# Attachment 1: Detailed Breakdown of Evidence Structure

The Darlington Refurbishment Program ("DRP" or "Program") evidence is organized into 11 different schedules as follows:

**Ex: D2-2-1: Darlington Refurbishment Program Overview**

1.0 Program Summary
2.0 Approvals Sought
3.0 Evidence Roadmap
4.0 Regulatory Framework
- 4.1 Ontario Regulation 53/05
- 4.2 Long Term Energy Plans
- 4.3 Ontario Government's Continued Support for DRP
- 4.4 CNSC Regulatory Framework

Attachments

- Attachment 1: Detailed Breakdown of Evidence Structure

**Ex: D2-2-2: Unit 2 Performance**

1.0 Overview
2.0 Unit 2 Execution Estimate
3.0 Quality Performance
4.0 Schedule Performance
- 4.1 Unit 2 Feeders – Function, Procurement and Installation
  - 4.1.1 Function of Feeder Pipes
  - 4.1.2 Feeder Pipe Procurement
  - 4.1.3 Feeder Pipe Installation Approach

5.0 Cost Performance

6.0 Oversight

7.0 Reporting

8.0 Rate Base and Capacity Refurbishment Variance Account Treatment

Attachments

Attachment 1: Darlington Refurbishment Program 2018 Annual Report

Attachment 2: Darlington Refurbishment Program 2019 Annual Report

**Ex: D2-2-3: Remaining Units Planning**

1.0 Overview

2.0 Unit-Over-Unit Scope Differences

2.1 Program Scope Development Process

2.2 Scope Differences – Unit 2 to Units 3, 1, and 4

3.0 Remaining Units Planning

3.1 Planning Strategy

3.2 Planning Process Overview

3.3 Planning Milestones

3.4 Unit 3 Planning and Current Status

3.5 Units 1 and 4 Planning and Current Status

4.0 Lessons Learned

4.1 The Lessons Learned Process

4.1.1 Phase 1: Identification and Documentation

4.1.2 Phase 2: Evaluation and Incorporation

4.1.2.1 Lessons Learned Monitoring

4.1.3 Phase 3: Verification

4.2 Application of Lessons Learned

5.0 Strategic Improvements

5.1 Examples of Strategic Improvements

5.1.1 Organizational Evolution

5.1.2 Engineering Replication

5.1.3 Darlington Unit 3 Innovations Project

5.1.4 Radiation Protection Improvements

5.1.5 Training Effectiveness Improvements

5.1.6 Trades Labour Hybrid Schedule

5.1.6.1 Trades Availability, Training and Proficiency

5.1.6.2 Project Management Team Availability, Training and Risk Mitigation

5.1.6.3 Construction Leadership

5.1.6.4 Schedule and Cost Management

6.0 Collaboration with Bruce Power

Attachments

Attachment 1: OPG-MAN-00120-0019, Project Phase Gate Management

Attachment 2: NK-38-MAN-09701-10005, Sheet MLST, R002, Refurbishment Unit Planning Milestones

Attachment 3: NK-38-MAN-09701-10005, Sheet WIN, R000, Refurbishment Unit Planning Window Milestones

Attachment 4: NK-38-GUID-09701-10054, R001, Nuclear Refurbishment Lessons Learned

Attachment 5: Schematic of OPG's Lessons Learned Process

Attachment 6: Summary of Feeder Lessons Learned and Actions

Attachment 7: Powering Ontario Together, 2018 Report on Nuclear Collaboration

Attachment 8: Joint Bruce Power/OPG Letter to the Minister of Energy, Northern Development and Mines and the Associate Minister of Energy re: Bruce Power/OPG Collaboration, November 19, 2019.

**Ex: D2-2-4: Unit 2 Performance**

1.0 Overview

2.0 Contract Management

2.1 Collaborative Contract Management

2.1.1 The One Team Approach

3.0 Major Contracts

3.1 Contracting Overview

3.2 Retube and Feeder Replacement

3.2.1 Amendments 7 to 10 to the RFR EPC

3.2.2 Amendments 11 and 12 to the RFR EPC contract dated November 3, 2020 and December 11, 2020 respectively (each effective as of October 17, 2019)

3.2.1.1 Revised Execution Phase Target Cost

3.2.1.2 The Unit 2 Credit

3.2.1.3 Revised Execution Phase Cost Incentive/Disincentive

3.2.1.4 Execution Phase Working Schedule Incentive

3.2.1.5 Revised Execution Phase Project Change Directive Terms

3.2.1.6 Revised Pricing Terms for Owner Specified Materials and Goods

3.2.1.7 Enhanced Collaboration Terms

3.3 Turbine Generator

3.3.1 TG Engineering Services and Equipment Supply and Field Services Agreement

3.3.2 TG Engineering Procurement and Construction Agreement

3.3.2.1 Amendment 5 dated November 3, 2020 (with effect as of October 17, 2019)

3.4 Fuel Handling and Defueling

3.5 Steam Generator

3.6 Balance of Plant

Attachments

Attachment 1: Summary of the Major Work Bundles

Attachment 2: Darlington Refurbishment Contract Program Management Plan

Attachment 3: Summary of the RFR EPC contract with CanAtom

Attachment 4: RFR EPC Agreement Amendment #7

Attachment 5: RFR EPC Agreement Amendment #8

Attachment 6: RFR EPC Agreement Amendment #9

Attachment 7: RFR EPC Agreement Amendment #10

Attachment 8: RFR EPC Agreement Amendment #11

Attachment 9: RFR EPC Agreement Amendment #12

Attachment 10: Summary of Turbine Generator ESESFSA contract with General Electric

Attachment 11: ESESFSA Amendment #3

Attachment 12: ESESFSA Amendment #4

Attachment 13: ESESFSA Amendment #5

Attachment 14: Summary of the TG EPC contract with CanAtom

Attachment 15: TG EPC Amendment #3

Attachment 16: TG EPC Amendment #4

Attachment 17: TG EPC Amendment #5

Attachment 18: Summary of the Steam Generator EPC contract with the BWXT/Candu JV

Attachment 19: Steam Generator EPC Amendment #3

Attachment 20: Summary of the ESMSA contract

Attachment 21: Amended and Restated ESMSA contract with CanAtom

**Ex: D2-2-5: Remaining Units Schedules**

1.0 Overview

2.0 Schedule Development and Management

2.1 Schedule Development and Management at the RQE

2.1.1 Formation of the Baseline Schedule

2.1.2 Schedule Management

3.0 Remaining Units Schedule

3.1 Remaining Units Program Schedule

3.2 Unit Schedules - Development and Refinement

3.2.1 Lessons Learned

3.2.2 Strategic Improvements

3.2.3 Developing Robust Schedule Logic

3.2.4 Reviewing the Overlapped Periods

3.3 Remaining Units Schedules

3.4 Unit-Over-Unit Efficiencies

Attachments

Attachment 1: OPG's Multi-Level Scheduling Approach

Attachment 2: Unit 3 Level 1 Working Schedule

Attachment 3: Unit 1 Level 1 Working Schedule

Attachment 4: Unit 4 Level 1 Working Schedule

**Ex: D2-2-6: Remaining Units Contingency**

1.0 Overview

2.0 Contingency Development

3.0 Contingency Amounts

3.1 Base Estimates and Contingency Amounts

3.2 Remaining Units' Contingency Amounts

3.2.1 Factors Driving Reduced Contingency Need

3.3 Control and Approval of Contingency Usage

Attachments

Attachment 1: Explanation of Monte Carlo Simulation

**Ex: D2-2-7: Remaining Units Cost**

1.0 Overview

2.0 Program Budgets

- 2.1 Release Quality Estimate
- 2.2 Unit 2 Execution Estimate
- 2.3 Unit 3 Execution Estimate

3.0 In-Service Amounts

- 3.1 Unit 3 versus Unit 2
- 3.2 Units 1 and 4 versus Unit 3
- 3.3 Major Work Bundle Costs
  - 3.3.1 Remaining Units Retube and Feeder Replacement
  - 3.3.2 Remaining Units Turbine Generators Costs
  - 3.3.3 Remaining Units Balance of Plant Costs
  - 3.3.4 Remaining Units Fuel Handling and Defuelling Costs
  - 3.3.5 Remaining Units Steam Generators Costs

Attachments

| | |
|---|---|
| Attachment 1 | Ontario Power Generation, Darlington Refurbishment – Final Unit 3 Execution Estimate, For Approval by Board of Directors, August 13, 2020 |
| Attachment 2: | Burns/Modus Report, Unit 3 Execution Estimate, Darlington Refurbishment Project, Burns McDonnell/Modus Strategic Solutions, March 5, 2019 |
| Attachment 3: | Independent Oversight Team, Report on Darlington Unit 3 Execution Estimate, Burns McDonnell/Modus Strategic Solutions, November 11-12, 2019 |

**Ex: D2-2-8: Program Structure and Oversight**

1.0 Overview

2.0 Organization for Remaining Units Execution

- 2.1 Program Management by Enterprise Project Management Office
- 2.2 DRP Organization to Manage the Remaining Units
  - 2.2.1 Refurbishment Execution - Unit 3
    - 2.2.1.1 Major Work Bundle Project Management Teams
    - 2.2.1.2 Operations and Maintenance
  - 2.2.2 Refurbishment Support
    - 2.2.2.1 Construction Support
    - 2.2.2.2 Work Management
    - 2.2.2.3 Quality Management
    - 2.2.2.4 Lessons Learned and Strategic Initiatives
  - 2.2.3 Refurbishment Planning – Units 1 and 4

3.0 Change Management

4.0 Reporting

5.0 Oversight

**Ex: D2-2-9: In-Service Amounts**

1.0 Overview

2.0 IR Term Capital In-Service Amounts

- 2.1 Unit Refurbishment – Remaining Units Amounts

2.2 Unit Refurbishment – Remaining Units Early In-Service Projects

3.0 D2O Storage Project

4.0 Comparison of In-Service Amounts

4.1 2021 Budget versus 2021 OEB Approved

4.2 2020 Budget versus 2020 OEB Approved

4.3 2019 Actual versus 2019 OEB Approved

4.4 2018 Actual versus 2018 OEB Approved

4.5 2017 Actual versus 2017 OEB Approved

4.6 2016 Actual versus 2016 OEB Approved

**Ex: D2-2-10: The D2O Storage Project**

1.0 Overview

2.0 Introduction

2.1 What is the D2O Storage Project

2.2 The Purpose of the D2O Storage Project

2.2.1 Supporting DRP

2.2.2 Addressing Ongoing Darlington Operational Needs and the TRF

2.3 OPG's Request and Ratemaking Treatment

2.4 D2O Storage Project Business Case Summaries

2.5 Expert Report

3.0 Description of the D2O Storage Facility

3.1 Overview

3.2 The Seismic Dike (Elevation 87 m)

3.3 The Drum Processing Area (Elevation 100 m)

3.4 Process and Building Support Systems (Electrical and Mechanical) (Elevation 107.8 m)

3.4.1 Electrical System

3.4.2 Mechanical Systems

3.4.3 Monitoring and Alarm Systems

3.5 The Roof (Elevation 115 m)

4.0 Origins of the D2O Storage Project

4.1 Operational Improvements to Heavy Water Storage and Handling

4.2 Advancing the Operational Improvement Project

5.0 Merging the Refurbishment Heavy Water Storage and Operational Improvement Projects to Form the D2O Storage Project

5.1 Initial Assessment of Refurbishment Storage

5.2 Alternatives Evaluated

5.2.1 Stand Alone Building

5.2.2 Additional Storage in an Existing Structure

5.2.3 Construction of a Refurbishment Only Storage

5.2.4 Construction of a Drum Warehouse

6.0 Development of the D2O Storage Project

7.0 Contracting for the D2O Storage Project

7.1 Initial Contracting Efforts

7.2 Contracting Under the ESMSA

7.2.1 The ESMSA

7.2.2 Initial Competitive Procurement for the D2O Storage Project under the ESMSA

8.0 Designing and Constructing the D2O Project

8.1 Project Execution by Black & McDonald: Overview of the Project Plan and Timelines

8.2 Initial Planning and Design

8.2.1 The Context of Design Changes within Darlington

8.2.2 Design Work

8.3 OPG's Commitment to Safe Construction

8.4 Site Clearing and Preparation

8.4.1 Soil Management

8.4.2 Dewatering

8.5 Relocation of Buried Services

8.5.1 Buried Services

8.5.2 Low Pressure Service Water Line

8.5.3 Tie-ins for Piping Connections

8.5.4 Other Buried Services

8.6 Installing the Caisson Wall and Excavating the Seismic Dike

8.6.1 Caisson Installation and Tie-backs

8.6.2 Excavation

8.7 Temporary Trailers

8.8. Continuing Difficulties Completing Design

8.9 Efforts to Recover Project Cost and Schedule

8.10 Scope Review

8.11 Termination of Black & McDonald and Settlement

8.11.1 Termination

8.11.2 Settlement

9.0 Project Execution by OPG and the Second Project Procurement

9.1 Assumption of Subcontracts and Retaining ES Fox

9.2 Sub-Slab and Rock Anchor Installation

9.3 Seismic Dike Foundation Slab and Walls

9.4 Seismic Dike Topping Slab

10 Project Execution by the SNC-Lavalin/Aecon Joint Venture

10.1 Retention of an EPC Contractor to Complete the Project

10.2 CanAtom Begins Work Pursuant to a Limited Notice to Proceed

10.3 Review of RCMT Design and the CanAtom's Proposed Redesign

10.4 CanAtom Assumes Control of the Project Site

10.5 Piping Installation in the Seismic Dike

10.6 Pouring the Seismic Dike Top Slab and Erecting the Building Frame

10.7 Pipe Chase Excavation, Shoring and Construction

10.8 Storage of Unit 2 Heavy Water During Construction

10.9 Completing the Building Envelope, Pouring Floor Slabs and Constructing the Causeway

10.10 Construction Slowdown and Dispute Over Redesign

10.11 OPG Negotiates a Comprehensive Settlement with CanAtom

11.0 Project Completion

11.1 CanAtom Resumes Construction

11.2 Project Phase 2 – Completion Pursuant to the Revised Statement of Work

12.0 Commissioning and Related Activities

12.1 Pre-Commissioning

12.2 Commissioning

13.0 Business Case Summaries for the D2O Storage Project

13.1 2006 Developmental Release Business Case Summary for the Operational Improvement Project

13.2 The 2011 Draft Developmental Business Case

13.3 June 2012 Full Release Definition Business Case Summary

13.4 August 2012 Partial Release Execution Business Case Summary

13.5 2013 Full Release Execution Business Case Summary

13.6 2015 Superseding Release Execution Business Case Summary

13.7 2018 Superseding Release Execution Business Case Summary

14.0 Conclusion

Attachments

Attachment 1: Introduction to Heavy Water and its Use in CANDU Reactors

Attachment 2: D2O Storage Project - Key Documents

Attachment 3: List of Acronyms Associated with the Project

Attachment 4: Timeline of the Major Project Milestones

Attachment 5: Temporary Storage of Unit 2 Heavy Water

**Ex: D2-2-11: Independent Studies**

1.0 Independent Assessment of OPG's Preparedness to Refurbish Units 3, 1, and 4

2.0 Independent Cost Estimate of the As-Built Heavy Water Storage Facility

Attachments

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|---|---|
| Attachment 1: | Pegasus Global Holdings, Inc. – Testimony of Dr. Patricia D. Galloway |
| Attachment 2: | Pegasus Global Holdings, Inc. Engagement Letter |
| Attachment 3: | Bates White Economic Consulting - Report: Construction Cost Estimate for the Darlington Nuclear Generating Station D2O Storage Project |
| Attachment 4: | Bates White Economic Consulting Engagement Letter |