#### ONTARIO POWER GENERATION

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### **Ontario Electricity Generation**





### **Darlington Refurbishment**

- Mid-life refurbishment required for CANDU
  - For Darlington, that time is now
- Strong economic case:
  - World class high performing asset
  - Help moderate electricity prices
  - 12.8B investment
  - GHG-free base-load energy
  - Economic benefits and long-term
     employment opportunities





#### **Project Development**

**Initiation Phase** 

2007-2009

#### **SCOPE OF WORK**

1

- Initial determination of refurbishment scope through completion of:
  - Technical assessments of all major components
  - Condition assessments of balance of plant components
  - Initiation of regulatory processes; Integrated Safety Review and Environmental Assessment
- Develop reference plans for cost and schedule
- Complete economic feasibility assessment
- Establish project management approach and governance
- Establish overall contracting strategy
- OPG Board and Shareholder agree with recommendation to proceed with preliminary planning within the Definition Phase of the project

#### Definition Phase 2010-2015

#### **SCOPE OF WORK**

2

- Obtain regulatory approvals:
  - Environmental Assessment
  - Integrated Safety Review
  - Integrated Implementation Plan
- Implement project management and oversight
- Complete infrastructure upgrades, i.e. Darlington Energy Complex
- Implement safety improvements
- Award major contracts
- Finalize project scope and complete engineering work
- Procure long lead materials
- Complete unit prerequisite work
- Construct reactor mock-up and fabricate and test tooling
- Develop release quality cost and schedule estimate
- Obtain all permits and licences
- Mobilize and train Trades staff

#### Execution Phase 2016-2026

#### **SCOPE OF WORK**

3

- Unit shutdown and defueling
- Island unit and lay up systems
- Execute all refurbishment scope:
  - Reactor components
  - Fuel handling systems
  - Turbine / generator
  - Steam generators
  - Balance of plant
- Meet all regulatory commitments
- Plant maintenance and inspection activities
- Manage plant configuration
- Load fuel
- Commissioning
- Unit start-up
- Apply lessons learned to subsequent unit refurbishments
- Project close-out



#### **Refurbishment Schedule**





### **Risks are Managed**

- · Years of extensive planning
- Lessons learned have been incorporated
- Scope, schedule and cost are developed to a level of detail not seen on prior projects.
- Contingencies are included in the budget and schedule
- Site infrastructure in place
- Significant Oversight/Public Reporting:
  - Funding strategy provides for realistic off-ramps at key decision points.
  - Extensive public oversight and reporting.





### Innovation at Darlington







#### Steps to Refurbishment







#### **Refurbishment Key Vendor Partners**

Defuel, Fuel Handling, Special

















#### **Balance of Plant**





Turbine / Generator









### Eye on the Ball

- Human Performance
  - Right Work Right the First Time
  - Strengthening Relationships
  - Building Engineering Leaders
- Applying Processes
  - Graded Approaches Need to be Used Consistently
  - Standards Need to be Known and Practiced Consistently
- Technical Conscience Challenges
  - Industry Lessons on First of a Kind / First in a While
  - Fast Track Engineering / Schedule Pressure
  - Management / Escalation of Issues





#### **Building Together**

# · BUILDINGTOGETHER ·

THE DARLINGTON REFURBISHMENT PROJECT





### U2 Project Status

- Just past the halfway mark for schedule duration and about 60% complete for work execution
- disassembly complete start of reassembly
- Unit 2 remains on time and on budget



- Applying Lessons Learned
- Government approval to proceed with Unit 3
- Average of 14,200 jobs annually





### Top Program Risks:

- Vendor Performance
- Skilled trades/craft
- Retention of Leadership
- Foreign Material Control





### Unit 3 Planning

- On February 15, 2018, the Ontario government confirmed its commitment to begin the refurbishment of Unit 3 at Darlington Nuclear.
- Unit 3 planning is underway to be ready to commence Unit 3 execution once Unit 2 is complete
- An independent planning team is being established to ensure distractions around the execution of Unit 2 are minimized. Unit 3 scope is similar to Unit 2
  - Excludes one-time facility and safety projects, and in-station support service projects.
  - Includes Turbine Generator Controls and Stator Replacement and Rewind.
- Engineering has commenced
  - Preliminary Engineering is underway for balance of plant projects.
  - Detailed Engineering and long lead material procurement is advancing for Turbine Generator and Re-tube and Feeder Replacement projects.
- Life-to-date costs for Unit 3 are \$31 Million.





#### **Ontario Nuclear Refurbishment Schedule**

#### Nuclear Refurbishment Schedule









### **Additional Options**



#### **Building Together – OPG One Team**







## Key Lessons

Lack of involvement of dedicated Operations & Maintenance organization can result in commissioning and restart issues.	<ul> <li>Incorporation of an Operations and Maintenance organization in the DRP to reduce commissioning and restart challenges</li> </ul>
Insufficient front end planning as a primary source of failure and importance of good project management processes and controls	<ul> <li>Adoption of industry recommended practices, processes and controls to administer the Program</li> </ul>
Mis-categorization of estimate class by contractor can lead to underestimation of budget and effort	<ul> <li>Ensure that the classification reflects the level of engineering completed and estimates are fully vetted b OPG</li> <li>Complete detailed engineering prior to beginning construction, awarding contracts and estimating material quantities</li> </ul>
Projects that require ty-in with existing facilities and large, first-of-kind projects are complex	<ul> <li>Ensure added resources and oversight and account for added complexity</li> <li>Ensure that the contractor hired to do the work has the right skills and experience</li> </ul>



#### **Return to Service Processes**

- Construction Completion Declaration (CCD) is a declaration that construction work and supporting documentation is complete.
  - Prepared by the Executing Group.
  - Accepted by Engineering (design and system).
  - Accepted by RTS for O&M .
- CCD is not an Available for Service (AFS).
- AFS is done for:
  - Modifications per N-PROC-MP-0090 (MTL lead)
  - Systems per NK38-INS-09701-10005 (SRE Lead)
- AFS's will be scheduled as early as possible to maximize window available prior to requiring the systems to be in service and grouped logically to minimize effort.





#### **RTS is Processes and Behaviours**



#### **Processes:**

- Installation of new equipment
- Restart Control Hold Points
- Regulatory Hold Points
- Evolution Procedures
- Systems Available for Service (SAFS)

#### **Behaviours:**

- Safety / Hu
- Work readiness
- Quality workmanship
- FME behaviours
- Cost behaviours
- Teamwork

