Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

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Supplementary Information

Renseignements supplémentaires

Revised presentation from Ontario Power Generation (OPG)

Présentation révisée d'Ontario Power Generation (OPG)

OPG Update on the Refurbishment Project at the Darlington Nuclear Generating Station

Mise à jour d'OPG sur le projet de réfection à la centrale nucléaire de Darlington

Commission Meeting

Réunion de la Commission

December 9, 2020

Le 9 décembre 2020

Canada

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Update to the Canadian Nuclear Safety Commission

December 9, 2020

Agenda

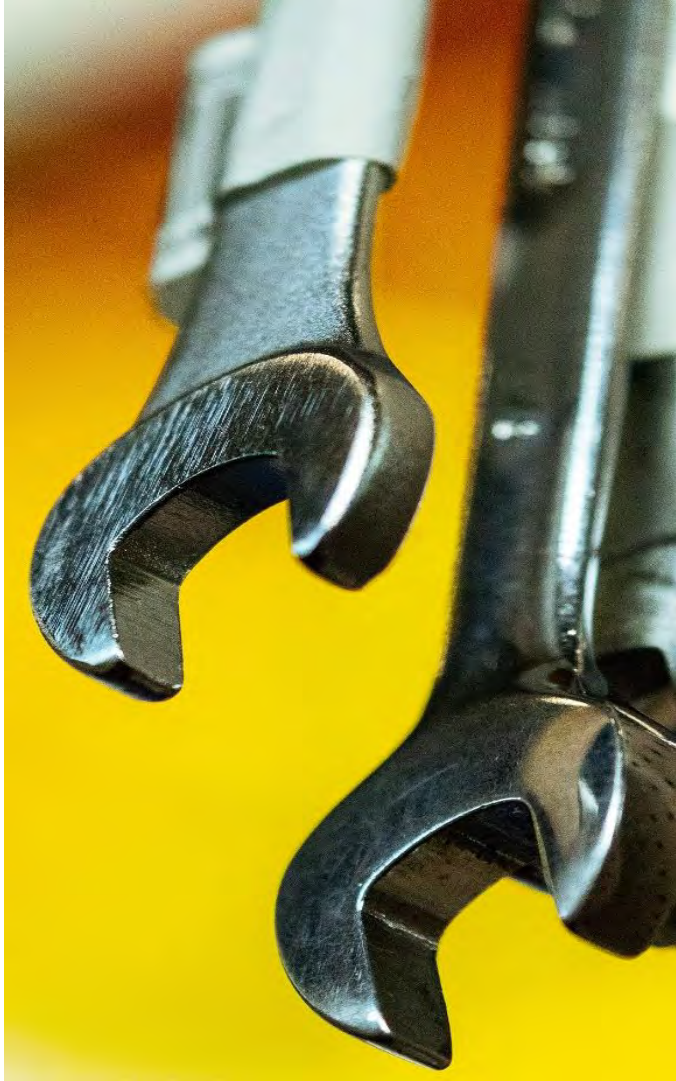
1 | Darlington Overview

2 | Darlington Refurbishment Program

- Unit 2 Refurbishment Complete
- Unit 3 Overview and Readiness

3 | Darlington Nuclear for the Future

4 | Additional Information




Darlington Overview
ONTARIO POWER GENERATION
Where a brighter tomorrow begins.

Darlington Nuclear

Low cost, reliable, clean baseload generation, as well as delivering substantial economic benefits to the province

In-service early 1990's, providing over 25 years of clean, competitive, reliable power

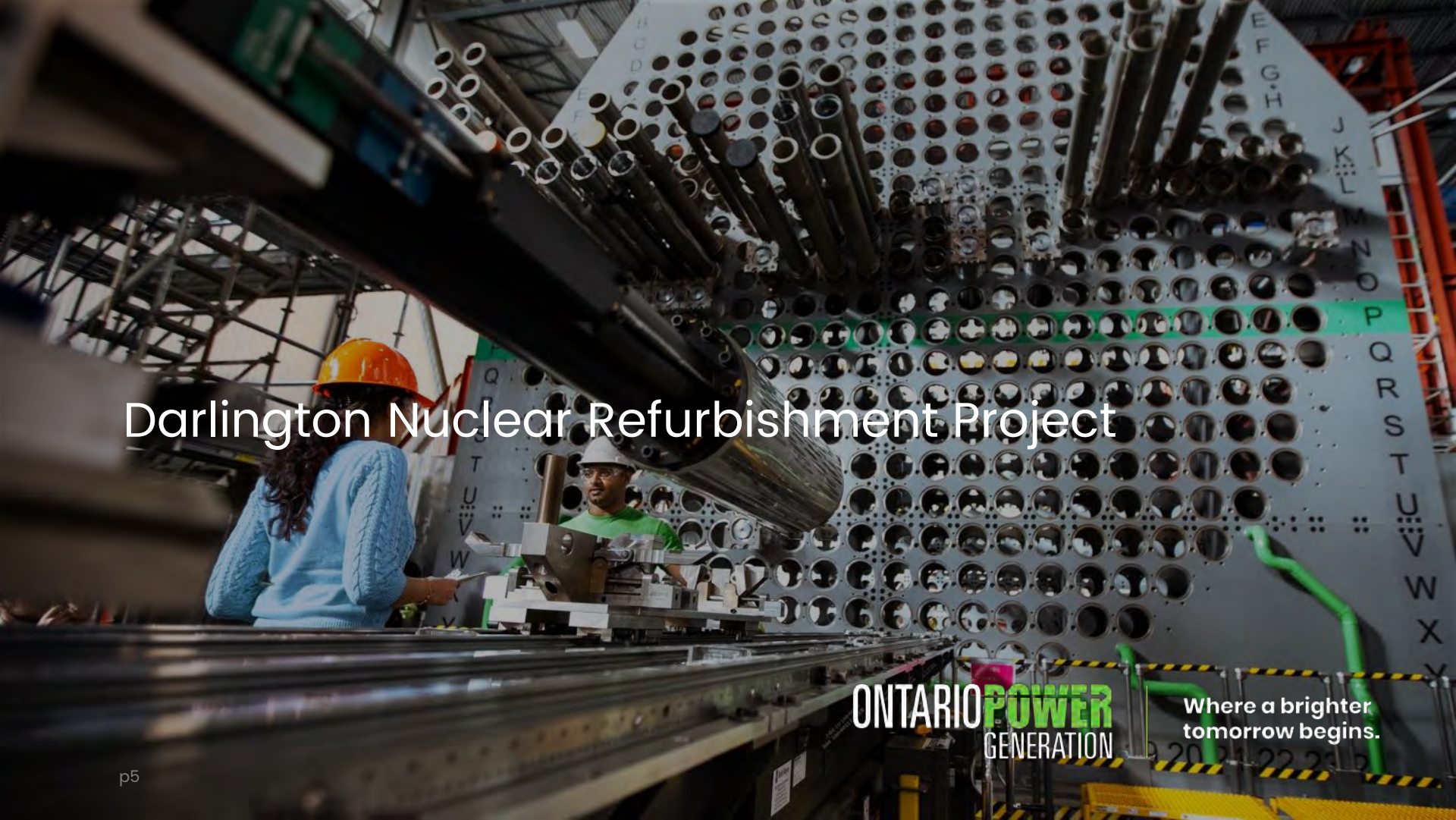
- Four units; 3524 MW net output
- Delivers 20 percent of Ontario's electricity; power for 2 million homes

Recognized internationally for excellent safety, equipment reliability and operating performance

Strong community support

Unit 1 now holds the world record for continuous operation of a nuclear reactor, surpassing previous record of 962 days

DNRU2 completion sets a new standard for CANDU refurbishment


Darlington Nuclear Refurbishment Project
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Darlington Nuclear Refurbishment Project

20-year project

- 10 years planning, 10 years execution
- Each Unit will undergo Refurbishment outage of 35-44 months; overlapping outages of U3/U1 and U1/U4

Replace major reactor components and upgrade key plant systems

Substantial safety and equipment investments

Economic benefits

- $12.8B investment, 14,000+ jobs; and $89.9B boost to Ontario's GDP

30 more years of safe, reliable, low-cost, clean electricity

Darlington Refurbishment Scope

Defuel, Fuel Handling, Special Projects

Retube and Feeder Replacement

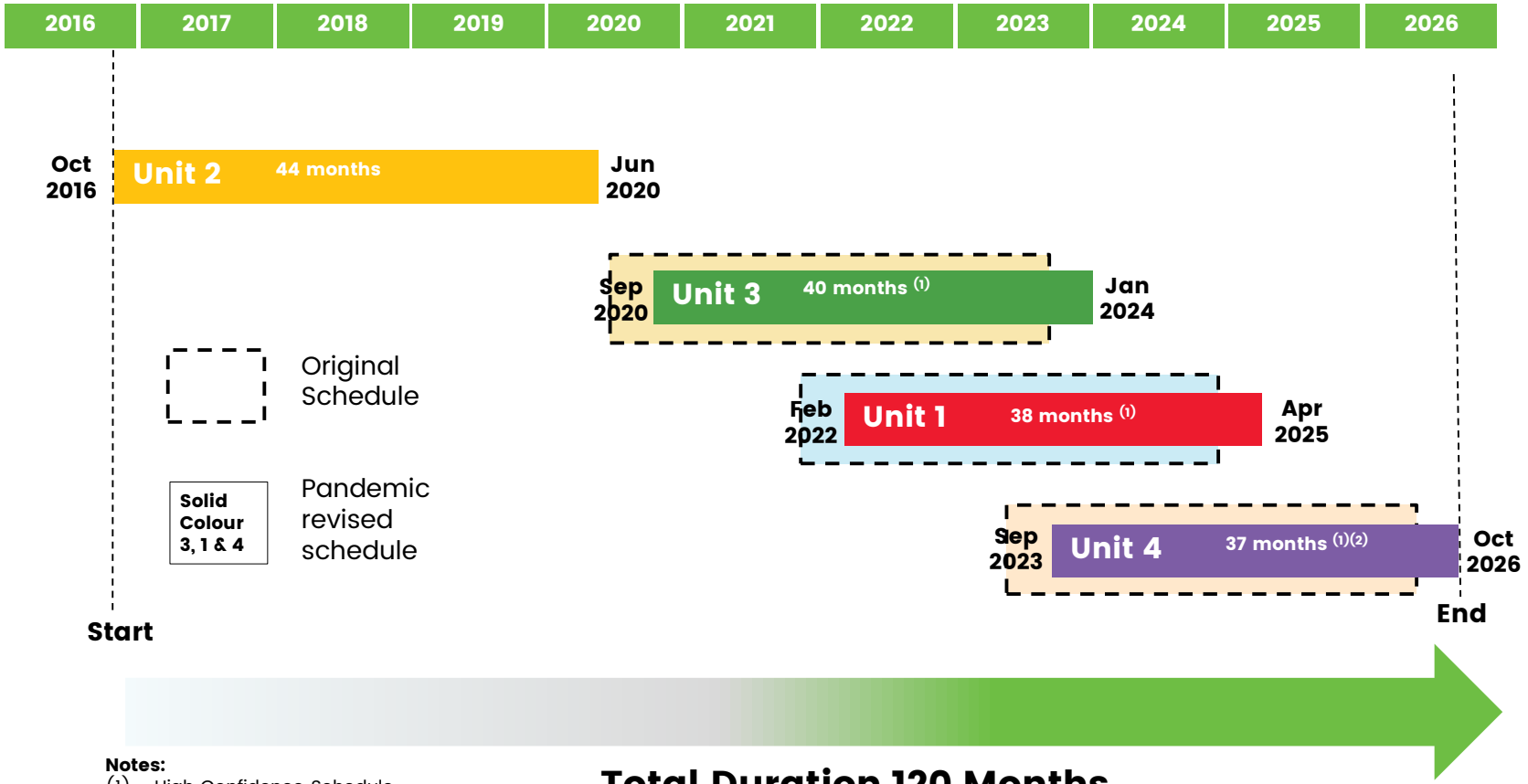
Turbine / Generator

Steam Generators

Balance of Plant

Cyclic Outage

Darlington Refurbishment Schedule



Notes:
(1) High Confidence Schedule
(2) Unit 4 will commence upon completion of Unit 3 between Sep/23 and Jan/24

Unit 2

Unit 2 returned to service on June 4, 2020

- 24 Million hours worked with 1 Lost Time Accident (LTA) – final months completed safely with COVID restrictions
- 58 Systems, 13 major infrastructure projects and 5 safety improvement opportunity projects placed in-service

Unit 2 operating reliably post-refurbishment

Four unit Refurbishment remains on budget and on time for revised schedule

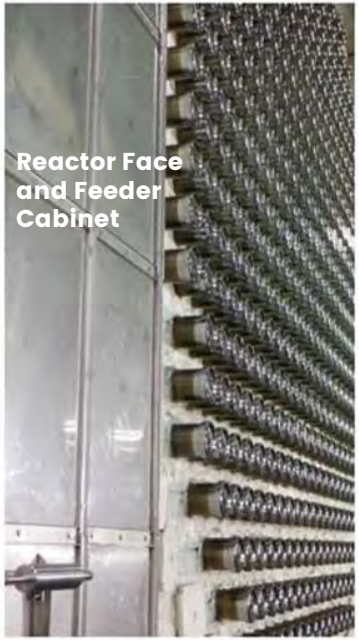
Unit 2
100% Complete

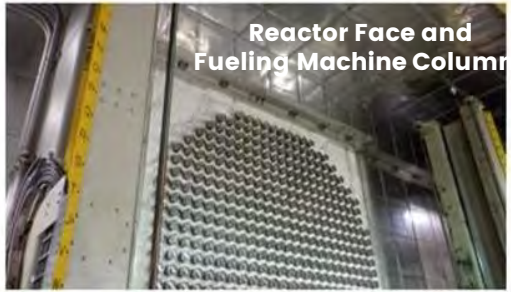
24
Million Hours Worked

58
Systems in Service

18
Major Safety & Infrastructure Projects

Unit 2 Reactor Vault





Integrated Implementation Plan (IIP)

100% completion of IIP tasks on time(1)

All 93 IIP tasks required to clear Unit 2 Regulatory Hold Points and return the Unit to 100% power are complete

U3 has 28 IIP tasks tied to unit Return to Service

Regular meetings with the CNSC staff to communicate progress and completion of IIP tasks

All remaining IIP tasks are tracked and progressing well

(1) Timing of some tasks changed with CNSC concurrence
Data as of date: Dec.1 2020

Interface with the CNSC and clearing of the Regulatory Hold Points (RHPs)

All Regulatory requirements for refurbishment of Unit 2 were met:

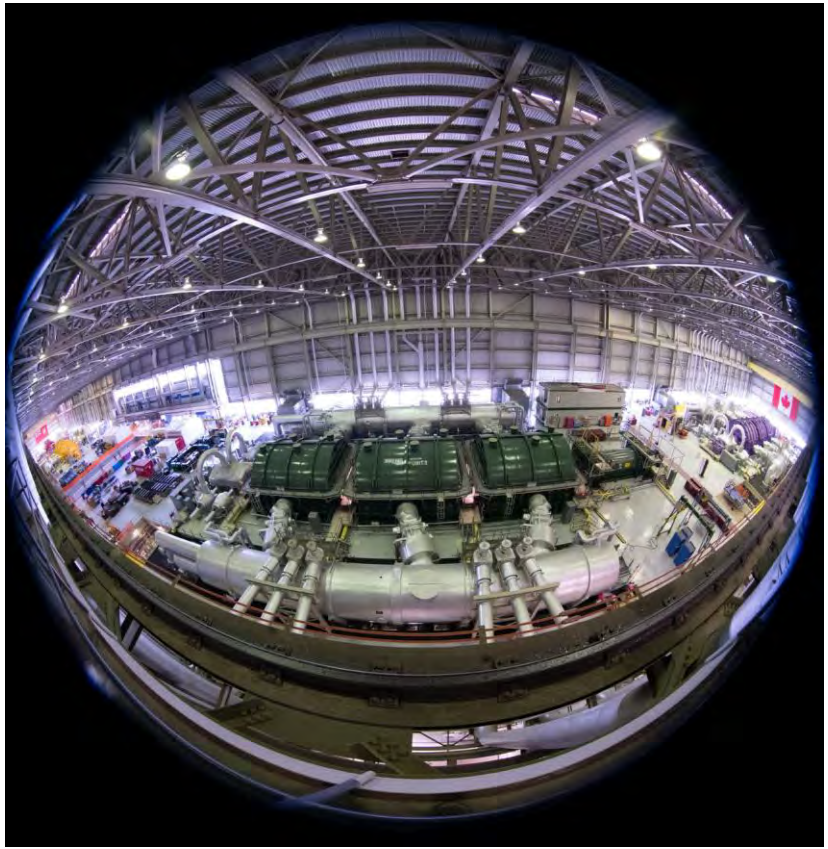
- All licence conditions were met for Unit 2 Return to Service(RTS)
- Licence Condition 15.3 & 15.4 included completion of IIP commitments and clearing RHPs - All Completed
- RTS Protocol identified detailed deliverables to clear each RHP. This was accomplished on time and to CNSC Staff satisfaction
- An extensive study of Unit 2 Lessons Learned was undertaken and incorporated into Unit 3 Protocol, allowing enhancement of the Refurbishment project and regulatory interface

Unit 3

Deferred start of Unit 3 Refurbishment due to COVID-19

Unit 3 Refurbishment started September 3, 2020

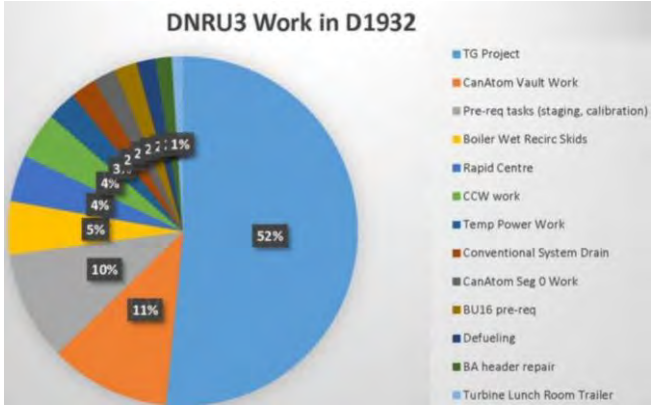
- Safety continues to be our top priority
  - COVID-19 measures are in place to protect staff and workers
- On-boarding of Trades and pre-requisite field work underway
- Defueling of Unit 3 commenced September 3 and completed November 25 (7 days early)
- 36-month schedule



Single Fuel Channel Replacement (SFCR)

SFCR was a 30-day outage to validate lifespans of Units 1 and 4

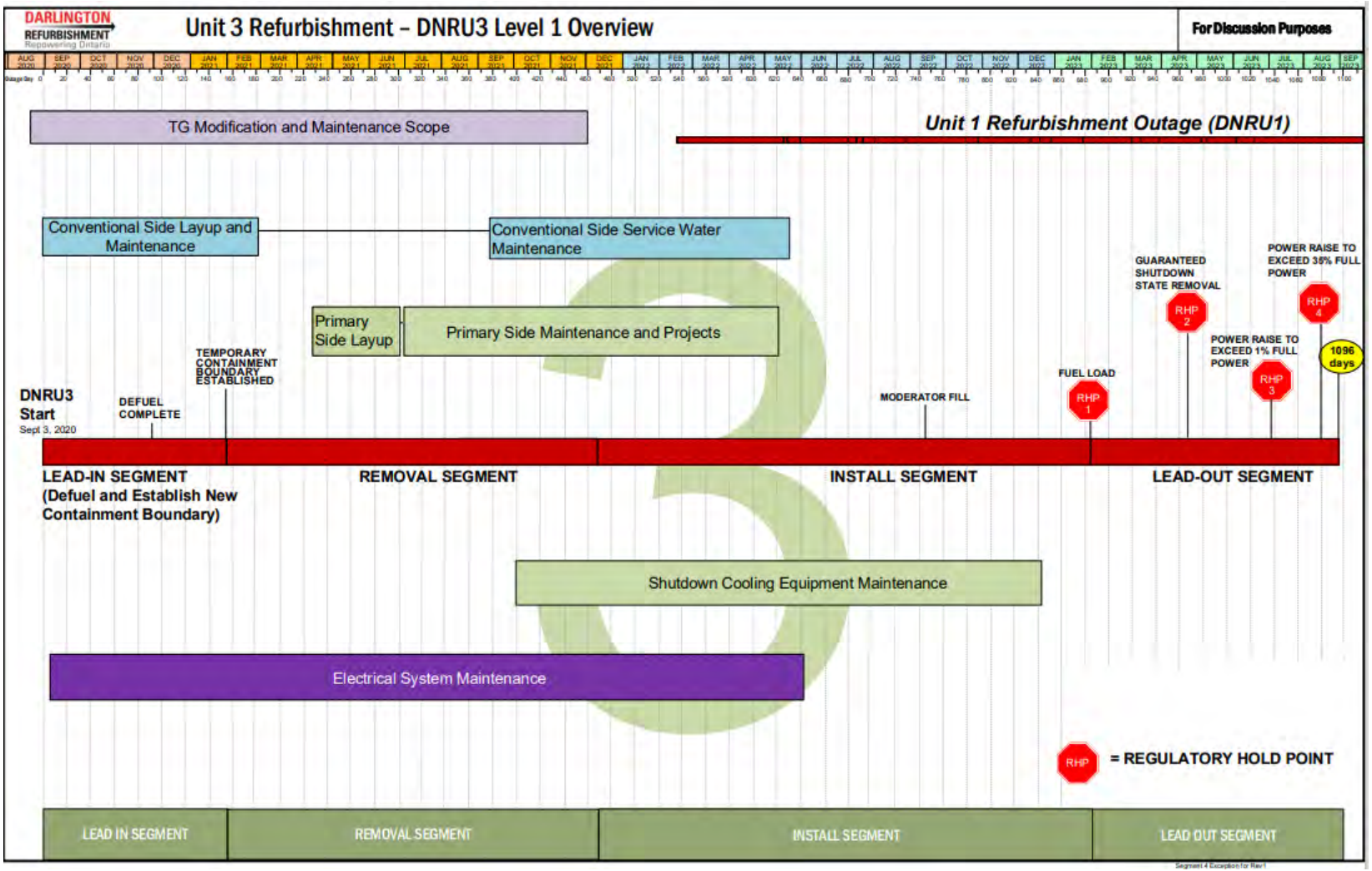
Collaboration and integration with the station determined what DNRU3 work could be done



DNRU3 mitigated schedule risks by commencing work on:

- vault work without interfering with outage activities
- first steps for the extensive turbine and generator project
- remove many interferences to ensure the drain/dry of the heat transport system

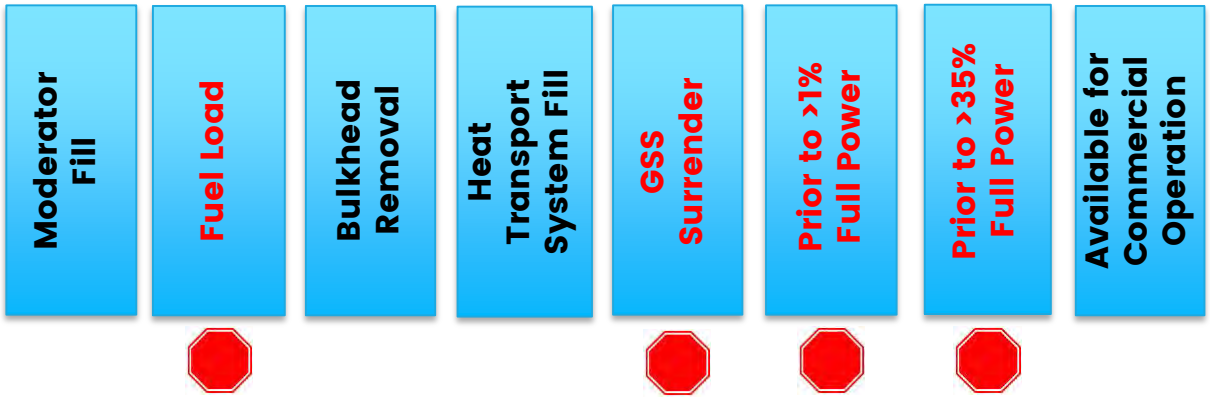
Using OPEX and lessons learned from Unit 2, and by collaborating with station teams, decreased DNRU3 schedule, cost and resource risk


DARLINGTON REFURBISHMENT
Repowering Ontario
Unit 3 Refurbishment – DNRU3 Level 1 Overview
For Discussion Purposes
TG Modification and Maintenance Scope
Unit 1 Refurbishment Outage (DNRU1)
Conventional Side Layup and Maintenance
Conventional Side Service Water Maintenance
Primary Side Layup
Primary Side Maintenance and Projects
GUARANTEED SHUTDOWN STATE REMOVAL
RHP 2
POWER RAISE TO EXCEED 35% FULL POWER
RHP 4
POWER RAISE TO EXCEED 1% FULL POWER
RHP 3
1096 days
FUEL LOAD
RHP 1
MODERATOR FILL
TEMPORARY CONTAINMENT BOUNDARY ESTABLISHED
DNRU3 Start
Sept 3, 2020
DEFUEL COMPLETE
LEAD-IN SEGMENT (Defuel and Establish New Containment Boundary)
REMOVAL SEGMENT
INSTALL SEGMENT
LEAD-OUT SEGMENT
Shutdown Cooling Equipment Maintenance
Electrical System Maintenance
RHP = REGULATORY HOLD POINT
LEAD IN SEGMENT
REMOVAL SEGMENT
INSTALL SEGMENT
LEAD OUT SEGMENT

Restart Control Hold Points (RCHP)

Unit 3

- 8 Restart Control Hold Points will need to be cleared, including 4 CNSC RHPs ( )
- Completion Assurance Documents (CADs) will be produced for each of 8 RCHPs, including 4 RHPs



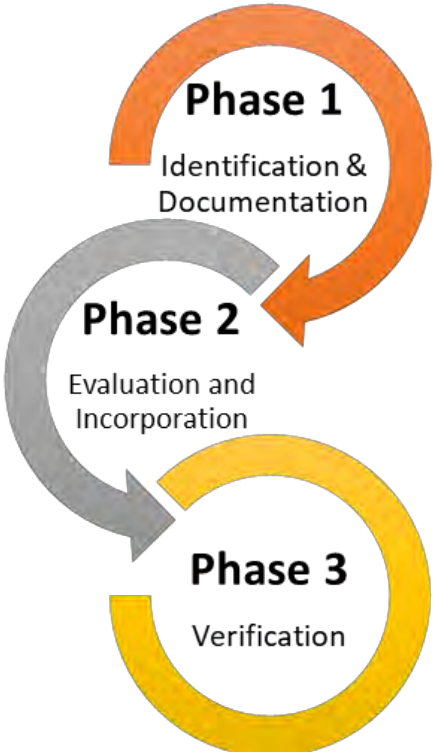
Lessons Learned Process

OPG and our Contractors have developed effective Lessons Learned (LL) processes

- Capture and implement the knowledge and experience gained on Unit 2 planning and execution, and
- Building those lessons into Unit 3 for continuous improvement.

Some of those lessons learned include:

1. Industrial Safety and Radiological Practices
2. Tooling changes/upgrades
3. Critical task training
4. LEAN/Kaizen process improvements
5. Workstream optimization and organizational alignment



U3 Keys to Success

Industrial Safety

Radiological Safety

Construction Planning Approach

Revised Feeder Strategy

Tooling Program

Training Effectiveness

ONE Team Model

Lean Kaizen


Darlington Nuclear for the Future
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Darlington Nuclear for the Future

Plant Reliability

Implement Life Cycle Management Plans to ensure a high level of equipment reliability.

Optimize Pressure Tube Life

Enable 30 years (250k EFPH) of safe, reliable operation.

Planned Outage Duration

Optimize through benchmarking, technology, innovation, execution & resource strategies.

Financial Performance

Maximize value to the Province.

Performance Measures (Post Refurbishment)

Outages ≤58 p20 days → **Nuclear Performance Index ≥ 99.9%** → **Pressure Tube Life 250k (EFPH)** → **Total Generating Costs ≤$40.54** → **Forced Loss Rate ≤1.0%** → **Unit Capacity Factor 92%**

Darlington Nuclear for the Future

Darlington for the Future is our vision, our 10 year plan: Post–refurbishment, Darlington will continue to be a top performing nuclear station, operating to the highest levels of safety, equipment reliability and operational performance.

ONTARIO POWER GENERATION

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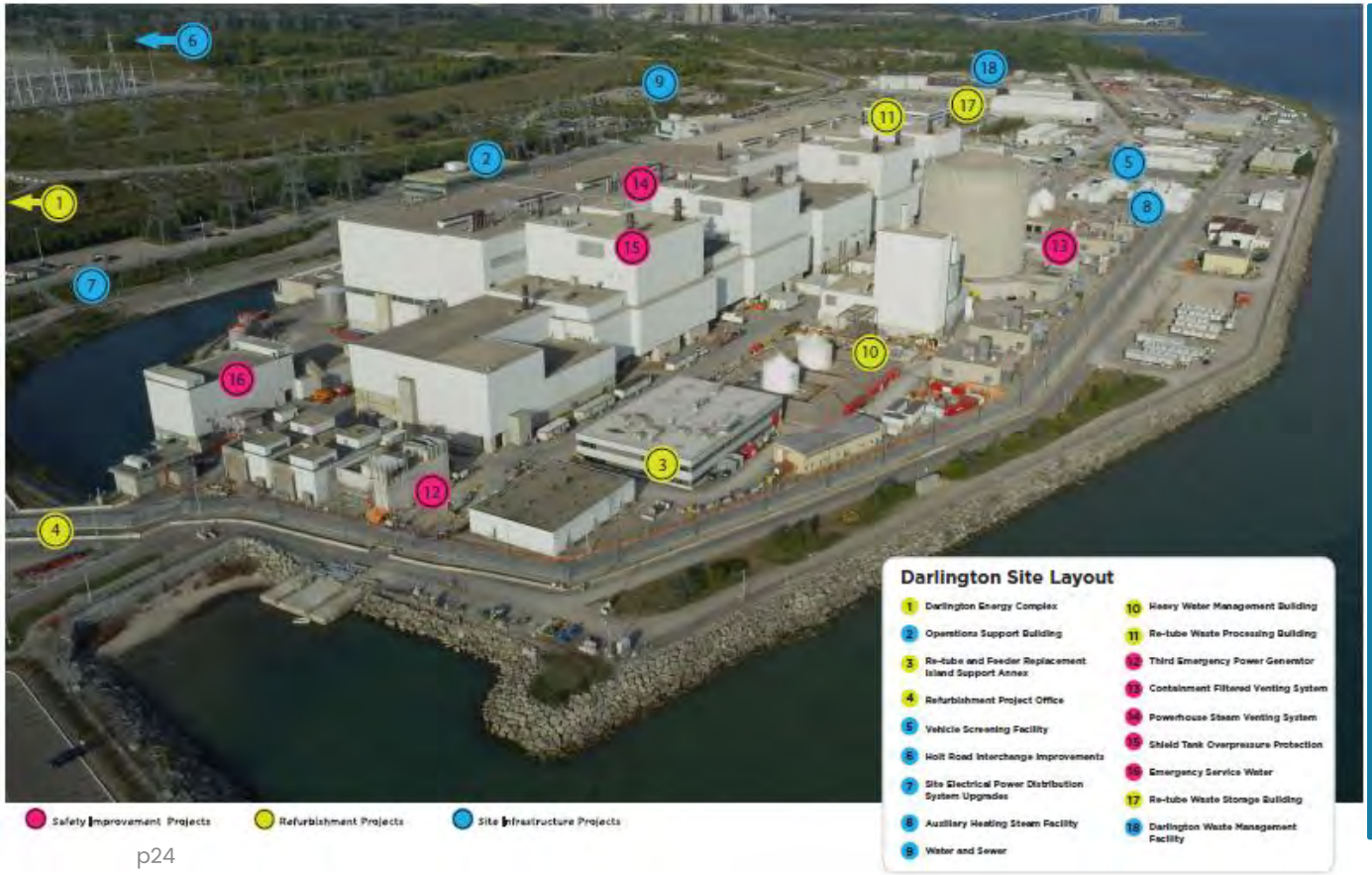
Appendix Slides

18 Infrastructure and Safety Projects In-Service



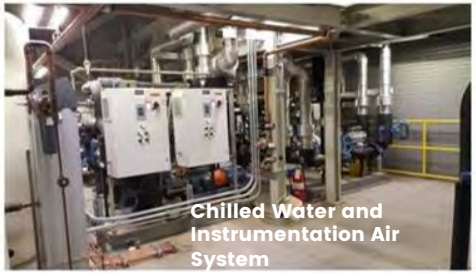
Safety Improvement Opportunities

- Third Emergency Generator
- Containment Filtered Venting System
- Powerhouse Steam Venting System
- Shield Tank Overpressure Protection
- Emergency Service Water

Heavy Water Storage Facility


View of West Annex with Stack and Causeway


Drum Handling & Cleaning Room


Chilled Water and Instrumentation Air System


Active and Inactive Drain Tanks


Drum Traversal Route


D2O Supply Pumps


Building HVAC Controls


100 Mg Storage Tank


Maintenance Catwalk


Feed and Product Pumps

Industrial Safety

Strong conventional safety performance

- Total Recordable Injury Frequency (TRIF) is 10x lower than Ontario construction industry

Continue to strive for zero Injuries

- **Safety First** in everything we do; proactive safety related stand ups
- Extensive mock-up training; New to nuclear and supervisory training
- OPG and Contractor safety plans & field oversight

COVID-19 Measures:

- Implemented a Work from Home strategy in March
- Staggered return to workplace; limiting staff in the station to support physical distancing
- Staggered and staged work schedules and lunch breaks
- Increased use of Personal Protective Equipment (PPE) and elevated cleaning practices

Radiological Safety

OPG set aggressive targets

- Improved performance on Unit 2
- Lessons Learned captured and implemented

For Unit 3 Significant investments in workers and Technology

- Powered Air Purifying Respirators (PAPRs – photo)
- Enhancements to alpha monitoring program
- Streamlined Radiation Protection requests process via Radiation Protection Information Dosimetry (RaPID) Access Program
- Optimized qualification requirements to perform low level radiation risk work

Radiation Protection Initiative

Status to Date:

Alpha program recommendation Complete for U3

Powered Air Purifying Respirators (PAPRs) selection process Completed – procurement begins in Q3

Streamlined RP requests process (Rapid Access Program)

Emphasis on building good relationships between RP and Trades

Construction Planning Approach

Adopted standard Window Execution Readiness process

- Comprehensive Work Packages (CWPs) incorporate Lessons Learned from Unit 2 and are ready 16 weeks prior to the start of the execution work
- Safety, Radiation Protection, Material, and Resource planning are integrated with readiness reviews

An optimized shift schedule has been implemented to improve project efficiency and manage worker fatigue

Training program has been enhanced to better represent field conditions in the full-scale reactor mock-up and to train on abnormal conditions

- Integrated Radiation Protection, Safety Planning, and Quality activities into training.

Enhancements to CWP close-out and documentation strategies including increased automation and progress monitoring

Revised Feeder Strategy

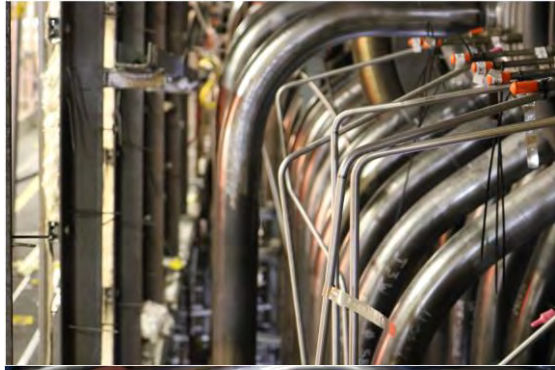
Feeder supplier oversight augmented to ensure quality of feeders as delivered

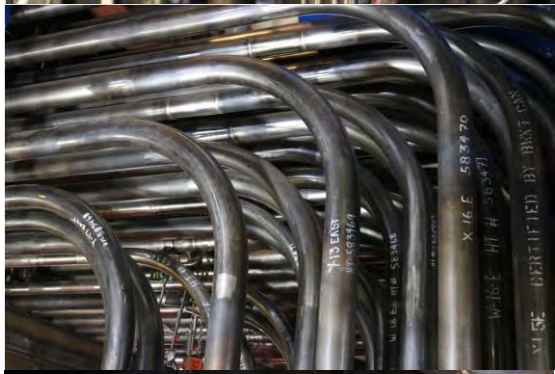
Implemented Improvements on tooling for installation including minimization of foreign material

Improved the field productivity progress tracking

Created a Welding Centre of Excellence to implement improvements to the welding program to lower overall weld failure rate

Focus on **“Right the First Time”** strategy to minimize re-work





Tooling Program

Investments made in tooling improvements to implement lessons learned from Unit 2 to reduce schedule which improves safety and reduces both Dose and costs

Pressure Tube/ Calandria Tube Removal

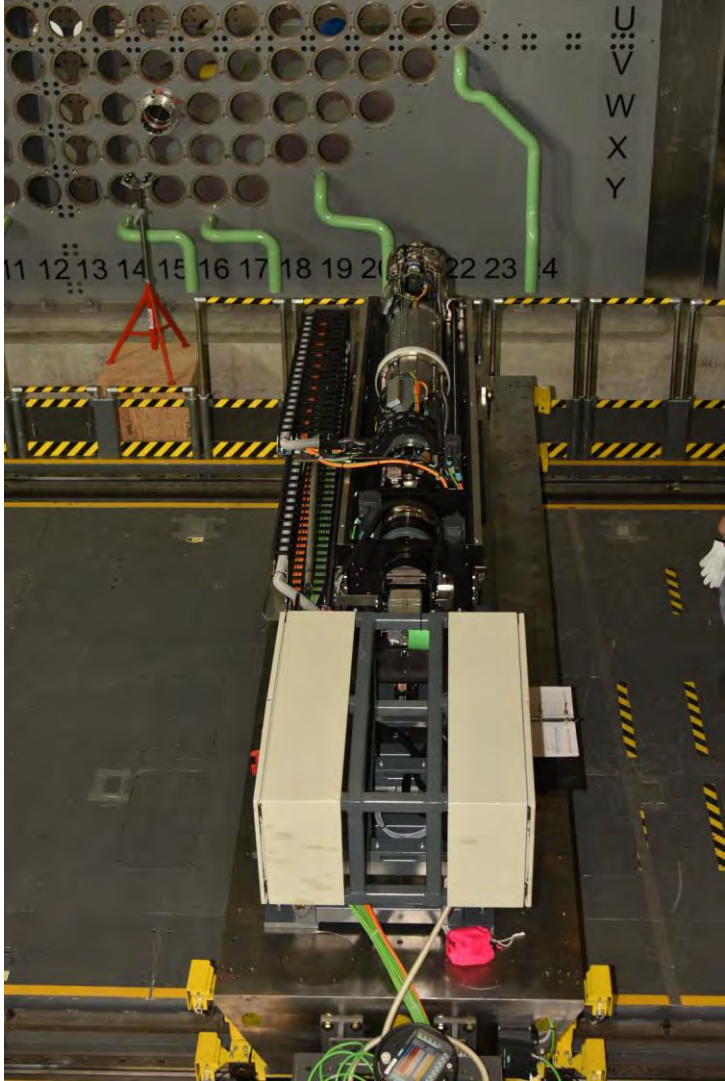
- Integration Testing **On Track** for completion Oct 2020

Modified Installation Worktables

- Integration testing **Complete**

Bellows Cut Tool Mods

- Factory Acceptance Testing (FAT) **Complete**
- Mod Kits available to install on Contaminated Tools



Training Effectiveness

Performed a Unit 2 Post Training Effectiveness Evaluation, as part of our continuous improvement efforts, to prepare for Unit 3/1/4 refurbishments

Training is leveraging the full scale reactor mock-up to enhance training, including:

- Replicating station environment,
- Collaboration with the trades to develop training materials,
- Training on individual steps within the process to develop expertise,
- Integrated full-team training, with all support staff, to build proficiency for each work series, and
- Introducing irregularities to allow the team to practice on dealing with potential field issues.

These changes will positively impact efficiency, as well as both safety and quality

OneTeam: One Goal

Deliver overlapping Refurbishments, on-time, on-budget, with safety & quality.

HOW?

Build on the DNRU2 experience & Lessons Learned

Create a High Performance Culture

Improve our Processes & Technology

Detailed planning, preparation & training

Empowered, collaborative teamwork (OneTEAM!)

Lean Kaizen

Leveraging operating experience and lessons learned from Unit 2, team is embracing a culture of continuous improvement and change through facilitative leadership

- Developed training strategy for Project manager/Area Managers, Series Leads, General Foreman and Superintendents on LEAN/Kaizen methodology and tools
- Empowered front line staff and leaders to conduct their own improvements
- Transform organization into a high performance team and identify areas to improve efficiency (cost and schedule), quality, and safety performance.

To date, over $1 Million in direct savings / year have accumulated through these sessions. A number of additional Kaizen sessions are planned in the coming months in advance of some critical work series for Unit 3.