

Darlington Refurbishment Program

Operating Experience from Effective Management of Large Scale Nuclear Power Plant Projects

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ONTARIO POWER
GENERATION

Where a brighter
tomorrow begins.

\$12.8 BILLION

project investment

\$89.9 BILLION

boost to Ontario's GDP

704,112

person-years of increased employment

8¢/kWh

30 years of power below average costs

CONTINUED OPERATIONS OF DARLINGTON

(2017 - 2055)



Average number of jobs per year
14,200



Government revenues
\$9.3 billion



Corporate profits before tax
\$7 billion

INCREASE IN:



Household consumption
\$53.4 billion



Personal income
\$61.4 billion



Exports
\$11 billion

EVERY \$1 INVESTED INTO THIS STATION IS A \$1.40 INCREASE TO THE GDP

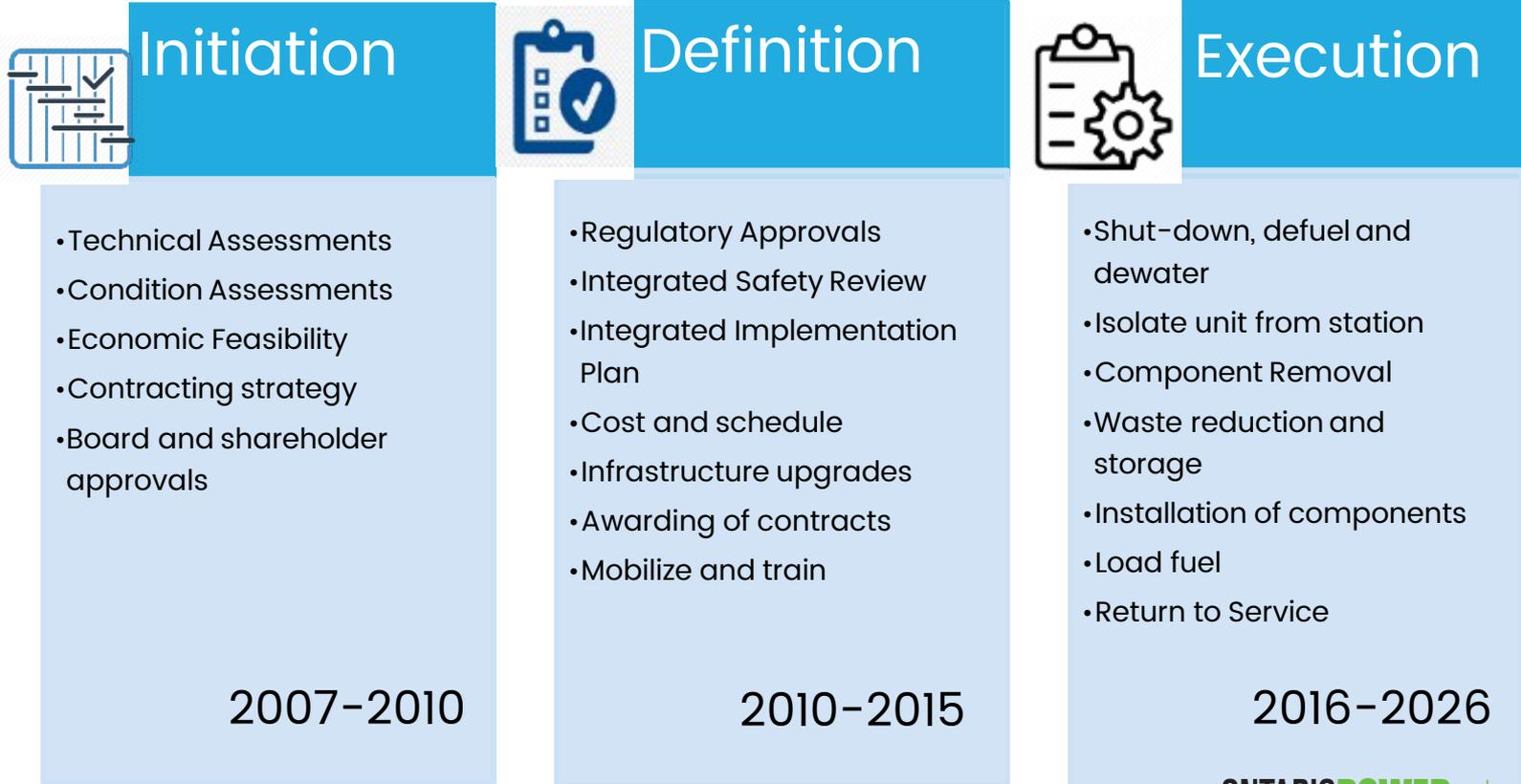


4 PHWR

3500 MW

~20% Ontario's supply

Phased Project Management



Pre-Planning Unit 2 Refurbishment

Vogtle



Bruce



Wolsong



Industry
Best
Practices



Embalse



Pt. Lepreau



Pickering

Early Learnings from the Industry

- ✓ Full scale Mock-up
- ✓ Infrastructure Upgrades & Campus Plan
- ✓ Waste Processing Optimization
- ✓ 60% Bulk-work
- ✓ Unit 2 followed by Units 3, 1 & 4

Refurbishment Scope and Vendors

Defuel, Fuel Handling, Special



Retube and Feeder Replacement



Turbine / Generator



SNC-LAVALIN
Nuclear

AECON
Joint Venture

Steam Generators



Balance of Plant



Cyclic Outage



Refurbishment Schedule Plan vs Forecast



Driving Improvements

- Culture
- Innovation
- Lessons Learned



Start

Total Duration 112 months

End

Culture that **Drives** Continuous Improvement

OneTeam Culture

- ✓ Leadership Development
- ✓ Secondments
- ✓ Trades Empowerment
- ✓ Training Effectiveness

Innovation

- ✓ LEAN Process Improvements
- ✓ Tooling Innovation

Lessons Learned

- ✓ Work Team Optimization
- ✓ Hybrid Schedule
- ✓ Engineering Replication
- ✓ RP Improvements



Enabling Behaviors

- Safety and quality first
- Empowered and accountable
- Trust and Respect
- Open and Transparent
- Continually improve and drive opportunities

Construction Center of Excellence Services

Delivering project excellence through world class construction management



Work Planning



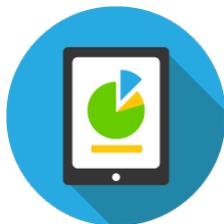
Project Assurance



Quality Management



Field Support



Process Improvement



Constructability



Trades Resource Management



Lessons Learned

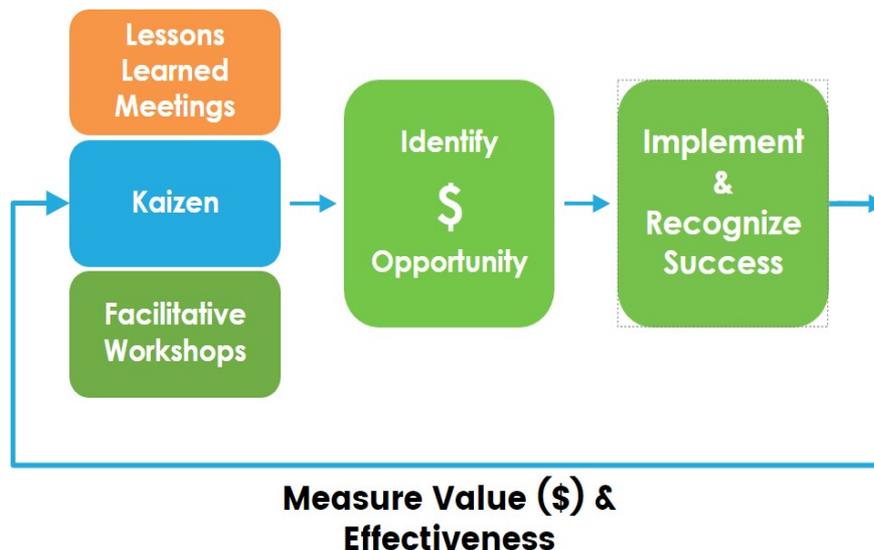
57d

**DNGS U3
Critical Path
Improvement
Refurbishment**



Lessons Learned

Over 4,000 Lessons Learned documented to capture tacit knowledge and experience gained through Unit 2 planning and execution



Lessons Learned built into Unit 3



- I. Industrial Safety and Radiological Practices
- II. Tooling changes / upgrades
- III. Training for Proficiency
- IV. Process improvements
- V. Work Stream optimization and organizational alignment
- VI. OneTeam culture advancements

I. Industrial Safety & Radiological Practices

- Leading Innovation with PAPRs to replace plastic suits
- Cost reduction of ~40%
- Improved mobility and reduced risk
- Relief on the station breathing air systems
- Improved worker morale

Powered Air Purifying Respirators (PAPRs)



Falling Object Prevention



- 92% reduction in higher potential falling-object incidents on Unit 3 versus Unit 2.
- All tools used at heights required to be tethered
- Kickplates installed on all walkways
- Dandex sheeting installed on walkways and work areas to prevent objects from slipping through small openings.

II. Tooling Changes and Upgrades



- A dedicated Innovation Project Team successfully saved 90 days on Critical Path with an investment of \$75 Million
- Significant volume reduction of radioactive waste & shipments
- Eliminated contamination issues from Garter Spring debris and reduced Lead blanket shielding (7d U2 delay)



III. Training for Proficiency



Feeder Removal Training

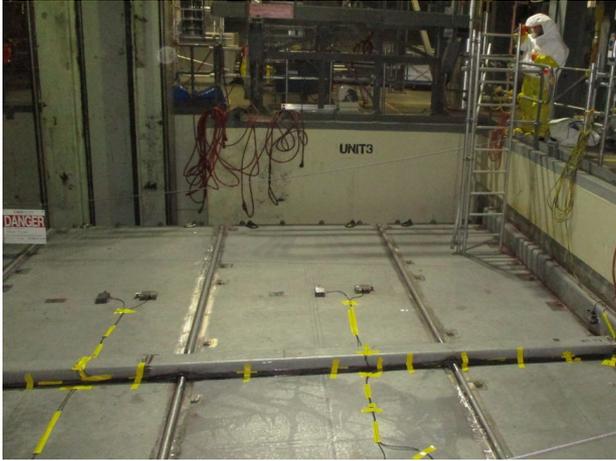


- Implemented U2 Lessons Learned into subsequent unit training program (e.g. falling object prevention, Foreign Material Exclusion (FME) and time-saving techniques).
- Increased the duration of training and use of the Mock-up facility.
- All candidates required to pass a performance test in full RPPE, before being allowed into the field.



Bulkhead Shielding Installation

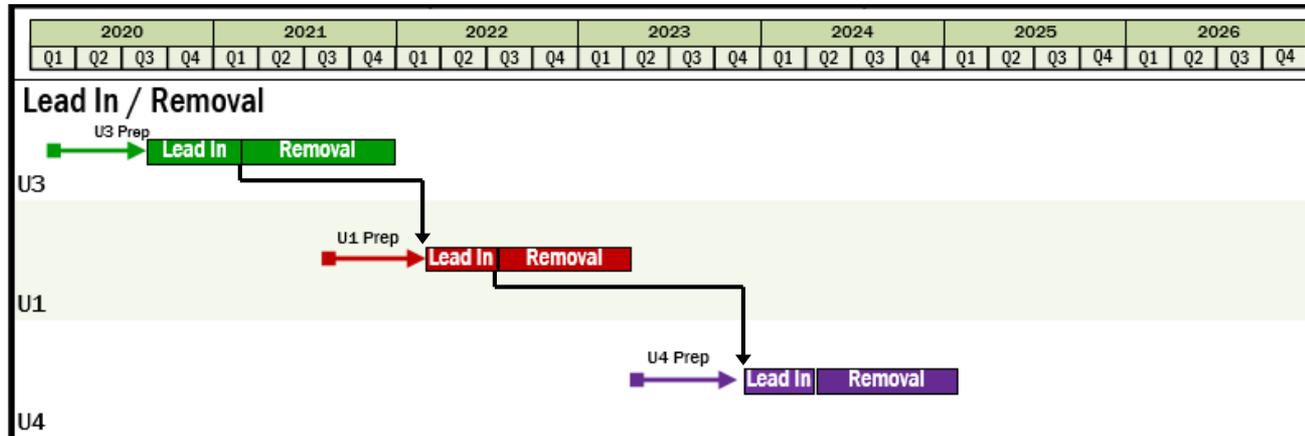
- 26-day Critical Path reduction realized on Unit 3
- LEAN/Kaizen methods & culture adopted
- Equipment modifications and innovations implemented
- Training improved to optimize proficiency
- Tooling jigs developed to reduce rework



V. Work Stream Optimization & Organizational Alignment

Work Stream Optimization

- Three standalone specialized teams (i.e. Lead In/Removal, Feeders Install & FC Install/Lead Out) allows broader scope of control by distributing decision-making deeper into the organization.
- Specialization allows high-proficiency teams to repeat the same work, improve through lessons learned and perform at an increasingly high level for subsequent units.
- This format is particularly beneficial during the overlapping outages for Units 3, 1 & 4.



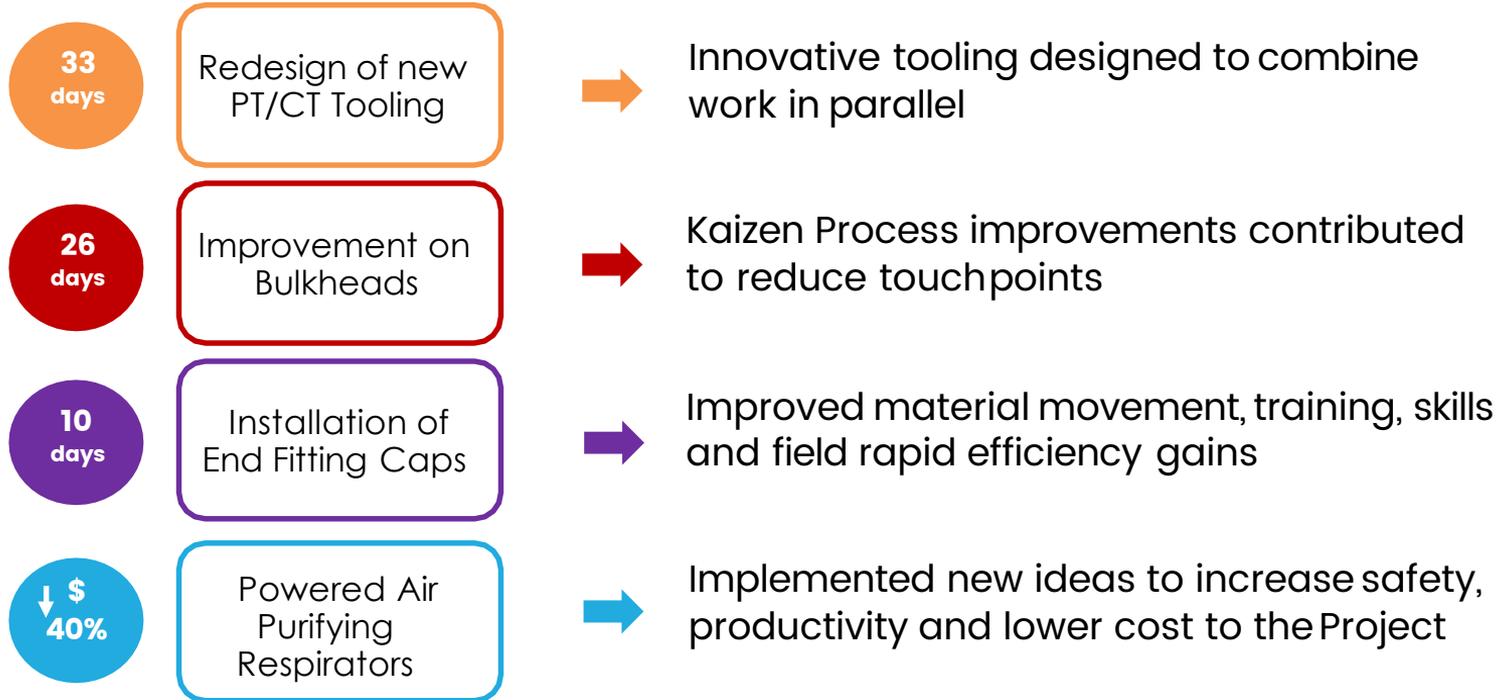
VI. OneTeam Culture Advancements

ONE Team = One OPG

- Project leadership roles are staffed by an OPG or vendor partner employee, based on “best qualified individual”. This removed the “Us vs. Them” attitude.
- Fosters support for Leadership and a collaborative work environment.



U3 Improvements Realized To Date



Lessons Learned Culture

Engage Employees | Innovative Solutions | Recognition



- ✓ COVID-19
- ✓ Assurance
- ✓ Alignment
- ✓ Innovation



Leadership Buy-in



Communication

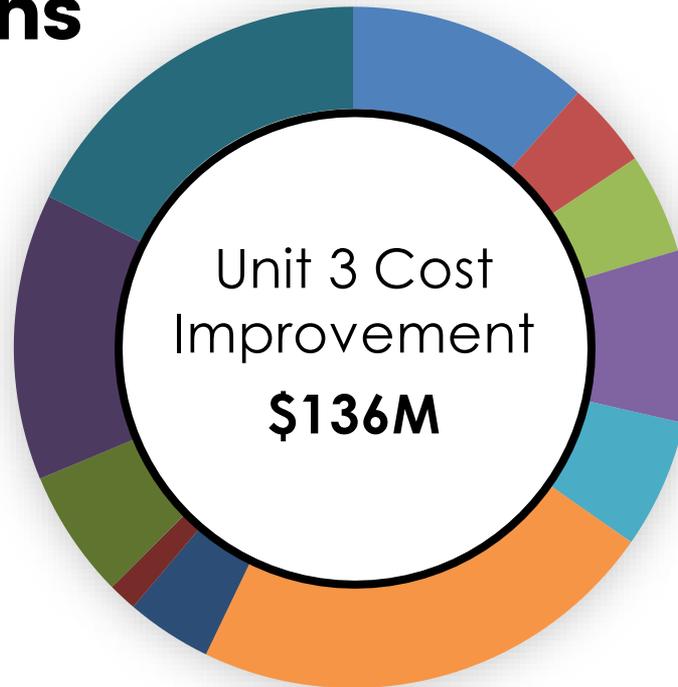


People Recognition



Measure & Report

Proven Success: Savings Realized & Efficiency Gains



- Installation EF Caps
- Sever Bellows
- Dummy Fuel Bundle
- Feeder Removal
- Containment Test
- End Fitting Removal
- Bellow Inspection
- Bulkhead Installation
- Remove FM Bridge
- CT/PT Removal
- Tubesheet Bore Cleaning

Proud but not Satisfied

Unit 3 Lessons Carried Over to Unit 1

25
days

Two Trolley
Defuel



Sequence activities and additional operators to use two defueling trolleys

29
days

Reactivity
Management
Enhancements



Elimination of Bulkhead Shielding for DNRU1 and DNRU4

- Lessons Learned (LL) has been a critical part of the overall Refurbishment success
- The LL program at Refurbishment is being leveraged by the OPG Enterprise Project Organization



A large industrial crane in a factory lifting a massive turbine component. The crane is yellow and has a large hook and pulley system. The turbine component is dark and has many blades. The factory has a high ceiling with a complex steel truss structure and many lights. The word "Questions?" is overlaid in white text in the center of the image.

Questions?

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