Chapter 2
Point Lepreau Generating Station Refurbishment – Phase II

Contents

Point Lepreau Generating Station Refurbishment – Phase II

Introduction

2.1 As indicated in Chapter 6, Volume 2 of the 2013 Auditor General of New Brunswick (AGNB) Report, we approached the examination of the Point Lepreau Generating Station (PLGS) refurbishment in two phases. In the Phase I, we:

- described key aspects of NB Power's planning and execution of the Point Lepreau refurbishment; and
- reported summary-level financial information of amounts making up the $1.4 billion capital asset account and the $1.0 billion deferral account related to the refurbishment, as shown in Exhibit 2.1.

Exhibit 2.1 - Summary Financial Information of PLGS

Components of Capitalized PLGS (in $ millions)	
Phase I Project Planning	$ 90.2
Phase II Engineering, Procurement, and Construction:	
Contracted or Professional Services	780.3
Capitalized Interest	292.9
NB Power internal costs	260.5
Sub total	**$1,423.9**
Components of Deferred Costs (in $ millions)	
Nuclearco Period Costs	$ 839.8
Genco Replacement Power Costs	1,032.9
Costs Recovered Through Current Rates	(957.1)
Interest Assigned to Deferral	112.0
Sub total	**$1,027.6**
Grand total	**$2,451.5**

Source: Created by AGNB with data obtained from NB Power (unaudited)

2.2 The refurbishment of PLGS was the first time a CANDU 6 reactor had ever been refurbished. Given the magnitude and uniqueness of this capital project and the likelihood that NB Power will undertake future large capital projects, we believe this chapter should be of considerable interest to the Legislative Assembly as well as the New Brunswick public, most of whom are also NB Power rate payers.

Audit Objective

2.3 The objective of our Phase II work was:

To assess the reasonableness of key project costs of Point Lepreau Generating Station Refurbishment Project.

2.4 First, we analyzed the summary financial information from Phase I in more detail to determine which areas would be our focus. Our analysis is shown in Appendix I. Pursuant to our analysis we decided to focus on the following six areas during our Phase II work:

- procurement and contract management;
- key services contracts;
- major component costs;
- overtime charges;
- overhead allocation; and
- operations maintenance and administration (OMA) costs of PLGS.

2.5 In total, we examined on a test basis $1.7 billion of the $2.5 billion costs associated with the refurbishment.

Conclusion

2.6 We concluded that key project costs of the Point Lepreau Generating Station Refurbishment Project were generally reasonable. As a result of our testing and expert consultation, however, we believe NB Power can make improvements in areas such as:

- procurement;
- contract management; and
- active risk management of key contractors.

2.7 We have made 10 recommendations to improve how NB Power carries out future large capital projects. The recommendations and the responses from NB Power are summarized in Exhibit 2.2.

Results In Brief

2.8 The PLGS refurbishment was completed by November 2012. The refurbishment took 37 months longer and cost $1 billion more than anticipated.

Procurement and Contract Management

2.9 NB Power manages significant capital projects on a regular basis. Sound procurement and contract management is critical to the success of those projects. NB Power generally followed competitive tendering practices for PLGS refurbishment-related contracts.

Without obtaining competitive bids, NB Power may have lost cost saving opportunities

2.10 However, four of the 11 contracts we tested were exempted from public tendering, three for engineering and consulting services valued at $46.6 million and one for specific skills valued at $15 million. Sole source exemptions applied were in compliance with the requirements in the *Public Purchasing Act and Regulation*. However, there is no evidence that NB Power solicited quotations from other engineering firms for engineering services. Given the significant dollar values of those services, without obtaining competitive bids, NB Power may have lost cost saving opportunities.

Majority parts of contract administration well handled

2.11 NB Power has established processes to administer contracts, including monitoring contractor performance, quality controls, and managing contract changes. In general, these processes were properly followed.

Contract structure needs improvement in some cases

2.12 Three contracts signed with two vendors appeared to lack uniformity in how they were structured. Specifically the Sunny Corner ($30.8 million) and O'Brien contracts ($9.8 million) appeared to lag behind industry standards. For contracts of such size and scope, we recommended NB Power adopt industry standard modern contract forms, for example based on standardized contract templates offered by the International Federation of Consulting Engineers.

Lack of post contract review

2.13 Post contract review is critical to proper contract management. It involves an organizational assessment of the benefits or losses from carrying out the procurement and lessons learned. There was no evidence that NB Power performed and properly documented post contract reviews for 9 of 11 contracts in our sample.

Analysis of Individual Significant Contracts

Siemens contract restructuring was prudent

2.14 We selected 11 high dollar value contracts from nine vendors who worked on the PLGS refurbishment, along with their applicable change orders to examine. We identified three significant issues in contracts with four of the nine vendors.

2.15 Siemens was under contract with NB Power to provide new turbines, new generators and to provide turbine auxiliary system work during the refurbishment outage. The contract with Siemens had originally been a part of the large fixed price contract with Atomic Energy of Canada, Ltd. (AECL).

2.16 Separating the Siemens contract from the AECL contract was prudent. It is important to contract directly with vendors providing major components or equipment during a large capital project.

2.17 During their transportation from Saint John to PLGS, two turbines fell into the Saint John harbour. The turbines were damaged. Siemens refurbished and installed them at its cost. Siemens also delivered two new turbines. The new ones are stored at PLGS awaiting installation during a planned outage in 2016 which is currently expected to last 40 days. Siemens will be responsible for all aspects of the installation, labor, material, supervision, and engineering. NB Power will be responsible for costs related to oversight of Siemens. As long as the turbines can be replaced within the planned outage, there will likely be no further cost impact to NB Power due to the transportation accident.

More active NB Power risk management needed

2.18 This event probably could have been avoided with better planning, more active risk assessment, and subcontractor oversight by NB Power. Historical precedent shows transportation of critical components by rail or barge has resulted in similar events to the one that occurred during the PLGS refurbishment.

Insufficient preparatory work on Castle Rock contract

2.19 Castle Rock was hired to both build a new office building for NB Power and to refurbish an existing office building. NB Power did not adequately define the contract scope and perform sufficient preparatory work to avoid emergent design changes for the construction of an administration building on-site at PLGS. The proposed costs ($6.3 million) were exceeded ($7.2 million actual).

2.20 As per NB Power's analysis, the impact of the scheduling delay would have been one consideration in the decision not to wait for a detailed design. NB Power stated the building was needed for refurbishment activities and needed to be completed on schedule. The cost of a month's delay in the outage and subsequent return to power would far outweigh the cost of design changes, as estimated by NB Power.

Premium rates paid for Acres-Sargent & Lundy (ASL) and Hatch Sargent & Lundy (HSL) services

2.21 Acres-Sargent & Lundy (ASL), a joint venture consulting firm based in Oakville and Chicago with significant nuclear engineering and project management experience, was hired to periodically update the NB Power Board of Directors regarding the status and execution of the refurbishment project. Hatch-Sargent & Lundy (HSL) transitioned to providing engineering and technical services during the PLGS restart. ASL had been acquired by HSL by the time this agreement was made. NB Power paid $6.2 million for the services.

2.22 It is unclear what level of success these contracts have achieved, given the numerous challenges encountered during the refurbishment.

2.23 As a consequence of the direct project knowledge gained by HSL's team of experts NB Power retained their services beyond the original oversight mandate. NB Power paid premium rates for their engineering services and associated administrative support. These rates were 25-35% higher than any other engineering firm hired by NB Power during the refurbishment.

Component Cost Analysis

2.24 The budgeted capital project cost was $1,022 million in 2005. The final capital project cost was $1,424 million at November 2012, an additional 39% increase from the 2005 budget.

2.25 When the cost overruns were broken down into financial components, the two largest ones were:

- labour and contracted services; and
- capitalized interest.

2.26 Labour and contracted services are typically the largest financial components associated with an outage. Many of these contracted services are directly related to the extended duration of the project. These costs are often hard to mitigate during a difficult outage.

Overtime Charged to Project

2.27 A total of $41.2 million in overtime cost was charged to the refurbishment project. NB Power attributed a significant portion of the overtime used to unexpected additional work that resulted from an outage of an extended duration. According to NB Power, a key driver of unexpected work was that the level of system and component deterioration was greater than anticipated.

2.28 It took seven months to start up the plant rather than the four months originally planned. A significant amount of overtime was required during these seven months to avoid further extending the outage.

2.29 It is reasonable for NB Power to attribute the majority of the overtime usage to system deterioration, but the fact that systems deteriorated worse than initially anticipated during the extended outage should have been accounted for while planning for the restart.

2.30 As part of the overtime charge testing, we selected ten NB Power employees with the most overtime pay during the refurbishment to test.

2.31 These ten employees worked on the refurbishment project, while performing their regular duties. Therefore, only part of their compensation was charged to the project. On average, the overtime pay charged to the project was 57% of the regular pay. The overtime hours charged to the project were 34% of the regular hours. The average percentage for these ten employees was reasonable, given the fact that working more hours of overtime during a challenging refurbishment outage is not unusual.

Overhead Allocation Analysis

2.32 NB Power allocated corporate overhead costs to the project on a percentage basis. For that reason, growth in project costs due to the longer outage duration resulted in corresponding growth of the amount of the corporate overhead allocation.

2.33 In general, overhead cost allocated to the PLGS refurbishment appeared reasonable given the corporate oversight, managerial, and legal activities required to support the refurbishment project.

Operating, Maintenance and Administration (OMA) Cost Analysis

2.34 NB Power advised that approximately 70% of the systems within PLGS remained operational during the refurbishment. This estimated level of operating systems usage during an outage is typical for a CANDU nuclear plant, according to the expert we consulted.

2.35 NB Power applied standard nuclear industry practices in managing their OMA costs during the refurbishment. Although slightly higher than adjusted US industry costs, the variance is explainable and NB Power's costs appear to have been reasonable.

Exhibit 2.2 - Summary of Recommendations

Recommendation	Entity's response	Target date for implementation
2.51 We recommend NB Power obtain competitive bids for all significant engineering services, even if not required by legislation to do so.	*NB Power is in agreement that competitive bids or comparative proposal evaluation is appropriate for the procurement of general engineering services.* *Where specific engineering skills are required, NB Power will seek to find multiple sources for comparative assessment of proposals. In these cases, price would be one factor in determining the preferred vendor along with experience, reputation, innovation and schedule delivery experience. In some circumstances, where the engineering work involves design-sensitive components and NB Power does not own the blueprints then the original firm will need to be engaged.*	*Immediate*
2.60 We recommend NB Power use industry standardized formats for all external contracts. The International Federation of Consulting Engineers offers standardized contract templates which can be used as a model.	*NB Power is currently updating contract templates to align with best practice and also reduce the number of contract templates being used by the Corporation. This effort will result in consistency of terms and conditions employed.*	*12 months*
2.61 We recommend NB Power use a consistent approach to perform post contract reviews and document any areas for improvement.	*NB Power will use a standardized approach for post-contract reviews.* *NB Power is currently enhancing its project processes including those related to project close-out activities, which will increase consistency in completion of post-contract and project lessons learned reviews.*	*12 months*

Exhibit 2.2 - Summary of Recommendations (continued)

Recommendation	Entity's response	Target date for implementation
2.77 We recommend NB Power: **• contract directly with vendors providing major components or equipment;** **• require the contractors and subcontractors demonstrate that they have appropriate safety and risk mitigation procedures in place;** **• include provisions in contracts which provide sufficient liability protection based on NB Power's assessment of risks; and** **• increase oversight on the transportation of major equipment with the contractor and transportation vendor.**	*NB Power agrees that contracting directly with major component vendors and contractors provides the greatest degree of control and oversight on vendor and contractor performance, safety and risk mitigation strategies including manufacture, transportation and construction.* *NB Power is currently modifying contract templates to contain provisions for addressing liability protection and conducting training of staff to increase awareness of the need to balance risk and liability protection with contract costs.*	*Immediate*
2.82 We recommend for future building construction contracts NB Power perform sufficient due diligence and preparatory work prior to proceeding to the procurement process to avoid cost overruns.	*NB Power understands that successful project execution for all projects, including building construction, hinges on comprehensive project scoping, estimating and planning. NB Power is currently enhancing its overall project execution framework to increase success in major project delivery.*	*Immediate*
2.95 We recommend NB Power conduct an annual review of all major ongoing time and materials contracts. This review should assess the level of success achieved by the vendor over the past year based on set criteria including results achieved and value for money. During an annual review NB Power should conduct interviews with key vendor personnel and perform internal assessments by NB Power staff responsible for interaction with that vendor.	*NB Power will develop a standardized template for an annual review of major ongoing time and material contracts, which will be provided to all contract owners.*	*12 months*

Exhibit 2.2 - Summary of Recommendations (continued)

Recommendation	Entity's response	Target date for implementation
2.96 We recommend NB Power benchmark market rates for similar services and retain this support with procurement documentation to support the contractor choice.	*NB Power will ensure that documentation regarding the evaluation of supply alternatives is maintained in the procurement files.*	*Immediate*
2.106 We recommend NB Power assess its project cost management methodology for large projects. Earned Value Management System, which is an industry best practice, could be used as a model.	*NB Power is developing a new corporate project management framework to enhance project governance, planning and execution. As part of this work, NB Power is exploring alternative project cost management methodologies in recognition of different project approaches including fixed costs vs. variable cost project strategies.*	*June 2015*
2.121 We recommend NB Power develop contingency plans to manage overtime during project delays, including: **• periodically reevaluating during the project to account for major changes in project timelines;** **• sufficiently analyzing the new circumstances and revise the plan as necessary, when a major unanticipated event impacts a project; and** **• carrying out sufficient equipment testing to address any equipment challenges resulting from extended delays.**	*NB Power develops project contingency plans as part of its project risk management processes. NB Power will enhance these processes by ensuring proper documentation reflects the reviews conducted and action plans developed, including the use of overtime where appropriate, to address project changes.*	*Immediate*
2.136 We recommend NB Power prepare a staffing plan for each major project and revise when it is determined that major project changes have occurred.	*NB Power prepares staffing plans for major projects. NB Power will enhance its processes to ensure documentation is updated to reflect changes to staffing needs when required.*	*Implemented for next major project*

Audit scope

2.36 Our audit work included:

- conducting interviews with various NB Power and PLGS representatives;
- reviewing NB Power's corporate procurement policies and procedures;
- testing procurement and contract management documents related to the sample contracts we selected; and
- analyzing overtime pay of sample PLGS employees.

2.37 During our audit, we engaged an independent nuclear consulting firm to assist us to:

- evaluate a sample of 11 contracts and associated amendments, determining if the contract provisions were structured in line with industry best practice and contained sufficient and appropriate provisions to mitigate risks and protect the best interests of NB Power;
- analyze major component costs and supporting documentation to assess and identify any unreasonable costs based on industry best practice;
- assess the reasonableness of NB Power practices regarding the nature and level of overtime charges compared to industry best practice;
- assess the reasonableness of the overhead allocation rate used by NB Power compared to industry best practice; and
- review operating, maintenance and administration (OMA) costs of Nuclearco during refurbishment, including the reasonableness of the OMA costs incurred.

2.38 The expert compared the Point Lepreau refurbishment with other nuclear projects. The purpose of these comparisons was to gain insight in terms of how NB Power performed in relation to industry best practice.

2.39 We provided in Appendix II the definitions for the key terms we used in this chapter, considering the technical nature of this subject.

2.40 Our audit was performed in accordance with standards for assurance engagements, encompassing value-for-money and compliance, established by the Chartered Professional Accountants of Canada, and accordingly included such tests

and other procedures as we considered necessary in the circumstances.

2.41 Certain financial and statistical information presented in this chapter was compiled from information provided by NB Power. It has not been audited or otherwise verified. Readers are cautioned that this financial and statistical information may not be appropriate for their purposes.

Procurement and Contract Management

2.42 NB Power manages significant capital projects on a regular basis. Sound procurement and contract management is critical to the success of those projects.

2.43 We selected 11 contracts from nine vendors who worked on the PLGS refurbishment, along with their applicable change orders to examine. We did not include the contract with Atomic Energy of Canada Limited (AECL), as NB Power paid only the fixed price specified in the AECL contract of $580 million.

Criteria used to assess NB Power's procurement practices

2.44 We used the following criteria to assess NB Power's procurement practices:

- Services should be acquired in accordance with government's legislation, regulations and related corporate policies; and
- Competitive selection processes should be used, or the reasons for not doing so should be supported and properly documented.

2.45 We summarized our testing in Exhibit 2.3:

Exhibit 2.3 - Summary of Procurement Testing – Sample of 11 Contracts

Company	Main services provided	Contract value (millions $)	Method of procurement	Justification for not publicly tendering	Does exemption comply with Act and Regulation?
Acres-Sargent & Lundy and Hatch Sargent & Lundy (2 contracts)	Consulting and project management services	6.2	Sole sourced	under exemption 27.0	Yes
Areva Np Canada Ltd.	Containment filtered venting system	15	Sole sourced	under exemption 27.1	Yes
Atlantic Nuclear Service Inc.	Engineering services	34.6	Sole sourced	under exemption 27.0	Yes
Castle Rock Construction (2 contracts)	Construction of office building and building interior fit-up	7.2	Competitive tenders	N/A	N/A
Stantec Consulting Ltd. (formerly Neill & Gunter)	Engineering services	5.8	Sole sourced	under exemption 27.0	Yes
O'Brien Electric Co Ltd. (2 contracts)	Maintenance services	9.8	Competitive tenders	N/A	N/A
Siemens Power Generation	New turbines, new generators and turbine auxiliary system	28.6	AECL competitively bid	N/A	N/A
Sunny Corner Enterprises Inc.	Planning, packaging, fabrication and installation of project work	30.8	Competitive tenders	N/A	N/A

Source: Created by AGNB

Background

2.46 The *Public Purchasing Act* [1] applies to NB Power as a government funded body, according to New Brunswick Regulation 94-157 under the Act.

Public Purchasing Act applies to NB Power

2.47 Section 27 of the Regulation lists services exempted from the application of the Act, including:

- services that may be provided by certain professionals such as engineers;
- where supplies or services are required in the event of an emergency or urgent situation; and
- where there is an absence of competition for technical reasons and the supplies or services can be supplied only by a particular vendor and no alternative or substitute exists (i.e. sole source of supply).

2.48 We also reviewed NB Power's internal procurement policy, which states:

> *"The Supply Chain Strategy & Management department is responsible for the acquisition of NB Power's materials and services in accordance with the respective* Public Purchasing Act *or the* Crown Construction Contracts Act *and the laws of competitive bidding. Effective purchasing and management of materials and services is imperative to ensure the best value for the dollar is achieved.* [2]
>
> *"The Supply Chain Strategy & Management department is responsible to ensure the process of evaluating, negotiating and selecting successful candidates is conducted in accordance with this policy and all relevant legislation, such as the* Public Purchasing Act.
>
> *It is imperative that all tenders are evaluated properly and fairly based on the pre-existing evaluation criteria as stated in the tender document.*[3]

[1] *The Public Purchasing Act* was replaced by the *Procurement Act*. *The Procurement Act* was proclaimed and came into force October 15, 2014.
[2] Corporate Policies number SC-01: Purchasing
[3] Corporate Policies number SC-18: Evaluation Process

What We Found

2.49 NB Power's internal documents describe in detail the procedures for purchasing items and services, evaluating vendors, and administering contracts. The procedures listed are complete, reasonable and in compliance with the relevant government Acts and Regulation.

NB Power generally followed the competitive tendering process

2.50 NB Power generally followed a competitive tendering process. Four of the 11 contracts we tested were exempt from public tendering, three for engineering and consulting services valued at $46.6 million and one for specific skills valued at $15 million. Sole source exemptions applied were in compliance with the requirements listed in the Regulation. We were not provided with evidence that NB Power solicited quotations from other engineering firms for the engineering services. However, given the significant dollar value of those services, NB Power may have lost cost saving opportunities by not obtaining competitive bids.

Without obtaining competitive bids for engineering services, NB Power may have lost cost saving opportunities

Recommendation

2.51 We recommend NB Power obtain competitive bids for all significant engineering services, even if not required by legislation to do so.

Contract management

2.52 Effective contract management requires an organization to establish a process to systematically and efficiently manage contract creation, execution and analysis for maximizing operational and financial performance and minimizing risks.

2.53 It not only improves financial and operational performance, but also mitigates the risks due to increases in complexity and number of contracts.

Criteria used to assess contract management

2.54 We used the following criteria to assess NB Power's contract management practices:

- a business case should be prepared to set out the contract objectives, the outcome(s), the risks, identification of any contingent needs, and timescale;
- deliverables should be clearly and accurately specified in the contracts;
- the contract provisions should be structured consistent with industry best practice and contain sufficient and appropriate provisions to mitigate risks and protect the best interests of NB Power;
- contract extensions and amendments should comply with government and corporate policies and be

adequately supported; and

- a post-contract review should be performed to assess the benefits or losses from carrying out the procurement and gather any lessons that can be learned.

2.55 We summarized our testing in Exhibit 2.4.

Exhibit 2.4 - Summary of Contract Management Testing

Company	Was a business case prepared?	Were deliverables clearly and accurately specified in the contract?	Were contract provisions structured consistent with industry best practice?	Were contract extensions and amendments properly supported and approved?	Was post-contract review performed and documented?
Acres-Sargent & Lundy and Hatch Sargent & Lundy (2 contracts)	The business case was prepared for the refurbishment project as a whole rather than at each contract level. The justification for PLGS refurbishment and risk assessment were completed and presented to the EUB. In addressing the improvements recommended by Dr. Robin Jeffery on behalf of the government, the risk mitigation measures were further tightened. A risk register was utilized throughout refurbishment and a risk mitigation strategy was implemented for each identified risk by the project team and for which highlights of key risks were included in monthly executive reporting.	Yes	Yes	Yes	No
Areva Np Canada Ltd.		Yes	Yes	Yes	No
Atlantic Nuclear Service Inc.		Yes	Yes	Yes	No
Castle Rock Construction (2 contracts)		Yes	No, the standard contract provisions used were outdated compared to industry best practice.	Yes	No
Stantec Consulting Ltd. (formerly Neill & Gunter)		Yes	Yes	Yes	No
O'Brien Electric Co Ltd. (2 contracts)		Yes	No, the standard contract provisions used were outdated compared to industry best practice.	Yes	No
Siemens Power Generation		Yes	Yes	Yes	Yes
Sunny Corner Enterprises Inc.		Yes	Yes	Yes	Yes

Source: Created by AGNB

What We Found

2.56 NB Power's internal contract management process requires:

- the ongoing evaluation and monitoring of vendor performance; and
- proper approval of contract changes.

2.57 NB Power has established a process to administer contracts, including monitoring contractor performance, quality controls, and managing contract changes. In general, procedures were properly followed for PLGS contracts we tested.

2.58 NB Power representatives indicated they have established a process at PLGS called Problem Identification and Corrective Action (PICA) to document lessons learned, recommend corrective actions, and track the implementation of the recommendations. PICA is focused on the problem to be corrected rather than a specific contract or contractor. NB Power was able to provide evidence that post contract reviews were performed through PICA for Siemens and Sunny Corner contracts. No formal post contract review was documented for the other nine contracts in our sample.

Lack of uniformity in contract structure

2.59 In reviewing the contracts there appeared to be a lack of uniformity in contract structure. Specifically, the Sunny Corner Enterprises Inc. and O'Brien Electric Co Ltd. contracts appeared to lag behind industry standards for contracts of their size and scope. Typically large utilities utilize a standard contract format to promote efficiency in developing contracts and to ensure that all key elements have been included.

Recommendations

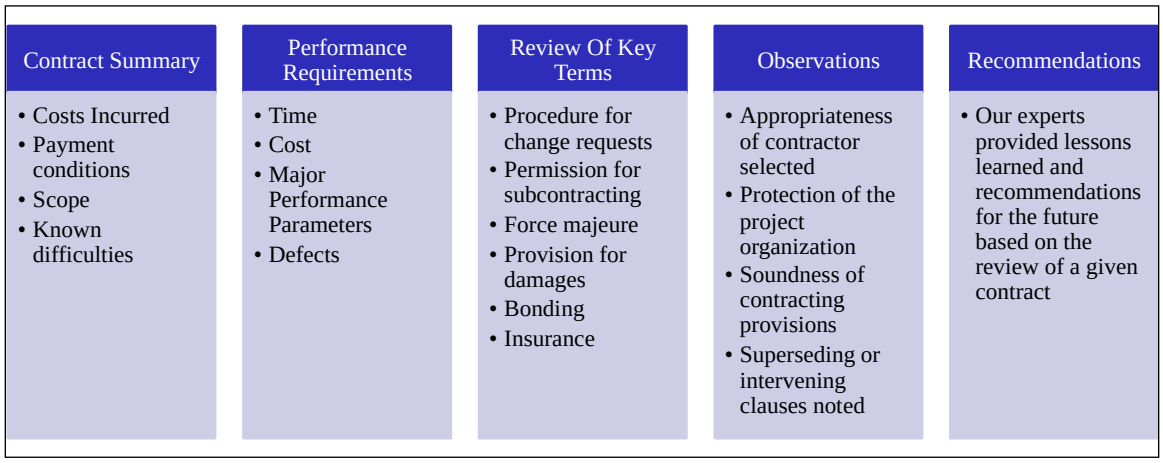
2.60 We recommend NB Power use industry standardized formats for all external contracts. The International Federation of Consulting Engineers offers standardized contract templates which can be used as a model.

2.61 We recommend NB Power use a consistent approach to perform post contract reviews and document any areas for improvement.

Contract Analysis

2.62 We used the same 11 contracts as noted in Exhibits 2.3 and 2.4 to complete our contract analysis work. We applied a uniform review process and criteria to all 11 contracts. A summary of the factors considered is shown in Exhibit 2.5.

Exhibit 2.5 - Contract Analysis factors considered



Source: Created by AGNB

2.63 We identified three significant issues in contracts with four of the nine vendors. These findings are discussed in the sections that follow.

Siemens Contract Review

Background

2.64 Siemens was under contract with NB Power to provide new turbines, new generators and to provide turbine auxiliary system work during the refurbishment outage. It had manufactured the original equipment in place at PLGS prior to the refurbishment. The contract with Siemens had originally been part of the large fixed price contract with Atomic Energy of Canada, Ltd. (AECL). Siemens' portion of the work was later carved out of the AECL contract, and assigned directly to NB Power. The Siemens contract was a fixed-price contract, which was awarded based on a tendered low bid. In total $28.6 million was paid to Siemens for the generators and $46 million for the turbines.

Siemens labour rates 25-30% higher

2.65 Based on the labour rate table provided in the contract, we estimate that Siemens labour rates were 25-30% higher than the base rates found in NB Power's collective-bargaining agreements (CBAs). NB Power was purchasing specialized skills from Siemens not covered by NB Power's collective agreement. Therefore, some premium would be expected in this situation. The premium was only paid for specialty engineering and technical labour skills not available from local building trades or local engineering providers.

Exhibit 2.6 - Turbines on barge

Source: NB Power

What we found

2.66 It is typical for a nuclear plant to contract directly with a vendor who will be providing and installing major components such as turbines (see Exhibit 2.6) or generators. As these components are of critical importance to a nuclear plant, a great deal of time, effort and energy is typically involved with negotiations and subsequent oversight of vendors providing such components.

There was a transportation accident involving the turbines

2.67 However, a transportation accident occurred (i.e. the turbines fell into the Saint John harbour) which damaged the turbines. Turbines are very expensive and include specialized components that are not easily replaced. Siemens refurbished the turbines that fell into the harbour, and installed them at Siemens cost.

2.68 The estimated life for the refurbished turbines is six years, rather than 30 years for new turbines. Accordingly, Siemens went beyond their liquidated damages obligation and in addition to completing the repairs to the damaged turbines, Siemens supplied two replacement turbines at its cost. Siemens will be responsible for all aspects of the installation,

labour, material, supervision, and engineering. NB Power will be responsible for costs related to oversight of Siemens. The new turbines have been delivered and are stored at PLGS awaiting installation during a planned outage in 2016 which is currently expected to last 40 days. As long as the turbines can be replaced within the planned outage, there will likely be no further cost impact to NB Power due to the transportation accident.

If the calandria tube delay had not occurred, the turbine delivery accident could have extended the outage on its own

2.69 At the time of this transportation accident, AECL was already beginning to experience delays in removing old reactor components and preparing the reactor for the installation of new calandria tubes. Had the calandria tube difficulty and related delay not occurred, the damage to the turbines alone could have extended the outage.

2.70 NB Power had a contingency plan to return PLGS to commercial operation using the existing turbines and to replace them during a future scheduled outage. However, had that not been possible, and if the project had not already been delayed, the cost of an extended outage could have been incurred as a result of the transportation accident.

More active risk assessment needed for critical equipment

2.71 Historical precedent shows that transportation of critical components by rail or barge has resulted in similar events to the one discussed here. This event probably could have been avoided with better planning, more active risk assessment, and subcontractor oversight.

2.72 A great deal of planning and oversight goes into transporting major components such as turbines. The financial liability and loss of revenue in the event of failure to perform/deliver would be so significant, that it is a common practice to require a limit on liability of no less than 100% of the contract value.

2.73 Siemens' limit on liability was 20% of the contract value. The amount of liquidated damages is a negotiated item, with every percentage increase in liquidated damages resulting in a higher cost in the contract. The liquidated damages negotiated in this contract represented the best available balance of risk and cost, according to NB Power.

2.74 NB Power's risk mitigation plan for this activity included retaining their old turbines, storing and protecting them in the event the turbines needed to be put back in service to address

unforeseen short-term problems.

2.75 However, NB Power's risk assessment was not sufficiently documented to support its decision to limit the liquidated damages to 20%. Based on our expert consultation, this plan was appropriate in the circumstances, but did not reduce the need for adequate liability limitation language within the contract.

Separating the Siemens contract from the AECL contract was prudent

2.76 Separating the Siemens contract from the AECL contract was prudent. It is advisable to have a direct contractual relationship with a vendor providing important components like turbines or generators. The additional administrative layer that would have existed if AECL was involved probably would have made the challenges encountered with the turbines even more difficult for NB Power.

Recommendations

2.77 We recommend NB Power:

- **contract directly with vendors providing major components or equipment;**
- **require the contractors and subcontractors demonstrate that they have appropriate safety and risk mitigation procedures in place;**
- **include provisions in contracts which provide sufficient liability protection based on NB Power's assessment of risks; and**
- **increase oversight on the transportation of major equipment with the contractor and transportation vendor.**

Castle Rock Contract Review

Background

2.78 Castle Rock was hired to both build a new office building for NB Power (see Exhibit 2.7) and to refurbish an existing office building at PLGS. Castle Rock performed these services during the refurbishment at PLGS on a fixed-price basis.

2.79 It is typical for the owner of a nuclear site to utilize a contractor to build and outfit office space when it is needed. Ideally, such a contractor would be rigorously evaluated and required to perform on time and on budget, as change orders to construction contracts are typically more expensive than work negotiated ahead of time.

Exhibit 2.7 - PLGS Office Building

Source: NB Power

What we found

2.80 The proposed costs ($6.3 million) were exceeded by $900,000 ($7.2 million actual). NB Power had not noted a new design requirement at the time it signed the contracts, nor had it adequately defined the contract scope. Late design and scope changes resulted in $900,000 of cost overruns for the office building work.

2.81 NB Power representatives indicated scheduling demands required the office building be made available for refurbishment activities. The impact of scheduling delays would have been one consideration in the decision not to wait for a detailed design. NB Power indicated the cost of a month's delay in the outage and subsequent return to power would far outweigh the cost of design changes.

Recommendation

2.82 We recommend for future building construction contracts NB Power perform sufficient due diligence and preparatory work prior to proceeding to the procurement process to avoid cost overruns.

Acres-Sargent & Lundy and Hatch-Sargent & Lundy Contracts Review

2.83 Acres-Sargent & Lundy (ASL) was hired to periodically update the NB Power Board of Directors regarding the status and execution of the refurbishment project. This was a sole sourced time and materials contract that lasted about six years from November 2005 to February 2012 and cost $6.2 million.

Background

2.84 Hatch-Sargent & Lundy (HSL) provided engineering and technical services during the PLGS restart. ASL had been acquired by HSL by the time this agreement was made. This contract was with individuals already familiar with the circumstances surrounding the refurbishment. Several members of HSL's team had been affiliated with ASL in the past and had therefore been involved with the refurbishment for a long period of time. They also had experience on other refurbishment projects. NB Power believed utilizing HSL was more efficient and saved time by not having to bring new contractors up to speed.

What we found

2.85 A contract which provides technical expertise to a Board or an executive team is not unusual during a large project. Under ideal circumstances, such a contract would enhance the Board's understanding of the project and allow them to make more informed decisions. It also provides a third party evaluation and perspective on the work being performed by key employees.

2.86 It is important the Board have a detailed understanding of the status of the project including any technical challenges encountered along the way.

2.87 We reviewed the ASL and HSL contracts. Scopes of work per the contracts were clearly defined. We also reviewed the quarterly reports from ASL to the Board. Systemic issues and risks during the refurbishment were identified by ASL and reported to the Board on a quarterly basis. Issues and risks were colour coded based on the severity of the issues.

2.88 A nuclear plant becomes a very hectic place as an outage comes to a close, and preparations to restart the plant are underway. This type of "pressure cooker" environment can sometimes necessitate hiring relatively expensive outside experts with unique capabilities to support the completion of critical tasks within stipulated timeframes. Such experts can also be more efficient than less experienced counterparts. In an ideal scenario an owner would endeavor to not become overly dependent on a given expert or group of experts, and would utilize all possible avenues of leverage to negotiate the best possible contract terms with those experts when and if they are needed.

Services provided by ASL did not fully mitigate the numerous challenges encountered

2.89 While it is recognized as necessary and valuable to have independent oversight in support of the Board's governance role, this effort did not fully mitigate the numerous challenges encountered during the refurbishment including a major transportation incident with the turbines and the physical damage to the calandria tube sheet bores in preparation for the calandria tube installation in the reactor.

2.90 As a consequence of the direct project knowledge gained by HSL's team of experts NB Power retained their services beyond the original oversight mandate. NB Power paid premium rates of 25% to 35% higher than any other engineering firm hired by NB Power during the refurbishment. NB Power also paid higher than market rates for associated administrative support. For example, HSL's rates include $75 per hour for administrative support services from their corporate office in Chicago as compared to an average of $45 per hour for administrative services from other firms retained by NB Power.

NB Power paid a premium for HSL's expertise

2.91 The reliance and high rates paid for their services were seemingly, at least in part, due to the intense pressure surrounding the restart of the plant. That pressure created an environment that made it difficult for NB Power to utilize its leverage in the negotiation process with HSL.

2.92 Before the completion of the refurbishment, NB Power evaluated their contract with HSL and prudently determined that it was time to discontinue use of their services by February 2012.

2.93 In general, the more knowledge NB Power acquires about rates charged by service providers, the more pressure NB Power can bring during the negotiation process. Ideally this will allow more favorable rate and contract terms to be negotiated even where unique expertise exists.

2.94 Further, limiting reliance on a single vendor by distributing work among multiple suppliers before an outage would help NB Power avoid becoming overly reliant on a single service provider.

Recommendations

2.95 We recommend NB Power conduct an annual review of all major ongoing time and materials contracts. This review should assess the level of success achieved by the vendor over the past year based on set criteria including results achieved and value for money. During an annual review NB Power should conduct interviews with key vendor personnel and perform internal assessments by NB Power staff responsible for interaction with that vendor.

2.96 We recommend NB Power benchmark market rates for similar services and retain this support with procurement documentation to support the contractor choice.

Component Cost Analysis

Background

2.97 As we mentioned in our Phase I report, the total capital costs of PLGS refurbishment were $1.4 billion, consisting of four major components:

- project planning $90.2 million;
- contracted services $780.3 million;
- capitalized interest $292.9 million; and
- NB Power internal cost $260.5 million.

2.98 The refurbishment project at PLGS was originally planned for 18 months. The actual duration was nearly five years. The extended duration was due mostly to the previously noted issues with the calandria tubes. While a significant amount of time, effort, and resources go into planning for outages at nuclear plants, cost and duration overruns do occur. However, an outage originally planned for 18 months that lasts nearly five years is unusual.

2.99 Between NB Power's original project estimate in January 2004 and the budget approved in July 2005, several of the refurbishment contracts were renegotiated from fixed price with escalation to fixed price. NB Power implemented these and other actions in response to New Brunswick government consultant Dr. Robin Jeffrey's recommendations in April 2004[4], as discussed in our 2013 Report.

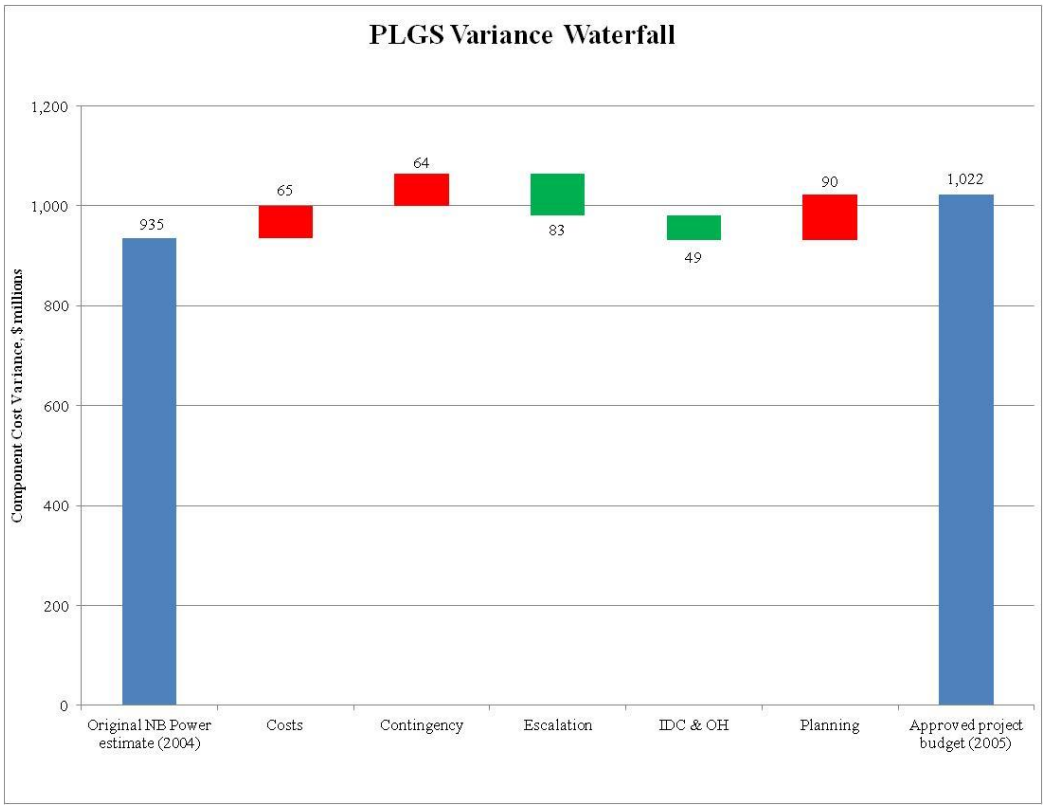
[4] (Jeffrey's Study, page 7, Recommendation #2)

Estimated capital project cost increased about 9.3% from $935 million (original from 2004) to $1,022 million (revised in 2005)

2.100 These renegotiations were based on a project start date of August 2005 and an outage start date of April 2008. These renegotiated fixed price contracts with AECL accounted for approximately 2/3 of the contracted service of $935 million. As shown in Exhibit 2.8.1, this resulted in an increase in costs and contingency of $65 million and $64 million, respectively. Estimated escalation and interest during construction and overhead (IDC & OH) were reduced by $83 million and 49 million, respectively. While not a complete offset, this renegotiation allowed NB Power to transfer much of the scheduling risk for the contracted scope to AECL.

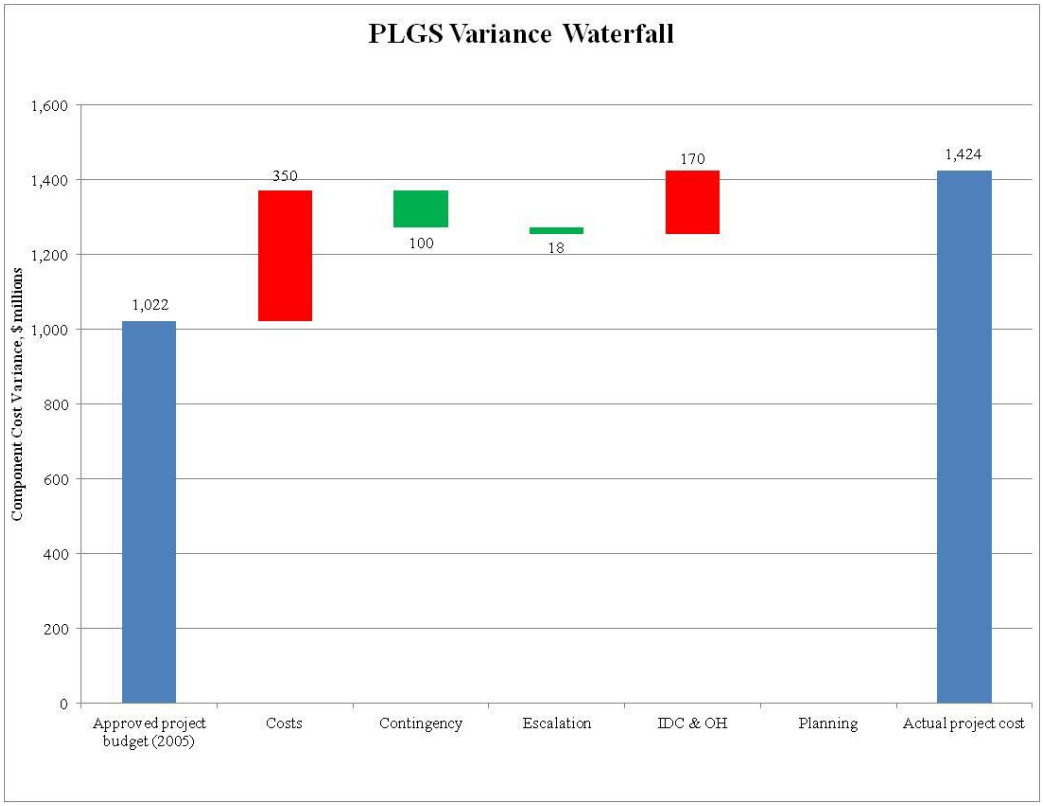
2.101 NB Power also incorporated project planning costs of $90 million into the approved project budget as a separate category. $70 million was estimated for planning costs in the original project estimates. It was not listed as a separate item but built into the original project estimates of $935 million. As a result, the estimated capital project cost increased about 9.3% from $935 million to $1,022 million.

Exhibit 2.8.1 - Cost Overages from Original Estimate to Approved Project Budget



Source: Created by AGNB with data obtained from NB Power (unaudited)

Exhibit 2.8.2- Cost Overages from Approved Project Budget to Actual Project Cost



Source: Created by AGNB with data obtained from NB Power (unaudited)

Actual project cost of $1,424 million, a 39% increase from $1,022 million approved budget in 2005

2.102 As the outage continued beyond the originally scheduled restart date of September 2009, interest during construction continued to accrue at an estimated rate of 5.8% per annum for approximately three years. This resulted in an unfavorable variance from the approved estimate of $170 million in IDC and OH. Additionally, the other construction costs such as contracted services, NB Power labour, and fees over these three years added $350 million to the project, due to the extended outage. The unfavorable components were partially offset by the escalation and contingency estimate included in the approved estimate of about $118 million. Taken together, these variances resulted in a final project cost of approximately $1,424 million at November 2012, a 39% increase from the approved project budget of $1,022 million, as shown in Exhibit 2.8.2.

2.103 When the overage costs are broken down into financial components, the two largest ones were:

- contracted services $153.3 million; and
- capitalized interest $156.8 million

2.104 Labour and contracted services are typically the largest financial components associated with an outage. Many of these contracted services are directly related to the extended duration of the project. Therefore, they would have been difficult for NB Power to reduce.

Improvement needed in project financial data

2.105 In order to compare to other similar nuclear plant projects, we tried to assign the component costs directly to specific parts of the plant. However, we were unable to accomplish this task, as NB Power maintained PLGS financial data in a corporate accounting system mainly for financial accounting purposes. Current industry best practice for project cost management is the Earned Value Management System (EVMS)[5]. The key components of EVMS include:

- work package, budget, and change control management;
- progress measurement; and
- expenditure and schedule integration.

Recommendation

2.106 We recommend NB Power assess its project cost management methodology for large projects. Earned Value Management System, which is an industry best practice, could be used as a model.

Overtime Charge Analysis

Background

2.107 The total of overtime charged to the refurbishment was $41.2 million. We assessed the reasonableness of NB Power's practices regarding the nature and level of overtime charges compared to industry best practice.

[5] *The EVMS is codified in ANSI/EIA 748-C, which contains EVMS Guideline, Common Terminology, Process Discussion, System Documentation, and System Evaluation sections – See American National Standards Institute (ansi.org).*

Best Practice in Overtime Usage

2.108 Careful planning of overtime usage is a best practice in project management across the nuclear industry. Keeping to the original plan for overtime allocation often requires significant discipline from project managers facing significant job completion pressure. External pressures often result in an increase in overtime usage towards the end of an outage.

2.109 Experienced project managers indicate that it is often more efficient to complete a task through overtime, than to stop and restart that task again on regular time. Some common reasons cited for the use of overtime are emergency work, a strong desire to complete the project, and the fact that it is typically easier to use employees rather than bring contractors up to speed. Retaining contractors on short notice presents other challenges as well such as long procurement lead times, time-consuming administrative processing, and training requirements.

A key driver of unexpected work was that the level of system and component deterioration was greater than anticipated

2.110 NB Power attributed a significant portion of the overtime used to unexpected additional work that resulted from an outage of an extended duration. A key driver of unexpected work was that the level of system and component deterioration was greater than anticipated. Systems not in use deteriorate over time. That deterioration can become more severe the longer the equipment is not in use. If an outage lasts much longer than anticipated, this can create more work during startup than originally planned for.

2.111 However, there are systems tests that can be conducted as well as industry precedents that can be reviewed to help prepare for the system-related impacts of an extended outage.

What we found

2.112 It took seven months to start up the plant rather than the four months originally planned. Although NB Power tried to revise their startup plan to fully account for the work that would be necessary to restart the plant, their plans do not appear to have addressed the deterioration issues which were greater than anticipated. A significant amount of overtime was required during these seven months to avoid further extending the outage.

Analysis of Overtime Charge by Individual Employees

2.113 As part of the overtime charge testing, we also selected ten NB Power employees with the most overtime pay during the refurbishment to test. We focused on the eligibility and reasonableness of overtime charged in relation to regular pay.

2.114 All these employees worked through the full refurbishment period of 7.3 years from 1 August 2005 to 23

November 2012[6]. They all belong to the same union "Local 37-The International Brotherhood of Electrical Workers". Based on the collective bargaining agreement, these employees were eligible to receive overtime pay. All positions in the sample we examined are technical and operational.

2.115 The number of overtime hours worked by each individual is key in determining whether the overtime they received was reasonable. Assuming the overtime rate they are paid averages 1.5 times the base pay, and assuming the average overtime hours are 50% of a regular work week, overtime will average 40-50% of base pay. Obviously the more hours worked under this arrangement, the higher the ratio of overtime to base pay would be.

2.116 We reviewed their full regular and overtime pay over the 7.3 year full refurbishment period. Overtime pay was 48% of regular pay. Overtime hours were 27% of regular hours. The details are presented in Exhibit 2.9.1.

2.117 We also reviewed their regular and overtime pay charged to the refurbishment project. These ten employees worked on the refurbishment project, while performing their regular duties. Therefore, only part of their full compensation was charged to the project.

2.118 On average, the overtime pay charged to the project was 57% of the regular pay. The overtime hours charged to the project were 34% of the regular hours. The details are shown in Exhibit 2.9.2.

2.119 The average percentage for these ten employees was reasonable, given the fact that working more hours of overtime during a challenging refurbishment outage is not unusual.

[6] Includes planning, engineering, procurement and construction of the refurbishment project

Exhibit 2.9.1 - Analysis of Refurbishment Overtime Pay of Top 10 Employees – Total Compensation During Full Refurbishment Period

Title/Position	Total compensation during the full refurbishment period *		Full gross pay				Full overtime pay				% of overtime vs. regular	
	Total pay ($)	Annualized total pay ($)	Regular pay ($)	Annualized regular pay ($)	Regular hours	Annualized regular hours	Overtime pay ($)	Annualized overtime pay ($)	Overtime hours	Annualized overtime hours	Pay	Hours
Nuclear Fuel Handling	1,364,304	186,126	871,999	118,963	15,204	2,074	492,305	67,163	5,082	693	56	33
Electrical Instrumentation and Controls	1,135,874	154,963	718,903	98,077	15,760	2,150	416,971	56,886	4,913	670	58	31
Nuclear Fuel Handling	1,209,937	165,103	812,582	110,894	15,284	2,085	397,355	54,209	4,301	587	49	28
Operations	1,230,787	167,911	841,371	114,785	15,250	2,080	389,416	53,126	3,643	497	46	24
Operations/ Nuclear Fuel Handling	1,072,517	146,319	702,943	95,900	15,187	2,072	369,574	50,419	4,660	636	53	31
Nuclear Radiation Control	1,146,061	156,352	788,689	107,597	15,639	2,133	357,372	48,755	4,321	589	45	28
Operations/ Nuclear Fuel Handling	1,009,204	137,681	691,132	94,288	15,379	2,098	318,072	43,393	4,135	564	46	27
Operations/ Nuclear Fuel Handling	1,009,301	137,694	700,963	95,629	14,920	2,035	308,338	42,065	3,768	514	44	25
Commissioning	1,043,567	142,375	738,858	100,799	15,335	2,092	304,709	41,576	3,460	472	41	23
Project Lead	943,039	128,655	661,540	90,251	14,877	2,030	281,499	38,404	3,410	465	43	23
Total	**11,164,900**		**7,529,250**		**152,835**		**3,635,650**		**41,693**		**48**	**27**

Source: Created by AGNB with data obtained from NB Power (unaudited)

* The full refurbishment period of 7.3 years started from 1 August 2005 to 23 November 2012. Compensation amounts do not include employer share of employee benefits.

Exhibit 2.9.2- Analysis of Refurbishment Overtime Pay of Top 10 Employees – Portion of Compensation Charged to Refurbishment Project

Title/Position	Portion compensation charged to the refurbishment project *		Regular pay and hours charged to refurbishment project				Overtime pay and hours charged to refurbishment project				% of overtime vs. regular	
	Refurbishment related pay ($)	Annualized Refurbishment related pay ($)	Regular pay ($)	Annualized regular pay ($)	Regular hours	Annualized regular hours	Overtime pay ($)	Annualized overtime pay ($)	Overtime hours	Annualized overtime hours	Pay	Hours
Nuclear Fuel Handling	959,230	130,863	584,284	79,711	9,421	1,285	374,946	51,152	3,757	513	64	40
Electrical Instrumentation and Controls	578,958	78,984	289,545	39,501	6,182	843	289,413	39,483	3,315	452	100	54
Nuclear Fuel Handling	806,424	110,017	515,301	70,300	8,796	1,200	291,123	39,717	3,023	412	56	34
Operations	720,283	98,264	498,691	68,033	8,241	1,124	221,592	30,231	2,039	278	44	25
Operations/ Nuclear Fuel Handling	743,570	101,442	455,284	62,112	8,258	1,127	288,286	39,330	3,360	458	63	41
Nuclear Radiation Control	828,214	112,989	553,572	75,521	9,511	1,298	274,642	37,468	3,140	428	50	33
Operations/ Nuclear Fuel Handling	565,846	77,196	337,809	46,086	6,514	889	228,037	31,110	2,776	379	68	43
Operations/ Nuclear Fuel Handling	720,679	98,319	483,226	65,924	8,967	1,223	237,453	32,395	2,690	367	49	30
Commissioning	693,638	94,630	471,107	64,271	9,426	1,286	222,531	30,359	2,452	335	47	26
Project Lead	777,422	106,060	530,495	72,373	11,573	1,579	246,927	33,687	2,977	406	47	26
Total	**7,394,264**		**4,719,314**		**86,889**		**2,674,950**		**29,529**		**57**	**34**

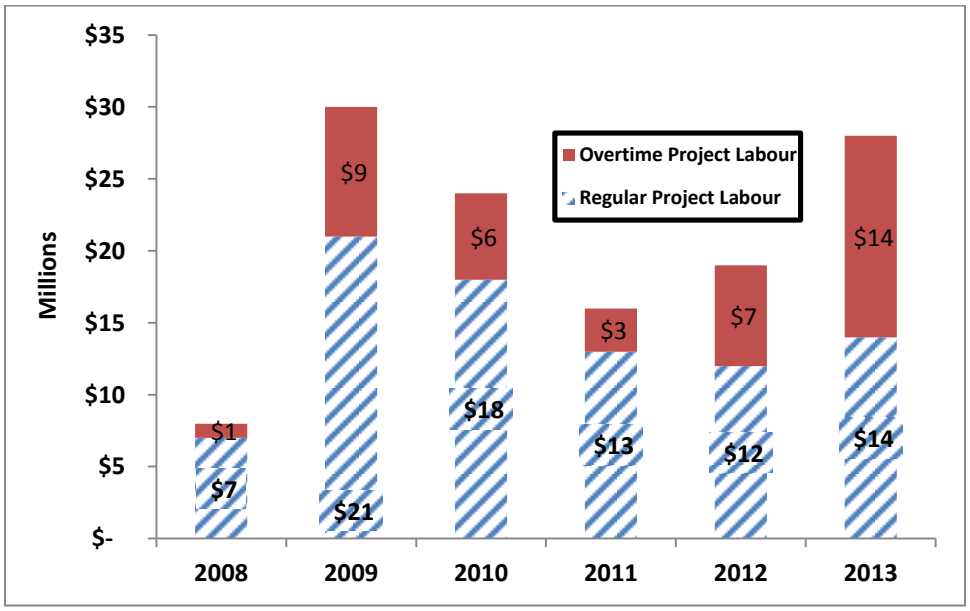
Source: Created by AGNB with data obtained from NB Power (unaudited)

* The full refurbishment period of 7.3 years started from 1 August 2005 to 23 November 2012. Compensation amounts do not include employer share of employee benefits.

It took NB Power seven months to prepare the plant for restart, three months longer than planned

2.120 Originally NB Power planned to use three months to prepare the plant for restart at the end of the outage. When a project changes significantly in scope or duration, it is common practice to revaluate the original plan and make adjustments as needed. NB Power's reevaluation resulted in a change in the duration of the restart plan from three months to four. It ultimately took seven months to restart the plant. A significant amount of overtime was used during the restart period. Exhibit 2.10 lists the amounts of regular labour and overtime costs by fiscal year over the duration of the refurbishment.

Exhibit 2.10 - NB Power Regular and Overtime Labour Cost Data (Unadjusted)



Source: Created by AGNB with data obtained from NB Power (unaudited)

Recommendation

2.121 We recommend NB Power develop contingency plans to manage overtime during project delays, including:

- **periodically reevaluating during the project to account for major changes in project timelines;**
- **sufficiently analyzing the new circumstances and revise the plan as necessary, when a major unanticipated event impacts a project; and**
- **carrying out sufficient equipment testing to address any equipment challenges resulting from extended delays.**

Overhead Allocation Analysis

2.122 We assessed the reasonableness of the overhead allocation rate used by NB Power, including comparing it to industry best practice.

Background

2.123 Like most nuclear plant owners, NB Power has a corporate allocation rate in place to support ongoing baseline capital projects at PLGS. The majority of these allocated overhead costs typically support labour-related activities provided by the corporate organization such as management, IT, oversight, and accounting. NB Power typically uses an overhead allocation of approximately 10% on $30-40 million in annual capital. This $3-4 million allocation covers corporate support of these ongoing capital projects at PLGS.

What we found

NB Power used 0.2% as the overhead allocation rate

2.124 NB Power determined the size and scope of the refurbishment project warranted a different overhead rate than the 10% rate it normally applies to capital projects. NB Power initially estimated 0.3% of the total project capital costs should be allocated to corporate support. NB Power's estimate was revised to 0.2% in 2008 before the project began. The application of a special corporate overhead allocation rate for a project of unusual size or scope is common in the nuclear industry.

The method NB Power used to develop the overhead allocation rate was assessed by an accounting firm and found to be reasonable

2.125 Because NB Power estimated corporate overhead costs on a percentage basis, growth in project costs due to the longer outage duration resulted in a growth to the amount of the corporate overhead allocation. When the allocation rate is applied to the original estimated costs, it produces an overhead allocation of $2 million (0.2% x $1.0 billion = $2 million). NB Power's project rate produces an estimated $2.8 million of corporate overhead costs allocated to the refurbishment when applying the actual costs of the project (0.2% x $1.4 billion = $2.8 million). The methodology NB Power used to develop this rate was assessed by an accounting firm and found to be reasonable. NB Power representatives indicated that the corporate support requirements grew as the project experienced challenges and setbacks. When a severe setback on a major project occurs, it is common across the nuclear industry to see an increase in corporate support provided.

2.126 Overhead cost allocated to the PLGS refurbishment appeared reasonable given the corporate oversight, managerial, and legal activities required to support the

refurbishment project.

Operating, Maintenance and Administration Cost Analysis

2.127 We reviewed operating, maintenance and administration (OMA) costs of Nuclearco during refurbishment to assess the reasonableness of the costs charged to the refurbishment.

Background

2.128 Nuclear plants require a significant amount of attention even when they are not operating. The many activities that continue during an outage are labour-intensive. These are shown in Exhibit 2.11.

Exhibit 2.11 - Description of Ongoing Activities at a Nuclear Generation Facility

Operations •Individuals who are qualified to operate the plant must remain on site to operate the systems that are still active and retain their training qualifications	**Maintenance** •Qualified maintenance technicians must remain on site to maintain the equipment still in operation	**Engineering** •Engineers familiar with the operating equipment must still be available to support ongoing activities as well as support to emergent issues
Security •Because nuclear material is still found at the site, security must be maintained	**Radiation Protection** •Qualified Radiation protection workers must be available to support ongoing maintenance activities and ensure contractor safety for those on the project	**Environmental Protection** •Environmental Protection workers must continue to regularly monitoring the site as stipulated by the regulator
Training •Nuclear operators and maintenance workers are highly trained and training must continue even during an outage period; training for some contractor staff is also required	**Outage Workers** •Even if contractors are performing a majority of the outage work, plant employees still must perform oversight duties during an outage	**Regulatory Support** •Interface with regulators requires monitoring and reporting by dedicated personnel, these requirements remain in place during an outage

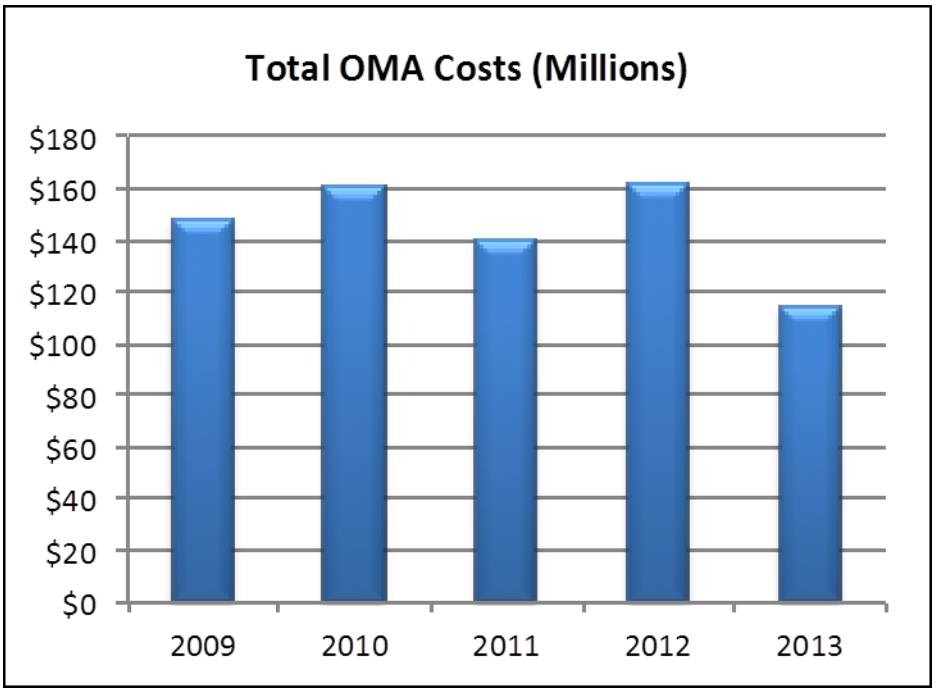
Exhibit 2.12 - PLGS control room

Source: NB Power

What we found

2.129 NB Power OMA costs were relatively steady during the refurbishment project, as shown in Exhibit 2.13. Compensation increased as the outage ended in 2012, which is partially due to increased overtime discussed earlier in this report.

Exhibit 2.13 - Total OMA Costs



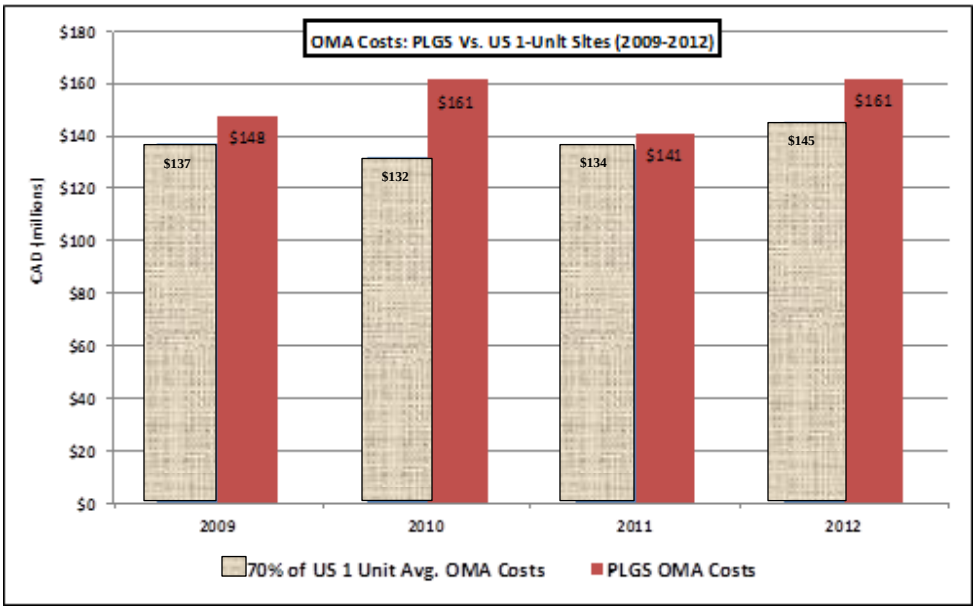
Source: Created by AGNB with data obtained from NB Power (unaudited)

NB Power advised that approximately 70% of the systems within PLGS remained operational during the refurbishment

2.130 NB Power advised that approximately 70% of the systems within PLGS remained operational during the refurbishment. This estimated level of operating systems usage during an outage is typical for a CANDU nuclear plant.

2.131 PLGS OMA costs during the refurbishment were higher than the United States average, as shown in Exhibit 2.14. Although higher than US costs, they appear to be reasonable. The US numbers may be somewhat lower because many of the stand-alone sites in the US are managed by a parent utility company that provides significant cost savings through economies of scale (sometimes as much as 20%) versus stand-alone sites like PLGS.

Exhibit 2.14 - Comparison between OMA Costs PLGS vs. US Sites



Source: Created by AGNB with data obtained from NB Power and other sources (unaudited)

NB Power applied standard nuclear industry practices in managing their OMA costs during the refurbishment

2.132 NB Power applied standard nuclear industry practices in managing their OMA costs during the refurbishment. Although slightly higher than adjusted US industry costs, the variance is explainable and NB Power's costs appear reasonable.

2.133 A number of NB Power employees were working in direct support of the refurbishment project. Some NB Power employees were retained to operate and conduct surveillance on active systems operating during the project. Others were retained to ensure their availability after the outage, regardless of the extent to which they were required at the plant during the outage.

2.134 Nuclear plant owners rarely release staff going into an outage situation. This is largely because they invest a significant amount of resources in training these individuals. The licensing process for each nuclear plant is unique, requiring a ramp-up training period for new workers irrespective of their level of experience in nuclear power. Terminating staff prior to refurbishment and then sourcing replacements of these individuals after the outage would be extremely difficult and costly. Further, significant loss of staff would create the risk of loss of the generating station operating license.

A staffing plan with cost benefit analysis of each alternative is needed

2.135 In the case of the PLGS refurbishment, however, a staffing plan with a cost benefit analysis for each alternative should have been prepared, given the size and complexity of the project and given the extended outage lasted significantly beyond originally anticipated timelines. There is no evidence that NB Power prepared such a plan before the refurbishment.

Recommendation

2.136 We recommend NB Power prepare a staffing plan for each major project and revise when it is determined that major project changes have occurred.

Appendix I – Components of Refurbishment Costs

<table>
<tr><th>Component</th><th colspan="3">Component Cost (millions)</th><th>Covered in our detailed examination?</th><th>Rationale</th></tr>
<tr><td>Project planning</td><td colspan="3">$90.2</td><td>Yes</td><td>Our work focused on procurement and contract management. Financial statement audits provided assurance on the reasonableness of capitalizing the expenditures.</td></tr>
<tr><td>Contracted services</td><td colspan="3">$780.3</td><td>Yes</td><td>Our work focused on procurement and contract management</td></tr>
<tr><td>Capitalized interest</td><td colspan="3">$292.9</td><td>No</td><td>Audit of financial statements provided assurance on the accuracy and reasonableness of the interest expenses</td></tr>
<tr><td rowspan="6">NB Power internal costs</td><td rowspan="6">$260.5</td><td>NB Power Labour</td><td>$ 149.6</td><td>Yes</td><td>Our work focused on labour costs: overtime and overhead allocation</td></tr>
<tr><td>Fees (Regulatory, Environmental, Training, Insurance etc.)</td><td>$52.8</td><td>No</td><td rowspan="5">• less significant amounts
• less risky areas in terms of reasonableness
• extensive coverage by financial statements audit</td></tr>
<tr><td>NB Power Materials</td><td>$29.0</td><td>No</td></tr>
<tr><td>Properties (Heating, Lighting etc.)</td><td>$18.6</td><td>No</td></tr>
<tr><td>Inter-Company Services</td><td>$9.3</td><td>No</td></tr>
<tr><td>Operational – Various</td><td>$1.2</td><td>No</td></tr>
<tr><td colspan="6">Total capital costs: $1,423.9 million
Total costs covered in our detailed examination: $1,020.1 million(shaded)</td></tr>
</table>

Appendix I – Components of Refurbishment Costs (continued)

Component	Component Cost (millions)			Covered in our detailed examination?	Rationale
Nuclearco period costs	$892.3	OM&A	$725.9	Yes	The OM&A remained roughly the same before and after plant shut down. Our work focused on whether it was reasonable to incur the same amount of OM&A during shut down.
		Fuel & Transmission Expenses	$9.1	No	Financial statement audit provided assurance on this amount.
		Amortization & Decommissioning	$171.0	No	
		Property Taxes	$27.7	No	
		Finance Charges	$(41.4)	No	
Replacement power minus costs recovered through current rates	$75.8			No	Financial statement audit provided assurance on this amount. Amount of replacement power was calculated based on a model approved by regulator
Interest assigned to deferral	$112.0			No	Financial statement audit provided assurance on the accuracy and reasonableness of the interest expenses.
Total deferral costs: $1,080.1 million **Total costs covered in our detailed examination: $725.9 million (shaded)**					

Source: Created by AGNB with data obtained from NB Power (unaudited)

Appendix II: Glossary of Key Terms

American National Standards Institute (ANSI)	A private non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems, and personnel in the United States and abroad.
Auxiliary (Turbine)	Support systems to help steam turbine-driven generators to work efficiently and safely.
CANDU	A nuclear reactor of a Canadian design in which the fuel is unenriched uranium oxide clad in zircaloy and the coolant and moderator is heavy water.
Change Order/ Requests / Contract Change Requests (CCRs)	A component of the change management process whereby changes in the Scope of Work agreed to by the Owner, Contractor and Architect/Engineer are implemented.
Collective Bargaining Agreement (CBA)	Contract(s) resulting from a process of negotiations between employers and a group of employees aimed at reaching agreements to regulate working conditions. The interests of the employees are commonly presented by representatives of a trade union to which the employees belong.
Earned Value Management System (EVMS)	Project planning and control designed around the integration of technical scope, schedule, and budget.
Generator	A device that converts mechanical energy to electrical energy.
Liquidated Damages (LDs)	An amount of money agreed upon by both parties to a contract which one will pay to the other upon breaching (breaking or backing out of) the agreement or if a lawsuit arises due to the breach. Sometimes the liquidated damages are the amount of a deposit or a down payment, or are based on a formula (such as 10% of the contract amount).
Outage	A period when a power supply or other service is not available or when equipment is closed down.
Risk Register	A Risk Management tool commonly used in Project Management and organizational risk assessments. It acts as a central repository for all risks identified by the project or organization and, for each risk, includes information such as risk probability, impact, counter-measures, and risk owner and so on.
Subcontractor	One that enters into a subcontract and assumes some of the obligations of the primary contractor.
Surveillance	Confirmation of compliance, usually via remote detection, with operational limits and conditions of equipment and to detect and correct any abnormal condition before it can give rise to significant consequences for safety.
Turbine	A turbo machine with at least one moving part called a rotor assembly, which is a shaft or drum with blades attached. Moving fluid acts on the blades so that they move and impart rotational energy to the rotor. Early turbine examples are windmills and waterwheels.