotiate or cancel the entire Air Emission Permit.
- Impact on Burrard Upgrade Project
Removing G1 from service will have an impact on present work done under the Burrard Upgrade project (BUP), mostly involving the installation of the SCR's at BGS. SCR work was completed on Unit 1 in June 1998 as part of BUP. There are now five units at BGS completed with SCR's. The sixth and final SCR work on BGS Unit 3 is well underway and due for in-service June 2000. While most of this work will be stranded investment, SCR work on Unit 3 would have to be halted immediately and the Unit 3 generator may have to be moved to the Unit 1 position.
- BC Gas Transportation Agreement
A transportation agreement was recently completed with BC Gas which enables BC Hydro to plan six unit operation at BGS, twelve months per year after November 2000. The agreement contains sunk costs of approximately \$9 million annually, the majority of which is gas transportation for BGS. Therefore, approximately \$1.5 million per year for G1 is being paid under this agreement. This agreement is helping change the role of BGS in BC Hydro's generation mix from a displaceable, firm energy resource to a firm energy resource. Taking G1 out of service would not allow BC Hydro to take full advantage of the transportation agreement, effectively paying for the transportation of gas that BC Hydro cannot use.
- Reduced Transmission Line Capacity
Operation of the BGS generators increases the capacity of the transmission line connecting the Interior and the Lower Mainland by 800 MW (Burrard Utilisation Study, October 1992) by reducing transmission line losses and providing a generation source close to the load

centre. This increase in line capacity enables energy produced by other facilities to be transferred to the export market. While this has financial value to B.C. Hydro it has not been quantified in dollar terms. In terms of physical contribution to the system, BGS contributes an increase of between 600 MW and 1850 MW in the capacity of the tie lines to the U.S.A., allowing import/export to/from the B.C. Hydro system (Resource Management/T&D data at 9 Sept 1999). BGS G1 contributes to a portion of this benefit and if G1 was taken out of service this would reduce the benefits from increased transmission line capacity thereby reducing the available energy which could be used for export.

- Reduced Transmission System Voltage Support

Operation of the BGS generators also provides voltage stability (also known as synchronous condense benefits) to the BC Hydro integrated transmission grid. If BGS were not available, alternative grid improvement solutions would require capital expenditures up to approximately \$250 million, annual OMA costs of \$2 million and would result in annual transmission line losses of \$6 million as confirmed 23 Sept 1999 by T&D Engineering Network Performance Planning. BGS G1 contributes to this voltage stability and if G1 was taken out of service it may result in a proportion of the above costs required to provide alternative grid improvement solutions.

Therefore, for the above reasons, this alternative is not recommended.

2.2.2 Alternative 2 - Rehabilitate BGS G1

This alternative represents carrying out the necessary rehabilitation work on G1 to permit its return to service. The balance of the Unit 1 equipment will still be utilized, including the recently completed SCR equipment.

The total estimated cost for rehabilitation is \$14.5 million (direct) including engineering and contingency. The generator would have a warranty on the repairs of two years and the service life of the generator stator coils would be extended by approximately 30 years. The parts of the generator that were not rehabilitated would not have their service lives extended.

The planned in-service date is 4 May 2001, based on a CAR approval date of 17 April 2000. To simplify the analysis, an in-service date of 1 May 2001 is used.

The time required to perform the rehabilitation work will result in lost opportunity (cost) to generate/export energy, particularly during periods of high electricity prices. With a G1 return to service date of 1 May 2001, the present value benefit of six unit operation vs. five unit operation (not including capital costs for rehabilitation) over the 10 year economic life of the plant is \$27.0 million. With the capital costs of rehabilitation included, the net present value incremental benefit of this alternative is \$15.6 million and the present value incremental SVA is \$16.9 million.

This alternative mitigates the issues identified in Alternative 1, namely:

- Generating Capacity

Returning G1 to service will realize the full “pre-failure” generating capacity of BGS.

- GVRD Air Emission Permit
With BGS G1 in service, BC Hydro would meet the requirements of the GVRD Air Emission Permit. Therefore, the risk of reductions in the permitted output of the plant and the risk of cancellation of the permit for non-compliance is mitigated.
- Impact on Burrard Upgrade Project
With G1 in service BGS can realize full benefits of the Burrard Upgrade Project (BUP). All the SCR work would be fully utilized and there would be no risk of stranded investment. Costs to decommission and dismantle the Unit 1 boiler and other costs are avoided.
- BC Gas Transportation Agreement
With G1 in service, BC Hydro can take full advantage of the transportation agreement with BC Gas.
- Reduced Transmission Line Capacity and System Voltage Support
With G1 in service BGS can realize full benefits in maximizing transmission line capacity and BGS can provide full system voltage support to the integrated transmission system. The maximum energy could be transmitted between the Interior and the Lower Mainland and maximum import/export can be realized by the increased capacity in the tie to the U.S.A. Capital and OMA costs for alternative grid improvements are avoided.

2.2.3 Alternative 3 - Replace BGS G1

This alternative represents replacing BGS G1 with a new generator. The assumptions and activities are the same as with Alternative 2 except this alternative replaces G1 with a new generator. The service life of the generator would be as new and therefore 30 years per BC Hydro policy. The warranty on the whole generating unit would be six years.

The cost is estimated at \$25 million (direct) including engineering and contingency. The time required to tender and perform the installation of the new generator will result in lost opportunity to generate/export energy, particularly during periods of high electricity prices. Tender preparation and approval would take 4 to 6 months and estimated generator delivery would take 18 to 24 months from receipt of order for a total 30 months. The in-service date would be approximately 1 November 2002.

With a G1 return to service date of 1 November 2002, the present value benefit of six unit operation vs. five unit operation (not including capital costs for rehabilitation) over the same 10 year timeframe as in Alternative 2 is \$15.9 million. With the capital costs of rehabilitation included, the present value incremental benefit of this alternative is \$18.9 million and the present value incremental SVA is -\$3.7 million.

The additional benefits identified for Alternative 2 are similarly addressed with this alternative:

- Realizes the full “pre-failure” generating capacity of BGS.
- Meets the requirements of the GVRD Air Emission Permit and therefore mitigates risk of reduced permitted output or cancellation of permit.
- Realizes full benefits of the Burrard Upgrade Project (BUP).
- BC Hydro can take full advantage of the transportation agreement with BC Gas.

- Realizes the full benefits in maximizing transmission line capacity (maximizes export capabilities) and system voltage support to the integrated transmission system.

The above benefits from Alternative 3 are similar to Alternative 2. However, this alternative to replace G1 with a new unit has a greater direct capital cost of \$10.5 million and the in-service date is delayed an additional 18 months due to the increased time required for tender work and equipment installation.

2.3 Summary of Results

The analysis assumes BGS generation will occur regardless as to whether five or six generating units are operated, i.e. BGS generating units will be dispatched according to the Hysim model. Therefore, the analysis presented is intended to show which alternative represents the least cost alternative. The costs have been segmented into:

- the BC Hydro operating cost to operate BGS with either five units or six, according to the Hysim analysis; and
- the capital cost associated with implementing each alternative.

A summary of the results is shown in Table 2. The results indicate that operating six units at BGS is more economic than operating five units. This is primarily due to the advantages of being able to dispatch BGS during periods of high electricity prices in addition to not having to purchase energy from the open market to meet domestic load.

Further, the analysis indicates that after adjusting these savings to reflect the capital costs of bringing G1 back into service, Alternative 2 provides a ten year present value SVA of \$16.9 million and is the most economic option. Rehabilitation results in \$30.0 million in present value benefits for an investment of \$14.4 million in present value capital costs (a benefit-cost ratio of 2.1). In comparison, replacement results in \$26.3 million in present value benefits and requires a present value investment estimated at \$24.9 million (a benefit-cost ratio of 1.06).

Table 2
Summary of Financial Results for Expected In-Service Date
(in \$ million)

Alternative	PV of Operating Costs	PV of Depreciation	PV of Capital Charges	PV of SVA	PV Capital	NPV
Gross Results						
Alt. 1: Do Nothing (Base Case)	3,343.91	0.00	0.00	(3,343.91)	0.00	(3,343.91)
Alt. 2: Rehabilitate G1 (In-service 1 May 2001)	3,313.96	6.89	6.20	(3,327.05)	14.35	(3,328.31)
Alt. 3: Replace G1 (In-service 1 Nov 2002)	3,325.05	12.90	9.64	(3,347.58)	24.88	3,349.93
Incremental Results (Relative to Base Case)						
Alt. 1: Do Nothing	0.00	0.00	0.00	0.00	0.00	0.00
Alt. 2: Rehabilitate G1	(29.95)	6.89	6.20	16.86	14.35	15.60
Alt. 3: Replace G1	(18.86)	12.90	9.64	(3.68)	24.88	6.02

3. RECOMMENDATION

The present value of incremental benefits to be achieved by restoring BGS G1 to its pre-failure condition (75 % availability) is approximately \$27.0 million (not including capital costs), based on the Hysim analysis. Therefore, G1 should be returned to service to maximize system benefits and net revenue from investment in BGS.

The financial analysis indicates that Alternative 2 (Rehabilitate BGS G1) provides incremental SVA of \$16.9 million. The least cost analysis methodology confirms that Alternative 2 is the preferred alternative.

In addition, this alternative to rehabilitate BGS G1 provides the following benefits:

- Realizes the full “pre-failure” generating capacity of BGS.
- Meets the requirements of the GVRD Air Emission Permit and therefore mitigates risk of reduced permitted output or cancellation of permit.
- Realizes full benefits of the Burrard Upgrade Project (BUP).
- BC Hydro can take full advantage of the transportation agreement with BC Gas.
- Realizes the full benefits in maximizing transmission line capacity (maximizes export capabilities)
- Provides system voltage support to the integrated transmission system.

The Value Based Management initiative score for this project is 62.4.

It is recommended that this project be approved to proceed with the rehabilitation of the BGS G1.

4. RISK

The following risks have been given consideration:

Rehabilitation Cost Estimates: The rehabilitation cost estimates have been managed and detailed as much as possible to arrive at a realistic, expected cost for the generator rehabilitation work. The following are the main cost items where risk of cost increases may impact total project construction costs:

1. *Generator Repair Estimate:* The contractor (Southern California Edison) provided the cost estimate for rehabilitation of the generator. Due to the short time frame to meet BC Hydro deadlines for CAR approval, the project team agreed that an estimate from the contractor within +/- 10% of the actual cost would be acceptable for CAR purposes and for preparation of the business case. The generator rehabilitation work comprises approximately 70% of the total project cost.
2. *Stator Coils:* The generator repair estimate from the contractor included a quote from Siemens Westinghouse for the purchase of stator coils, which expires 14 March 2000. The repair estimate states that the actual cost of these stator coils will be determined at the time the repair contract is awarded. The actual cost will depend on factors such as how busy the manufacturer is at the time of order, cost of materials and labour, etc. While it is expected that the cost will not differ significantly, it is not a certainty.
3. *Tender for Rehabilitation Work:* The contract to provide the repair estimate included an option for BC Hydro to award the repair work if efficiencies or savings can be realized. If the decision is made to re-tender the contract for the repair work it will potentially delay the G1 in-service date by a minimum two months for the tender process. In addition to a reduction in the benefits from this delay, additional costs may result from rescheduling and mobilizing the contractor staff and equipment, increases in the tendered repair estimates, etc.

Allocating 10% of the original cost estimate for contingencies mitigates these risks of cost rise for the generator rehabilitation.

Generator Repair Warranty: The repair estimate from the contractor includes a one year warranty on the repair work and materials. Warranties beyond one year must be negotiated (premiums increase with the length of the term). An estimated amount for a two year warranty was provided in the cost estimate but the actual cost must still be negotiated. A two year warranty was deemed by the project team as acceptable risk.

Construction Timing: Any delays in the time required to perform the generator rehabilitation and associated work and return G1 to service could result in a foregone opportunity to generate at a time when the energy could have a high market value.

The additional cost of delaying the return to service of G1 will result in a reduction in the benefits from this alternative. A Hysim analysis was performed to determine the present value of BGS six

unit operation vs. five unit operation² (not including capital costs for rehabilitation). The difference of the two cases helps illustrate the differences (savings) in cost.

With a G1 return to service date of 1 October 2001, the present value benefit of six unit operation vs. five unit operation (not including capital costs for rehabilitation) over the 10 year economic life of the plant is \$23.4 million. With the capital costs of rehabilitation included, the present value incremental benefit of this alternative is \$12.0 million and the present value incremental SVA is \$13.3 million. Therefore, the five month delay of the in-service date results in a reduction in present value incremental benefits of \$3.6 million.

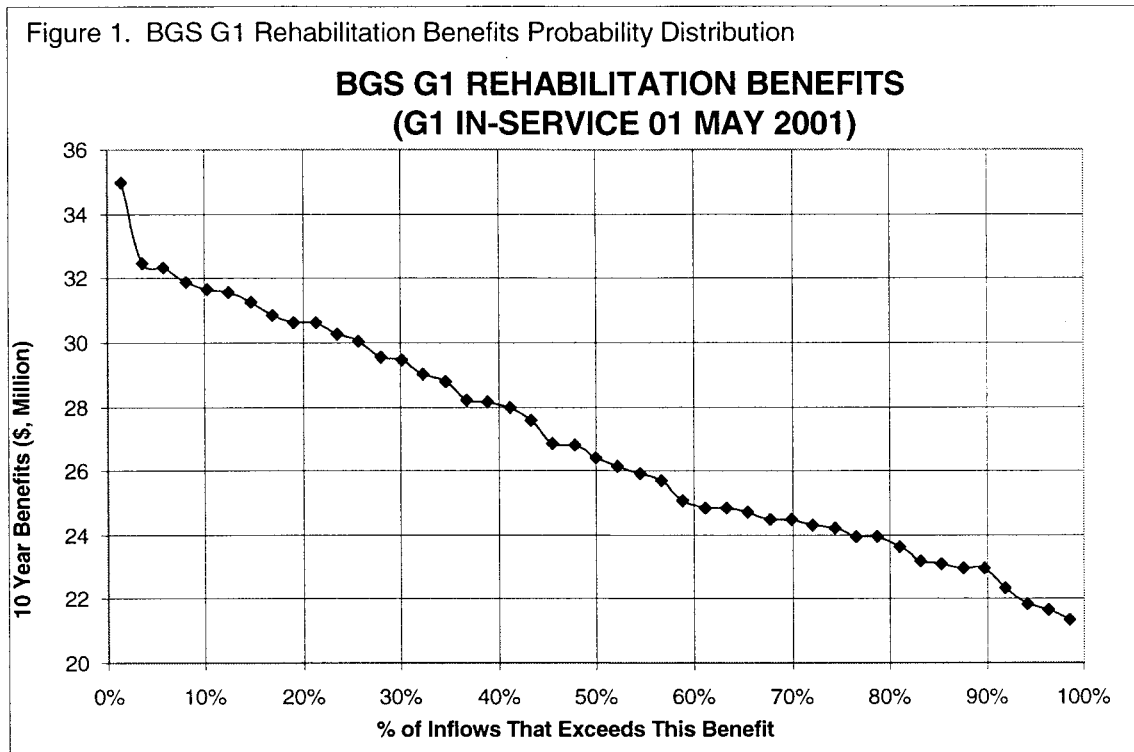
Table 3
Summary of Financial Results for 5 Month Delay of In-Service Date
(in \$ million)

Alternative	PV of Operating Costs	PV of Depreciation	PV of Capital Charges	PV of SVA	PV Capital	NPV
Gross Results						
Alt. 1: Do Nothing (Base Case)	3,343.91	0.00	0.00	(3,343.91)	0.00	(3,343.91)
Alt. 2: Rehabilitate G1 (In-service 1 Oct 2001)	3,317.56	6.89	6.20	(3,330.66)	14.35	(3,331.91)
Incremental Results (Relative to Base Case)						
Alt. 1: Do Nothing	0.00	0.00	0.00	0.00	0.00	0.00
Alt. 2: Rehabilitate G1	(26.34)	6.89	6.20	13.25	14.35	11.99

Benefits Realization: The benefits identified from the Hysim analysis are dependent on the spread between the gas prices and electricity prices as well as the reservoir levels over ten years. Since these factors influence BC Hydro's plans to export energy they will impact the dispatch of BGS. These risks, however, are mitigated by the benefits BGS brings to the integrated system (which are excluded from this analysis) for system voltage support and the increase in transmission transfer capabilities.

The Hysim analysis results uses the average of 45 inflow years as input. The probability distribution of each inflow year for the proposed alternative is shown in Figure 1. The results show that 90% of the time (based on 45 inflow years) the ten year incremental benefits from the proposed alternative are not less than \$23.0 million and that the average is \$27.0 million.

² Details of the Hysim Analysis are located in Appendix C.



Project Returns: The project provides a benefit cost ratio of 2.1 ten years after completion. This benefit cost ratio implies that the project will break-even within ten years if benefits realized are not less than 48% of the estimate or if costs do not increase by more than 210%.

Impact on the Burrard Upgrade Project (BUP): While the analysis for the BGS G1 rehabilitation assumes no benefits from BUP (i.e. return G1 to pre-failure condition), the method and timing of returning G1 back to service will have an impact on the BUP completion work.

A delay in starting some or all of the BGS G1 rehabilitation will delay the finish date for the BUP Completion scope by a similar time duration. If BUP Completion work is delayed until the beginning of the next fiscal year, the total benefits from the Burrard Upgrade Project will be reduced by approximately \$5 million. In addition, project indirect and IDC costs will increase by approximately \$600,000.

It is essential that a capital project of this magnitude be continuous to ensure that team capability can be maintained. If the project team is demobilized until the beginning of the next fiscal year, there is significant risk that current team specialists will be unavailable to continue with BUP work.

The scope of the Burrard Upgrade Project includes health and safety related work including asbestos abatement and fire risk reduction that was scheduled to begin within the next 5 months.

Delaying the BGS G1 rehabilitation will therefore delay the completion of the BUP Completion scope which will impact the completion of this due diligence work.

5. PROJECT PLAN

Following is a summary of the work:

- Phase 1 [Investigation]: Investigate the incident to determine the root cause of failure, extent of equipment damage and order of magnitude of cost and schedule.
- Phase 2 [Remedial Action Plan]: Develop the remedial action plan (including scope, schedule and cost), prepare the business case, arrange for funding and start preparation of tender documents for remediation work.
- Phase 3 [Implementation]: On approval of funding, implement the remedial action plan including commissioning and acceptance for the return of G1 to service.

5.1 Project Team

The project team consists of:

Albert Low	Project Manager
Mike Strachan	BGS Manager
Stan Wylie	Plant Communication
Cheong Hui	Plant Safety and Technical Coordination
Bruce Cuthbert	Plant Resources Support and Planning
Gordon Hamill	Plant Business Planning
Gordon Zeron	Plant IBEW Rep
Doug Hill	Plant OPEIU Rep
Clint Anderson	Plant OSH Committee (Electrician)
Stew Symmes	Plant OSH Committee (Operator)
Covena Hilford	Plant OSH Committee (COSH)
Clement Ma	Power Planning
Bob Bernard	Corporate Safety
Steve Bruyneel	Corporate Communication
Tony Cohen	Project Management Support (Contracts)
Marilyn Renaud	Project Management Support (Admin)
Richard Huber	Electrical Engineering
Tom Soltys	Mechanical Engineering

5.2 Key Milestones

The key milestone dates for this project are:

1. Phase 1 (Investigation)

Incident Summary and PPC Report 113750-H791 Submission	30 November 1999
2. <u>Phase 2 (Remedial Action Plan)</u>	
Tender Documents [Q9-1614] for G1 Inspection Issued.....	15 November 1999
Tender Q9-1614 Close.....	1 December 1999
Award Inspection Contract for Tender Q9-1614.....	10 December 1999
Q9-1614 G1 Inspection Report Submission	15 February 2000
CAR Approval by CMC	30 March 2000
CAR Approval by the Board of Directors	17 April 2000
Award G1 Repair Contract	30 April 2000
3. <u>Phase 3 (Implementation)</u>	
Unit 1 Refurbishment Start.....	1 May 2000
Unit 1 In-Service Date	4 May 2001

5.3 Deliverables

The return to service of BGS G1 is shown to have a number of benefits, particularly reduced operating costs as well as revenue from the availability of G1 during peak export periods, i.e. the summer months. The actual amount of these benefits depend on market conditions such as electricity and gas prices as well as other uncontrollable factors. Therefore, the best measure of project success is the successful rehabilitation of BGS G1, on budget and on schedule. Success will be measured by meeting budgeted spending and meeting the scheduled in-service date to maximize benefits from BGS operation during peak electricity price periods.

The detailed Project Plan is provided in Appendix A.

6. PROJECT ASSESSMENT & VBM SCORING

6.1 Summary of Value Based Management Results

Table 3
Summary of Value Based Management (VBM) Scoring

STRATEGIC IMPACTS (0 – 25)		FINANCIAL BENEFITS (0 – 25)	
Secure the Base		PV SVA: \$15.6 Million	17.5 18
Efficiency & Productivity	8 10		
Effective Governance	0 5		
Public Support	0		
Build a Strong & Capable Organization	0	Score out of 25	17.5 18
Enhance Customer Focus			
Service Excellence	0		
Value Added Solutions	0		
Grow the Business			
Market Development	0		
Strategic Businesses & Markets	0		
Score out of 25	8 15		
ADDITIONAL BENEFITS (0 – 20)		INITIATIVE COSTS (0 – 15)	
Environmental Impacts	5	PV Cost: estimated \$ 14.4 Million	5
Legal/Regulatory Adherence	1		
Public Support	2	Score out of 15	5
Employee/Union Issues	2 3		
Aboriginal Relations	0		
Public/Employee Safety & Health	0		
Community/Employment Impacts	0 3		
Score out of 20	10 16		
IMPLEMENTATION RISKS (0 – 15)			
		Time to Implement	-4
		Complexity	-5
		Past Performance	0
		Technology/Methodology	0
		Assumptions	-2
		Mitigation Strategy	40%
		Score out of 15	9 8.4

VBM Score for the Burrard Generating Station Unit 1 Generator Rehabilitation Project	
62.4	49.5

6.2 Strategic Alignment and Impact

SECURE THE BASE through:

Efficiency & Productivity
Support competitive pricing

Optimize commercial availability
Develop operating plans to maximize total margin
Develop investment plans for new plants
Invest/divest/maintain assets commercially
Gather customer, market and competitor intelligence
Optimize operating and resource data including the role of each plant

The initiative directly supports: (Y or N)

Y: Improved generation capacity results in lower energy costs.
Y: Improved reliability
Y: Availability of G1 impacts plans
N
Y: G1 is a direct investment in PS assets.
N
N

Effective Governance & Public Support

Enhance goodwill and consent to operate
Balance multiple objectives
Manage issues (i. e. Sinkhole)
Understand constraints and impacts (e.g. Dam Safety, WUPs)
Develop and maintain Gov't and community relationships

Y: Impact on perception/relations with GVRD.
N
N
Y: Impacts of GVRD Air Emission Permit
Y: Impact on Burrard GS relations with GVRD and community.
N

Seek stakeholder input

BUILD A STRONG AND CAPABLE ORGANIZATION through:

Development of leadership
Improved communication and information
Development of competencies
Improved relationship
Establishment of collaborative management
Alignment of the workforce
Fostering diversity
Encouragement of flexibility

N
Y: Staff experience and communication enhanced.
Y: Experience with generator rehabilitation.
N
N
N
N
N

ENHANCE CUSTOMER FOCUS through:

Service Excellence

Deliver on promises
Build a strategic relationship with Powerex
Continue to strengthen operating relationship with Powerex
Manage M&CS and T&D relationships
Define/develop relationships with M&CS and T&D

Y: GVRD Air Emission Permit
N
Y: Increased generation capacity for potential export.
Y: Increased support for transmission system.
Y: Defers need for generation/transmission facilities.

Value-Added Solutions

Create new product and service ideas
Enhance Power Supply's capabilities
Understand customer needs and market requirements
Partner with direct customers
Understand core capabilities

N
Y: Increased generation capability
N
N
Y: Impacts Burrard GS role in the system.

GROW THE BUSINESS through:

Market Development

Create new product and service ideas
Enhance Power Supply's capabilities
Understand customer needs and market requirements
Partner with direct customers
Understand core capabilities

N
Y: Increased generation capacity for potential export.
N
N
Y: Impacts PS future business strategies.

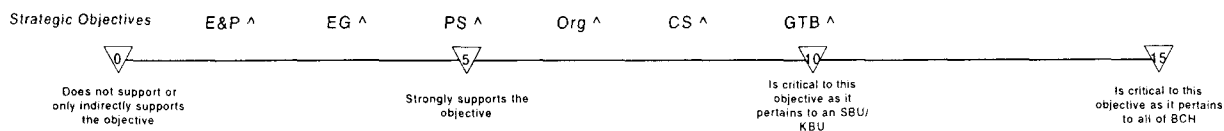
New Strategic Businesses & Markets

Develop targeted energy-related solutions
Build/invest/divest to capitalize on new opportunities
Partner with direct customers
Ensure fit with Power Supply's strengths and strategic direction

N
Y: Future export flexibility.
N
Y: Improved PS strategic opportunities.

Scan for opportunities entry / exit

N



Financial Efficiency and Productivity (E&P)

Score: 10/8

Notes: The funds are being spent to directly increase this strategic objective. The new generator will have improved fuel efficiency, which reduces the cost of energy. Improved reliability increases the unit availability and reduces future OMA increases.

Effective Governance (EG)

Score: 5/6

Notes: Rehabilitation of BGS G1 will permit operation of BGS to meet requirements of the GVRD Air Emission Permit. The GVRD Air Emission Permit for BGS requires that one SCR be installed annually until all units are equipped with SCR's. If BC Hydro fails to meet this condition of the Emission Permit, there is significant risk that the permitted output of the plant may be permanently reduced from 960 MW to 800 MW and that the entire Air Emission Permit could be cancelled.

Build and Maintain Public Support (PS)

Score: 0

Notes: No direct impact. However, the availability of G1 improves the reliability of generation and the emergency generation at the load centre.

Build a Strong and Capable Organization (ORG)

Score: 0

Notes: No direct impact. However, staff experience with the rehabilitation work in general increases technical knowledge and communication skills.

Lead the Market – Enhance Customer Service (CS)

Score: 0

Notes: No direct impact. However, the increased availability of G1 will result in some improvement in service performance and reliability.

Lead the Market - Grow the Business (GTB)

Score: 0

Notes: No direct impact.

The final scoring for the Strategic Impacts is based on the following matrix, taking into account the strategic objective grouping, the strategic objectives and the strategic priorities from the preceding pages.

Breadth of Support	Strength of Support			
	Strongly Supports for single SBU	Critical for single SBU	Strongly Supports for all of BCH	Critical For all of BCH
Entire Strategic Objective Grouping (e.g. SECURE THE BASE)	12 Points	16 Points	20 Points	25 Points
ONE Strategic Objective (e.g. "Efficiency and Productivity")	10 Points	12 Points	16 Points	20 Points
Several related priorities	8 Points	10 Points	12 Points	16 Points
Single Priority	5 Points	8 Points	10 Points	12 Points

Based on the preceding information, the total VBM scoring for Strategic Alignment and Impact assumes the following:

- The rehabilitation of BGS G1 covers one strategic objective (Efficiency and Productivity) and strongly supports Power Supply (10⁸ points), and
- ~~The rehabilitation of BGS G1 also covers one single priority (Effective Governance) and strongly supports Power Supply (5 points).~~

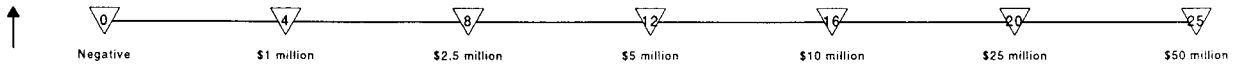
Therefore, the total VBM scoring for Strategic Impacts is: 15⁸ points.

Following is a summary of impacts the Burrard Generating Station Unit 1 Generator Rehabilitation Project has on the Corporate performance measures.

Corporate Measure	Planned Impact Y/N	Describe the impact of the initiative on Corporate Performance Measures
SVA		
Secure the Base		
COMA/Customer before specific capital	Y	Avoided future OMA increases due to existing end of life equipment. OMA ↓
COMA/Customer including specific capital	Y	C ↑ OMA ↓ positive NPV, therefore COMA ↓
Public Opinion – Overall Impressions	N	No known impacts on this measure.
Total Generation Index	Y	The project increases generation capability.
Environmental Performance Index	Y	Efficiency ↑ therefore pollution / MWh ↓
Enhance Customer Focus		
Customer Satisfaction	N	No known impacts on this measure.
Customer Profitability from a corporate perspective	N	No known impacts on this measure.
Service performance & reliability	Y	Availability ↑ reliability ↑
Value-added solutions	N	No known impacts on this measure.
Grow the Business		
SVA from Grow the Business Ventures	N	No known impacts on this measure.
Commodity Risk Exposure Ratio		Measure for Powerex only.
Strategic Tools for the Future		
Strategic IT Coverage	N	No known impacts on this measure.
Build a Strong & Capable Org.		
Organizational Climate	Y	Employee attitudes measure. Completion will boost morale.
Safety	N	No known impacts on this measure.
Leadership Effectiveness	N	No known impacts on this measure.

6.3 Financial Benefits

Financial Benefit (SVA)



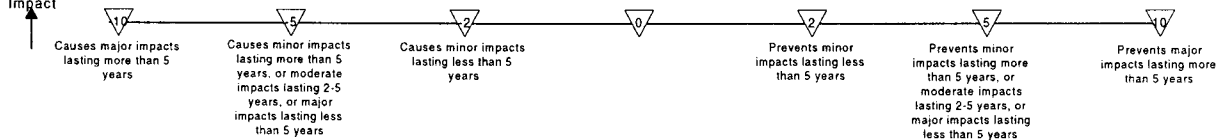
PV SVA: \$16.9 million

Score: ~~18~~ 17.5

Notes: The G1 rehabilitation is scheduled for completion and in-service May 2001. The analysis follows Corporate Business Case Requirements and provides costs and benefits using a ten-year economic life from the project in-service date.

6.4 Additional Benefits/Impacts

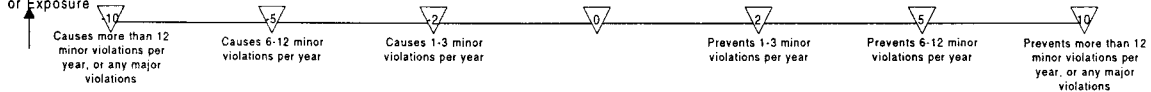
Environmental Impact



Score: 5

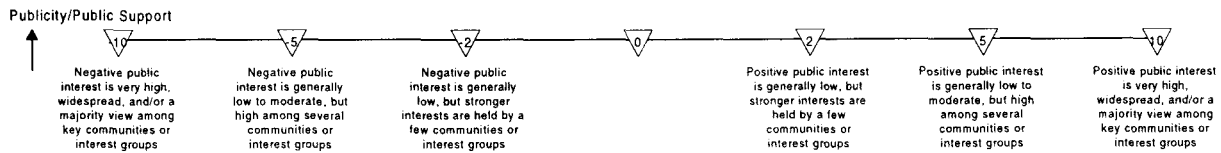
Notes: The additional generation from operating BGS G1 will displace other fossil fuel generation. It will also reduce the impact on the environment by deferring the construction of new generation and transmission facilities, i.e. it will reduce the need for increased transmission line capacity.

Legal/Regulatory Adherence or Exposure



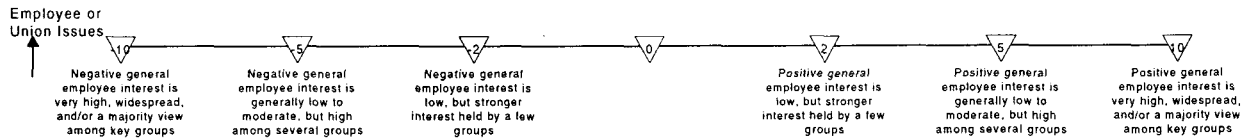
Score: 1

Notes: Rehabilitation of the G1 will ensure compliance with the GVRD Air Emission Permit.



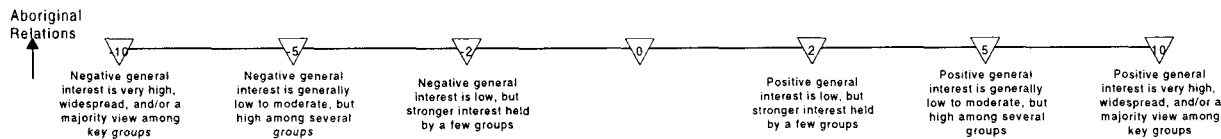
Score: 2

Notes: BGS operation is of low interest to the general public but is of strong interest to a few environmental, community and municipal groups.



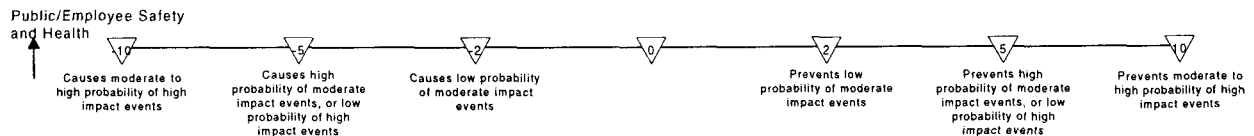
Score: 3/2

Notes: This work will improve the employee morale at the plant as it confirms an increased level of plant operation for the next ten years. Events which impact BGS operation are of general employee interest.



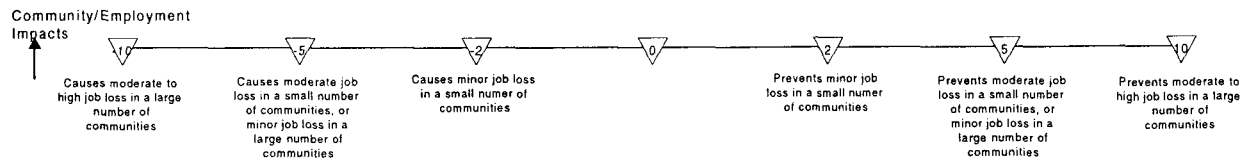
Score: 0

Notes: No direct impact on aboriginal relations have been identified. The only known link is the general aboriginal claims on BC Hydro assets.



Score: 0

Notes: There are no known impacts.



Score: 5/0

Notes: The requirement for workers with specialized trade and engineering skills for the generator rehabilitation will ensure employment for workers in the consulting, engineering and equipment supply industry.

6.5 Costs



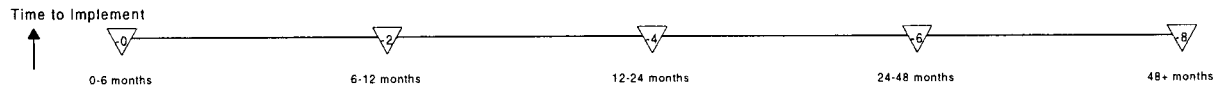
Score: 5

Notes: The present value of the project costs is approximately \$14.4 million for the generator rehabilitation.

6.6 Implementation Risk Factors

Time to implement

(What is the total elapsed time of the initiative, from commitment to full deployment?)

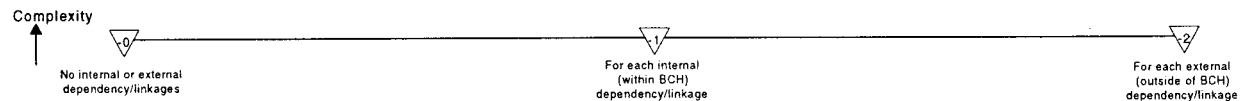


Score: -4

Notes: The estimated time to perform the generator rehabilitation is 13 months.

Complexity

(Describe any specific dependencies and linkages between this and a) other initiatives, b) other SBUs or KBUs, or c) external organizations.)



Score: -5

Notes: The project relies on the following external organizations:

- Pacific Power Consultants to perform the failure investigation, and
- An external contractor to provide the repair cost estimate and perform the rehabilitation work.

The remaining work will be completed within Power Supply.

Past Performance

(Does BC Hydro have past experience implementing similar initiatives? If so, would you characterize past results as being successful or unsuccessful? Explain.)



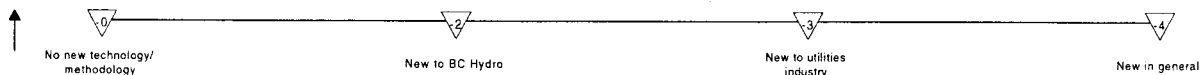
Score: 0

Notes: Typical projects of this type at BC Hydro have been successful in the past.

Technology/Methodology

(Does this initiative rely upon any technology or methodology that is new to BCH, the Utilities industry, or new in general? Describe)

Technology/Methodology



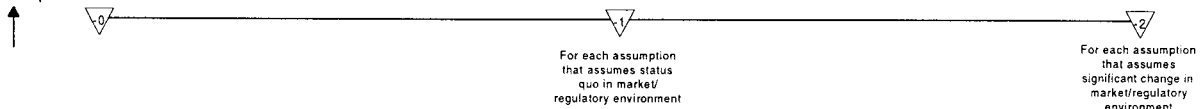
Score: 0

Notes: The technology and methodologies for generator rehabilitation are proven and generally accepted in utility practice. No new technologies are introduced.

Assumptions

(Describe any market or regulatory assumptions that the business case is based upon.)

Assumptions



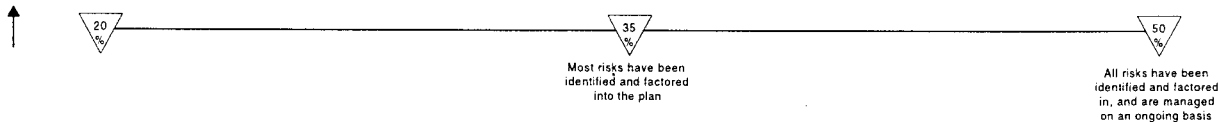
Score: -2

Notes: The business case is based on assumptions of the forecasted real value of bulk electricity and gas as detailed in Appendix B. If the spread between gas prices and electricity prices narrows due to high water years it is possible there would be a reduction in the dispatch of BGS. An assumption is also made of the discount rate.

Implementation Risk Mitigation Strategy

(Is there a risk mitigation plan in place? If so, attach.)

Mitigation Strategy



Score: 40%

Notes: As many reasonable risks have been identified and factored in, and will be managed according to PSE Operating Manual Quality Plans.

Engineering risk is mitigated by the use of Pacific Power Consultants (PPC), which is a joint venture between Stone & Webster, Sandwell, B.C. Hydro Power Supply Engineering and Anderson Consulting. Installation risk is mitigated by the use of contractors skilled in generator installation and refurbishment.

**Burrard Generating Station
Unit 1 Generator Rehabilitation
Initiative Assessment**

APPENDIX A

Project Plan

POWER SUPPLY

BURRARD GENERATING STATION UNIT 1 - GENERATOR AUGUST 23, 1999 INCIDENT INVESTIGATION & REMEDIATION PROJECT

PROJECT PLAN

DEFINITION PHASE

Power Supply

BURRARD GENERATING STATION UNIT 1 - GENERATOR AUGUST 23, 1999 INCIDENT INVESTIGATION & REMEDIATION PROJECT

PROJECT PLAN - DEFINITION

The purpose of the project is to:

Investigate the BGS unit 1 generator August 23, 1999 incident to determine the root cause of failure, recommend corrective actions, develop a remedial action plan (including scope, schedule and cost) and arrange for funding. On approval of funding, implement the remedial action plan including commissioning and acceptance for the return of unit 1 to service

Estimated costs:

Until the results of phase 2 is completed, the present order of magnitude of cost for the project ranges from \$[17-25] million

Scheduled completion date:

<i>Phase 1 [Investigation]:</i>	<i>30 November, 1999 [complete]</i>
<i>Phase 2 [Remedial Action Plan]:</i>	<i>31 March, 2000 [CAR submission]</i>
<i>Phase 3 [Implementation]:</i>	<i>A target date of 31 October, 2001 is desired. However this will be subject to results of phase 2 work</i>

Power Supply

BURRARD GENERATING STATION UNIT 1 - GENERATOR AUGUST 23, 1999 INCIDENT INVESTIGATION & REMEDIATION PROJECT

PROJECT PLAN - DEFINITION

Issued by:

Albert Y. M. Low, Project Manager

Dated

**Power Supply
 BURRARD GENERATING STATION
 UNIT 1 - GENERATOR AUGUST 23, 1999 INCIDENT
 INVESTIGATION & REMEDIATION PROJECT
 PROJECT PLAN - DEFINITION**

TABLE OF CONTENTS

	Page
1. Executive Summary	5
2. Introduction.....	5
3. Project Description	6
4. Objectives.....	6
5. Scope of Work.....	6
6. Issues	7
7. Strategies	7
8. Communication and Organization	7
9. Schedule.....	7
10. Quality Assurance Plan	8
11. Plan Cost.....	8

FIGURES

1. Work Breakdown Structure (Variance Report)
2. Project Cost Plan (Cashflow Report)
3. Task Assignment Sheets

APPENDICES

- A Statement of Objectives
- B Communication and Organization Plan
- C Project Schedule
- D CAR Documents

BURRARD GENERATING STATION UNIT 1 - AUGUST 23, 1999 INCIDENT INVESTIGATION & REMEDIATION

1.0 EXECUTIVE SUMMARY

On 23 August 1999, while BGS Unit 1 was being returned to service following a major maintenance outage, a fault within the generator enclosure caused significant damage to the generator stator.

A professional Engineer from Power Supply Engineering was requested and assigned to be the Project Manager and the Engineer of Record and also assigned to lead the investigation into the cause of the failure and the unit repair. The root cause of the failure was investigated with assistance from GEC-Alstom, the original equipment manufacturer (OEM), and Pacific Power Consultants (PPC), a thermal generation consultant. An in-house incident summary report and PPC report #113750-H791 has been issued.

Although "Order of magnitude" estimates were received from PPC, GEC-Alstom and GE Canada, it is incomplete. The generator manufacturers and repair contractors contacted are reluctant to provide CAR quality estimates of damage unseen. Accordingly, a tender has been prepared for the detailed inspection of unit 1 in order to determine reparability, logistics of repair and associated costs, including methodology and schedule. The tender was issued on 15 November, 1999 and closes 1 December, 1999.

This work is expected to take approximately 5 months to complete. As a result, a detailed cost estimate and schedule to repair BGS Unit 1 will not be available until the end of the current fiscal year.

This project is divided into 3 phases. Phase 1 [investigation] target completion date is 30 November, 1999. Phase 2 [Remedial Action Plan] CAR submission target date is 31 March, 2000. Phase 3 [implementation] desired target completion date is 31 October, 2001 but will be subject to results of phase 2 work.

Until the results of phase 2 are available, the present order of magnitude of cost for the project ranges from \$[17-25] million.

2.0 INTRODUCTION

On 23 August, 1999 at about 15:34 hours an incident occurred in BGS Unit 1 while it was in the process of being tested following a 50,000 hours major generator inspection, hydrogen cooler modification and rework of the turbine governor valves & hydraulic system. The unit was to be balanced and test synchronized onto the System for a short period of time, shutdown and put on standby ready for service.

During the day shift, it was decided to start up and run the unit in air for the test. Barring of the unit was started and the generator pressurized with air to 25 psig. Following normal operating procedures, the turbine-generator unit was run up to synchronous speed [3600 RPM]. When the generator was excited, BGS staff in the Control Room heard a "pop". Operators on the turbine floor observed a cloud of oil mist coming out from the inboard hydrogen shaft seal and a drop in the casing pressure from approx. 30 psig to 5 psig in seconds. The unit was manually tripped and shutdown.

Subsequent inspection on the unit revealed that the generator has sustained internal damage.

3.0 PROJECT DESCRIPTION

The project is divided into 3 phases as follows:

Phase 1 [Investigation]:	Investigate the incident to determine the root cause of failure, extent of equipment damage and order of magnitude of cost and schedule
Phase 2 [Remedial Action Plan]:	Develop the remedial action plan (including scope, schedule and cost), prepare the business case, arrange for funding and start preparation of tender documents for remediation work
Phase 3 [Implementation]:	On approval of funding, implement the remedial action plan including commissioning and acceptance for the return of unit 1 to service

4.0 OBJECTIVES

The objectives are as follows:

- To determine the root cause and recommend corrective actions
- To refurbish the unit 1 and return it to service

5.0 SCOPE OF WORK

The work for the project is to investigate the internal generator incident on 23 August 1999 and carry out remedial work including commissioning and acceptance of Unit 1 generator and associated equipment for its return to service. The scope of work shall include the following:

1. project managing and coordinating the investigation and remedial work
2. leading the failure investigation & determining the root cause of the failure
3. developing the remedial action plan including scope, schedule and cost
4. executing the remedial action plan when the funding is approved
5. arranging the necessary resources to complete the work
6. establishing the Site Supervision Contract with GEC Alstom [original equipment manufacturer]
7. managing the GEC Alstom liability issues
8. making recommendations on personal, equipment and operational safety
9. providing timely progress reporting
10. preparing relevant records & documentation including background information, sequence of events, failure analysis, root cause analysis, work history, commissioning and acceptance results, etc.

6.0 ISSUES

1. In consultation with GEC-Alstom, PPC [Pacific Power Consultants] and GE Canada, it has been determined that a CAR-quality estimate can only be developed following disassembly of the generator. A tender has been prepared to request bids on the disassembly and assessment of the generator components, development of a minimum refurbishment cost strategy and preparation of an accurate refurbishment cost estimate. This work is expected to take 5 months to complete (including time to tender and award contract) and cost approximately \$370,000. As a result, a detailed cost estimate to refurbish BGS Unit 1 will not be available until the end of the current fiscal year.
2. The incident has caused substantial damage to the generator. In places, the damage is extensive particularly to the internal attachments and structural frame of the generator casing. In contrast,

the stator winding sustained less damage, probably due to the open and flexible construction of the end winding. [Reference: PPC Report 113750-H791, 15 November, 1999].

3. There is some concern with the difficulty of repairing the damage that has incurred to the ventilation circuit inner casing which has collapsed into the stator core at six places. Access to the area is restricted and removing the damaged material would add to the considerable debris already collected behind the core. The sections now damaged were originally installed before the core was in place. The core is not a detachable component and can not be removed without it being completely re-stacked.
4. There has been much debris (some of it magnetic) that has been circulated in the stator. If the stator core is not re-stacked, cleaning and removal of debris will be important.
5. The combined capacity of the two existing turbine hall cranes [rated approximately 53 ½ tons each] cannot lift the heaviest lift of 155 tons (347,200 lbs), the recorded weight of the stator without attachments.

7.0 STRATEGIES

1. An independent 3rd party generator specialist was engaged to lead in the technical investigation of the generator incident, to provide an unbiased technical investigation of the incident in the event of liability claims are made against the original equipment manufacturer [OEM].
2. A service engineer from GEC Alstom [OEM], was present on site to observe the disassembly of the generator and provide equipment information as required.
3. A tender has been prepared to request bids from experienced contractors and manufacturers on the disassembly and assessment of the generator components, development of a minimum refurbishment cost strategy, methodology, schedule and preparation of an accurate cost estimate.

8.0 COMMUNICATION AND ORGANIZATION

The manager of the Thermal Generation Area is the Sponsor and Initiator for this project. For further information, refer to the Project Communication & Organization Plan

9.0 SCHEDULE

Phase 1 [Investigation]:

- This phase of the project is complete.
- The Incident Summary and Pacific Power Consultant Report 113750-H791 have been submitted and distributed

Phase 2 [Remedial Action Plan]:

- The Tender Documents [Q9-1614] for the detail inspection of unit 1 was issued on 15 November, 1999. The Tender closes on 1 December, 1999.
- The Unit 1 Business case based on order of magnitude estimates is presently being prepared for submission to upper management by the 1st week of December, 1999.
- The CAR submission and detail schedule will not be available until 31 March, 2000, after submission of report by the Q9-1614 Contractor.

NOTE:

Due to the anticipated tight work schedule for the implementation phase, in order to meet the desired target return to service date, it is intended that preliminary engineering design work to prepare tender documents for the refurbishment of unit 1 will continue after March, 2000. This will help expedite the work to have the contract tendered, awarded and the remedial work started as soon as possible, after receipt of CAR approval

Phase 3 [Implementation]:

- Target date desired for refurbishment of unit 1 is 31 October, 2001. This will be subject to results of phase 2 and CAR approval

10.0 QUALITY ASSURANCE PLAN

The Project will be planned, managed and completed in accordance with standard PSE Operating Manual Quality Plans.

11.0 PLAN COST

Total costs [in 1999 dollars x 10³] are planned as follows:

	OMA	Capital
Phase 1 - Initial Investigation		
Cost Center 4161	200	
Phase 2 - Definition - CAR 29083 Rev. 0		
Project Support		200
Contract Q9-1614		400
OMA transfer	-200	200
Phase 3 - Implementation - CAR 29083 Rev. 1		
Implementation Forecast		17,000
ESTIMATED PROJECT TOTAL	0	17,800

**Burrard Generating Station
Unit 1 Generator Rehabilitation
Initiative Assessment**

APPENDIX B

Detailed Assumptions

Detailed Assumptions

Hysim Analysis

The HYSIM model is a BC Hydro monthly model developed to simulate the operations of the BC Hydro system over a range of historical streamflow conditions. For the study period, it uses forecasts of load growth, electricity prices, and dispatch costs (for thermal plants, this would include forecasted gas prices) for each generating facility to simulate energy generation. The HYSIM model first dispatches resources to meet the requirements of the integrated system forecast at minimum costs. This is done usually through a combination of operating BC Hydro's resources and purchasing electricity from the market. Subsequently, additional resources are dispatched as economic for discretionary export transactions.

Therefore, the "operating cost" is defined as the production cost corresponding to the energy dispatch less export revenues. The production cost would include costs such as water rentals, variable OMA, fuel costs, and costs to import energy.

Key assumptions in the Hysim simulation include:

- Unit variable OMA of \$1.25/MWh
- No incremental OMA between cases
- October 1998 Load Forecast
- 8% fuel taxes
- Exchange rates are the October 1999 market forward exchange rate
- Dispatch decisions are based on 1 mill trade margin

- The electricity prices used are BC Hydro's February 2000 electricity price forecast
- The gas prices used are Confer's December 1999 gas price forecast (base case)
- BGS G1 in-service date is 1 May 2001 or 1 Oct 2001
- Resource additions after 2000 follow BC Hydro's 2000 Integrated Electricity Plan, including the requirement for 10% Green Energy portfolio

Economic & Financial Indicators

The economic and financial indicators used to evaluate alternatives are:

Net Inflation: Operating Cost and Capital	1.15% (2000/01) 1.40% (2001/02) 1.30% (2002/03 onwards)
Discount Rate (Nominal)	9.0% (2000/01) 8.6% (2001/02 onwards)

BGS Availability

For the base case, BGS G1 is assumed to be out of service with the remaining five generating units in service at the present availability as shown in the table below. This base case assumes that the work on the sixth SCR on Unit 3 will proceed as approved for a June 2000 in-service date. It is assumed that a half plant upgrade is required to maintain the availability of Units 4-6 at 85% in the long term.

Unit	Capacity (MW)	Availability (%)	Heat-rate (KJ/KWh)
1	157.5	75%	11060
2	150.0	75%	11210
3	150.0	70%	11210
4	157.5	85%	11060
5	157.5	85%	11060
6	162.5	85%	11060

Maintenance and Curtailment Schedules

Month	Maintenance	Expected Curtailment
Apr	1 unit	
May	1 unit	
June	2 units	
July	1 unit	1 unit curtailed for 4 days due to cooling water /air permit
Aug	1 unit	1 unit curtailed for 14 days due to cooling water /air permit
Sep		2 units curtailed for 4 days due to cooling water /air permit

Used Equipment

Used equipment for the rehabilitation of G1 was not considered a reasonable alternative. Suitable equipment could not be located or an accurate cost estimate could not be determined in a reasonable timeframe. The use of used generating equipment to replace G1 raised a number of additional issues:

- The generating equipment available did not meet specifications and/or were incompatible, thereby requiring additional transformation equipment and modifications.
- The time and costs required to locate, test and install additional equipment were not acceptable or difficult to determine as it is very situation specific.
- The generating equipment that was available came complete with a turbine or other accessories that were not required.

**Burrard Generating Station
Unit 1 Generator Rehabilitation
Initiative Assessment**

APPENDIX C

Hysim Analysis Results

BURRARD G1 REHABILITATION

Notes:		Fiscal Year (except gas and electricity prices are in calendar year)													
2000-2001 Fiscal Year Money		(project end)													
Dec 1999 Confer Gas, Feb 2000 BCH Price Forecast		2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	
Annual Average Gas Prices	Can\$/MMBtu	3.14	3.07	3.01	2.96	2.92	2.87	2.85	2.84	2.83	2.82	2.82	2.82	2.82	
Annual Average Gas Prices	Can\$/GJ	2.98	2.91	2.85	2.80	2.76	2.72	2.71	2.69	2.68	2.67	2.67	2.67	2.67	
Annual Average Market Prices	Can\$/MWh	40.61	43.89	43.57	42.52	36.93	36.50	36.35	36.24	36.15	36.09	36.08	36.08	36.08	
BC CPI (inflation)			1.40%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	
Compounded Inflation Rate		100%	101.4%	102.7%	104.1%	105.4%	106.8%	108.2%	109.6%	111.0%	112.4%	113.9%	115.4%	116.9%	
Nominal Discount Rate			8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	
Compounded Discount Rate		100%	92.1%	84.8%	78.1%	71.9%	66.2%	61.0%	56.1%	51.7%	47.6%	43.8%	40.4%	37.2%	
Hysim Result in \$Million		(Real\$)													
Case0	5 Unit BUR (Base)	355.39	408.73	397.31	324.49	421.79	406.20	457.74	477.59	468.83	497.81	528.74	558.63	570.62	
Case2	G1 Back May 2001 (Base)	355.39	402.60	388.86	318.68	419.07	404.51	456.48	474.28	466.81	496.15	526.68	557.33	567.77	
Case3	G1 Back Oct 2001 (Base)	355.39	406.47	388.85	318.68	419.07	404.51	456.48	474.28	466.81	496.15	526.68	557.33	567.77	
Case0 vs Case2		(Nominal \$)													
		NPV													
	Operating Cost Savings in 13 Yrs.	\$ 28.83	0.00	5.72	7.36	4.72	2.06	1.19	0.83	2.04	1.16	0.89	1.03	0.60	1.24
	Operating Cost Savings in 11 Yrs.	\$ 26.99	0.00	5.72	7.36	4.72	2.06	1.19	0.83	2.04	1.16	0.89	1.03		
Dispatch Differences in GWh															
	Exports	0	-598	-626	-427	-158	-166	-164	-192	-279	-272	-273	-257	-292	
	Hydro	0	28	-22	12	-22	5	17	-35	-6	8	-7	17	-21	
	Burrard differences GWh	0	-993	-989	-813	-477	-493	-585	-555	-636	-647	-664	-659	-728	
	Imports	0	368	390	373	343	320	401	402	360	364	392	380	458	
Case0 vs Case3		(Nominal \$)													
		NPV													
	Operating Cost Savings in 13 Yrs.	\$ 25.22	0.00	2.10	7.36	4.72	2.06	1.19	0.83	2.04	1.16	0.89	1.03	0.60	1.24
	Operating Cost Savings in 11 Yrs.	\$ 23.38	0.00	2.10	7.36	4.72	2.06	1.19	0.83	2.04	1.16	0.89	1.03		
Dispatch Differences in GWh															
	Exports	0	-302	-626	-427	-158	-166	-164	-192	-279	-272	-273	-257	-292	
	Hydro	0	32	-21	12	-22	5	17	-35	-6	8	-7	17	-21	
	Burrard differences GWh	0	-577	-989	-813	-477	-493	-585	-555	-636	-647	-664	-659	-728	
	Imports	0	246	390	373	343	320	401	402	360	364	392	380	458	

BURRARD G1 REHABILITATION

Notes: 2000-2001 Fiscal Year Money

Dec 1999 Confer Gas, Feb 2000 BCH Price Forecast

Fiscal Year (except gas and electricity prices are in calendar year)

(project end)

		2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Annual Average Gas Prices	Can\$/MMBtu	3.14	3.07	3.01	2.96	2.92	2.87	2.85	2.84	2.83	2.82	2.82	2.82	2.82
Annual Average Gas Prices	Can\$/GJ	2.98	2.91	2.85	2.80	2.76	2.72	2.71	2.69	2.68	2.67	2.67	2.67	2.67
Annual Average Market Prices	Can\$/MWh	40.61	43.89	43.57	42.52	36.93	36.50	36.35	36.24	36.15	36.09	36.08	36.08	36.08
BC CPI (inflation)			1.40%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%
Compounded Inflation Rate		100%	101.4%	102.7%	104.1%	105.4%	106.8%	108.2%	109.6%	111.0%	112.4%	113.9%	115.4%	116.9%
Nominal Discount Rate			8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%
Compounded Discount Rate		100%	92.1%	84.8%	78.1%	71.9%	66.2%	61.0%	56.1%	51.7%	47.6%	43.8%	40.4%	37.2%
Hysim Result in \$Million		(Reals)												
Case0	5 Unit BUR (Base*)	355.39	408.73	397.31	324.49	421.79	406.20	457.74	477.59	468.83	497.81	528.74	558.63	570.62
Case2	G1 Back 01Nov2002 (Base*)	355.39	408.73	394.86	318.87	419.07	404.51	456.48	474.28	466.81	496.15	526.68	557.33	567.77
Case3	G1 Back 01May2003 (Base*)	355.39	408.73	397.31	319.19	419.07	404.51	456.48	474.28	466.81	496.15	526.68	557.33	567.77
Case0 vs Case2		(Nominal \$)												
	NPV													
	Operating Cost Savings in 13 Yrs.	\$ 17.73	0.00	0.00	2.13	4.57	2.06	1.19	0.83	2.04	1.16	0.89	1.03	0.60
	Operating Cost Savings in 11 Yrs.	\$ 15.89	0.00	0.00	2.13	4.57	2.06	1.19	0.83	2.04	1.16	0.89	1.03	
Dispatch Differences in GWh														
	Exports	0	0	-265	-423	-158	-166	-164	-192	-279	-272	-273	-257	-292
	Hydro	0	0	9	17	-22	5	17	-35	-6	8	-7	17	-21
	Burrard differences GWh	0	0	-467	-813	-477	-493	-585	-555	-636	-647	-664	-659	-728
	Imports	0	0	193	372	343	320	401	402	360	364	392	380	458
Case0 vs Case3		(Nominal \$)												
	NPV													
	Operating Cost Savings in 14 Yrs.	\$ 17.08	0.00	0.00	0.00	4.30	2.06	1.19	0.83	2.04	1.16	0.89	1.03	0.60
	Operating Cost Savings in 12 Yrs.	\$ 13.50	0.00	0.00	0.00	4.30	2.06	1.19	0.83	2.04	1.16	0.89	1.03	
Dispatch Differences in GWh														
	Exports	0	0	0	-418	-158	-166	-164	-192	-279	-272	-273	-257	-292
	Hydro	0	0	0	30	-22	5	17	-35	-6	8	-7	17	-21
	Burrard differences GWh	0	0	0	-813	-477	-493	-585	-555	-636	-647	-664	-659	-728
	Imports	0	0	0	368	343	320	401	402	360	364	392	380	458

**Burrard Generating Station
Unit 1 Generator Rehabilitation
Initiative Assessment**

APPENDIX D

Summary of Results (Spreadsheets)

**Burrard Generating Station
Unit 1 Generator Rehabilitation**

Gross Results

	PV Operating Costs	PV Depreciation	PV Capital Charges	PV SVA	PV Capital	NPV
Operate 5 Units: Do Nothing	\$3,343.91	\$0.00	\$0.00	-\$3,343.91	\$0.00	\$3,343.91
Operate 6 Units Rehabilitate: In Service May 2001	\$3,313.96	\$6.89	\$6.20	-\$3,327.05	\$14.35	\$3,328.31
Operate 6 Units Replace: In Service Nov 2002	\$3,325.05	\$12.90	\$9.64	-\$3,347.58	\$24.88	\$3,349.93
Operate 5 Units: Do Nothing	\$3,343.91	\$0.00	\$0.00	-\$3,343.91	\$0.00	\$3,343.91
Operate 6 Units Rehabilitate: In Service October 2001	\$3,317.56	\$6.89	\$6.20	-\$3,330.66	\$14.35	\$3,331.91
Operate 6 Units Replace: In Service May 2003	\$3,327.45	\$12.90	\$9.64	-\$3,349.98	\$24.88	\$3,352.32

Incremental Results (Do Nothing is the Base Case Against which Increments are Measured)

Operate 5 Units: Do Nothing	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Operate 6 Units Rehabilitate: In Service May 2001	-\$29.95	\$6.89	\$6.20	\$16.86	\$14.35	-\$15.60
Operate 6 Units Replace: In Service Nov 2002	-\$18.86	\$12.90	\$9.64	-\$3.68	\$24.88	\$6.02
Operate 5 Units: Do Nothing	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Operate 6 Units Rehabilitate: In Service October 2001	-\$26.34	\$6.89	\$6.20	\$13.25	\$14.35	-\$11.99
Operate 6 Units Replace: In Service May 2003	-\$16.46	\$12.90	\$9.64	-\$6.07	\$24.88	\$8.42

Alternative 1 - Do Not Replace BGS G1

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Discount Year	0	1	2	3	4	5	6	7	8	9	10	11	12
Discount Rate	9.00%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%
Inflation Rate	0.00%	1.40%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%
Compound Inflation Factor	100.00	101.40	102.70	104.00	105.30	106.60	107.90	109.20	110.50	111.80	113.10	114.40	115.70

Alternative: Do Nothing: Operate 5 Units

Capital Cost (Direct \$)	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
PV of Capital	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Cumulative PV of Capital	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Economic Life	10												
In-Service Year	1												
Net Book Value Opening	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Additions	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Depreciation	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Closing Net Book Value	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00

Cost of Operating 5 Units	\$355.39	\$408.73	\$397.31	\$324.49	\$421.79	\$406.20	\$457.74	\$477.59	\$468.83	\$497.81	\$528.74	\$558.63	\$570.62
---------------------------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------

SVA Calculation

Deductions from Revenue (see note 1)	\$3.00												
Operating Cost	\$355.39	\$414.45	\$408.03	\$337.47	\$444.14	\$433.00	\$493.90	\$521.53	\$518.06	\$556.55	\$598.01	\$639.07	\$660.21
Depreciation	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Capital Charges	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
SVA	-\$358.39	-\$414.45	-\$408.03	-\$337.47	-\$444.14	-\$433.00	-\$493.90	-\$521.53	-\$518.06	-\$556.55	-\$598.01	-\$639.07	-\$660.21
PV of SVA	-\$358.39	-\$381.63	-\$345.97	-\$263.48	-\$319.30	-\$286.64	-\$301.07	-\$292.73	-\$267.76	-\$264.87	-\$262.07	-\$257.88	-\$245.31
Cumulative PV of SVA	-\$358.39	-\$740.02	-\$1,085.99	-\$1,349.47	-\$1,668.77	-\$1,955.42	-\$2,256.48	-\$2,549.21	-\$2,816.97	-\$3,081.84	-\$3,343.91	-\$3,601.79	-\$3,847.10
PV of Operating Costs	\$358.39	\$381.63	\$345.97	\$263.48	\$319.30	\$286.64	\$301.07	\$292.73	\$267.76	\$264.87	\$262.07	\$257.88	\$245.31
Cumulative PV of Operating Costs	\$358.39	\$740.02	\$1,085.99	\$1,349.47	\$1,668.77	\$1,955.42	\$2,256.48	\$2,549.21	\$2,816.97	\$3,081.84	\$3,343.91	\$3,601.79	\$3,847.10
PV of Depreciation	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Cumulative PV of Depreciation	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
PV of Capital Charges	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Cumulative PV of Capital Charges	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00

Notes:

1. This line is the miscellaneous decommissioning and disposal costs and are considered non-revenue, non-cost of energy, non-OMA and non-capital items.

Alternative 2 - Rehabilitate BGS G1

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Discount Year	0	1	2	3	4	5	6	7	8	9	10	11	12
Discount Rate	9.00%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%
Inflation Rate	0.00%	1.40%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%
Compound Inflation Factor	100.00	101.40	102.70	104.00	105.30	106.60	107.90	109.20	110.50	111.80	113.10	114.40	115.70

Alternative: Rehabilitate G1: Operate 6 Units with In-Service of May 2001

Capital Cost (Direct \$)	\$13.18	\$1.27	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
PV of Capital	\$13.18	\$1.17	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Cumulative PV of Capital	\$13.18	\$14.35	\$14.35	\$14.35	\$14.35	\$14.35	\$14.35	\$14.35	\$14.35	\$14.35	\$14.35	\$14.35	\$14.35
Economic Life	10												
In-Service Year	1												
Net Book Value Opening	\$0.00	\$13.18	\$14.47	\$13.02	\$11.57	\$10.13	\$8.68	\$7.23	\$5.79	\$4.34	\$2.89	\$1.45	\$0.00
Additions	\$13.18	\$1.29	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Depreciation	\$0.00	\$0.00	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$0.00
Closing Net Book Value	\$13.18	\$14.47	\$13.02	\$11.57	\$10.13	\$8.68	\$7.23	\$5.79	\$4.34	\$2.89	\$1.45	\$0.00	\$0.00

Cost of Operating 6 Units (In-Ser)	\$355.39	\$402.60	\$388.86	\$318.68	\$419.07	\$404.51	\$456.48	\$474.28	\$466.81	\$496.15	\$526.68	\$557.33	\$567.77
------------------------------------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------

SVA Calculation

Operating Cost	\$355.39	\$408.24	\$399.36	\$331.43	\$441.29	\$431.20	\$492.54	\$517.91	\$515.83	\$554.70	\$595.68	\$637.59	\$656.91
Depreciation	\$0.00	\$0.00	\$0.00	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45
Capital Charges	\$1.19	\$1.24	\$1.12	\$1.00	\$0.87	\$0.75	\$0.62	\$0.50	\$0.37	\$0.25	\$0.12	\$0.00	\$0.00
SVA	-\$356.58	-\$409.49	-\$400.48	-\$333.87	-\$443.60	-\$433.40	-\$494.61	-\$519.86	-\$517.65	-\$556.39	-\$597.25	-\$639.03	-\$658.35
PV of SVA	-\$356.58	-\$377.06	-\$339.56	-\$260.67	-\$318.92	-\$286.90	-\$301.50	-\$291.79	-\$267.55	-\$264.80	-\$261.73	-\$257.87	-\$244.63
Cumulative PV of SVA	-\$356.58	-\$733.64	-\$1,073.20	-\$1,333.87	-\$1,652.78	-\$1,939.69	-\$2,241.18	-\$2,532.98	-\$2,800.52	-\$3,065.32	-\$3,327.05	-\$3,584.92	-\$3,829.54
PV of Operating Costs	\$355.39	\$375.91	\$338.61	\$258.76	\$317.25	\$285.45	\$300.23	\$290.70	\$266.60	\$263.99	\$261.04	\$257.28	\$244.09
Cumulative PV of Operating Cos	\$355.39	\$731.31	\$1,069.92	\$1,328.68	\$1,645.93	\$1,931.38	\$2,231.62	\$2,522.32	\$2,788.92	\$3,052.91	\$3,313.96	\$3,571.24	\$3,815.33
PV of Depreciation	\$0.00	\$0.00	\$0.00	\$1.13	\$1.04	\$0.96	\$0.88	\$0.81	\$0.75	\$0.69	\$0.63	\$0.58	\$0.54
Cumulative PV of Depreciation	\$0.00	\$0.00	\$0.00	\$1.13	\$2.17	\$3.13	\$4.01	\$4.82	\$5.57	\$6.26	\$6.89	\$7.48	\$8.01
PV of Capital Charges	\$1.19	\$1.15	\$0.95	\$0.78	\$0.63	\$0.49	\$0.38	\$0.28	\$0.19	\$0.12	\$0.05	\$0.00	\$0.00
Cumulative PV of Capital Charge	\$1.19	\$2.33	\$3.28	\$4.06	\$4.68	\$5.18	\$5.56	\$5.84	\$6.03	\$6.15	\$6.20	\$6.20	\$6.20

Alternative: Rehabilitate G1: Operate 6 Units with In-Service of October 2001

Capital Cost (Direct \$)	\$13.18	\$1.27	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Economic Life	10												
In-Service Year	1												
Net Book Value Opening	\$0.00	\$13.18	\$14.47	\$13.02	\$11.57	\$10.13	\$8.68	\$7.23	\$5.79	\$4.34	\$2.89	\$1.45	\$0.00
Additions	\$13.18	\$1.29	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Depreciation	\$0.00	\$0.00	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$0.00
Closing Net Book Value	\$13.18	\$14.47	\$13.02	\$11.57	\$10.13	\$8.68	\$7.23	\$5.79	\$4.34	\$2.89	\$1.45	\$0.00	\$0.00

Cost of Operating 6 Units (In-Ser)	\$355.39	\$406.47	\$388.85	\$318.68	\$419.07	\$404.51	\$456.48	\$474.28	\$466.81	\$496.15	\$526.68	\$557.33	\$567.77
------------------------------------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------

SVA Calculation

Operating Cost	\$355.39	\$412.16	\$399.35	\$331.43	\$441.29	\$431.20	\$492.54	\$517.91	\$515.83	\$554.70	\$595.68	\$637.59	\$656.91
Depreciation	\$0.00	\$0.00	\$0.00	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45	\$1.45
Capital Charges	\$1.19	\$1.24	\$1.12	\$1.00	\$0.87	\$0.75	\$0.62	\$0.50	\$0.37	\$0.25	\$0.12	\$0.00	\$0.00
SVA	-\$356.58	-\$413.41	-\$400.47	-\$333.87	-\$443.60	-\$433.40	-\$494.61	-\$519.86	-\$517.65	-\$556.39	-\$597.25	-\$639.03	-\$658.35
PV of SVA	-\$356.58	-\$380.67	-\$339.56	-\$260.67	-\$318.92	-\$286.90	-\$301.50	-\$291.79	-\$267.55	-\$264.80	-\$261.73	-\$257.87	-\$244.63
Cumulative PV of SVA	-\$356.58	-\$737.25	-\$1,076.81	-\$1,337.48	-\$1,656.39	-\$1,943.30	-\$2,244.79	-\$2,536.58	-\$2,804.13	-\$3,068.93	-\$3,330.66	-\$3,588.53	-\$3,833.15
PV of Operating Costs	\$355.39	\$379.53	\$338.61	\$258.76	\$317.25	\$285.45	\$300.23	\$290.70	\$266.60	\$263.99	\$261.04	\$257.28	\$244.09
Cumulative PV of Operating Cos	\$355.39	\$734.92	\$1,073.53	\$1,332.29	\$1,649.54	\$1,934.99	\$2,235.22	\$2,525.93	\$2,792.53	\$3,056.52	\$3,317.56	\$3,574.85	\$3,818.93
PV of Depreciation	\$0.00	\$0.00	\$0.00	\$1.13	\$1.04	\$0.96	\$0.88	\$0.81	\$0.75	\$0.69	\$0.63	\$0.58	\$0.54
Cumulative PV of Depreciation	\$0.00	\$0.00	\$0.00	\$1.13	\$2.17	\$3.13	\$4.01	\$4.82	\$5.57	\$6.26	\$6.89	\$7.48	\$8.01
PV of Capital Charges	\$1.19	\$1.15	\$0.95	\$0.78	\$0.63	\$0.49	\$0.38	\$0.28	\$0.19	\$0.12	\$0.05	\$0.00	\$0.00
Cumulative PV of Capital Charge	\$1.19	\$2.33	\$3.28	\$4.06	\$4.68	\$5.18	\$5.56	\$5.84	\$6.03	\$6.15	\$6.20	\$6.20	\$6.20

Alternative 3 - Replace BGS G1

	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Discount Year	0	1	2	3	4	5	6	7	8	9	10	11	12
Discount Rate	9.00%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%	8.60%
Inflation Rate	0.00%	1.40%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%	1.30%
Compound Inflation Factor	100.00	101.40	102.70	104.00	105.30	106.60	107.90	109.20	110.50	111.80	113.10	114.40	115.70

Alternative: Replace G1: Operate 6 Units with In-Service of May 2001

Capital Cost (Direct \$)	\$3.75	\$21.25	\$0.00	\$2.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
PV of Capital	\$3.75	\$19.57	\$0.00	\$1.56	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Cumulative PV of Capital	\$3.75	\$23.32	\$23.32	\$24.88	\$24.88	\$24.88	\$24.88	\$24.88	\$24.88	\$24.88	\$24.88	\$24.88	\$24.88
Economic Life	10												
In-Service Year	1												
Net Book Value Opening	\$0.00	\$3.75	\$25.30	\$22.77	\$22.32	\$19.53	\$16.74	\$13.95	\$11.16	\$8.37	\$5.58	\$2.79	\$0.00
Additions	\$3.75	\$21.55	\$0.00	\$2.08	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Depreciation	\$0.00	\$0.00	\$2.53	\$2.53	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$0.00
Closing Net Book Value	\$3.75	\$25.30	\$22.77	\$22.32	\$19.53	\$16.74	\$13.95	\$11.16	\$8.37	\$5.58	\$2.79	\$0.00	\$0.00
Cost of Operating 6 Units (In-Ser	\$355.39	\$408.73	\$394.86	\$318.87	\$419.07	\$404.51	\$456.48	\$474.28	\$466.81	\$496.15	\$526.68	\$557.33	\$567.77
SVA Calculation													
Operating Cost	\$355.39	\$414.45	\$405.52	\$331.62	\$441.29	\$431.20	\$492.54	\$517.91	\$515.83	\$554.70	\$595.68	\$637.59	\$656.91
Depreciation	\$0.00	\$0.00	\$0.00	\$2.53	\$2.53	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79
Capital Charges	\$0.34	\$2.18	\$1.96	\$1.92	\$1.68	\$1.44	\$1.20	\$0.96	\$0.72	\$0.48	\$0.24	\$0.00	\$0.00
SVA	-\$355.73	-\$416.63	-\$407.48	-\$336.07	-\$445.49	-\$435.43	-\$496.53	-\$521.66	-\$519.34	-\$557.97	-\$598.71	-\$640.37	-\$659.70
PV of SVA	-\$355.73	-\$383.63	-\$345.50	-\$262.39	-\$320.28	-\$288.25	-\$302.67	-\$292.81	-\$268.42	-\$265.55	-\$262.37	-\$258.41	-\$245.12
Cumulative PV of SVA	-\$355.73	-\$739.36	-\$1,084.86	-\$1,347.25	-\$1,667.52	-\$1,955.78	-\$2,258.44	-\$2,551.25	-\$2,819.67	-\$3,085.21	-\$3,347.58	-\$3,605.99	-\$3,851.12
PV of Operating Costs	\$355.39	\$381.63	\$343.84	\$258.91	\$317.25	\$285.45	\$300.23	\$290.70	\$266.60	\$263.99	\$261.04	\$257.28	\$244.09
Cumulative PV of Operating Cos	\$355.39	\$737.02	\$1,080.86	\$1,339.78	\$1,657.02	\$1,942.48	\$2,242.71	\$2,533.41	\$2,800.02	\$3,064.01	\$3,325.05	\$3,582.33	\$3,826.42
PV of Depreciation	\$0.00	\$0.00	\$0.00	\$1.98	\$1.82	\$1.85	\$1.70	\$1.57	\$1.44	\$1.33	\$1.22	\$1.13	\$1.04
Cumulative PV of Depreciation	\$0.00	\$0.00	\$0.00	\$1.98	\$3.79	\$5.64	\$7.34	\$8.91	\$10.35	\$11.68	\$12.90	\$14.02	\$15.06
PV of Capital Charges	\$0.34	\$2.00	\$1.66	\$1.50	\$1.21	\$0.95	\$0.73	\$0.54	\$0.37	\$0.23	\$0.11	\$0.00	\$0.00
Cumulative PV of Capital Charge	\$0.34	\$2.34	\$4.00	\$5.50	\$6.71	\$7.66	\$8.39	\$8.93	\$9.30	\$9.53	\$9.64	\$9.64	\$9.64

Alternative: Replace G1: Operate 6 Units with In-Service of October 2001

Capital Cost (Direct \$)	\$3.75	\$21.25	\$0.00	\$2.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Economic Life	10												
In-Service Year	1												
Net Book Value Opening	\$0.00	\$3.75	\$25.30	\$22.77	\$22.32	\$19.53	\$16.74	\$13.95	\$11.16	\$8.37	\$5.58	\$2.79	\$0.00
Additions	\$3.75	\$21.55	\$0.00	\$2.08	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Depreciation	\$0.00	\$0.00	\$2.53	\$2.53	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$0.00
Closing Net Book Value	\$3.75	\$25.30	\$22.77	\$22.32	\$19.53	\$16.74	\$13.95	\$11.16	\$8.37	\$5.58	\$2.79	\$0.00	\$0.00
Cost of Operating 6 Units (In-Ser	\$355.39	\$408.73	\$397.31	\$319.19	\$419.07	\$404.51	\$456.48	\$474.28	\$466.81	\$496.15	\$526.68	\$557.33	\$567.77
SVA Calculation													
Operating Cost	\$355.39	\$414.45	\$408.03	\$331.96	\$441.29	\$431.20	\$492.54	\$517.91	\$515.83	\$554.70	\$595.68	\$637.59	\$656.91
Depreciation	\$0.00	\$0.00	\$0.00	\$2.53	\$2.53	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79	\$2.79
Capital Charges	\$0.34	\$2.18	\$1.96	\$1.92	\$1.68	\$1.44	\$1.20	\$0.96	\$0.72	\$0.48	\$0.24	\$0.00	\$0.00
SVA	-\$355.73	-\$416.63	-\$409.99	-\$336.41	-\$445.49	-\$435.43	-\$496.53	-\$521.66	-\$519.34	-\$557.97	-\$598.71	-\$640.37	-\$659.70
PV of SVA	-\$355.73	-\$383.63	-\$347.63	-\$262.65	-\$320.28	-\$288.25	-\$302.67	-\$292.81	-\$268.42	-\$265.55	-\$262.37	-\$258.41	-\$245.12
Cumulative PV of SVA	-\$355.73	-\$739.36	-\$1,086.99	-\$1,349.65	-\$1,669.92	-\$1,958.17	-\$2,260.84	-\$2,553.64	-\$2,822.06	-\$3,087.61	-\$3,349.98	-\$3,608.39	-\$3,853.51
PV of Operating Costs	\$355.39	\$381.63	\$345.97	\$259.18	\$317.25	\$285.45	\$300.23	\$290.70	\$266.60	\$263.99	\$261.04	\$257.28	\$244.09
Cumulative PV of Operating Cos	\$355.39	\$737.02	\$1,082.99	\$1,342.17	\$1,659.42	\$1,944.87	\$2,245.11	\$2,535.81	\$2,802.41	\$3,066.40	\$3,327.45	\$3,584.73	\$3,828.82
PV of Depreciation	\$0.00	\$0.00	\$0.00	\$1.98	\$1.82	\$1.85	\$1.70	\$1.57	\$1.44	\$1.33	\$1.22	\$1.13	\$1.04
Cumulative PV of Depreciation	\$0.00	\$0.00	\$0.00	\$1.98	\$3.79	\$5.64	\$7.34	\$8.91	\$10.35	\$11.68	\$12.90	\$14.02	\$15.06
PV of Capital Charges	\$0.34	\$2.00	\$1.66	\$1.50	\$1.21	\$0.95	\$0.73	\$0.54	\$0.37	\$0.23	\$0.11	\$0.00	\$0.00
Cumulative PV of Capital Charge	\$0.34	\$2.34	\$4.00	\$5.50	\$6.71	\$7.66	\$8.39	\$8.93	\$9.30	\$9.53	\$9.64	\$9.64	\$9.64