ONTARIOPOWER GENERATION

Incident Investigation Report

Internal Use Only	
SCR Number: D-2013-19100	R002

Event Title: DELAY IN D20 STORAGE PROJECT

Event Date: 2013-10-24

Revision 2

SCR No.: D-2013-19100

Resolution Category: B

Significance Level: 2

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1.0 EXECUTIVE SUMMARY

What happened: The original committed to milestone date of October 5, 2013 for the Low Pressure Service Water tie-ins was missed by the D2O Storage Project which resulted in a 2 month delay to the Tritium Removal Facility (TRF) Outage.

How it happened: The D2O Project was delayed pending OPG Board approval to proceed with Darlington Refurbishment, implementation of the Extended Services Master Service Agreement (ESMSA), and implementation of Engineering Procure and Construct (EPC) modification process. As a result the project got off to a late start and this was not flagged as a risk. The other main risks associated with being:

- The first project for the refurbishment organization
- The first major project to use the EPC process
- The first project to use the ESMSA process

were to be mitigated by the EPC process. Adverse conditions arising from these risks had to be corrected as this "pilot" project progressed. The refurbishment interfaces with the Station Operations and Contractor processes were not clarified and effective. Contractor expertise was not initially aligned with OPG methods and standards for modification design requirements (MDR) and schedule preparation. As a result Contractor developed MDR, and project schedule were not aligned with OPG standards to facilitate risk identification and milestone threats. This was due to failure of involving the right expertise at the right time to get detailed MDR's and a quality project construction schedule. As result, all the risks were not visible via the schedule and further delays in the project occurred.

Extent of Condition: applicable to all projects including refurbishment which have an impact on milestones external to the project. Evaluation Organization Manager briefed the affected Project Managers on the results of this investigation to assist in recognizing and correcting similar issues.

Direct Cause:	D20 Project was not effectively interfaced with station schedule to align both organizations in support of critical tie-in.
Root Cause (RC-1):	Failure of OPG and B&M to engage all sub-contractors in development of quality schedule. Risks and duration of activities were not clearly understood resulting in missed station interface milestones.
Contributing Cause (CC-1):	Failure of OPG to anticipate and mitigate risk prior to affecting external milestones.
Contributing Cause (CC-2):	Modification Design Requirements not sufficiently detailed.
Contributing Cause (CC-3):	Late issuance of Purchase Order (PO) - 18 months after approval memo.
Contributing Cause (CC-4):	Competing for station support

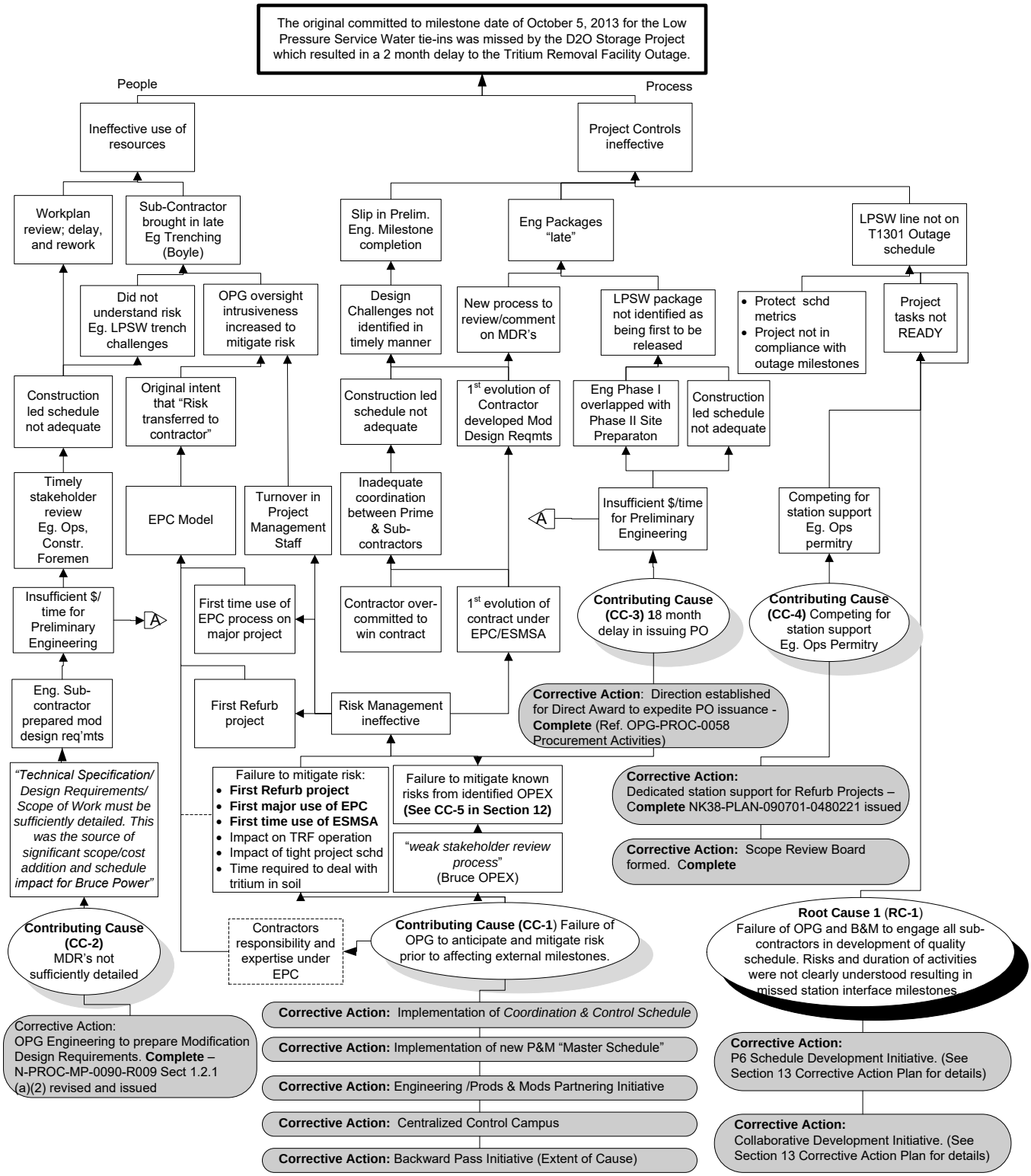
Extent of Cause: The causes identified in this report and the lessons learned identified in the D2O Storage and Drum Handling Project: Modification Planning Lessons Learned Report are applicable to all projects including refurbishment.

Corrective actions:

- (RC-1): - P6 Schedule Development Initiative.
  - Collaborative Development Initiative.
- (CC-1): - Implementation of Coordination and Control Schedule.
  - Implementation of new P&M "Master Schedule".
  - Engineering /Projects and Modifications Partnering Initiative.
  - Centralized Control Campus.
- (Extent of Cause) - Backward Pass Initiative - review of current schedules' timeline do ability

Detailed description of all actions is in Section 13 - Corrective Action Plan

D20 Project Missed Milestone Event Causal Analysis Map



See Section 13 Corrective Action Plan for full description of action

2.0 PROBLEM STATEMENT

The original committed to milestone date of October 5, 2013 for the Low Pressure Service Water (LPSW) tie-ins was missed by the D2O Storage Project which resulted in a 2 month delay to the Tritium Removal Facility Outage.

Terms of Reference is in Appendix A.

3.0 IMMEDIATE AND INTERIM ACTIONS

The following are main corrective actions that were implemented by the OPG Project team during the project:

- Projects & Mods (D2O Project) embedded Modification Team Leader (MTL) into Black and McDonald (B&M) organization to support preparation and co-ordination of LPSW trench.
- A tight alignment between work plan authors and reviewers, included relocation of B&M/RCMT staff to Engineering Services Building.
- Construction shift expanded to 6 day 10hrs immediately, 2nd shift to commence 01 Aug 2013.
- Double shifting days and nights started in August 2013.
- Increased oversight from OPG Senior Vice President and director level weekly project meetings with all involved parties
- Design Improvement Recovery Team (DIRT) established (OPG/RCM/B&M).
- Weekly status and help needed presented to Darlington Senior Work Management meeting.
- Project Manager provided daily update to Darlington and Projects SVP's.
- Engineering Lead on the D2O Storage Project consolidated all comments among all OPG stakeholders reviewing documents before leaving OPG
    - Reviewer only to comment for their discipline.
    - Reviewers to be aware of the EPC model which holds vendor responsible for how to execute the work.
- OPG will produce MDRs and Modification Outlines (MO) to lay groundwork for plan prior to EPC start. N-PROC-MP-0090-R009, Modification Process, Sect 1.2.1(a)(2) was revised and issued.

4.0 EVENT NARRATIVE

Brief Description of Project

The D2O Storage Project involves the construction of an Annex to the TRF that includes additional office space, storage of heavy water tanks and systems to enhance TRF operations in the:

- The segregation and storage of different streams of heavy water
- Reduction of OPG Nuclear drum backlog

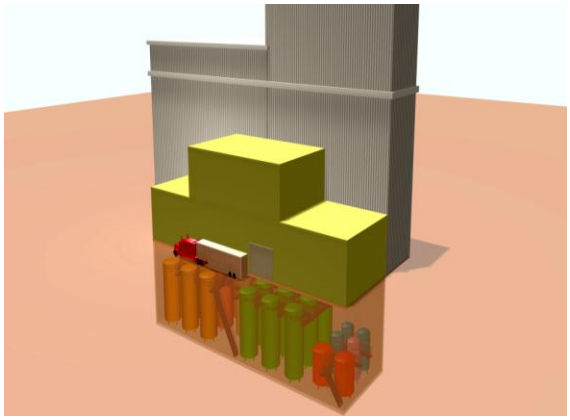
- Transfer and storage of heavy water for the Darlington refurbishment Project

A number of existing buried services needed to be relocated prior to construction of the facility. One of these was a 30 inch diameter LPSW line. This investigation was to determine why the scheduled milestone was missed in relocating and tying the line back in service.

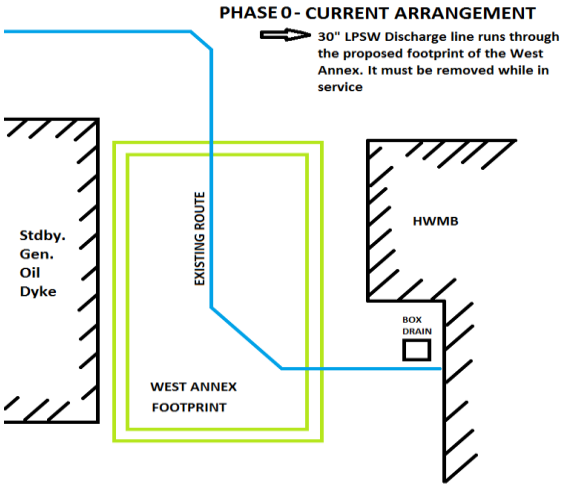
The following pictures show the location, facility and LPSW line route and excavation,

Site Location

LPSW Re-route Excavation



Schematic of Faciltiy



Routing of LPSW Buried Line

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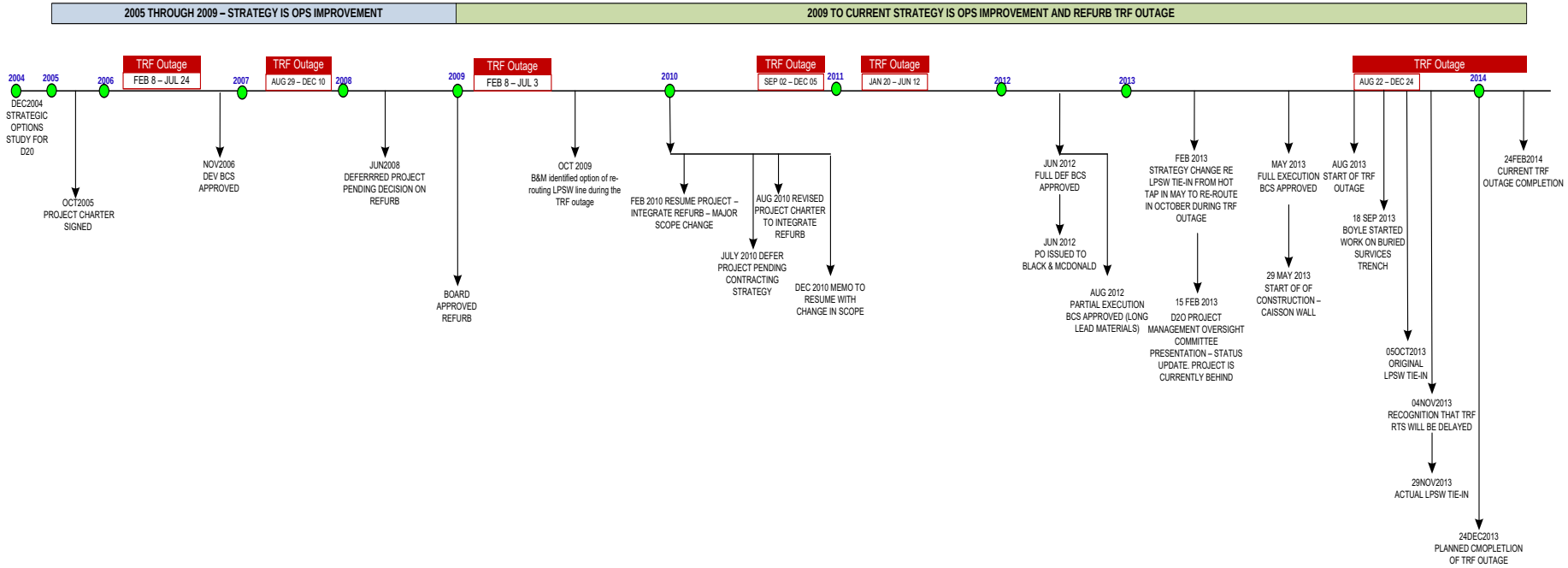
SCR Title:
DELAY IN D20 STORAGE PROJECT

This is an overview timeline of the project/event. A detailed timeline is in Appendix B.

D20 STORAGE PROJECT TIMELINE – HIGH LEVEL SUMMARY



5.0 EXTENT OF CONDITION

Other large refurbishment projects use the same organizational, programmatic processes as were used in the D2O Storage Project. The Evaluation Organization Manager for this investigation has briefed the Project Managers of these projects on the results of this investigation to assist in recognizing and correcting similar issues.

6.0 DATA ANALYSIS

6.1 Event Timeline

Appendix B contains a timeline of the project starting from December 21, 2004 up to the October 29, 2013 when SCR was generated that initiated this root cause investigation.

The timeline shows that the project was subjected to incremental slip due to a number of factors beyond the control of the project management:

Date	Event	Delay
December 2004	Strategic options study issued	Project start
September 2007	Change in funding and contracting strategy	6 months
June 2008	Project was deferred pending decision to refurbish Darlington. Scope of D2O Storage Project would change to accommodate D2O storage of refurbished unit.	18 months
July 2010	Project was deferred pending change in contracting strategy	13 months
December 2010	Memo to resume project	
January 2012	Decision to obtain engineering services and engage in Extended Services Master Services Agreement	5 months
June 22, 2012	EPC contract awarded	
Total delay	42 months or 3-1/2 years of the 7-1/2 years between 2004 start of project concept to contract award in 2012	

The delay in starting the project was not identified as a risk in either the initial June 2012 Business Case Summary (BCS) or the May 2013 BCS. Through interviews this was attributed to:

- [redacted]
- [redacted]
- [redacted]

These risks were mitigated by the EPC process (project efficiency gains due to the expertise and autonomy of the contractor), mitigation strategies, recovery plans and increased project oversight. The objective of making this first key refurbishment project a success, the Project Organization escalated its commitment via these strategies and recovery plans with a

reluctance to acknowledge reality that the schedule was unachievable until ultimately the LPSW line re-route and tie-in date was missed and Darlington TRF staff generated the SCR that precipitated this investigation.

6.2 Barrier Analysis

The governance requirements for project controls were reviewed to identify potential ineffective and or weak barriers that may have had an impact on the outcome of this event. The barrier analysis in Appendix D shows the procedural barriers deemed relevant to the problem statement.

The project controls were implement per governance requirements but were unable on their own to mitigate the slow evolving sequence leading up to the missed LPSW re-route/tie-in.

The milestone process was ineffective in raising a red flag sufficiently to mitigate and prevent the risk to the project. The governance mandated milestones and the contractual set milestones were not effective in their objective of addressing risk to the schedule. Station interface milestones such as Innage and Outage Scheduling milestones were not identified as project milestones. Section 6.4 analyzes the use of the Project milestones in more detail.

6.3 Organizational Review

Appendix G shows a simplified stream analysis of the main organizational/management failure modes. The predominant failure modes were identified via input from input of the project staff (Appendix L – Interview Summary Notes). They were:

- Inadequate Planning
- Inadequate Program Management
  - A number of those interviewed attributed the missed LPSW milestone to the lack of a “transition plan” or “strategy” at the onset of the project given the first time using the EPC process for such a major project.

- Insufficient Staffing
  - [redacted]
  - OPG Project Team underwent 9 changes during the project (Appendix C).

- Inadequate Communication among organizations and inadequate teamwork.
  - Initially per the EPC process model, the Contractor was given autonomy of the project without support from OPG resulting in unclear expectations, re-work, frustration.

As suggested by the interviewees, it was believed that a transition plan or strategy at the outset of the project would have addressed these issues.

6.4 Programmatic Review

As a result of the organizational/management challenges the following process failure modes were adversely affected as shown in Appendix F:

- Persons specified not able to perform task – [redacted]

- Actions not clear – expectations and understanding of quality standards not clarified (e.g. Contractor developed MDR's).

- No process monitoring – Milestone and float reports were not fully effective to mitigate threats to the project schedule.

- Methods not clearly described – difficulties in achieving Contractor's schedule quality to integrate with OPG outage and innage schedule.

The use of milestones to identify and ensure quality of the D20 Project progression was compared to the number of milestones to another large project in Appendix M:

Milestone	D2O Storage Project	Auxiliary Heating System Project
Number of Project Manager Defined	16	53
Total Number	36	85
Level 2 Activities	193	51
Level 3 Activities	3139	2142
Ratio of Milestone/L2 Activity	1:95	1:25
Ratio of Milestone/L3 Activity	1:196	1:40

The D2O Storage Project milestones were not fully effective because:

- The project manager defined milestones were based on contractual obligations

- The contractual obligations were based on a EC package delivery schedule per the Engineering Sub-contractor

- The Sub-contractor provided schedule was based on the system criticality, complexity and long lead time material, approvals rather than a construction led schedule

- A construction led schedule was not used because the project was planned to have substantial engineering complete in Phase I prior to the start of Phase II – site preparation.

6.5 Human Performance Review

Appendix G – Stream Analysis of Human Performance Failure Modes identifies that the "flawed process/model", "Wrong Assumptions" being the lack of a "transition plan" to implement the first time use of EPC on this first major refurbishment project led to the contractors having "inadequate knowledge of [OPG] standards" and being "unfamiliar or infrequent task". This compelled the contractors to make corrective actions during the course of the project which resulted in associated "work arounds" and "time/schedule pressure".

6.6 Review of Related Procedures

Appendix N lists the documents reviewed for this investigation. Of note was the reason why the need for re-routing the LPSW line was not identified earlier. This was attributed to the communication of the requirement in the Conceptual Design Report (applicable sections shown in Appendix N) and the lack of adequate preliminary engineering planning time/budget. This was in turn attributed to the delay in awarding the contract and the concept that the Preferred Contractor required less time for preliminary engineering planning.

The risk identification and mitigation processes were reviewed to gain an understanding as to why the schedule risk was not anticipated and addressed. Known risks to the project were handled per procedures. The Project Staff did not a have mitigation strategy or recovery plan in place to address the poor quality of the schedule. There was the belief at the time, that the efficiencies expected in the EPC process would mitigate the slip in schedule.

6.7 Benchmark to Industry

In Appendix I, the D2O Storage Project elements were compared against general industry recognized elements in order to learn from any potential identified gaps. No major gaps were identified.

The OPG Project contract awards process management appeared to fail to accommodate the interrelationship between cost and technical strength when evaluating contract proposals. In this event the contractor had a lower technical score and won the contract on price.

6.8 Interview Summary

Appendix L contains a summary notes of the staff interviewed (Appendix K). Common themes heard in the interviews were:

- Engineering cost and schedule were underestimated
- Unfamiliarity of all requirements
- Scope and schedule not fully defined
- Lack of facilities
- Numerous changes to schedule logic ties
- Time allocated for preliminary engineering planning inadequate
- Perceived ill-defined project strategy (1st evolution EPC/Refurb Project)

These factors all contributed to the repeated suggestion that the project did not have an adequate “transition plan” and/or “strategy” at the outset.

7.0 DATA ANALYSIS SUMMARY

Review of the event timeline showed that there was no one or two actions/events that were pivotal in determining the missed LPSW re-route target dates. But rather the sequence of events evolved slowly over time. The barrier analysis indicated that there was no apparent failure in project governance that had a major contributor to the event. This was also borne out by a comparison to general industry practices in the Benchmarking section.

The Organizational, Programmatic, Human Performance Reviews along with the Input from the interviews point to project challenges stemming from the first time in using the EPC/ESMSA process for such a large project, the first for the Refurbishment organization.

These challenges – risks to the project schedule were believed, at the time, to be appropriately addressed by the use of the EPC process, and increased oversight and recovery plans. The Project Staff believed at the time that the EPC process was a risk mitigation tool rather than a risk in and of itself due to its first time use in a major project.

A number of those interviewed stressed the many first time aspects of the project and when asked what they would have done differently, the response was to have a “transition plan” and/or better strategy for the project in order better identify, monitor and mitigate the risks

The Event Causal map on page 5 analyzed these findings in terms of causal relationships to identify the fundamental root cause and contributing causes. It shows that the challenges due to the first time evolutions of the project led to further delays in the schedule. As detailed engineering was delayed and the lack of detailed project construction schedule based on expert stakeholder input made it difficult to identify risks and threats to milestones.

When the risks were known, the Project Staff effectively implemented the required risk mitigation processes. The threat to the overall project progress and impact on the tie-in milestone was not anticipated because of the lack of a quality schedule, integrated with all interfacing schedules. The visibility of milestone risks is dependent on the quality of the schedule. As result the Project missed a major milestone because it was not clearly evident to either Project Staff or Management oversight forums.

The direct cause for failing to meet the LPSW re-route and tie-in schedule date was due to the D20 Project not being effectively interfaced with station schedule to align both organizations in support of critical tie-in. As a result the tasks interfacing with Station Schedules were not READY per the outage schedule preparation milestones. The root cause was the failure of OPG and B&M to engage all sub-contractors in development of quality schedule. Risks and duration of activities were not clearly understood resulting in missed station interface milestones.

8.0 OPERATING EXPERIENCE REVIEW

8.1 Industry Operating Experience

The Project Team conducted a benchmarking meeting and site visit to Bruce Power on Feb 11, 2011 and April 28, 2011 respectively. The purpose was to gain lessons learned from the Bruce Heavy Water Storage Project, for the Darlington D2O Storage Project.

The investigation team compared the Bruce lessons learned to all relevant SCRs’ for the Darlington D2O Storage Project. The Bruce Lessons Learned were not fully utilized to avoid similar pitfalls during the D2O Storage and Drum Handling Project. Sustainable corrective actions from the original self-assessment and subsequent SCR’s were not implemented.

All of the listed SCR’s were designated a resolution and significance of D4. Only immediate corrective actions were required. The self-assessment had no listed SCR or Management Actions. The conclusion of the self-assessment was that “Benchmarking OPEX was

completed and all aspects have been either addressed or listed in the Risk Management document.

8.2 Site Operating Experience

The investigation team queried the SCR database. 10 SCRs associated with the D2O Storage Project, 8 of them are missing milestone related.

There were 178 SCR's associated with T1301. Of these, 41 are Milestone/Schedule related.

Prior to the re-start of the Project, the project management team reviewed relevant OPEX in order to ensure the design of the Heavy Water Management Building did not repeat past errors and improves working conditions. The review in the report (NK38-DRT-38000-10001, NK38-REF-38000-0427531) did not include project execution OPEX.

SCR N-2012-00198 documents the cancellation of a second submission of Request for Proposal for Engineering Services for the D20 Project. The cancellation resulted in a 6 week delay in the schedule. The Apparent cause was attributed to not adequately recognizing risks associated with the new approach for processing the RFP, the project schedule should have been adjusted accordingly.

[redacted] Apparent causes were attributed to:

- [redacted] OPG did not have a formal process in place to efficiently communicate and resolve schedule issues and commitments.
    - Departmental resource planning processes did not ensure that personnel with the required qualifications were available to perform the tasks as scheduled.
- [redacted].

A March 3, 2013, Engineering Oversight Findings PowerPoint Presentation summarized 119 SCR's related to all project work conducted by RCM over the previous 12 Months were binned as:

- 49 Process and Procedure
- 39 Design Quality
- 29 Schedule Delays
- 2 Scope related

8.3 Operating Experience Review Conclusions

The Project Team sought out, self-identified both external Bruce and internal OPEX. [redacted]

[redacted]. Sustainable corrective actions from the original self-assessment and subsequent SCR's were not implemented.

8.4 Outgoing Operating Experience

A preliminary World Association of Nuclear Operators preliminary event report was initiated for this event.

9.0 SAFETY SIGNIFICANCE AND REPORTABILITY

9.1 Nuclear Safety Significance

Challenges with the D2O Storage Project resulted in delaying the LPSW line relocation. This caused a potential push to the TRF restart due to the T1301 maintenance window becoming critical path. The impact of this included:

- Rework to the T1301 outage schedule to achieve a recovery date for TRF restart. The time delay had a potential financial impact on the heavy water business.
- Reduced 2014 TRF production will:
  - Challenge development of the prerequisite 2015 VBO PHT D_2O inventory (430 Mg) to shutdown the four units
  - Impact the 2014 HW business plan target, affecting detritiation targets for all Ontario CANDU units
- Two Upgrader shutdowns.
- Increased moderator tritium across all Darlington units as moderator detritiation does not occur during TRF outages.

The actions involved in this event were analyzed in terms of the Traits for a Strong Nuclear Safety Culture– Appendix J. The traits adversely affected were:

2. Questioning Attitude – The Project was not "watchful for assumptions, values, conditions or activities that can have an undesirable effect on plant safety" such that this important LPSW re-route activity did not proceed as planned.

5. Decision-Making – not all stakeholders were engaged at the right time in the project to poetically identify risks.

7. Respectful Work Environment – [redacted] This imposed a stress on the project staff. Initial implementation of the EPC model failed to provide the contractor clear expectations and guidance on how to achieve desire outcomes during this "pilot" project resulting in some frustration (re-work) and resentment.

9.2 Radiological Safety Significance

The challenges with the D2O Storage resulted in a nine week push from the planned TRF restart. The impact of this includes

- No moderator online transfers will have been completed from early July 2013 to at the earliest, February 2014 resulting in:
  - Increased moderator tritium, predicted to be on average 10.3 Ci/kg by T1301 end and almost 9.5 Ci/kg on average at 2014 year end.
- Challenged ability to detritiate for the D1411 outage (April 2014), resulting in potential increased dose (200 mrem incremental dose per Ci/kg target increase)

9.3 Industrial Safety Significance

There was no impact to industrial safety. The event had no environmental impact and no worker injury.

9.4 Reportability

This event was not reportable because it did not impact any conventional or nuclear safety, environment reporting criteria.

10.0 DIRECT, ROOT AND CONTRIBUTING CAUSES

10.1 Direct Cause (DC)

D20 Project was not effectively interfaced with station schedule to align both organizations in support of critical tie-in.

As a result the tasks interfacing with Station Schedules were not READY per the outage schedule preparation milestones.

10.2 Root Cause (RC-1)

Failure of OPG [redacted]. Risks and duration of activities were not clearly understood resulting in missed station interface milestones.

[redacted] Therefore the tasks were not shown on the station schedules, effectively monitored, and done.

10.3 Contributing Cause (CC-1)

Failure of OPG [redacted]

The Project Staff effectively handled known risks, however the threat to meeting milestones was not clearly visible because of a lack of quality schedule that interfaced with station schedules and milestones.

10.4 Contributing Cause (CC-2)

MDR's not sufficiently detailed.

This was evident in the first MDR that was submitted. It was rejected due to noncompliance with N-INS-00700-10007, Preparation of Modification Design Requirements. Subsequently EC118632 regarding standby generator fuel tank control cables, yard drainage & fuel tank fire protection was rejected due to insufficient detail in solution and justifications (Ref. D-LLD-38000-10001, D20 Storage And Drum Handling Project: Mod. Planning Lessons Learned Report). The vendor had limited experience in producing MDR's.

10.5 Contributing Cause (CC-3)

Late issuance of PO - 18 months following approval memo.

The approval to proceed with the project was granted in December 2010. The purchase order was issued to Black and McDonald in June 2012.

10.6 Contributing Cause (CC-4)

Competing priorities for station support of the Project due in part to the lack of integration of project schedule to station schedules (Direct Cause).

10.7 Contributing Cause (CC-5)

OPEX not fully implemented into sustainable actions.

The causes found in this investigation were previously identified and documented in the D2O Storage and Drum Handling Project: Modification Planning Lessons Learned Report, and in the Self-Assessment: Lessons Learned Evaluation - Bruce Power D2O Storage Project.

11.0 EXTENT OF CAUSE

The causes identified in this report and the lessons learned identified in the D2O Storage and Drum Handling Project: Modification Planning Lessons Learned Report, D-LLD-38000-10001 are applicable to all Refurbishment projects. (Ref. Corrective Actions for CC-5 and Extent of Cause in Section 13 – Corrective Action Plan)

12.0 REVISION SUMMARY

12.1 Revision 1; 2014-02-06

Report revised to incorporate changes per Evaluation Organization Manager.

Section	Description
1.0 Executive Summary	Added [redacted] to description of root cause.
Causal Analysis Map on Page 5	Added corrective action for CC-1 see Section 13 for details.
13 Corrective Action Plan	Added “90% completion rate” and revised “scope stability of 87%” Added corrective action for CC-1. Incorporation of P&M VP initiative on schedule improvement, oversight, risk resolution and project progression.
12 Revision Summary	New section added.

12.2 Revision 2; 2014-03-13

Report revised based on feedback from Darlington Corrective Action Review Board on February 25, 2014. Revision bars used.

Section	Description
1.0 Executive Summary	• Revised description of Direct Cause, Root Cause, and associated action for root cause. • Added corrective actions for Contributing Cause 1.
Causal Analysis Map on Page 5	• Revised wording of corrective action for RC-1. • Added corrective actions for Contributing Cause 1.
7.0 Data Analysis Summary	• Added summary on the failure to anticipate risk. • Re-worded causes to align with Executive Summary and rest of report.
10.0 Direct, Root And Contributing Causes	• Elaborated on basis of each cause
11.0 Extent of Cause	• Added reference to associated corrective action
13 Corrective Action Plan	• Wording of causes and corrective actions revised to align within report. • Added corrective actions for Contributing Cause 1. • Added Completion and Success Criteria to all outstanding contributing causes. • Added extent of cause action.

13.0 CORRECTIVE ACTION PLAN

CAUSE TO IMMEDIATE AND COMPENSATORY ACTIONS MATRIX	
CAUSE	**CORRRECTIVE ACTION**
B&M unfamiliar with OPG processes and standards.	MTL embedded into B&M to support preparation and co-ordination of LPSW trench. - **complete**
New, unfamiliar interface between B&M and OPG in reviewing and approving documents.	(1) Alignment between work plan authors and reviewers, including relocation of B&M/RCMT staff to Engineering Services Building. - **complete** (2) Engineering Lead on the D2O Storage Project consolidated all comments among all OPG stakeholders reviewing documents before leaving OPG - **complete** • Reviewer only to comment for their discipline. • Reviewers to be aware of the EPC model which holds vendor responsible for how to execute the work.
First EPC project identified need for increased oversight.	Weekly project meetings with all involved parties including increased oversight from OPG Senior Vice President and director.
	Project Manager provided daily update to Darlington and Projects SVP's.
	Weekly status and help needed presented to Darlington Senior Work Management meeting.

ROOT CAUSE TO CORRECTIVE ACTION MATRIX		
CAUSE	**CORRECTIVE ACTION**	**COMPLETION AND SUCCESS CRITERIA**
(RC-1) Failure of OPG and B&M to engage all sub-contractors in development of quality schedule. Risks and duration of activities were not clearly understood resulting in missed station interface milestones.	**(CAPR-1) Description:** P6 Schedule Development Initiative: P&M to integrate and simplify P6 process from existing multiple schedule model to a single, fully resource loaded, deliverable based schedule that is developed with all subcontractors and stakeholders that have accountability for the successful completion of the work. This single schedule will be located in the OPG P6 database with N-PROC-MA-0022 milestones clearly defined. **Due Date:** June 30, 2014 **Owner:** PMPCCSM	**Completion Criteria** Issue Integrated P6 schedule of all major Facilities and Infrastructure Projects. **Success Criteria:** Achievement of VP directed Business Case Summary defined milestone target. 90% completion rate of project tasks on Integrate On-Line Work Schedule.
	(CAPR-2) Description: Collaborative Development Initiative: P&M implementing process to develop Business Case Summary “conceptual” work scope jointly with selected vendors. This will be done in a collaborative effort. Key objective is to achieve better scope definition, including value engineering, identification of long lead materials, and quality schedules that will result in increased success of project execution. This initiative engages the selected vendors throughout the entire life cycle of project. Early engagement by selected vendors, allows for increased planning and risk mitigation in downstream execution activities. **Due Date:** June 30, 2014 **Owner:** PMPMPD	**Completion Criteria** Expectation issued, communicated and understood by all Project Managers/Leaders that Conceptual Work Scope for Business Case Submission may require Vendor input for selected priority projects. **Success Criteria:** Documented evidence that initiative is being used. Number of instances implemented meets P&M VP expectations. Of the implemented instances, there should be documented evidence that Business Case Summaries requiring Vendor collaboration have included input from Vendors in developing the “conceptual” work scope.

CONTRIBUTING CAUSE TO CORRECTIVE ACTIONS MATRIX		
CAUSE	**CORRECTIVE ACTION**	**COMPLETION AND SUCCESS CRITERIA**
(CC-1) Failure of OPG and B&M to mitigate project risks prior to adversely affecting external milestones.	**Description:** Implementation of *Coordination and Control Schedule* (C&CL2) per N-MAN-00120-10001, Nuclear Projects Schedule Management. Purpose of C&CL2 is to integrate, monitor, escalate, communicate, and control threats to interconnecting Projects and interfaces. **Completion Date:** May 28, 2013 **Owner:** N-PMFPM	**Action Complete** *Coordination and Control Schedule* issued
	Description: Implementation of new P&M "Master Schedule" improvement initiative. Schedule consists of fully integrated, resource loaded schedules which are aligned with MA22, MA13, and VBO Milestones. Allows for improved oversight to ensure quick resolution to risks and delays in project progression on a daily basis. **Completion Date**: June 30, 2014 **Owner**: PMPCCSM	**Completion Criteria:** Process up and running to monitor coordination and control. **Success Criteria:** Self-assessment conducted and documented in database confirming documented evidence from Meeting Actions, Minutes or action log of risks identified, mitigated, eliminated.
	Description: Engineering /Prods & Mods Partnering Initiative: • Late designs have proven to be a significant risk for the 2014 and 2015 work program. Key initiative for 2014 will be to establish a process of enhancing design oversight of project milestones. • P&M and Refurb design will be placing OPG staff into each of the vendor design studios. Imbedded OPG staff will ensure issues are immediately addressed and subsequently escalated if resolution cannot be obtained. **Completion Date**: June 6, 2014 **Owner**: NRPESPM	**Completion Criteria:** OPG staff embedded into each of vendor design offices. **Success Criteria:** Documented evidence that embedded OPG staff have identified, tracked and dispositioned issues related to assigned vendor/design.
	Description: Centralized Control Campus: • On grounds campus for all stakeholders to support P&M work on the Darlington site. Facility will house all necessary personnel for field engineering, design engineering (as needed), OPG staff and vendor teams that need to be close to the project site. Daily POD meeting will be held in the newly constructed war room. **Completion Date**: Sept 30, 2014 **Owner**: N-PMFPM	**Completion Criteria:** Centralized Campus Control Centre set-up and running. **Success Criteria:** Observable and documented evidence that Campus Control Centre is in place, monitoring, identifying, tracking and resolving risks to Campus Plan Schedules/Projects.
(CC-2) MDR's not sufficiently detailed	**Description:** OPG Design Authority responsible for the preparation of MDR. **Completion Date:** May 3, 2013 **Owner:** PMFPM	**Action Complete** N-PROC-MP-0090-R009, Modification Process, Sect 1.2.1(a)(2) revised and issued.
(CC-3) Late issuance of Purchase Order - 18 mo following approval memo.	**Description:** Direct Award to expedite PO issuance. **Completion Date:** December 6, 2013 **Owner:** N-PMFPM	**Action Complete** (Ref. OPG-PROC-0058 Procurement Activities)
(CC-4) Competing priorities for station support of the	**Description:** Dedicated station support for Refurbishment Projects. **Completion Date:** October 8, 2013	**Action Complete** NK38-PLAN-090701-0480221 issued.

CONTRIBUTING CAUSE TO CORRECTIVE ACTIONS MATRIX		
CAUSE	**CORRECTIVE ACTION**	**COMPLETION AND SUCCESS CRITERIA**
Project.	**Owner:** N-PMFPM	
	Description: Scope Review Board and meeting formed. **Completion Date:** January 14, 2014 **Owner:** N-PMFPM	**Action Complete**
(CC-5) OPEX not fully implemented into sustainable actions.	**Description:** Assess recommendations from D20 Storage And Drum Handling Project: Mod. Planning Lessons Learned Report (D-LLD-38000-10001): (1) Accepted recommendations to be implemented with sustainable actions by being included in appropriate governance process documentation. (2) Recommendations that are not accepted are to have rationale for non-implementation documented in closure notes of this action. **Due Date:** June 27, 2014 **Owner:** N-PMFPM	**Completion Criteria:** Recommendations assessed, dispositioned, and documented **Success Criteria:** Documented results and conclusions are retrievable to facilitate sharing this OPEX. Confirm other Project Managers are able to retrieve the OPEX.
Extent of Cause Action	**Description**: Backward Pass Initiative: Perform extensive review of the current schedules for Facilities & Infrastructure Projects to: (1) identify all current / potential interface points between P&M and the Operating Units (2) confirm the reasonableness of all key schedule durations and start/finish dates for F&I structures; (3) identify the “drop dead” dates for each structure based on the last possible date for AFS **Completion Date**: June 30, 2014 **Owner**: PMPCCSM	**Completion Criteria:** Findings and conclusions documented in a self-assessment. **Success Criteria:** Identified risks SCR’d, evaluated and addressed.

Appendix A - Investigation Terms of Reference

ONTARIOPOWER GENERATION

Records File Information:
Attach file electronically to
Station Condition Record

Internal Use Only

N-FORM-10139 R007*

Incident Investigation Terms of Reference

Routing: For personnel safety investigations please route copies to:
- Site Safety Manager
- Director, Corporate Safety

SCR number: D-2013-19100 Event Title: T1301 Further Delays Relating to D2O Storage Project

Resolution Category: B Significance Level: 2

Specific Evaluation Techniques to be Used: in accordance with N-STD-RA-0008, Incident Investigation

S-99 reportable: Yes ☐ No ☒ If YES, Event Follow-up Report due date:

Licensing Contact (S-99 only): No

CACG Mentor: N/A

Manager's Instructions:

Problem Statement: (precise and concise description of the problem)

The original committed to milestone date of Oct 5th for TRF LPSW Tie Ins was missed by the D20 Storage Project which resulted in a 2 month delay to the TRF Outage.

General:

Items to be included in scope of investigation:

Project Identification, Initiation, Definition & Execution Phase schedule / timing

Contract Mgmt including Communication, Escalation & Dispute Resolution processes

Project Mgmt including Risk Mgmt / Mitigation process

Project Oversight process

Project schedule/Project Risk Management/Project & Contract Oversight/Eng Issues/Scope Control/Unidentified services during excavation

Interface issues including knowledge of station processes and system operation / configuration.

Estimation methods

Quality of preparation and readiness to execute on-site work.

Items which are outside the scope of this investigation include:

ES MSA process

Resources:

Team members, work groups represented:

P&M D2O Projects SME's: Julian Read, Josh Burns
Prime Vendor SME's: B&M PM: Kelani Rickard
P&M DN: Fred Enns
P&M PN: Terry Chong

Facilities:

GM Building and Luca Ceccato's Office at 777 Brock Rd

Overtime authorized (to be used at leader's discretion, within applicable policies):

No overtime

Key Dates:

*Associated with N-STD-RA-0008, Incident Investigation

Internal Use Only
N-FORM-10139-R007
INCIDENT INVESTIGATION TERMS OF REFERENCE

Manager Update Meetings Scheduled? Every Tuesday 1300-1400 for course of investigation

Yes ☒ No ☐

	Target	Actual
Investigation start:	2013-12-04	2013-12-04
Preliminary report to Manager:	2013-12-19	
Draft report to Manager:	2014-01-13	
Final report to Manager:	2014-01-21	

Investigation to be performed in accordance with N-STD-RA-0008, Incident Investigation

Additional Comments:

CAP Due date: 2014-01-22

These Terms are agreed upon by:

EVALUATING ORGANIZATION MANAGER: Luca Ceccato (print name/signature) Date: 2013-12-05

TEAM LEADER/EVALUATOR: Martin Spelt (print name/signature) Date: 2013-12-05

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Appendix B - Event Timeline

The following is a detailed timeline of events leading up the problem statement.

Date	What happened? What was the outcome?	What should have happened? Consequences of the Differences Significance of the Differences
21-Dec-2004	Strategic Options Study for OPG D20 Storage and Handling	
30-June-2005	New Project Request – Add heavy water facilities at Darlington/TRF and Pickering.	
13-Oct-2005	Project Charter – Heavy Water Storage/Drum Handling Facilities Rev 0	
27-Feb-2006	Request for Proposals (RFP) for OPG Heavy Water Storage and Drum Handling Study	
Nov 2006	Developmental Business Case Summary approved to complete a Technical Evaluation	
3-May-2007	Request for Proposal - Darlington New D20 Storage Facility – Phase I: Development of EPC Technical and commercial package. – 2 phases: Award of EPC Contract "Firm Fixed Price"	

18-Sep-2007,	Project Change Request (PCR)
	Description of Proposed Change:
	• DCA and DES milestones from 30-May-07 to 10-Oct-08 and 11-Dec-07 to 27-Mar-09 respectively
	• Change funding strategy
	• Change in contracting strategy
	  • Reduces risk of cost escalation; contractors will be responsible for the quality of their technical evaluation work
	  • Change funding strategy – Requires reflow of cash (limit funding in 2008, pushing to 2009 and delaying the project by 6 months)
	  • Impact
	Key milestones moved	

January – May 2008	Firm fixed price bids for the EC contracts were received	

9-Jun-2008	Project Change Request (PCR)
	Details of Proposed Change:
	• Defer project for a period of longer than 6 months until the Darlington Refurbishment decision has been made
	  • Phase 1 (Technical Evaluation) completed
	  • Vendors submitted quotes (bid evaluations were completed in February 2008)
		Deferred to avoid paying interest on capital while the project scope was being re-evaluated.

Date	What happened? What was the outcome?	What should have happened? Consequences of the Differences Significance of the Differences
2009	OPG Board approves Darlington refurbishment	
28-May-2009	Darlington Refurbishment D20 Storage Facility Evaluation NK38-REP-09701-0265054-R000 T20 • Overall objective to provide sufficient heavy water storage capacity at the Darlington site during the refurbishment period.	
09-Feb-2010	Resume project to: (4) Increase Darlington Nuclear Supply & Inventory D20 Storage Capacity. (5) Integrate the D20 storage needs with the storage requirements for the Darlington Refurbishment.	
18-Aug-2010	Project Charter – Refurbishment, Operational Improvement & Long Term D20 Storage R0	
July- 2010	Defer project pending contracting strategy. Effective February 2010.	Work was not started on Feb 2010 because strategy had not been finalized.
Aug-2010	Project Charter revised to integrate refurbishment requirements	"Internal OPEX site excavation activities typically result in discovery issues so this needs to be addressed as part of contingency planning". External OPEX Bruce Power [D2O storage tanks] project experienced numerous problems, which resulted in schedule delays…"
28-Sept-2010	Report Long term strategy for D20 Storage Facility	
8-Dec-2010	Memorandum to Resume Darlington Heavy Water Storage Facility Project	
7-Feb-2011	Statement (scope) of Work: Darlington D20 Storage Facility.	
29-Apr-2011	Request for Purchasing • Oct, 2011: Award Contract: • **Mar, 2012: Prelim design complete** • Mar, 2012: Specification of Long Lead materials complete: • **Nov, 2012: Detailed design complete:** • Dec, 2014: Construction Support Complete: • Apr, 2015: Final AFS:	
9-May-2011	Issue Request for Proposals for Design Contract	
20-Jun-2011	Project Charter- Refurbishment, Operational Improvement & Long Term D20 Storage R1	
28-Jun-2011	D2O Storage Project Update:	

Date	What happened? What was the outcome?	What should have happened? Consequences of the Differences Significance of the Differences
	Risks: Modification planning deliverable is of low quality and requires re-work, delays to schedule. Risk based on OPEX with design vendors and compressed timeframe for modification planning (4 months) Mitigating Actions: • Increase design oversight • Constructability review of design Risk: Project scope not finalized Mitigating Actions: • Draft revised charter for approval. Routing on hold pending resolution of sponsor/DA roles.	
24-Nov-2011	Scope of Work for Engineering Contract: Darlington Heavy Water Storage Facility Project	
29-Nov-2011	D2O Storage Project RFP in support of Engineering Services was issued to six proponents.	
7-Jan-2012	Request for Proposal for Engineering Services was cancelled because all bids did not meet the mandatory criteria. (Ref. N_2012-00198)	Decision made to stop the process and engage into the Extended Services Master Services Agreement initiative. This prevented the business case from moving forward for approval in March 2012 to the Board of Directors and resulted in a 6 week delay to project.
29-Feb-2012	Scope of Work for EPC Contract for the Darlington D2O Management Building West Annex	
6-June-2012	D20 Storage Project Update Risks: Tritium in ground water at preferred site location Cost of EPC contract increases due to discovery work or existing systems do not have adequate capacity. The EPC contract may be let before successful implementation assessment is conducted on the initial EPC project. Design & Procurement Engineering resources to support thorough & timely reviews.	
13-June-2012	D20 Storage Contract Recommendation Technical Expertise	The low technical score of Black & McDonald indicates a higher risk profile: Mitigation of this risk must be addressed by applying intensive oversight and including appropriate budget

Date	What happened? What was the outcome?	What should have happened? Consequences of the Differences Significance of the Differences
	• The lower technical score for Black and McDonald indicates a higher risk profile: • Mitigation of this risk must be addressed by applying intensive oversight and including appropriate budget contingency. Risk Management Plan • [redacted] Quality and Completeness of Proposals • Proposal was difficult to gauge for understanding of the CDR, SOW and DR. Proposal was largely generic. Proposal conflicts were observed between sub-contractors of the group (i.e. Ellis Don, RCMT, B&M).	contingency. This is included in the business case.
18-June-2012	Project Milestone: Phase I PO Issued (Detailed Design)	
22-June-2012	EPC Contract Awarded	
Aug-2012	Partial execution BCS approved for long lead materials	
10-Sept-2012	Project Milestone: Phase II PO Issued (Site Preparation)	
14-Sep-2012	Complete - Partial Execution BSC	
9-Oct-2012	B&M identified option of re-routing LPSW line during the TRF outage	
26-Oct-2012	D2O Storage Contractor - Recommendation to perform hot taps to relocate LPSW line	
29-Oct-2012	OPG declines option. Plan continued to be using the hot tap.	
6-Dec-2012	D2O Storage Project Update: top risks • Vehicle access to protected area not sufficient • Soil is contaminated • Ground water is contaminated • Readiness to execute site preparation	
13-Dec-2012	PO issued for tanks	
21-Dec-2012	Complete- Preliminary Engineering (2 months behind schedule)	Completion of the EC packages driven by payment rather than by construction schedule This was a major milestone that was 2 months behind schedule which resulted in compression of the detailed design, and when combined with additional scope items identified during the preliminary

Date	What happened? What was the outcome?	What should have happened? Consequences of the Differences Significance of the Differences
		engineering phase, resulted in a risk for the July 15th milestone.
15-Jan-2013	Complete- Award Phase II of EPC Contract (Site Preparation)	

4-Feb-2013	D20 Storage Project Update:
	• 30" LPSW line must be re-routed
	• This pipe supports cooling discharge of loads inside the TRF/HWMB and cannot be interrupted without simultaneous TRF and Upgrader outages.
	• Relocation of this line is a critical step that critical path must go through
	• Project is currently behind
	• Mod planning was completed 4 months behind schedule.
	• Delay in Modification Planning has created a log jam of work for the project:
	• Delayed Design EC Completion
	• OPG could not accept designs before mod planning was completed.
	• Delayed Work Plan Approvals
	• Work plans could not be drafted until detailed design in progress, which fell behind as a result of the delay in modification planning.
	• Work plans could not be approved before design was approved.
	• Delayed Assessing and Setting Tasks to Ready.
	• Without work plan or complete design, assessing could only be partially started
	• Assessing is behind as a result of designs and work plans behind schedule.
	• Moving the TRF outage to allow a conventional re-route currently not an option due to significant impact and cost to OPG operating units
	• 3 Main Schedule Options Remain
	(6) Continue with hot tap as schedule in May (not recommended – not ready)
	(7) Reschedule hot tap for August (not recommended – past break even)
	(8) Delay LPSW Re-route to October, during TRF outage (recommended)
	• Advantages of delaying LPSW re-route to October 2013
	  • Avoids rushing to do hot tap and therefore avoids safety and quality risks
	  • Lowest OPG cost ($2M vs $3.1M to execute hot tap)
	  • Allows time to better meet work control milestones
	  • Clears log jam of designs, work plans, and assessing currently being executed simultaneously (not enough bandwidth for vendor or OPG to be successful in these circumstances)
		Lesson's Learned Report Generated (D-LLD-38000-10001)

Date	What happened? What was the outcome?	What should have happened? Consequences of the Differences Significance of the Differences

	• Disadvantages of delaying LPSW re-route to October 2013
	  • Maximum schedule slippage of 4.5 months possible
	  • Recovery plans currently being developed by B&M to do better than 4.5 months
	  • Adversely affects refurbishment detritation strategies
	  • Alternative options to currently accepted strategy are under review
	  • Increased congestion on site during campus plan execution phase
	• **Recommendation* – Delay LPSW re-route to October 2013**
	  • Safety a concern
	  • Avoids expediting re-route using hot tap approach which would increase safety and quality risks due to less time prepare
	  • Readiness for hot tap very unlikely, cut losses now
	  • Materials not ordered but are long lead (i.e. valves, split tees)
	  • Hot tap equipment not yet reserved (currently no purchase order with TDW)
	  • Design is not complete
	  • Complex work plan will require significant effort, and has not started
	  • B&M does not currently have an approved welding procedure for this work
	  • Hot tap schedule advantage not guaranteed (back out possible)
	  • Back out due to zebra mussels possible
	  • Back out due to inadequate wall thickness possible
	  • Back out due to poor condition of buried pipe
	  • Past break even point where hot tap provides cost/schedule advantage
	  • Lowest cost option at this point
	• Key Risks
	  • Current cycle times through sally port not fast enough to support project
	  • Proposed solution to have remote security screening facility and larger number of vehicles permitted in the sally port
	  • Delays at sally port critical risk to project cost and schedule
	  • Owner obligation for OPG to facilitate movement of materials without unreasonable delays
	  • Delays risk concrete spoilage (increase costs)
	  • Delays risk schedule slippage (unable to remove soil at required rates or bring materials in timely manner)	

8-Feb-2013	Start of site preparation (**Phase II**)	Per Gate 3b Presentation, Phase I: site

Date	What happened? What was the outcome?	What should have happened? Consequences of the Differences Significance of the Differences
		preparation/long lead materials was to start Sept 2012. Original plan was to have phase I completed before phase II.

15-Feb-2013	D2O Project PMOC PowerPoint Presentation – Project Status Update
	• Project is currently behind
	• Mod planning was completed 4 months behind schedule
	• Lessons learned report drafted to document what happened and how to avoid repeating for other projects (N-2012-05956, N-2012-06082, N-2012-05614)
	• Delay in Modification Planning has created a log jam of work for the project:
	  • Delayed Design EC Completion
	  • OPG could not accept designs before mod planning was completed
	  • Delayed Work Plan Approvals
	  • Delayed Assessing and Setting Tasks to Ready
	  • Impact to D2O Schedule
	  • Delay of AFS to August 15, 2015 (4 month delay)
		N-2012-05614 - *The D2O Project missed the BCS committed date of October 29, 2012 for the Modification Planning Complete (DES) milestone*
		
		Recommended Actions to Resolve Condition *A recovery plan is in progress, with a new TCD of November 21, 2012. The project change control process will be followed.* ***There is no schedule impact*** *anticipated to downstream deliverables, such as completion of detailed design or the AFS date. Recommend* ***D4 for trending***
		
		Via interviews, the inadequate modification planning had an impact on the subsequent EC packages and their release. Since SCR was D4 no further corrective action was implemented.

3-Mar-2013	Engineering Oversight Findings PowerPoint Presentation
	• [redacted]
	  • •49 Process and Procedure
	  • •39 Design Quality
	  • •29 Schedule Delays
	  • •2 Scope related	

28-Mar-2013	Complete-All Long Lead Time Materials Contracts Awarded	
4-April-2013	PowerPoint presentation Team D20 Update Identified the top challenges: Traffic volume into protected area Soil disposal First large EPC project run by OPG Nuclear Testing procedures, particularly ECC process Step change for vendors Paradigm shift for project stakeholders	

Date	What happened? What was the outcome?	What should have happened? Consequences of the Differences Significance of the Differences
	Lessons from this project will help refurbishment project	
April-2013	D2O Storage Project Information Roll-out for TRF Operations	
22-April-2013	B&M Project Engineering Schedule Recovery Plan presentation: *"The CNO Milestone 'Engineering Complete by 15-Jul-13' is not achievable'*	This initial statement on the first slide was challenged and not accepted by OPG. [redacted] The presentation did not contain a justification/schedule showing why the milestone would not be met. The presentation only contained a description of actions going forward. The presentation failed to effectively communicate and convince need for changing the milestone so that an informed decision could have been made.
29-April-2013	D2O Storage Project Update – Gate 3b Presentation to Darlington Refurbishment Gate Review Board Implementation of traditional OPG roles by vendor has had challenges • First large scale ES-MSA EPC project inside the protected area. Some challenges are being encountered by both the vendor and OPG. • Project is reinforcing the roles and expectations of the COIR. This applies to both vendor staff & OPG staff who are still learning the EPC model.	
7-May-2013/PMOC Concurred Date: 15-Feb-2013	Project Change Authorization Details of Change: Additions to Scope Design of D2- Vapour Recovery Air Dryer System Additional design required for an Instrument Air/ Service Air Compressor Increased OPG involvement in Mod Planning Process Provide services to pump out box drain SPHW-1 west of TRF/HWMB to DNGS forebay (groundwater is contaminated at the west annex construction site, potentially exceeding the allowable tritium emissions limit) Supply/install of two office trailers and one washroom trailer Impact No schedule impact to project AFS date. The committed milestone dates for Design Recovery, Instrument Air and Service Air are revised from 15 May 2013 to 30 Aug 2013	
29-May-2013	Start of construction (Caisson Wall)	

SCR Title:
DELAY IN D20 STORAGE PROJECT

Date	What happened? What was the outcome?	What should have happened? Consequences of the Differences Significance of the Differences
12-June-2013	Team D20 Update ES-MSA contract for EPC is being utilized OPG is owner & constructor under OH&SA. Phase I/II of the EPC contract has been awarded to Black and MacDonald as the prime - Tier 1 subcontractors include RCMT and EllisDon Phased EPC Contract release as follows: Phase I: Detailed Design (*currently released and underway*). Phase II: Site Preparation/Construction Planning/Long Lead Materials ordered (*currently released and underway*). Phase III: Completion of Excavation/Construction/Commissioning/ Close-out (BCS Release approved by Board of Directors) Phase 1 Detailed Design Date of July 15, 2013 AT RISK	
26-Jun-2013/ 27-Jun-2013/ PMOC Concurred Date:27-Jun-2013	Consent to Proceed (CTP) Details: [redacted] (increase in assessing, procurement, PM support) **No impact to schedule**	[redacted] As a result, the preliminary and detailed design for the LPSW line relocation was not completed. The challenges in relocating this line along with other buried services was not fully identified resulting in schedule delay.
26-Jun-2013/ 27-Jun-2013/PMOC Concurred Date:27-Jun-2013	Project Change Authorization Details: Several sites identified as potential storage locations (groundwater and soil under the new D20 Storage building found to be contaminated) Cost impact, **no impact to schedule**	
30-June-2013	Project Milestone: Phase II Complete	
15-July-2013	Project Milestone: Detailed Design Complete	
17-Jul-2013/ 18-Jul-2013/ PMOC Concurred Date: 18-Jul-2013	Project Change Authorization Details: Contaminated soil confirmed, requirement of rental storage bins, purchase of various hose etc required. Cost impact, no impact to phase 2 schedule (November 1, 2013)	

Date	What happened? What was the outcome?	What should have happened? Consequences of the Differences Significance of the Differences
22-Aug-2013	Scheduled TRF outage start	
16-Sep-13/25-Oct-2013/PMOC Concurred date 19-Sept-2013	Project Change Authorization Details: Water hammer issues in the current transfer pipe designs based on OPG design requirements Impact to schedule and cost New Phase 2 Detail Design Complete – January 14	
18-Sep-2013	Boyle started work on buried services trench	The challenges with the buried services should have been identified during project planning Boyle expertise was not utilized sooner in the project both during planning and execution. This resulted in schedule delays in trenching for the buried services
30-Sep-2013	Project Change Authorization Details: • Setup and continued operation of the geotextile stockpile site for contaminated soils (additional cost) • Daylighting, testing and disposal of asbestos on the buried services that were discovered within the footprint of the building (additional cost) Not expected to affect overall Phase 2 Schedule (Jan 14, 2014)	
5-Oct-2013	Original scheduled date for LPSW tie-ins	
29-Oct-2013	SCR#D-2013-19100 generated documenting missed LPSW tie-in and delay relating to D2O Storage Project	Terminal Event
4-Nov-2013	Revised date for LPSW tie-ins	
29-Nov-2013	Revised date for LPSW tie-ins	
Target 15-Oct-2015	Available for service (BCS)	
Oct-2016	First Unit Refurbishment Outage	

Appendix C – History of Project Management Changes

The following table lists the 8 major changes to the Project Management Team that occurred over the course of the 7 year life of the project to date.

Date	Project Team
Nov 2006	MTL (1) Project Leader (1) Project Manager (1) Peter Floyd – Manager (1)
May 2007	MTL (1) DTL (1) Project Leader (2) Project Manager (1) Manager (2)
June 2008	Project Leader (3) Project Manager (1) Manager (2)
Feb 2011	MTL (2) Assistant Technical Officer (1) Project Leader (4) Project Manager (2)
Feb 2012	MTL (3) Project Leader (4) Project Manager (2)
June 2012	MTL (3) Project Leader (4) Project Manager (3)
Sept 2012	MTL (3) DTL (2) Project Leader (4) Project Manager (4)
April 2013	MTL (4) DTL (2) Project Manager (5) Manager (3)
August 2013	Intern (1) MTL (4) MTL (5) MTL (6) Project Manager (5)

Appendix D - Barrier Analysis

Adverse Condition	Barrier(s) that should have precluded Condition	How the Barrier Failed	Why(s) the Barrier Failed
LPSW tie-ins was missed by the D2O Storage Project which resulted in a 2 month delay to the Tritium Removal Facility Outage.	PC: **2.0 PROJECT CONTROLS** Project control is the process of tracking, reviewing, and regulating the progress to meet the performance objectives of the project. If performance issues, trends or risks are discovered during project execution, they must be investigated, understood and mitigated to maintain the baseline. The key is to detect such issues as early as possible, understand the potential impacts, and take appropriate steps to mitigate, as part of risk mitigation. Mitigation includes preventative and/or corrective actions to minimize the impact on the deliverables at risk.	The risks t the project for being the • The first project for the refurbishment organization • The first major project to use the EPC process • The first project to use the ESMSA process were not identified and acknowledged.	The EPC process appeared to be considered a risk mitigation method rather than a risk in itself as a first time use.
	PC: **2.2 Schedule Controls** 2.2.2 The current project schedule is updated, reported and communicated on a regular basis to show activity progress, overall progress, and actual milestone achievement dates. Comparison of the current schedule to the baseline provides the schedule variance and metrics that are used to flag and identify areas of concern and risks. These areas of concern must be understood and if necessary corrective actions implemented so that projects are completed within the committed time frame and approved budget. Updated schedule data can also be used for forecasting cost and time at completion and will identify whether or not the project is on track to meet its commitments. 2.2.3 In addition to reflecting the current status of the project, the update process allows for the detection and correction of possible errors (or incorrect assumptions) embedded in the schedule.	Escalation of commitment via more intensive recovery plans are not fully transparent in the schedule. The schedule incorporates the recovery plan activities to achieve the desired milestone.	Barrier Effective. The probability of recovery plan success is not intended to be conveyed by the schedule.
	PC: **2.3 Key Performance Indicators** 2.3.1 Key Performance Indicators are performance metrics established to assist in demonstrating performance achievements in safety, quality, scope, cost and schedule. The intent of monitoring these metrics is to identify performance gaps or trends early, allowing for timely implementation of recovery plans and corrective actions in order to maintain the project plan or at least minimize the impacts. It will also identify when initiation of change requests may be required. Typical areas addressed by Key Performance Indicators include: ((c) Scope (e.g. number of scope changes; design change revisions); (d) Schedule – life-to-date and projected “at-completion” milestone adherence;	Number of revisions to logic ties were noted during the execution of the project that triggered project management intervention.	Barrier Effective. The number of changes to schedule logic ties provided an indication that the scope and execution of the work was not well defined.
	PC: 2.3.2 For monitoring to be effective, any performance gaps or *variances* identified	Project Updates were frequent	Barrier Effective.

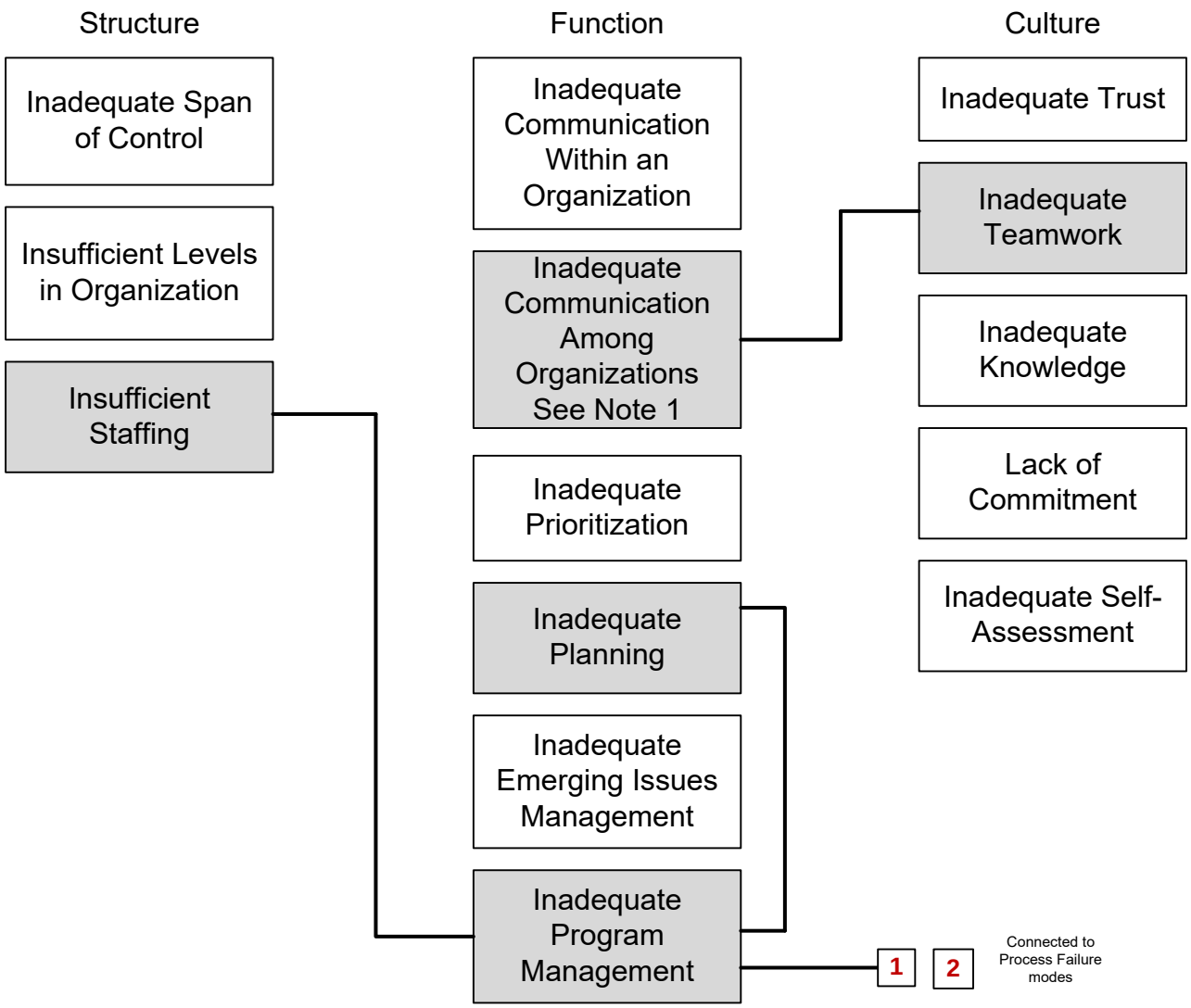
Adverse Condition	Barrier(s) that should have precluded Condition	How the Barrier Failed	Why(s) the Barrier Failed
	need to be investigated and understood. Analysis should be performed on an ongoing and routine basis to determine the causes of temporary and permanent *variances* and trends. The results of the analysis should be documented in project reports.	and provided risks, variances and recovery actions. E.g. weekly updates.	
	PC: 2.3.3 If performance is not meeting expectations, analysis should be conducted to determine appropriate corrective actions to be taken if contingency plans do not already exist as part of the Risk Management Plan process to determine if a mitigation plan is required	Performance risks were identified, reported and addressed via various mitigation plans.	Barrier Effective.
	PC-01: 1.1.4 NR shall establish a change control process, supported by the necessary procedures and tools, to provide a standard set of change control flowcharts with information necessary for NR and the contracting companies to understand the status of the work, causes of deviations and consequent reasons for changes to schedule or funding to manage the deviations.	No evidence that the change control process was not effective or contributed to the sequence of events in this investigation.	Barrier Effective. The status of work, causes of deviations were communicated, addressed and managed
	PC-02: 1.3 Change Control Process Change Management is the Project Management tool used to identify and record the effect of changes to the cost and schedule *baseline* and impacts on scope of work. A change control form (CCF) N-FORM-11252 will be used to record the change and identify the impacts on key milestones, costs and schedules in Nuclear Refurbishment (NR).	Per the timeline in Appendix B changes were processed per this procedure.	Barrier Effective.
	GRD: 1.1 Overview The intent of the gated process is to enable flexible management control of funding and gate progression approvals through the project life cycle. The process ensures that projects meet a consistent expectation of quality and performance. Gate progression approval is based on, ☐ Meeting previous phase requirements, ☐ Instilling confidence that the project team will deliver quality, safety, cost, value for money, and schedule performance for the next phase(s).	No evidence that the gated process played a contributing factor in this event.	Barrier Effective.
	COM: **1.1.3.3 Project Issue Management** Upon identification of an issue, it should be communicated to the appropriate authority and stakeholders as required. This should include any corrective actions that have been put in place or are planned. Communication also involves the timely escalation of issues and implementing corrective actions. The roles and responsibilities of project issues identification and the list of authorities and stakeholders for notification should be documented in the communications plan.	The project communication evolved into weekly update meetings to the station work management and project management oversight. Status, issues and any required assistance was identified	Barrier Effective.
	COM:1.1.4 Communications with Project Contractors and Suppliers Projects should have a communications plan for contractors and suppliers. Communications with contractors and suppliers should include:	Contractor reported via interviews that there was reluctance to provide	Barrier Effective Initially this communication

Adverse Condition	Barrier(s) that should have precluded Condition	How the Barrier Failed	Why(s) the Barrier Failed
	Progress and performance reports Issue/ action logs Change requests	expectations on how to achieve acceptable output quality to meet OPG standards. Subsequently there was evidence that the communication between the contractor and Project staff was a contributing factor to this event.	was ineffective due to paradigm that Project staff were not to tell the Contractor how to do the work.
	SCH: 1.0 DIRECTION Schedule detail must be developed at an appropriate level to allow the project team to communicate the plan, monitor project progress and cost performance, and use the data to make accurate forecasts, strategize and plan upcoming work.	[redacted]	Barrier Ineffective [redacted].
	SCH:1.1 Overview Scheduling includes: (b) Identification of key activities including their start and finish date, duration and resources. (d) The sequence and logical interrelationship of activities and milestones. (e) Identification and optimization of the critical path. (f) Regular monitoring and updating to track performance, forecasting, and initiate corrective action for schedule threats. (g) Look ahead at planning and strategizing to identify and manage priorities, opportunities, and threats.	Schedule reflected the recovery and mitigating actions to deal with threats.	Barrier Ineffective The schedule feeds into the milestone report showing what milestones are at risk. The milestone would show at risk with the scheduled activities impact on meeting the milestone. The LPSW re-route did not have a formal milestone.
	SCH: 2.3 Schedule Integration All Contractors' Level 3 Schedules or OPG Functional detailed schedule are fully aligned, utilizing a common Work Breakdown Structure and coding guideline, and integrated in the overall C& C Schedule.	[redacted] The project tasks were not fully integrated with the station schedules. They were managed off plan.	Barrier Ineffective [redacted] The project tasks preparation, timing and

Adverse Condition	Barrier(s) that should have precluded Condition	How the Barrier Failed	Why(s) the Barrier Failed
			execution did no align with station work management process.
	SCH: 3.1.2 Milestones The definition of ***milestones*** is different from ***deliverables*.** Deliverables are expressed by means of WBS components/activities at certain levels, while milestones refer to those most significant events or targets that mark achievement or progress of the program or project. For example all supplier contract dates and major interfaces shall be defined as milestones in the schedule.	The LPSW re-route was not formally defined as a milestone. The Project including the contractor were aware that the LPSW re-route had to be done during the TRF outage and the outage dates were known. Station interface milestones such as Innage Scheduling preparation milestones and Outage Scheduling milestones were not identified as project milestones. (see Appendix M)	Barrier Ineffective Milestones were designated per governance. The project manager defined milestones were based on contractual obligations of key deliverables. The LPSW re-route was not formally defined milestone. The engineering deliverables were initially defined based on criticality, complexity of the system, long lead materials. This was because the initial project plan was to have engineering phase I substantially finished prior to site preparation in phase II. The execution of engineering packages was not based on construction led schedule.
	SCH: 4.0 SCHEDULE MONITORING AND UPDATES Monitoring and updating a project schedule involves revising the project activity status and actual progress (e.g. started, completed, % complete), and forecasting future performance and completion data. The forecasting of completion dates and remaining costs ensures that accurate projections are reported for project metrics and the ongoing management of schedule risks.	It was not reported via interviews that the schedule failed to provide the required information for monitoring and updating the project schedule status.	Barrier effective.
	SCH: 4.2 Schedule Reporting (a) OPG project control and project teams shall review the progress status in all aspects as per Level 0, 1 and 2 schedules, and submit periodic progress reports and specific reports to OPG Senior Management, regarding the nuclear program or project. (b) All OPG project teams shall review the progress status in all aspects as per Level 2	Schedule reporting on progress of the project was evident via the mandated reports and frequent update presentations by both the Project management	Barrier effective

Adverse Condition	Barrier(s) that should have precluded Condition	How the Barrier Failed	Why(s) the Barrier Failed
	and contractors' Level 3 schedules, and submit periodic progress reports and specific reports to OPG project control. (c) All contractors shall submit periodic progress reports along with project schedules updated and further detailed for certain look ahead periods, to OPG project control and project teams. (d) Standard reports shall be issued by all Contractors as per OPG requirements.	team and contractor.	
	SCH-06: 2.0 MILESTONE DEFINITION REQUIREMENTS **2.1 Tier 1, 2 &3 Requirements** Individual Milestone Definitions in accordance with the requirements of this manual are required for all Milestones identified as Tier 1, Tier 2, and Tier 3. Tier 1, 2 & 3 are at the NR Program Level and represents Key Program Control Milestones Each project/ functional schedule, as a minimum, shall have the following program reportable (elevated Tier 3) milestones i. Detailed design complete ii. Scope Health progress to 20 iii. Request for proposal iv. Contract (s) award v. Long Lead Material Identified vi. Start of Installation vii. Commissioning Start viii. Available for Service ix. Any project or functional specific milestone that has important consequences for the Program i.e. EDM for Refueling	The LPSW re-route/TRF outage was not formally defined as a milestone	Barrier Ineffective Project milestones included governance mandated milestones and project manager defined milestones based on contractual deliverables. The milestones failed to identify the threat to project schedule prior to missing this LPSW re-route target completion date.
	SCH-06: 3.4.3 Milestone Recovery Plan Requirements In the event that the timely and quality completion of the identified Tier 1, 2 or 3 milestone is in jeopardy a Milestone Recovery Plan is required using D-FORM-10763. Instruction on how to fill in D-FORM-10763 is shown in Appendix F. If recovery is not possible, and a change in the milestone date is required milestone recovery form shall be attached to the Change Control Form as per N-MAN-00120-10001-PC-01.	The threatened and missed Engineering milestone plan initiated a recovery plan.	Barrier effective. The process does not guarantee the effectiveness of the recovery plan.

Appendix E - Stream Analysis: Organizational/Management Failure Modes



Organizational/Management Failure Modes

Inadequate Communication Among Organizations

- No apparent method or metric readily available to allow for an overview of float reports to identify threats to future milestones.
- [redacted]
- [redacted]

- Engineering felt that they were left on their own, did not get any support from OPG until challenges and schedule threats risked successful completion of the project.

- Missed LPSW service water line – need for relocating the buried services was stated at the proponents clarification meeting.

- Focus was on the building versus the underground services and tie-ins Original PO had convoluted milestones.

Inadequate Planning

- No apparent method or metric readily available to allow for an overview of float reports to identify threats to future milestones.

- Original estimate of the 11 month engineering schedule and cost was significantly underestimated (contract awarded June 2012).

- Competition aspect on initial bid led to unachievable schedule and budget commitment (original estimate was classed as a Level 5, allowing for substantial margin for cost and schedule).

- RCM was not provided construction schedule

    - Construction was phase II
    - Planned to have all of phase I (engineering) done prior to phase II
    - Project did not change strategy as schedule slipped

- Completion of the EC packages driven by cost rather than by construction schedule

Inadequate Program Management

- Project Team had frequent manpower turn-over – current staff have all come on board in 2013, with exception of current OPG Project Manager. This is not formally identified as a risk with associated mitigation plans.

Inadequate Teamwork

- Engineering felt that they were left on their own, did not get any support from OPG until challenges and schedule threats risked successful completion of the project.

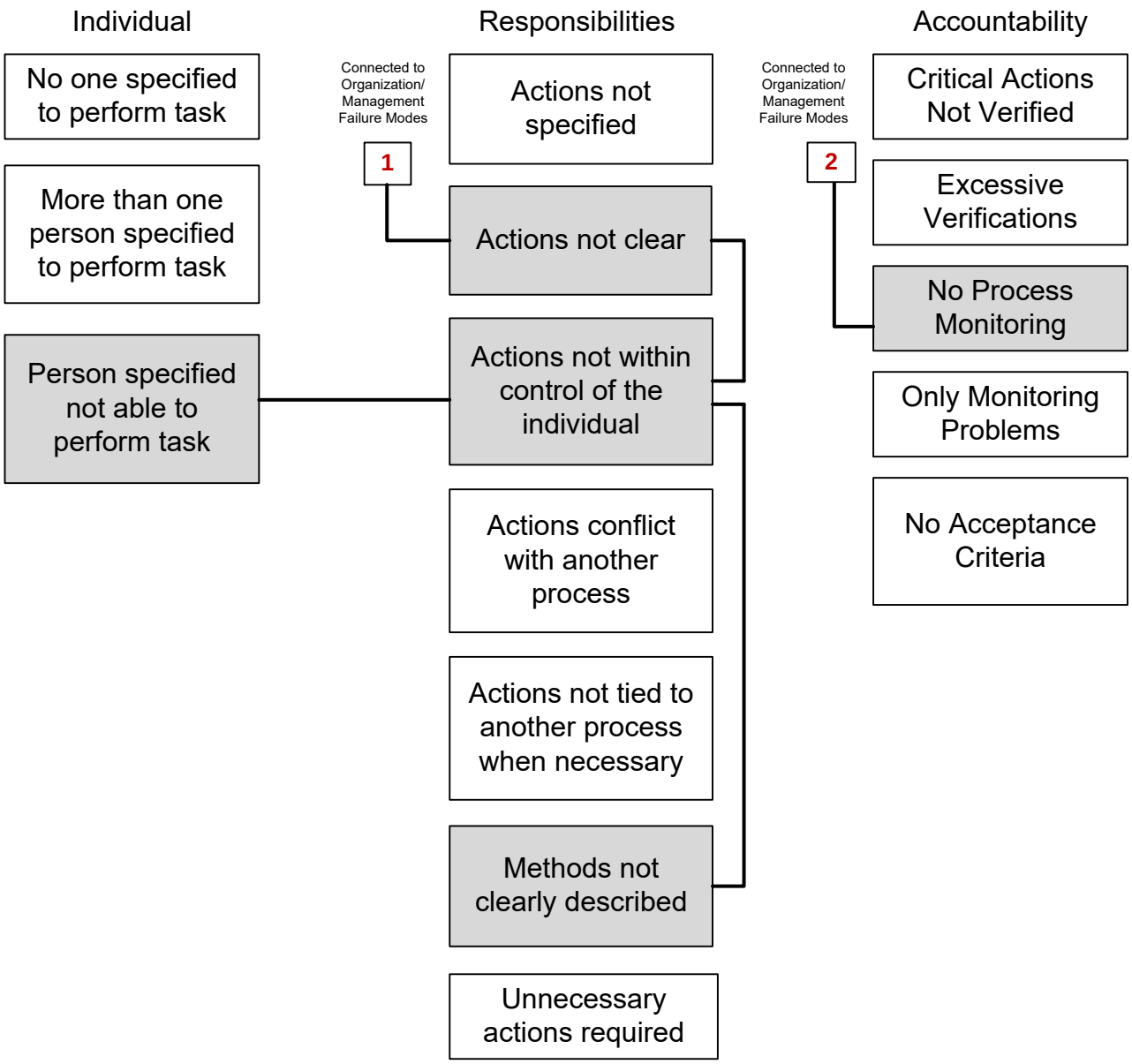
- Larger project need to schedule release of EC packages based on construction schedule

    - RCM was not provided construction schedule
    - Construction was phase II
    - Planned to have all of phase I (engineering) done prior to phase II
        - Project did not change strategy as schedule slipped

- Completion of the EC packages driven by cost rather than by construction schedule

- “Risk transferred to contractor”

Appendix F- Stream Analysis: Process Failure Modes



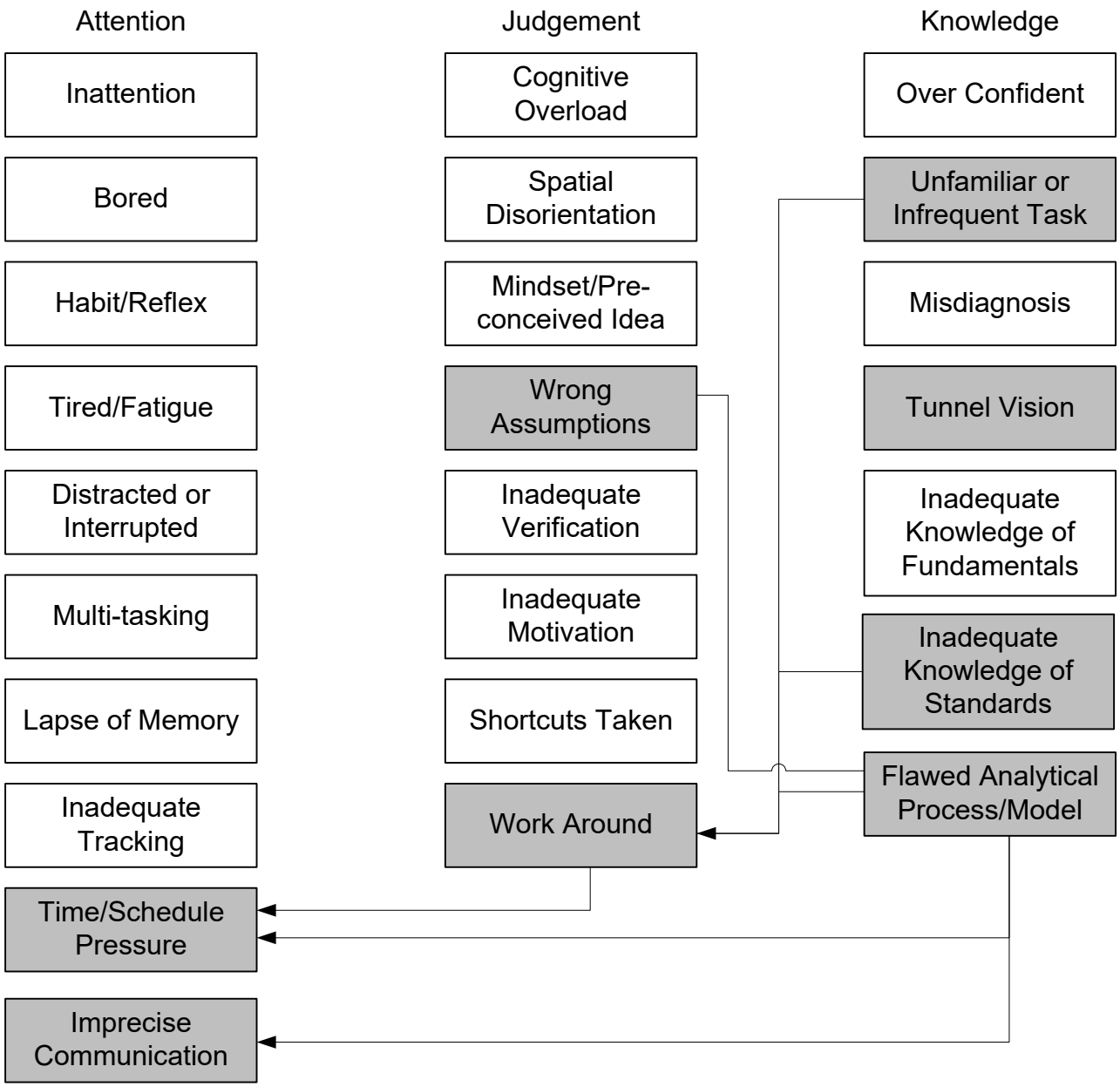
Process Failure Modes

No Process Monitoring

- Initial scope and schedule of work not fully defined (lack of MDR and Modification Outline at procurement phase of the contract)
    - Schedule lengthened 50% after contract was awarded.
    - Missed requirement to relocate LPSW line, however the scope had included buried services.
    - Delay in preliminary engineering.
    - “number of changes on the project – I can’t count”.

- When experience contractor - Boyle got involved the scope and schedule improved.
- Benchmarking not fully effective.
  - Pickering D20 Building project scope significantly smaller.
  - Did not review PNGS Retube Lessons Learned.
    - Separated dedicated Ops, issuing authority, shift manager to support project.
    - Ops not familiar with work.
  - Did not incorporate Bruce D2O project OPEX.
    - Believed not to be applicable.

Appendix G - Stream Analysis: Human Performance Failure Modes



Human Performance Failure Modes

Time/Schedule Pressure:

- All critical points in the project were not identified by milestones (TRF outage, LPSW tie in)
- No apparent method or metric readily available to allow for an overview of float reports to identify threats to future milestones.

- Competition aspect on initial bid led to unachievable schedule and budget commitment (original estimate was classed as a Level 5, allowing for substantial margin for cost and schedule.)

- Schedule quality poor:

    - Difficulties in committing to date and sticking to it
    - No input from key execution staff (General Foreman)
    - E.g. trench schedule was revised over 30 times
        - Revisions involved logic ties
            - Indication that work not fully understood

Imprecise Communication:

- Technical specification/design requirements/ scope of work was not sufficiently detailed for the procurement of an EPC contract

Wrong Assumptions

- Original estimate of the 11 month engineering schedule and cost was significantly underestimated (contract awarded June 2012);

- Initially key stakeholders were not involved in the early stages. The stakeholder input was not planned to be included in that phase (D2O Storage Project corrected this with construction representatives embedded in RCMTs shop providing constructability reviews).

- 1st large EPC contract, risk was seen to be passed onto contractor to complete the job

Work Around

- Numerous review and comment required in the preliminary engineering phase.

- Engineering sub-contractor believed funds for preliminary engineering planning were not sufficient.

- Scope change approvals for injected work required significant effort to get approved (contaminated soil, lack of office space, sally port access, dewatering etc).

Unfamiliar or Infrequent Task

- Unfamiliarity of all requirements, size of scope

- Only 2nd ESMSA project (1st on this scale) , there were no lessons learned from ES-MSA process from past projects (only pilot project done under ES-MSA process before D2O was a low-value $2M Pickering project to replace four valves)

- Capability of Contractor awarded the project was a known risk. This was not formally documented with associated mitigation plan. It was expected that the Project Team would provide increased oversight.

- Project Team had frequent manpower turn-over – with the exception of the current OPG Project Manager, all current staff have all come on board in 2013. This is not formally identified as a risk with associated mitigation plans.

Tunnel Vision

- No apparent method or metric readily available to allow for an overview of float reports to identify threats to future milestones.

Inadequate Knowledge of Standards

- Preliminary engineering incurred a lengthy review process due to back and forth between contractor and OPG.

- Technical specifications/Design Requirements/SOW were not sufficiently detailed

Appendix H – Project Operating Experience

SCR N-2011-04605, August 23rd, 2011; identified issues learned from Bruce Power during the course of a similar project. A benchmarking meeting and site visit to Bruce Power was conducted on Feb 11, 2011 and April 28, 2011 respectively. The purpose was to gain lessons learned from the Bruce Heavy Water Storage Project, for the Darlington D2O Storage Project. The following main Lessons Learned were documented in a self assessment NO11-000423.

(1) EC release was longer than planned, attributed to weak stakeholder review process. EC release took 2 months instead of 2 weeks as planned. Later, Bruce instituted additional informal review at 50% completion, then at 90%. Preliminary COMS was also followed. FE was involved in reviews.

(2) Significant scope addition and schedule interference from Refurbishment Organization. This caused large amounts of overtime work as Project was directed to meet compressed schedule, which was later unnecessary when Refurb project was delayed.

(3) No clear single line of direction over project scope & schedule. Multiple managers/VPs could sway scope & schedule requirements.

(4) Contractor / Project Manager were the same role. Contractor was not in a position to critically evaluate cost additions.

(5) EPC concept had advantages including procurement/internal CID process, with its inherent difficulty in ordering long lead material, were bypassed and streamlined.

(6) Technical Specification/Design Requirements/Scope of Work must be sufficiently detailed. This was the source of significant scope/cost addition and schedule impact for Bruce Power.

(7) Not enough support/direction of Contractor by Owner (Bruce Power).

(8) Status of registration of existing systems should be investigated for impact early on. This was the source of significant scope/cost addition and schedule impact for Bruce Power.

(9) Bruce had limited design & procurement resources conducting the reviews, and recommended to have a *dedicated multidisciplinary* team to help reduce turn around times for Bruce Power design reviews, and improve implementation schedule. This caused a 6 week delay to the project and prevented the business case from moving forward for approval in March 2012 to the Board of Directors. At this time it was decided to engage the new Extended Services Master Services Agreement initiative, and schedule would be revised accordingly to accommodate.

A search of SCRs related to the D20 storage facility was conducted. The SCR's were analyzed in comparison to the previously identified lessons learned from the Bruce. The Bruce lessons learned that appear to be repeated in the D2O project are listed by number.

SCR	Date	Description	Bruce Power Lessons Learned Not Fully Utilized
N-2012-03854 **N-2012-03914** (Both SCR's Referenced in Lessons Learned Report, D-LLD-38000-10001)	**31-Jul-12** **8-Aug-12**	Issues arose following the award to the contractor under the new agreement and were documented in "Document produced by EPC contractor rejected", in that the MDR was not completed in accordance with OPG governance; meetings were conducted and it was noted that the vendor had been coached. This caused a delay in schedule referenced in SCR N-2012-03914. As per request from OPG, the vendor prepared a recovery plan which proposes a 7-week delay to the Modification Planning Complete milestone, and subsequent 7-week delay to OPG Acceptance of Engineering Specs for Long Lead Materials. No BCS milestones were said to be affected for Phase I (Engineering) at this time, however float was noted to be "significantly reduced." **Note:** Lessons Learned Report also recommended: *(i) As per engineering directive, vendors will not produce MDR's in the future.* *(ii) Projects should be cognizant of time pressures.* (iii) *Managerial "courage" to recognize when schedule is unrealistic for the required deliverable and to escalate.* No referenced action, SCR's designated D4, no further action required.	2. Schedule Interference 6. Technical Specification/Design Requirements/ Scope of Work –Detail 7. Support by Owner (OPG)
N-2012-05069	**15-Oct-12**	Additional design quality issues were documented in N-2012-05069 identifying technical errors and deficiencies in the preparation of the MDR requiring the comments to be addressed by the preparer then reviewed and accepted by the OPG reviewer.	6. Technical Specification/Design Requirements/ Scope of Work –Detail 7. Support by Owner (OPG)
D-2012-08890 (Referenced in Lessons Learned Report D-LLD-38000-10001)	**7-Sept-12**	Initiated to address OPG comments to B&Ms final schedule. The SCR states that B&M had not provided a revised final schedule or dispositioned OPG comments "and continues to miss committed delivery dates for completion of the final schedule". An inability to track project progress was identified. The immediate action taken was to inform line management. An action was assigned to the vendor to provide a weekly schedule, and an apparent cause was initiated. The apparent causes were identified to be the following: The Apparent cause(s) were found to be the following: B&M's contractor team is comprised of 3 companies. Each company's portion of the schedule was contained in a separate database. Amalgamating the schedules into one useable vehicle was cumbersome and time consuming. The B&M Management team was understaffed at the inception of the project Consequences of this adverse condition: OPG Design Projects had to assign extra resources to the project to determine the cause of the schedule delays and inconsistencies.	3. Sway Scope and Schedule Requirements 6. Technical Specification/Design Requirements/ Scope of Work –Detail 7. Support by Owner (OPG)

SCR	Date	Description	Bruce Power Lessons Learned Not Fully Utilized
		B&M's contractor team use of multiple schedule databases, understaffed Management team at project inception caused our adverse condition. It should be noted that this is the first large EPC contract awarded to B&M. This is a new , untested process for OPG and it's contractors. In reaction to this SCR, B&M were increasing staff levels and arranging a project meeting review schedule with OPG to meet project demands at the time of this evaluation. **Note:** Lessons Learned Report recommend: *1. Projects should consider, and challenge, Contractor's "readiness to execute" and resources at the RFP stage.* *2. Consider requested granularity of schedule at contract award, based on project complexity. Acknowledge any unrealistic expectations.* *3. Scope of payment milestones need to balance SMART (Specific, Measurable, Achievable, Realistic, Timely) expectations with the state of scope definition."*	
N-2012-05234	**23-Oct-12**	Initiated to reflect the vendor's resubmission of a schedule for the D2O storage project for OPG acceptance. Modification Planning section did not accurately reflect the way that the work will be executed, and downstream impacts was not identified in the schedule. The schedule was rejected as a result.	1. Weak Stakeholder Review 3. Sway Scope and Schedule Requirements 6. Technical Specification/Design Requirements/ Scope of Work –Detail 7. Support by Owner (OPG) 9. Dedicated Multidisciplinary Team
N-2012-05237	**23-Oct-12**	Initiated to document The Engineer, Procure, Construct (EPC) Contractor's assessor has lost his Passport rights, and 3 additional assessors recently hired do not currently have assessing rights. Therefore to expedite Passport assessment and maintain the schedule, an OPG assessor is loading some tasks on a temporarily basis.	7. Support by Owner (OPG)
N-2012-05266	**24-Oct-12**	The Engineer, Procure, Construct (EPC) Contractor personnel assigned to the D2O Storage Project do not have NIM's access to schedule work order tasks, and do not have P6 online schedule access to draw logic for the plan. As a result, to expedite scheduling of work order tasks and drawing up the logic to support the D2O project, a PCC Coordinator is scheduling tasks and drawing the logic for the vendor. This work is vendor accountability under the EPC contract (see also SCR N-2012-05237). The action taken was to inform line management and discuss the issue with the vendor. Filed SCR to document the additional effort that OPG is undertaking, and EPC contractor not being 100% ready to execute all their responsibilities under the Contract. This is one of the first large EPC contracts under the new ES MSA and the condition is expected to correct itself as the Contractor gets fully mobilized for this project, and	6. Technical Specification/Design Requirements/ Scope of Work –Detail 7. Support by Owner (OPG)

SCR	Date	Description	Bruce Power Lessons Learned Not Fully Utilized
		others. Vendor has a plan to obtain access rights in order to take over this work.	
D-2012-10625	**30-Oct-12**	"The D2O Project Team did not meet scheduling milestone requirements of N-PROC--MA-0022 as related to Tminus 12" The requirement of the procedure is to have work appear on the work control schedule 12 weeks before the planned start of work activity/task. the project did not have work scheduled in work control P6 database untill 30-Oct-12 .The work is scheduled to take place on 1-Dec-12(borehole monitoring) and 8-Jan-13 (TRF Trailer). Work plans were also not submitted prior to T-12 for assessments. Immediate action taken: Contacted PCC work control coordinator who communicated with Darlington work control as to the status of the work. WO will remain on schedule and the project committed to ensuring work will be ready to execute as scheduled and that all holds will be removed prior to schedule issuance. SCR written to document this condition and pass through the WC quality gate with task not at ready status WO is now on scheduled on the IOP plan. The Team will need to meet subsequent deadlines related to the T-8 scheduling; Vendor coached.	3. Sway Scope and Schedule Requirements 9. Dedicated Multidisciplinary Team
D-2012-10620	**30-Oct-12**	"D2O project team did not meet the scheduling milestone requirements of N-PROC-MA-0022 for T minus 8" The requirement of the procedure is to have the work appear on the work control schedule eight weeks before the planned start of work activity/task in "ready" status. The project has not been able to achieve this milestone. The work is scheduled to take place on1-Dec-12(borehole monitoring) and 8-Jan-12(TRF Trailer). The work plan was also not issued therefore not allowing work order tasks to be created and assessed. WO is now scheduled on the IOP plan. The Team will take mitigating steps to account for the late EC completion of the Design Modification; Vendor coached	3. Sway Scope and Schedule Requirements 9. Dedicated Multidisciplinary Team
D-2012-10764	**2-Nov-12**	D2O Project Team did not meet schedule milestone as per N-PROC-MA--0022 as related to T minus 26. The requirements of the procedure are that (a) Project Manager should ensure detailed design is approved and long lead items are identified to Supply Chain and Procurement Engineering. Work Orders listed did not meet this requirement Work Orders that missed the T-26 DEC complete milestone were: 02839455, 02817132, 02817134, 02817135, 021817136, 02817137, 02839455, 02817138, 02817133.	1. Weak stakeholder review 3. Sway Scope and Schedule Requirements 6. Technical Specification/Design Requirements/ Scope of Work –Detail 7. Support by Owner (OPG) 9. Dedicated Multidisciplinary Team
N-2012-05956	**27-Nov-12**	The D2O Project missed the BCS committed date of October 29, 2012 for the Modification Planning Complete (DES) milestone (see SCR N-2012-05614). A recovery TCD of November 21, 2012 was chosen as part of the recovery plan. This recovery date was missed. New recovery date of December 11, 2012 was given by the vendor and associated risks with this date were identified to OPG	1. Weak stakeholder review 6. Technical Specification/Design - Requirements/Scope of Work - Detail 9. Dedicated Multidisciplinary Team
N-2012-05812	**19-Nov-12**	The D2O Project vendor submitted a final schedule on November 9, 2012. This schedule was submitted to complete action tracking from SCR D-2012-08890. The submitted schedule was rejected due to quality issue. The design engineering changes were not scheduled as the vendor plans to execute the work, and they were not aligned with the construction schedule needs. See	1. Weak stakeholder review 6. Technical Specification/Design Requirements/ Scope of

SCR	Date	Description	Bruce Power Lessons Learned Not Fully Utilized
		SCR N-2012-05234 and N-2012-05234 for further background. Vendor will be re-submitting schedule for acceptance by November 23, 2012 with OPG comments incorporated.	Work –Detail 7. Support by Owner (OPG) 9. Dedicated Multidisciplinary Team
N-2012-06082	**4-Dec-12**	The D2O Project missed the BCS committed date of October 29, 2012 for the Modification Planning Complete (DES) milestone (see SCR N-2012-05614). A recovery TCD of December 11, 2012 was chosen as part of the recovery plan. This second recovery date will be missed (SCR N-2012-05956). A new recovery plan is now required. New recovery date of December 21, 2012 has been established. The project is currently supporting vendor to achieve this date. Final package will be submitted to OPG by December 17, 2012, and OPG will have until December 21, 2012 to accept the documentation and complete this milestone.	1. Weak stakeholder review 6. Technical Specification/Design - Requirements/Scope of Work – Detail 7. Support by Owner 9. Dedicated Multidisciplinary Team
D-2013-00696	**22-Jan-13**	Design EC 120404 for 'Relocation of 30" LPSW Discharge Line' on DNGS HWMB-WA Project was scheduled for 22-Jan-2013, but will now take an additional 3.5 weeks to complete. Delay of EC is attributed in part to level effort needed to research and incorporate a high risk "hot tap" procedure for rerouting LPSW while in service. Although EC technical issues had been discussed with OPG as early as last November, project ability to forecast EC completion date was impeded by lack of information from vendor. Schedule shift was not communicated to OPG until late. Schedule update was initiated to move EC-120404 completion out on schedule to 15-Feb-2013.	1. Weak stakeholder review 3. Sway Scope and Schedule Requirements 6. Technical Specification/Design Requirements/ Scope of Work –Detail 7. Support by Owner (OPG)
D-2013-01119	**1-Feb-13**	The D2O Project Team will need to perform a number of process and services tie-ins to the TRF facility during the August 2013 TRF Outage. Work orders have not been inserted into the TRF outage schedule as required by the TRF outage management system. The TRF tie-ins will need to be coordinated with other TRF work that will be conducted during the outage window. It is imperative to the D2O Project Schedule that these tie-ins be given a window to be installed during this outage. The D2O Project Team attended the TRF outage meeting on 24-Jan.-13 and identified the need to perform this work. The TRF team accepted an action to assess the tie-ins and determine which of the tie-ins require an outage window to perform them. OPG's Project Leader requested that we submit this SCR to document the procedural breakdown "Dummy" work order tasks are being loaded into passport for each process tie-in until the team can confirm the outage requirements of each tie-in	1. Weak stakeholder review 6. Technical Specification/Design Requirements/ Scope of Work –Detail 7. Support by Owner (OPG)
D-2013-01121	**1-Feb-13**	The D20 Project team will not meet the schedule dates for the following tasks. 02-Electrical Determs (schedule date 01-Feb.13) 03-120 V Determs (schedule date 04-Feb.13) Holds were present on these tasks on 25-Jan-13 because the Workplan was not approved by the DOM The requirement of the OPG work control procedure N-PROC-MA-0022 "Integrated On-Line Schedule" procedure is to have work showing on the plan within the T-4 week window be set to "Ready" with "No holds". The Work Control Leader was unaware of the circumstances and wasted time trying to coordinate these tasks.	1. Weak stakeholder review

SCR	Date	Description	Bruce Power Lessons Learned Not Fully Utilized
D-2013-01571	**12-Feb-13**	Readiness Meeting Conducted By Vendor of D20 Storage Building Project did not meet the requirements of a readiness meeting. The meeting did not demonstrate the vendors readiness to execute work within the next few days on electrical disconnects, trailer removals, and boreholes. The vendor took 18 actions from the electrical disconnects / trailer removal portion of the meeting alone some significant stakeholders (TRF Ops, Ops, RP) had not even been contacted yet. Responsible CA had not been provided JSA, Lift Plan at or prior to this meeting although some of these documents may have been with the project. It is also an expectation that the form N-FORM-11470 work release is signed off at the end of the meeting but the vendor was not aware	7. Support by Owner (OPG)
D-2013-01651 (Referenced in Lessons Learned Report, D-LLD-38000-10001)	**14-Feb-2013**	Project 16-31555 Design Package Rejection Submitted Design Package for acceptance had a lack of information which cannot be appropriately managed through the comment and disposition process. Examples include missing design calculations that show the seismic dyke meets nuclear safety requirements, no material specification, no design details or calculations for secant pile structures and tie-backs, and missing impacted OPG drawings for configuration management.	1. Weak stakeholder review
N-2013-00847 Referenced in Lessons Learned Report, D-LLD-38000-10001)	**19-Feb-13**	Modification Outlines for Project 16-31555 (Master EC #88528, 118880, 118632, 119824) did not initially take advantage of ECC process and "EPC" nature of the contract strategy. One MO was planned and was eventually split into 5 in order to classify appropriately in terms of risk. The causes are considered to be: 1. From initial proposal, MO's and MDR were planned from an Engineering perspective not a holistic (engineering, construction) perspective. "E" part of planning was activated before "PC". 2. OPG Project Team could have escalate risk of the plan more effectively and that the contractor required help. 3. Time pressure to complete Mod Planning within 2 months did not allow much time for planning the work. 4. Proposal did not include funding for construction input in Phase I. **Note:** Lessons learned report recommended: (i) *The goal to allow EPC contractors to decide "how" to do the work. This strategy should include "show me" how the plan will work, not rely completely on the Contractor to develop/execute the plan.* (ii) *Critical need for a strategic plan before starting work.* (iii) *Going forward OPG will produce MDRs/MOs to lay groundwork for plan prior to EPC start.* *Senior Leadership present at the lessons learned workshop emphasized that project teams have the option to put work on hold until a strategic plan is in place, and this will be supported by the management team.*	7. Support by Owner (OPG)
N-2013-00848	**19-Feb-13**	On 16-31555 D2O Storage Project, OPG comments on submittals were initially not consolidated	1. Weak stakeholder review

SCR	Date	Description	Bruce Power Lessons Learned Not Fully Utilized
Referenced in Lessons Learned Report, D-LLD-38000-10001)		resulting in additional time/effort on part of the EPC vendor to resolve duplicate or conflicting comments. Cost change order resulted. Additionally, despite most comments being high quality, some OPG comments on deliverables were out of discipline, in the form of information requests, or preferential in nature. This issue is captured in lessons learned report NK38-LLD-38000-10001 which concludes that: Comments must be consolidated among all OPG stakeholders reviewing documents before leaving OPG. This is the role of the new Engineering Lead on the D2O Storage Project. Discipline in commenting and enforcement by Project Manager is required. Reviewers only comment for their discipline. Reviewers should be aware of the EPC model which holds vendor responsible for how to execute the work. Stop submittal review and escalate if required.	7. Support by Owner (OPG)
D-2013-07582	**26-Jul-13**	"WW40 Work Has Holds At T-10 For Work Plan" Work for D2O storage project for LPSW Line Relocates under WO 2817137 has a EK hold for a work plan. The TCD for issue of the work plan is 02 August 2013. Filed this SCR to document the hold and late issue of the work plan. This work has to be done during the TRF outage. D2O project work related to the TRF outage T1301 and their pre-reqs are currently late and not meeting all MA-22 milestones. This has been communicated to senior management via the SWM meeting.	1. Weak stakeholder review 6. Technical Specification/Design Requirements/ Scope of Work –Detail 7. Support by Owner (OPG)
N-2013-04031	**29-Jul-13**	Date for issuance of work plan for Argon Tank & Line Relocate WO 2973065 had a TCD of 29 July and has been missed. The TCD was given and during a work plan review meeting on Friday issues were identified which require changes to the work plan. Work plan authors will update the work plan and this will be reviewed with TRF staff who requested the change and then the work plan will have to go for signatures. Will require new TCD for work plan issue. Earlier preparation, review and approval of work plans and related documentation as per MA22 will result in higher stability and success of work scheduling, assessing, material purchasing and execution. READJ 2013/08/02 Significant issues identified by OPG reviewers required longer time period to resolve. Work plan has now been signed off as of August 1, 2013 having addressed OPG comments.	1. Weak stakeholder review 7. Support by Owner (OPG)
N-2013-04186	**31-Jul-13**	OPG Direction to reduce COMs frequency will adversely impact schedule for affected Design Deliverables OPG Project Management for Project 16-31555 (HWMB-WA Facility) provided direction to EPC project management on July 31 to have only one Design COMS meeting per week for the next 4 weeks. The direction is based on diminished availability of key TRF stakeholders who need to spend increased time preparing for upcoming TRF outage. Rescheduling COMS will have a domino effect on schedule for completion of respective Design ECs. Per this new project constraint, COMS meetings will now continue into September delaying issue of affected Design ECs to OPG accordingly. 1) Coordinate rescheduling for balance of outstanding COMS and all affected Design EC deliverables with OPG Project Management. READJ 2013/08/12 Current priority for the project is to ensure readiness for the TRF T1301 outage. Other project work is being re-scheduled to support outage readiness.	1. Weak stakeholder review
N-2013-04195	**31-Jul-13**	Completion of "FULL" HFE Analysis for design EC 120523 (Drum Handling Facility) has been delayed for TRF Staff support since July 22 (~17 days). TRF staff are currently preparing for upcoming TRF outage and have diminished availability to provide timely stakeholder support for PROJ 16-31555. If unresolved, failure to complete HFE analysis will impact scheduled completion date for this EC.	1. Weak stakeholder review

SCR	Date	Description	Bruce Power Lessons Learned Not Fully Utilized
		PROJ 16-31555 (HWMB-WA facility) includes 15 Design ECs requiring "Full" analysis for Human Factors Engineering of which 12 analyses are still in progress. Varying levels of TRF support will be required over the next 6 weeks to complete these HFE analyses in time to support respective EC submittal schedule	
D-2013-10298 (Referenced in Lessons Learned Report, D-LLD-38000-10001)	**15-Oct-12**	West Annex Project # 16-31555, Detailed Design COMS for SG Cable Duct Bank Relocation delayed due to failure to achieve Quorum **Note:** SCR did not capture or address the adverse condition learned from the Lessons Learned Report regarding *Modification Planning Milestone Missed.* *Apparent causes:* *The original contract start date was early June, 2012 and contract was not signed until July 5,2012 which used up some float.* *Quality issues (see lesson learned Q1) impacted schedule.* *Milestones were fixed and were not allowed to float "from APO"(award of purchase order).* *Mandated milestones rather than planned based on OPEX.*	
D-2013-01653 (Referenced in Lessons Learned Repor , D-LLD-38000-10001)	**14-Feb-13**	Project 16-31555 Submitted MDR Missing Requirement **Note:** SCR did not capture or address the adverse condition learned from the Lessons Learned Report regarding *initial design quality concerns*	6. Technical Specification/Design Requirements/ Scope of Work –Detail
N-2013-00850 (Referenced in Lesson's Learned Report, D-LLD-38000-10001)	**19-Feb-13**	Project 16-31555 MDR Challenge Meeting vs. Verification process not managed well **Note:** Lessons Learned Report recommended: • *For MDR development, a challenge meeting should be held to incorporate all stakeholder input, and this process should be completed (comments resolved prior to final verification by Engineering only* No reference to corrective action.	1. Weak stakeholder review
N-2013-00851 (Referenced in Lessons Learned Report, D-LLD-38000-10001)	**19-Feb-13**	Project 16-31555 Scoping COMS process issue **Note:** Lessons Learned Report recommended: • *Implement COMS in manageable chunks* No reference to corrective action.	6. Technical Specification/Design Requirements/ Scope of Work –Detail 1. Weak stakeholder review

The Lessons Learned Report Generated, D-LLD-38000-10001 also identified:

- *Positive involvement of expert stakeholder* (no SCR or action referenced)

- *Expectations of expert stakeholder involvement* (no SCR or action referenced)
- *Positive effect of implementing project staffing plan* (ref. SCR#N-2011-04605, Self-Assessment NO11-00042; no actions referenced in SCR or Self-assessment). The Lessons Learned Report recommended:
    - *Use of OPEX consultation with stakeholders, "acknowledging reality" that work could not be managed with existing resources, and execution of the plan "making it happen" in this case was successful.*

No action tracking or management actions were referenced in the Report or associated.

Conclusion:

The Bruce Lessons Learned were not fully utilized to avoid similar pitfalls during the D2O Storage and Drum Handling Project.

Sustainable corrective actions from the original self-assessment and subsequent SCR's were not implemented. All of the listed SCR's were designated a resolution and significance of D4. Only immediate corrective actions were required. The self-assessment had no listed SCR or Management Actions. The conclusion of the self-assessment was that "Benchmarking OPEX was completed and all aspects have been either addressed or listed in the Risk Management document.

The following lessons learned were presented in a presentation dated: August 23, 2013:

- **Staffing plan and positive involvement of expert stakeholders**. Due to the relative uniqueness of the TRF, and lessons learned from other Utilities around EPC Contractor oversight, the project benefitted from dedicated design oversight and expert stakeholder resources to review submittals and provide oversight. However, the expert stakeholder oversight must be carefully controlled and targeted for maximum efficiency.
- **Quality of schedule from EPC Contractor was not to expectations**. Challenge Contractor's readiness and resources at RFP stage. Carefully consider requested schedule granularity at contract award. The granularity of deliverables specified within payment milestones needs to be balanced with the state of scope definition at time of award.
- **Modification Planning Milestone missed**. After Modification Planning was complete, the team recognized that even with the avoidable quality issues, the schedule for Modification Planning had not been realistic. Essential to have credible schedule and to escalate when required. Properly delivered oversight required to prevent quality issues which had a large impact on missing milestone.
- **Initial design quality concerns**. Be cognizant of time pressures and exercise managerial "courage" to recognize when schedule is unrealistic for the required deliverable and to escalate. As per engineering directive, vendors will not produce MDRs in the future.

- **Modification Outlines did not initially take advantage of ECC process and "EPC"** nature of the contract strategy. There is a critical need to have a strategic plan before starting the work. Project teams have the option to put work on hold until a strategic plan is in place, and this will be supported by the management team.

- **Quality of OPG comments on submittals**. Comments from OPG must be consolidated among all stakeholders reviewing a submittal and vetted properly for quality – in discipline, specific, non preferential in nature.

- **Proposed piping run was not technically feasible (inverted U)**. Due diligence and applying the "STAR" technique challenged this Design. It should have been caught earlier but it was caught during a challenge meeting which resulted in total change to the piping route.

- **Undocumented underground piping.** Must scan and day light the first 8 feet to clear all the underground services.

- **Physical underground pipe didn't match the drawing, it was found in the foot print of the dig and must relocated.** Must scan and day light the first 8 feet to clear all the underground services. Include contingency Design ECs "maybe" relocations.

Appendix I- Benchmark to Industry

What is a Project

A project is a temporary endeavor undertaken to create a unique product, service, or result. The temporary nature of projects indicates that a project has a definite beginning and end. The end is reached when the project's objectives have been achieved or when the project is terminated because its objectives will not or cannot be met, or when the need for the project no longer exists. A project may also be terminated if the client (customer, sponsor, or champion) wishes to terminate the project. Temporary does not necessarily mean the duration of the project is short. It refers to the project's engagement and its longevity. Temporary does not typically apply to the product, service, or result created by the project; most projects are undertaken to create a lasting outcome. For example, a project to build a national monument will create a result expected to last for centuries. Projects can also have social, economic, and environmental impacts that far outlive the projects themselves.

What is Project Management

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. Project management is accomplished through the appropriate application and integration of the 47 logically grouped project management processes, which are categorized into five Process Groups. These five Process Groups are:

- Initiating
- Planning
- Executing
- Monitoring and Controlling, and
- Closing

Managing a project typically includes, but is not limited to;

- Identifying requirements;
- Addressing the various needs, concerns, and expectations of the stakeholders in planning and executing the project;
- Setting up, maintaining, and carrying out communications among stakeholders that are active, effective, and collaborative in nature;
- Managing stakeholders towards meeting project requirements and creating project deliverables;
- Balancing the competing project constraints, which include, but are not limited to:
    - Scope,
    - Quality,
    - Schedule,

- Budget,
- Resources, and
- Risks

Overview of a Project

Scope: Projects have defined objectives. Scope is progressively elaborated throughout the project life cycle.

Change: Project managers expect change and implement processes to keep change managed and controlled.

Planning: Project managers progressively elaborate high-level information into detailed plans throughout the project life-cycle.

Management: Project managers manage the project team to meet the project objectives.

Success: Success is measured by product and project quality, timeliness, budget compliance, and degree of customer satisfaction.

Monitoring: Project managers monitor and control the work of producing the products, services, or results that the project was undertaken to produce.

The Main Project Management Elements of the D2O Project were analyzed in terms of the PMI (See Note 1) Project Management Groups to learn from any potential identified gaps.

Knowledge Areas	Project Management Process Groups				
	Initiating Process Groups	**Planning Process Groups**	**Executing Process Groups**	**Monitoring and Controlling Process Groups**	**Closing Process Groups**
4. Project Integration Management	4.1 Develop Project Charter	4.2 Develop Project Management Plan • *Project began as Operational Improvement for D20 facility. Placed on hold pending refurb decision, then re-started with expanded scope. A number of stops and starts.*	4.3 Direct and manage project execution	4.4 Monitor and control project 4.5 Perform integrated change control	4.6 Close project or phase
5. Project Scope Management		5.1 Collect requirements 5.2 Define scope 5.3 Create WBS	• *Original LPSW tie was for a "Hot Tap", then changed to an "inverted U plan which was later deemed not feasible. Plan B (2) was then to re-route the line via trenching.*	5.4 Verify scope 5.5 Control scope	
6. Project Time Management		6.1 Define activities. 6.2 Sequence activities. 6.3 Estimate activity resources 6.4 Estimate activity durations. 6.5 Develop schedule.	• *Late engineering*	6.6 Control schedule • *Incremental slips to schedule caused by unanticipated delays - work plan approvals, etc.*	
7. Project Cost Management		7.1 Estimate costs. 7.2 Determine budget.	• *Significant cost overruns*	7.3 Control costs. • *Cost overruns continue to escalate.*	
8. Project Quality Management		8.1 Plan quality	8.2 Perform quality assurance. • *Numerous changes in schedule logic ties that seemed to illustrate lack of understanding on vendor's part*	8.3 Perform quality control.	
9. Project Human Resources Management		9.1 Develop human resources plan.	9.2 Acquire Project team 9.3 Develop project team. 9.4 Manage project team		

Knowledge Areas	Project Management Process Groups				
	Initiating Process Groups	**Planning Process Groups**	**Executing Process Groups**	**Monitoring and Controlling Process Groups**	**Closing Process Groups**
10. Project Communications Management	10.1 Identify Stakeholders	10.2 Plan communications	10.3 Distribute information. 10.4 Manage stakeholder expectations	10.5 Report performance • *Vendor continually assured project team that things were "OK" and time losses could be recovered.*	
11. Project Risk Management		11.1 Plan risk management. 11.2 Identify risks. 11.3 Perform qualitative risk analysis. 11.4 Perform quantitative risk analysis. 11.5 Plan risk responses.		11.6 Monitor and control risks.	
12. Project Procurement Management		12.1 Plan procurement • *Originally sent RFP to 3 vendors. Changed to ES MSA ECP after piloting process on much smaller project. Of note, the ECP process had only been piloted on a much smaller project then direct to this project.*	12.2 Conduct procurement • *Proposals were based on Technical strength - 50% and Price - 50%.*	12.3 Administer procurement.	12.4 Close procurement.

(Note 1) PMI

PMI is the world's largest not-for-profit membership association for the project management profession with more than 700,000 members, credential holders and volunteers in nearly every country in the world.

PMI is a worldwide advocacy for project management by reinforcing globally recognized standards and certification program, extensive academic and market research programs, chapters and communities of practice, and professional development opportunities.

Appendix J - Safety Culture Review

Nuclear Safety Culture Traits	Yes ✓	No X
1. **Personal Accountability -** All individuals take personal responsibility for safety. Responsibility and authority for nuclear safety are well defined and clearly understood. Reporting relationships, positional authority, and team responsibilities emphasize the overriding importance of nuclear safety.	✓	
2. **Questioning Attitude -** Individuals avoid complacency and continuously challenge existing conditions, assumptions, anomalies, and activities in order to identify discrepancies that might result in error or inappropriate action. All employees are watchful for assumptions, values, conditions, or activities that can have an undesirable effect on plant safety. • QA 3. Challenge Assumptions: Individuals must challenge assumptions and offer opposing views when they believe something is not correct. • QA 4. Avoid complacency: Individuals recognize and plan for the possibility of mistakes, latent issues, and inherent risk, even while expecting successful outcomes. • Insufficient time to integrate design, mod planning, and accommodate for injection of scope into the schedule. Interviews determined that the plan and schedule was significantly underestimated from the onset of the project. The inherent risk associated with the new EPC model was not planned for through mitigation (or transition) plans, nor was the need to involve construction (all important stakeholders) from the onset recognized. – Escalation of commitment scenario		X
3. **Effective Safety Communication -** Communications maintain a focus on safety. Safety communication is broad and includes plant-level communication, job-related communication, worker-level communication, equipment labeling, operating experience, and documentation. Leaders use formal and informal communication to convey the importance of safety. The flow of information up the organization is seen as important as the flow of information down the organization.	✓	
4. **Leadership Safety Values and Action -** Leaders demonstrate a commitment to safety in their decisions and behaviors. Executive and senior managers are the leading advocates of nuclear safety and demonstrate their commitment both in word and action. The nuclear safety message is communicated frequently and consistently, occasionally as a stand-alone theme. Leaders throughout the nuclear organization set an example for safety. Corporate policies emphasize the overriding importance of nuclear safety.	✓	
5. **Decision-Making -** Decisions that support or affect nuclear safety are systematic, rigorous, and thorough. Operators are vested with the authority and understand the expectation, when faced with unexpected or uncertain conditions, to place the plant in a safe condition. Senior leaders support and reinforce conservative decisions. • DM1 Consistent Process: Individuals use a consistent, systematic approach to make decisions. Risk insights are incorporated as appropriate. • DM.3 Accountability for Decisions: Single point accountability is maintained. • All stakeholders were not involved in the planning stages in the beginning, also the project team underwent several organizational changes.		X
6. **Continuous Learning -** Opportunities to continuously learn are valued, sought out, and implemented. Operating experience is highly valued, and the capacity to learn from experience is well developed. Training, self-assessments, and benchmarking are used to stimulate learning and improve performance. Nuclear safety is kept under constant scrutiny through a variety of monitoring techniques, some of which provide an independent "fresh look". • OPEX from Bruce Power highlighted "weak stakeholder review process", as well as failure to recognize risk.		X
7. **Respectful Work Environment -** Trust and respect permeate the organization, creating a respectful work		X

environment. A high level of trust is established in the organization, fostered, in part, through timely and accurate communication. Differing professional opinions are encouraged, discussed, and resolved in a timely manner. Employees are informed of steps taken in response to their concerns. • It was reported via interviews and document in the Lessons Learned report that there was a failure to acknowledge reality and that staff should exercise managerial courage to escalate when the schedule is not achievable. Risks and threats were recognized reported but challenged by senior leadership. • Initial direction that "contractors are the experts and OPG should not tell them how to do their work" did not provide contractors clear expectations on how to achieve the desire OPG standards. This led to some frustration and resentment by the contractor. The relationship evolved to a more collaborative effort as the project progressed.		
8. Problem Identification and Resolution - Issues potentially impacting safety are promptly identified, fully evaluated, and promptly addressed and corrected commensurate with their significance. Identification and resolution of a broad spectrum of problems, including organizational issues, are used to strengthen safety and improve performance.	✓	
9. Environment for Raising Concerns - A safety-conscious work environment (SCWE) is maintained where personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment, or discrimination. The station creates, maintains, and evaluates policies and processes that allow personnel to freely raise concerns.	✓	
10. Work Processes - The process of planning and controlling work activities is implemented so that safety is maintained. Work management is a deliberate process in which work is identified, selected, planned, scheduled, executed, closed, and critiqued. The entire organization is involved in and fully supports the process. • MDRs not sufficiently detailed from the beginning causing several required injections to scope, project tasks were not integrated into the outage schedule		X

Appendix K – People Contacted In the Course of Investigation

People Contacted
Position
Project Manager (1)
Project Manager (2)
Project Director (1)
Project Director (2)
Project Leader
Modification Team Leader
B&M D2O Project Manager
RCMT Design Project Manager
B&M Planner
B&M Scheduler
OPG Project Scheduler
OPG Contract Administrator (1)
OPG Contract Administrator (2)

Appendix L – Interview Summary Notes

The following is a summary of the main points from the interviews of the main people involved with the project.

- No milestone in the contract for the TRF outage, although aware of it.
- No apparent method or metric readily available to allow for an overview of float reports to identify threats to future milestones.
- Original estimate of the 11 month engineering schedule and cost was significantly underestimated (contract awarded June 2012);
- Unfamiliarity of all requirements, size of scope
- Competition aspect on initial bid led to unachievable schedule and budget commitment (original estimate was classed as a Level 5, allowing for substantial margin for cost and schedule.)
- Contaminated soil, requiring additional scope added to the project
- Lack of office space on Darlington site leading to significant productivity losses and difficulty in project coordination
- Funds for upfront planning were not adequately allocated. Contract Planner did not start until fall 2012 (Contract awarded around June 2012)
- Only 2nd ESMSA project – this was not identified as a risk
- Capability of Contractor awarded the project was a known risk. This was not formally documented with associated mitigation plan. It was expected that the Project Team would provide increased oversight.
    - Project Team had frequent manpower turn-over – One team member started January 2010. Other current staff have all come on board in 2013. This is not formally identified as a risk with associated mitigation plans.
- Initial scope and schedule of work not fully defined
    - Schedule lengthened 50% after contract was awarded
    - Missed requirement to relocate LPSW line, however the scope had included buried services.
    - Delay in preliminary engineering
    - “number of changes on the project – I can’t count”
    - When experience contractor - Boyle got involved the scope and schedule improved
    - Benchmarking not fully effective
        - Pickering D20 Building project scope significantly smaller
        - Did not review PNGS Retube Lessons Learned

        - Separated dedicated Ops, issuing authority, shift manager to support project
        - Ops not familiar with work
    - Did not incorporate Bruce D2O project OPEX
        - Believed not to be applicable

- Schedule quality poor:
    - Difficulties in committing to date and sticking to it
    - No input from key execution staff (General Foreman)
    - E.g. trench schedule was revised over 30 times
        - Revisions involved logic ties
            - Indication that work not fully understood
- Project Oversight
    - Review commitments, and
    - Revised schedule
- Numerous PM changes – project had 4 Project Managers plus delays/gaps between turnovers.
- Superseding BCS will go to GRB in February 2014 for Board in March 2014.
- #1 expertise missing
- #2 get on the outage plan:
    - Since project was not on the TRF outage plan it was “under the radar”
    - Did not get on the outage schedule until after missing the milestone
- Can’t get on the outage plan if scope of work not finalized prior to outage scope freeze
    - Delay in Engineering
- D2O project was not prepared for the newly rolled-out ES-MSA process. 1st major project to be done under ES-MSA process, there were no lessons learned from ES-MSA process from past projects (only pilot project done under ES-MSA process before D2O was a low-value $2M Pickering project to replace four valves)
    - This was not carried as a risk
- Milestone missed because of documentation (workplans from Eng)
    - Quality of workplans was low – numerous review comments
    - Station personel/experience not used up front
- Work was not on Station or outage Plans
- Not “READY”

- Scope change approvals for injected work required significant effort to get approved – up to seven signatures
- Engineering "holds" not evident for RCM as is the case for station engineering
- Holds/delays are not transparent and visible by everybody (in PassPort)
    - Therefore threats are not visible
    - Not on plan – work is not visible
    - Not transparent, difficult to manage
- Review cycle for Eng taking significantly longer
    - Workplans were taking up to 5-6 weeks to be reviewed
    - No contingency in schedule for EC package review (5-6 weeks)
- • Plan not tied into OPG procedures
- Missing LPSW "milestone" not a surprise since "we had missed all the other milestones"
- Believed ill-defined project strategy
- Left contractor too independent
- Believed threats were being communicated, but response was simply "what are you doing about it?"
    - Need to have organizational tool to provide a check and balance against objective focused direction at the expensive of core values (safety, integrity, excellence, people and citizenship)
- Philosophy was "don't tell the contractors anything; only give them high level"
- Design requirements not prepared and submitted to RCM.
    - "[project] never had a good foundation"
    - Did not scope project properly
- "a little rosier than things actually were"
- New P6 schedule shows January 2016 project completion date. Approved BCS has a project completion date or in-service date of 15-Oct-15.
- Phase I fixed price.
- Larger project need to schedule release of EC packages based on construction schedule.

- RCM was not provided construction schedule.
- Construction was phase II
- Planned to have all of phase I (engineering) done prior to phase II
  - Project did not change strategy as schedule slipped

- Completion of the EC packages driven by cost rather than by construction schedule
- Engineering was driven to get all EC packages done by end of April 2013.
- Payment based on milestones – grouped EC's.
- EC groupings did not include LPSW.
- Engineering driven by cost versus time even though project was predominantly time constrained.
- Engineering knew form onset that they would not achieve milestone.
- Engineering felt that they were left on their own, did not get any support from OPG until challenges and schedule threats risked successful completion of the project.
- Missed LPSW service water line – in the bid proposal because the need to relocate the line was near the very back of the concept report used to make the bid proposal.
- Focus was on the building versus the underground services and tie-ins Original PO had convoluted milestones.
- No B&M planners, project coordinator at start.
- Workplans went through a lot of churn
- No milestone in the contract for the TRF outage, although aware of it.
- No apparent method or metric readily available to allow for an overview of float reports to identify threats to future milestones.
- Original estimate of the 11 month engineering schedule and cost was significantly underestimated (contract awarded June 2012);
- Unfamiliarity of all requirements, size of scope.
- Competition aspect on initial bid led to unachievable schedule and budget commitment (original estimate was classed as a Level 5, allowing for substantial margin for cost and schedule.)
- Not acknowledging reality.

Appendix M – Project Milestones

This table compared the number of milestones and type of milestones to another large project

D20 Storage Project				Auxiliary Heating System - Phases 1 & 2 Alternative Heating			
Milest	Milestone Activity Name	Baseline	Current	Milestone	Milestone Activity Name	Baseline	Current
AFS	Gate 4 Execution Phase Completed (AFS)	2015-10-15	2015-10-15	AFS	AHS - AVAILABLE FOR SERVICE	2015-04-01	2015-04-01
ASC	Gate 3A AISC Disposition (Partial BCS) ASC	2012-09-18	2012-08-01		DEMO - AVAILABLE FOR SERVICE COMPLETE	2015-12-31	2015-11-24
	Gate 2 GRB Meeting (Full Definition BCS)_DEV 2	2012-06-15	2012-06-15	BID	DEMO - Bids Received	2013-09-23	2013-11-15
	Gate 3b AISC Disposition (Full Execution ASC)	2013-07-18	2013-04-25		EPC - Bids Received	2012-05-23	2012-05-23
CMS	Start of Commissioning (CMS)	2015-07-13	2015-07-13	DBC	Definition Release BCS PSRB OAR Approved	2011-09-30	2011-09-30
DBC	Gate 3A (Partial BCS) Business Case Approved	2012-09-14	2012-08-12		Dev BCS OAR Approved	2010-11-08	2010-11-08
DCA	Issue Purchase Order EPC Contract Awarded - Phase I	2012-07-04	2012-07-04	DCA	DEMO - PO Contract Award	2014-05-30	2014-05-05
DES	EPC Contract Preliminary Design Complete DES	2012-10-29	2012-12-21		AHS - EPC PO Contract Award (Committed)	2012-10-10	2012-10-10
ECP	EPC Design Documents Approved and Issued (ECP)	2013-07-15	2014-05-09	DCO	DEMO - EC CLOSEOUT COMPLETED	2016-06-30	2016-05-26
FRF	Gate 3b Business Case Approved (Construction/Commissioning)	2013-09-16	2013-05-29		AHS - EC CLOSEOUT COMPLETED	2015-07-03	2015-07-03
ICA	EPC Phase II Installation Labour Contracts Awarded	2013-01-15	2012-12-11	DES	DEMO - Preliminary Design Complete	2014-08-29	2014-08-05
	EPC Installation Labour Contracts Awarded - Phase III	2013-09-23	2013-08-27		AHS - OO - MODIFICATION PLANNING COMPLETE	2013-04-16	2013-02-27
LLA	EPC Contract Long Lead Time Materials Contracts	2013-03-28	2013-03-27		AHS - OC - MODIFICATION PLANNING COMPLETE	2013-02-27	2013-02-27
LLT	EPC Contract Long Lead Materials Identified MS	2012-11-26	2012-11-26	ECP	DEMO - DESIGN DOCS APPROVED AND ISSUED	2015-02-13	2015-01-06
PCM	Project Complete Milestone	2016-04-15	2016-04-15		AHS - OO - Detailed Design Complete New AHS	2013-10-22	2014-08-27
PCO	Gate 5 Project Close Out Phase Completed (PCO)	2016-04-15	2016-04-15		AHS - OC - Detailed Design Complete Tie In Systems	2013-11-29	2014-08-25
PMM	Award EPC Phase II	2012-09-07	2012-10-11	FRF	Full BCS OAR Approved	2012-09-14	2012-09-14
	Gate 3A GRB Meeting (Partial BCS) PMM	2012-07-31	2012-07-31		PART BCS OAR Approved (Committed)	2013-04-02	2013-04-02
	Gate 4 Final In-Service	2015-10-15	2015-10-15		Part Exec Superceding BCS OAR Approved	2014-04-30	2014-04-10
	Gate 3A Approval to Proceed to Execution Phase (Detailed Design/Procurement of LLM) PMM	2012-08-30	2012-08-29	IAE	DAIA Approved - AHS	2011-11-07	2011-11-07
	Gate 3b GRB Meeting (Full Execution BCS)	2013-03-18	2013-04-29	LLA	AHS - LONG LEAD MATERIAL CONTRACTS AWARDED	2013-06-03	2013-06-03
	EPC Contract 100% of all design EC's Accepted by OPG Complete MS	2013-07-15	2014-05-12	LLT	AHS - LONG LEAD MATERIAL IDENTIFIED	2013-04-18	2013-04-18
	EPC Contract Long Lead Time Materials Contracts	2012-11-15	2013-02-07	PCM	Plan Complete	2016-12-30	2016-12-05
	EPC Contract Completion of Final COMS Complete MS	2013-04-15	2014-04-29	PCO	CLOSEOUT COMPLETED	2016-12-21	2016-11-16
	EPC Contract 75% of all design EC's Accepted by OPG	2013-04-04	2014-04-17	PEP	Proj Execution Plan Approved	2011-09-30	2011-09-30
	EPC Contract Mobilization Complete MS	2012-07-12	2012-07-12		Approve PEP	2012-09-28	2012-09-28
	EPC Contract Modification Planning Complete MS	2012-08-27	2012-12-13			2014-01-06	2014-01-15
	EPC Contract Eng Specifications for LL Items Accept by	2012-09-25	2012-12-14			2012-07-26	2012-07-26
	EPC Contract 100% of TMods Accepted by OPG Complete MS	2013-04-30	2013-05-16	PMM	Definition Release BCS PSRB Approved	2011-09-28	2011-09-28

SCR Title:
DELAY IN D20 STORAGE PROJECT

D20 Storage Project				Auxiliary Heating System - Phases 1 & 2 Alternative Heating			
Milest	Milestone Activity Name	Baseline	Current	Milestone	Milestone Activity Name	Baseline	Current
	EPC Contract 25% of all design EC's Accepted by OPG Complete MS	2012-12-03	2013-05-27		Dev BCS PSRB Approved	2010-11-08	2010-11-08
	EPC Contract 65% of all design EC's Accepted by OPG	2013-03-06	2014-03-18		End of Dev Release	2011-09-30	2011-09-30
	EPC Contract 50% of all design EC's Accepted by OPG Complete MS	2013-01-08	2013-09-30		GAP Analysis Report/Design Requirements Issued	2011-07-29	2011-07-29
	SATM F-1 Available for Service	(blank)	2014-02-28		Issue GAP Analysis Report	2011-04-15	2011-04-15
PSM	Project Start	2005-10-14	2005-10-14		DEMO - Work Pkg Assesst Complete CBH	2015-05-06	2015-03-25
SOI	Start of Installation (SOI) Phase III	2013-10-16	2013-10-01		AHS - Submit MOE Approval	2014-05-30	2014-06-26
CDC	Conceptual Design Complete	2011-11-17	2011-11-17		DEMO - Work Pkg Asst Compl Abandon Serv	2015-05-06	2015-03-25
CFA	Gate 1 Approval to Proceed to Initiation Phase	2010-12-22	2010-12-22		EPC - Issue RFP	2012-02-28	2012-02-28
					SOW for Geotech Analysis Approved	2011-10-20	2011-10-20
					DEMO - Issue AFS Report	2015-12-15	2015-11-10
					END OF AHS	2016-12-30	2017-04-07
					OPG Accept GOTHIC Analysis *	2012-05-16	2012-05-16
					Full BCS GRB Approved	2014-02-10	2014-02-18
					Full Rel GRB Meeting	2014-02-03	2014-02-12
					DEMO - Issue RFP	2013-08-09	2013-10-01
					PO Contract Award Geotech	2011-11-22	2011-11-22
					Approve EPC SOW	2011-11-28	2011-11-28
					DEMO - Lessons Learned Report Complete	2016-03-14	2016-02-05
					Approve BOE	2012-09-28	2012-09-28
						2012-07-12	2012-07-12
						2013-12-03	2014-01-07
					Submit Full BCS to GRB	2014-01-06	2014-01-15
					DEMO - SOW Approved	2013-07-18	2013-09-30
					PO Contract Award GOTHIC	2012-01-12	2012-01-12
					Submit Part BCS to GRB	2012-09-28	2012-09-28
						2012-07-12	2012-07-12
					AHS - EPC PO Contract Award (Target)	2012-10-10	2012-10-10
					EPC - MDR - Eng Tech Spec ISSUED	2011-12-19	2011-12-19
					PART BCS Board of Directors Meeting	2012-11-15	2012-11-15
					PART BCS OAR Approved (Target)	2013-01-04	2013-01-04
					DEMO - Work Plans Issued	2015-04-15	2015-03-04
					AHS - Work Plans Issued	2013-06-21	2013-11-13
					AHS - Work Pkg(s) Assesst Complete	2013-07-19	2013-11-15
					DEMO - Work Identified in Passport	2015-01-19	2014-12-05
					AHS - EPC - NEW AHS - START OF CONSTRUCTION (SOI)	2013-11-14	2013-11-15

Incident Investigation Report

Internal Use Only

SCR Number: **D-2013-19100**

SCR Title:
DELAY IN D20 STORAGE PROJECT

D20 Storage Project				Auxiliary Heating System - Phases 1 & 2 Alternative Heating			
Milest	Milestone Activity Name	Baseline	Current	Milestone	Milestone Activity Name	Baseline	Current
					N/A Part BCS Board of Directors Meeting	2012-08-17	2012-08-17
					N/A Submit BCS to Board of Directors	2012-08-17	2012-08-17
					Part BCS GRB Approved	2012-08-17	2012-08-17
						2012-10-25	2012-10-25
					Part Rel GRB Meeting	2012-08-10	2012-08-10
						2012-10-22	2012-10-22
					AHS - EPC - LONG LEAD MATERIAL IDENTIFIED (LLT)	2013-02-08	2013-02-08
					Approve Geotech Analysis Work Plan	2011-11-14	2011-11-14
					Submit PART BCS to Board of Directors	2012-11-01	2012-11-01
					AHS - EPC - AVAILABLE FOR SERVICE (AFS)	2015-01-05	2015-01-30
					AHS - EPC - LONG LEAD MATERIAL CONTRACTS AWARDED (LLA)	2013-03-26	2013-05-15
					N/A Prepare for Board Meeting - Part	2012-08-17	2012-08-17
					AHS - EPC OC - MODIFICATION PLANNING COMPLETE	2012-12-19	2012-12-19
					AHS - WORK IDENTIFIED IN PASSPORT - BURIED	2013-03-25	2013-05-06
					AHS - WORK IDENTIFIED IN PASSPORT - TIE INS	2013-05-14	2013-06-04
					AHS - EPC OO - Detailed Design Complete New AHS (ECP)	2013-08-14	2014-08-25
					AHS - EPC OO - MODIFICATION PLANNING COMPLETE	2013-02-06	2013-02-15
					AHS - EPC OC - Detailed Design Complete Tie In Systems	2013-03-26	2014-08-25
					AHS - EPC - BURIED SERVICES - START OF CONSTRUCTION (SOI)	2013-05-23	2013-06-18
					AHS - EPC - TIE IN SYSTEMS - START OF CONSTRUCTION	2013-07-11	2013-11-15
					Part Exec Superceding BCS Board of Directors Meeting	2014-03-20	2014-03-06
					Submit Part Exec Superceding BCS to Board of Directors	2014-02-10	2014-02-18
				PSM	Project Start Milestone	2006-03-23	2006-03-23
				RMP	Risk Management Plan Approved	2011-03-01	2011-03-01
					Approve Risk Mngt Plan	2012-09-28	2012-09-28
						2012-07-12	2012-07-12
						2013-12-03	2014-01-08
				SOI	DEMO - START OF DEMOLITION	2015-08-14	2015-07-10
					AHS - BURIED SERVICES - START OF CONSTRUCTION	2013-07-30	2013-06-18
					AHS - TIE IN SYSTEMS - START OF CONSTRUCTION	2013-09-18	2013-11-15
					AHS - NEW AHS - START OF CONSTRUCTION	2014-01-23	2014-01-23

Appendix N – Documents Reviewed

The table contains a list of the documents reviewed during the course of the investigation.

Documents Reviewed	
Number	**Name**
	Risk Registers – previous ones throughout evolution of the project
	OPG Consent to Proceed with Performance Fee Work 2012-11-20R1 re. LPSW Line
	52 D2O Storage Project Update Presentations between 2011-06-28 to 2013-11-13
	Developmental Business Case Summary
	Project Determination
	POP-Integrated Project Oversight Plan
	L1 Schedules
	D2O Engineering Schedule – Recovery Plan Presentation by B&M Project Manager
16-31555 PCA #005	PCA moving PCA & DES Milestones
31555-006	PCA-Requesting deferral longer than 6 months until after Referb decision is made.
Correspondence	Environmental Concerns WO #01542600
D-DAI-38000-10001	List of Deviations to COIR
D-LLD-38000-10001	D20 Storage And Drum Handling Project: Mod. Planning Lessons Learned Report
N-FORM-10521	Document Scoping Checklist
N-FORM-10853	PSR Determination Checksheet for OPG Nuclear
N-FORM-10958 R005	Modification Outline
N-FORM-10959	Design Scoping Checklist
N-GUID-00700-10000	Guide to Modification Procedures
N-INS-00120-10025	Extended Services Master Services Agreement Request For Work
N-INS-00960-10000	Detailed Commissioning Specifications and Commissioning Reports
N-INS-09701-10007 R0N/A	Project Oversight Planning And Implementation
NK38-38000-T01	Memo-Deferral of Darlington D2O Storage and Drum handling Project #16-31555
NK38-CORR-38000-0362673	Memo-Resumption of Project
NK38-CORR-38000-0448421	Options to Re-Route LPSW
NK38-CORR-38110-0322683	Resumption of Darlington D2O Storage and Drum Handling Project #16-31555
NK38-DRT-38000-10001	Darlington D2O Management Building West Annex OPEX Report 2011-10-31
NK38-PEP-38000-0434605	Project Execution Plan
NK38-REF-38000-0427531	Summary Of Darlington D2O Management Building D2O Drum Related SCRs
NK38-REP-09701-0265054	Darlington Refurbishment D2O Storage Facility Evaluation
NK38-REP-38000-10002	Conceptual Design Report for the Heavy Water Management Building West Annex
NK38-REP-38000-10002	Conceptual design report for the Heavy Water Management Building West Annex
NK38-SOW-38000-10001	Statement of Work-Darlington D2O Storage facility
NK38-SOW-38000-10003	Scope of Work for Eng. Contract: Darlington Heavy Water Storage Facility Project
NK38-SOW-38000-10004	Scope of Work for EPC Contract for the Darlington D2O Storage Facility Project
N-MAN-00120-100001 SCH-10	Darlington Nuclear Refurbishment Co-ordination and Control Schedule (C&CL2) – Terms of Reference
N-MAN-00120-10001 -COM R000	Project Communications
N-MAN-00120-10001 –EST R001	Nuclear Projects Cost estimating

Documents Reviewed	
Number	**Name**
N-MAN-00120-10001 –EST-01 R000	Nuclear Refurbishment Cost estimate
N-MAN-00120-10001 -GRB R000	Nuclear Projects Gated Process
N-MAN-00120-10001 -PC R000	Projects Control
N-MAN-00120-10001 –PC-01 R000	Nuclear Refurbishment-Cost and Schedule Change Control
N-MAN-00120-10001 –PC-02 R001	Nuclear Refurbishment-Cost and Schedule Change Control Instruction
N-MAN-00120-10001 –PC-13 R000	Nuclear Refurbishment-Cost Management and reporting
N-MAN-00120-10001 –RDM-01 R001	Nuclear Projects SharePoint 2007
N-MAN-00120-10001 –RDM-02 R001	Nuclear Projects Supplier Document Hub
N-MAN-00120-10001 –Risk 03 R000	Task Instruction-Closing Risks
N-MAN-00120-10001 RISK-04	Nuclear Refurbishment Risk Management Guide
N-MAN-00120-10001 –SCH R001	Nuclear projects Schedule Management
N-MAN-00120-10001 –SCH-02 R003	Task Instruction-DNG Refurb-Standard Projects Milestones List
N-MAN-00120-10001 –SCH-03 R001	Task Instruction-DND Refurb-Program & Project missed Milestone Recovery Process
N-MAN-00120-10001 –SCH-06 R001	Nuclear Refurbishment-Milestone definition Framework
N-MAN-00120-10001 –SCH-09 R000	Nuclear Projects Scheduling requirements from EPC Contractors
N-MAN-09701-10002	Nuclear Projects Oversight
NO11-000423	Self-Assessment: Lessons Learned Evaluation - Bruce Power D2O Storage project.
NO-2013-315	Nuclear Oversight Assessment Report: ECC Vendor Oversight Projects and Modifications, OPGN
N-PR0C-MP-0083-R006	Constructability, Operability, Maintainabilty, And Safety (COMS)
N-PROC-MA-0013	Planned Outage Management
N-PROC-MA-0022	Integrated On-Line Work Schedule
N-PROC-MP-0074	Design Plan
N-PROC-MP-0090	Modification Process
N-PROC-MP-0090-R005	Modification Process
N-PROG-AS-0007	Project Management
N-PROG-MP-0009	Design Management
N-STD-AS-0028	Project Management Standard
N-STD-AS-0029	Contract Management Standard
N-STD-AS-0030	Project Oversight Standard
OPG-PROC-0058	Procurement Activities
Report	NSS Preliminary Environmental Assessment
RFP #2007204	Request for Proposals – Phase 1
Whiteboard	Extracts from DNGS White Board on D2O Project

RCMT Engineering did not recognized the need for re-locating the LPSW buried line. This was because it was noted on page 203 of 205 of the Conceptual Design Report for the Heavy Water Management Building West Annex. The need was identified in Appendix F: Buried Services of this report. It stated in bold and italicize font:

The portion of this line which intersects the West Annex footprint will need to be relocated and provisions will be required to accommodate the service water discharge during relocation.

The body of the report stated that the Attached Building Option B would require "*nearly all buried service on this site have to be modified*"

This report was used to prepare the bid proposal. The buried services were not considered high risk interfacing systems that were listed in Appendix B of the report.

Appendix B: High Risk Interfacing Systems

- D2O Management System Computer Hardware (SCI 69791)
- Fixed Gaseous Effluent Radioactivity Monitoring System (SCI 67989)
- Active Drainage System (SCI 79710)
- Inactive Plant Drainage System (SCI 79110)
- Sewage System (SCI 79120)
- Demineralized Water System (SCI 74250)
- Domestic Water System (SCI 72700)
- Fire Protection Water Supply/Distribution System (SCI 78110)
- Common Instrument Air System (SCI 75160)
- Service Air System (SCI 75110)
- Breathing Air System (SCI 75130)
- TRF & D2O Management Building Steam and Condensate System (SCI 73680)
- Auxiliary Heating Steam System (SCI 73110)
- Heavy Water Management and TRF Ventilation System (SCI 73690)
- TRF/HWMB Air Conditioning System (SCI 73870).

Project Milestones – comparison to auxiliary heating system project

Appendix O – List of Acronyms

Acronym	Description
AFS	Available for Service
AR	Action Request
B&M	Black and McDonald
BCS	Business Case Summary
CARB	Corrective Action Review Board
COMS	Constructability, Operability, Maintainability and Safety
D2O	Heavy Water
DA	Design Authority
DE	Design Engineer
DIRT	Design Improvement Recovery Team
DNGS	Darlington Nuclear Generating Station
DOM	Director of Operations and Maintenance
DTL	Design Team Leader
EC	Engineering Change
EOER	Evaluating Organization Effectiveness Review
EPC	Engineer, Procure and Construct
EPC	Engineer, Procure and Construct
ESMSA	Extended Services Master Services Agreement
FLM	First Line Manager
IER	Industry Event Report
INPO	Institute of Nuclear Power Operations
IPG	Integrated Operating Plan
LPSW	Low Pressure Service Water
LPSW	Low Pressure Service Water
MC	Maintenance Control
MO	Modification Outline
MTL	Modification Team Leader
OCC	Outage Control Centre
OPEX	Operating Experience
OPG	Ontario Power Generation
Ops	Operations or Operators
PCC	Project Control Centre
PJB	Pre-job Brief
PO	Purchase Order
PO	Purchase Order
POND	Plan of Next Day
PU&A	Procedure Use and Adherence
RC	Root Cause
RCM	Engineering Sub-contracting Firm
RFP	Request of Proposal
SCR	Station Condition Record
SOER	Significant Operating Experience Report

Acronym	Description
SVP	Senior Vice President
TRF	Tritium Removal Facility
WANO	World Association of Nuclear Operators
WO	Work Order