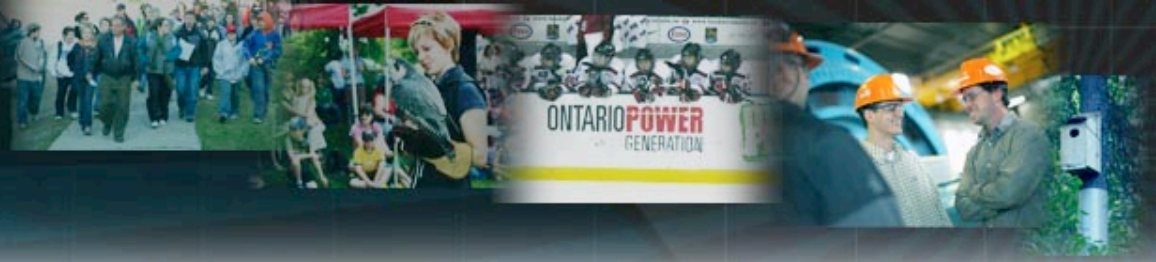
ONTARIO POWER GENERATION

Darlington Refurbishment:

Challenges and Opportunities in RP

Scott Stafford,

Section Manager ALARA – Nuclear Refurbishment

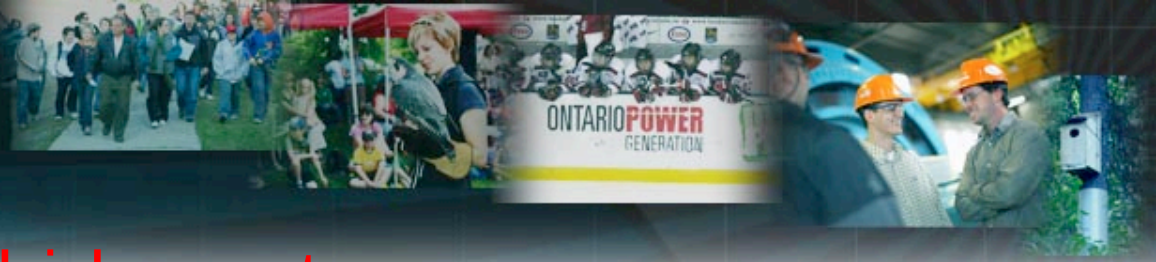


Darlington Refurbishment

- OPG is undertaking a project to refurbish Darlington Units 1-4 over a multi-year period.
- Scope of the Refurbishment includes Pressure Tubes, Calandria tubes and feeder replacement, Turbine and generator rehabilitation, Fuel handling system rehabilitation, balance of plant component rehabilitation, and infrastructure to support refurbishment and post refurbishment operations, including a full-scale reactor mock-up facility

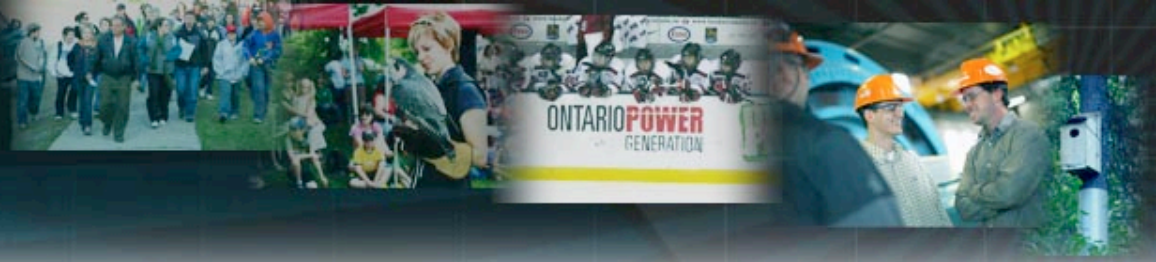
Darlington Refurbishment

- These activities include the removal of highly irradiated core components, and the potential for significant contamination.
- Due to the unique requirements associated with refurbishment activities, and the large scope of the project, it is recognized that high quality management of Radiation Protection is required to ensure that the refurbishment is completed in a safe, quality, and economic manner.



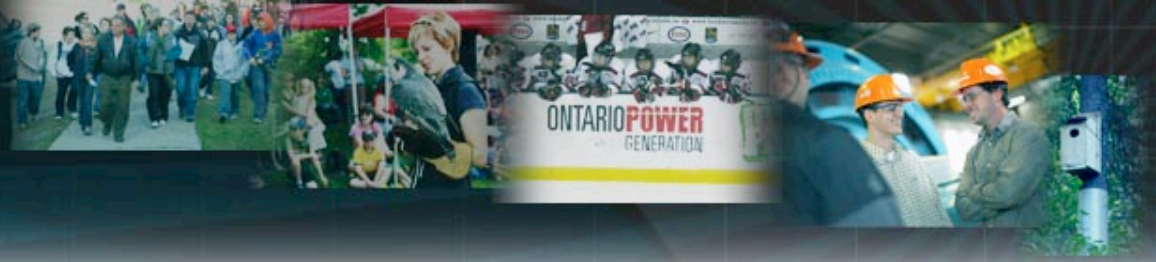
Scope of the Refurbishment Project

- The DNGS Refurbishment has been separated into 7 Major Projects
  - **Shutdown and Layup**
  - **Unit Islanding**
  - **Retube and Feeder Replacement (RFR)**
  - **Turbine/Generator**
  - **Steam Generator**
  - **Balance of Plant (BOP)**
  - **Return to Service**



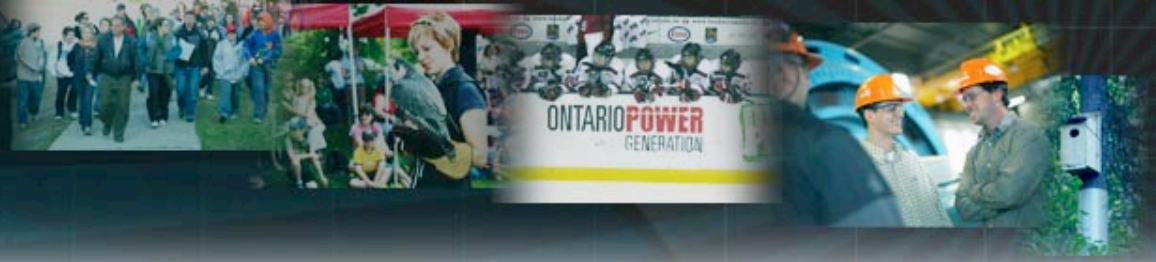
Shutdown and Layup

- The end state of the Primary Heat Transport system for the Refurbishment Unit will be defueled, dewatered and vacuum dried.
- The required state of the Calandria and the parts of the Main Moderator System for the refurbishment work, is dewatered, dried, and maintained at a pressure slightly more negative than the general vault atmosphere.
- This is essential to reduce vault atmosphere tritium levels and support the work dependent on an open airlock concept. This will reduce the likelihood of accidental D_2O spills and unplanned tritium exposure



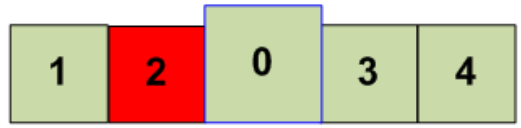
Unit Islanding

- A Refurbishment Island will be created for refurbishment of Darlington Units. Controlling Authority for the Refurbishment Unit and for equipment therein will be transferred to the Director Nuclear Refurbishment - Operations and Maintenance for the duration of refurbishment.
- The Refurbishment Island will envelop as much of the Refurbishment unit as is practicable. Barriers will be designed and installed to control access to the RI from the powerhouse (and vice versa).

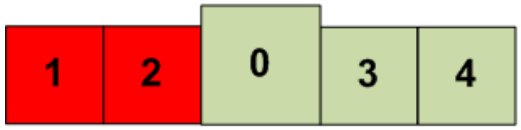


Unit Islanding

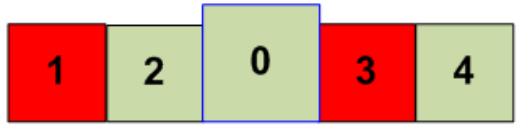
Unit Transitions for Barriers (Transition to each configuration)



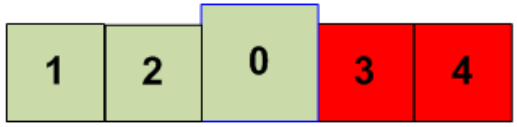
Configuration 1: Install Barriers for Unit 2



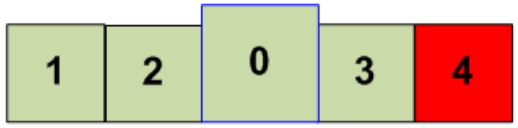
Configuration 2: Transition to Unit 1 and 2



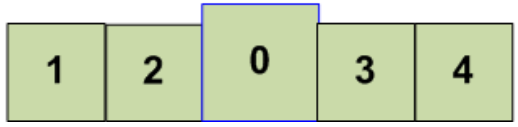
Configuration 3: Transition to Unit 1 and 3



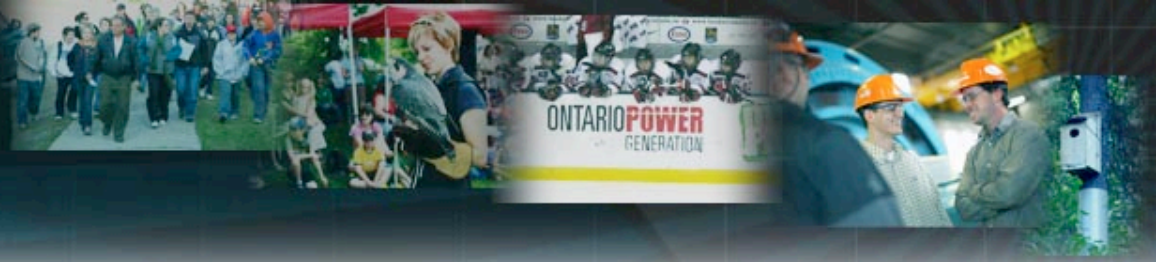
Configuration 4: Transition to Unit 3 and 4



Configuration 5: Transition to Unit 4

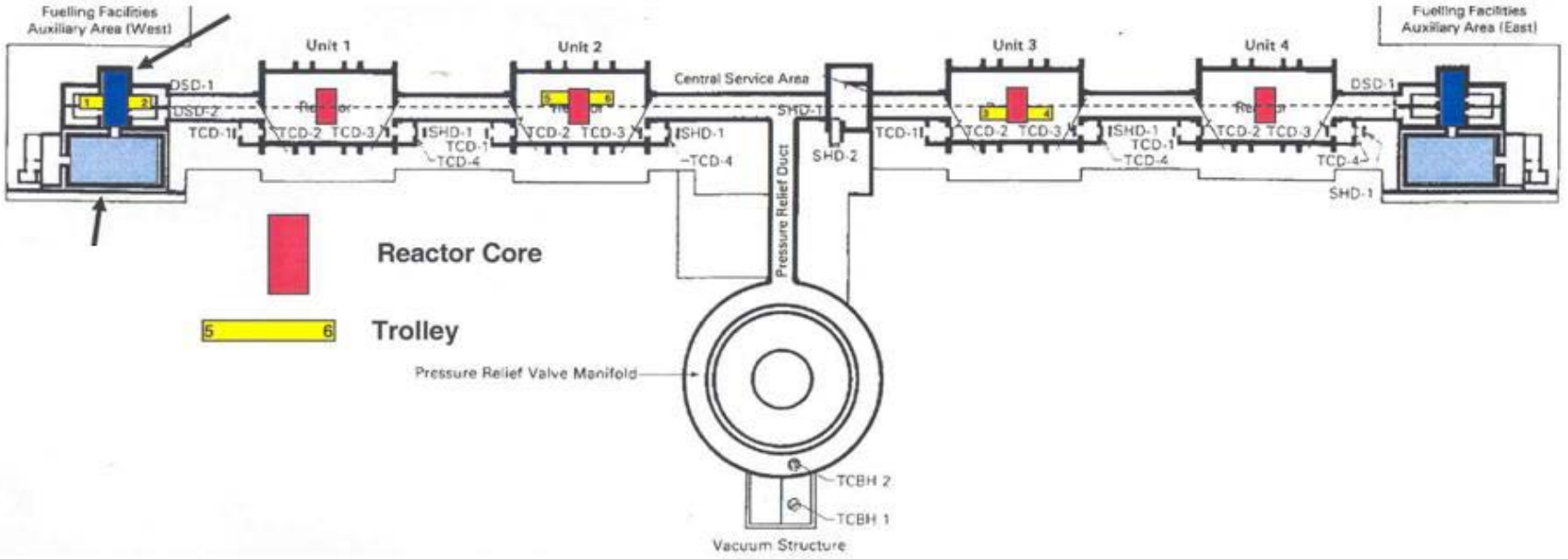


Configuration 6: Remove all Barriers

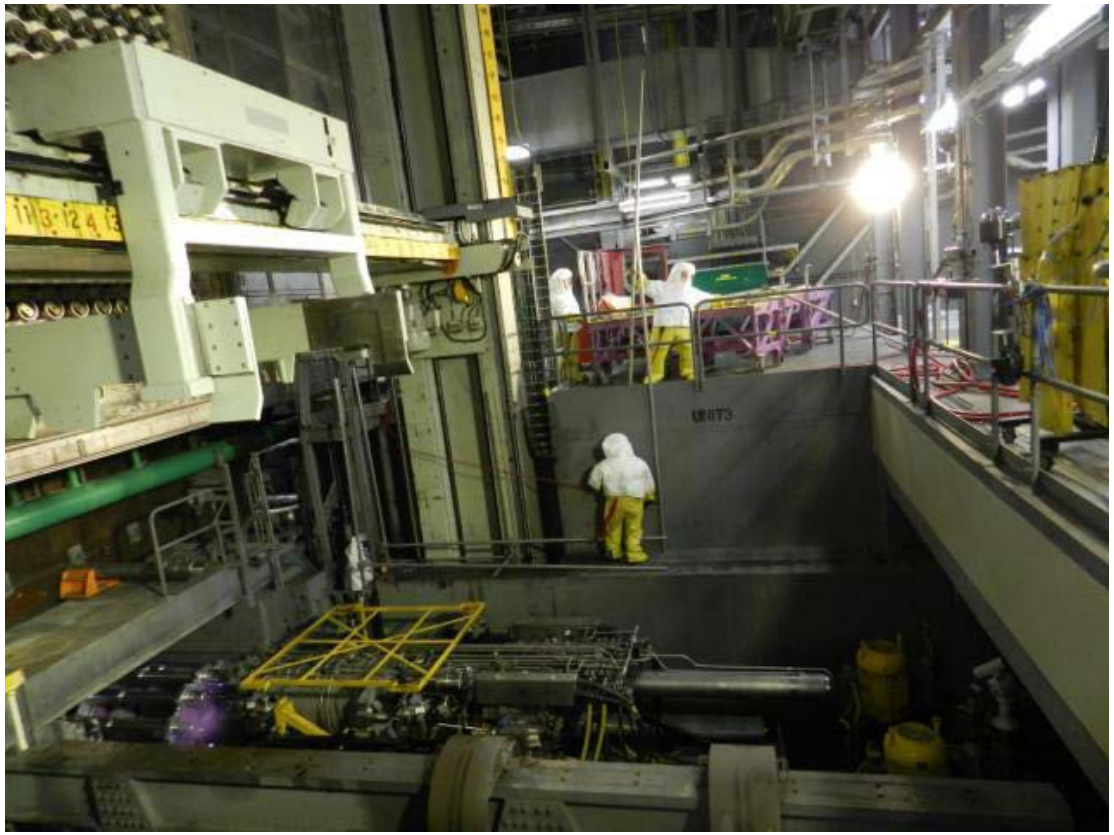


Unit Islanding - Bulkhead

Common containment volume – all vaults connected to each other and the vacuum building via fuel handling duct (FHD)

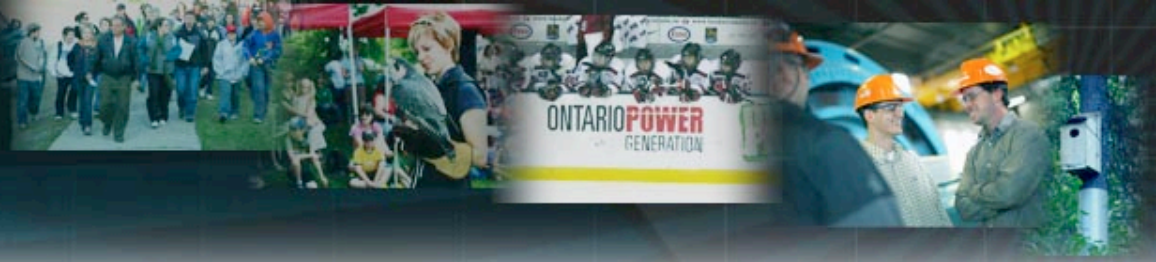


Unit Islanding - Bulkhead



Opening to Duct Requiring Bulkhead

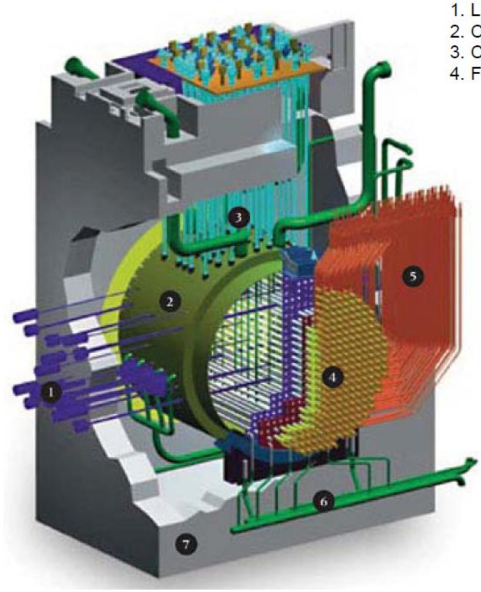
ONTARIO POWER GENERATION

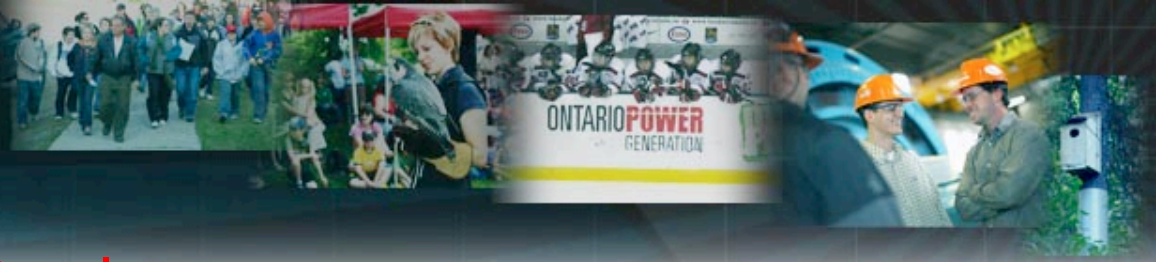


Unit Islanding - Bulkhead

Retube and Feeder Replacement (RFR)

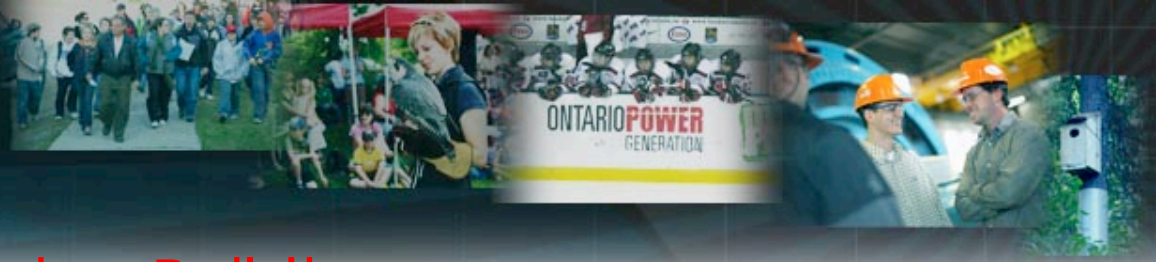
- The scope of the Retube and Feeder Replacement project is the removal and replacement of various core components, including Feeders, Pressure Tubes, Calandria tubes, End Fittings and other components external to the reactor core





Retube and Feeder Replacement (RFR)

- Generally, the activities of this project will be as follows:
  - Preparation Phase (Planning, Engineering, Tooling design)
  - Mock-up testing and Materials/Equipment Procurement
  - Vault Preparations and Construction Island Set-up
  - Retube and Feeder Replacement
    - Feeder Cabinet/Insulation/ Reactor Bridge Removal
    - Install Work Platforms
    - Remove Lower /Upper Feeders
    - Remove End Fittings
    - Remove Pressure Tubes
    - Remove Calandria Tubes
    - Install Calandria Tubes/Pressure Tubes
    - Install Upper/Lower Feeders
    - Install Feeder Cabinets/Reactor Bridge/Insulation
  - Commissioning and Return to Service

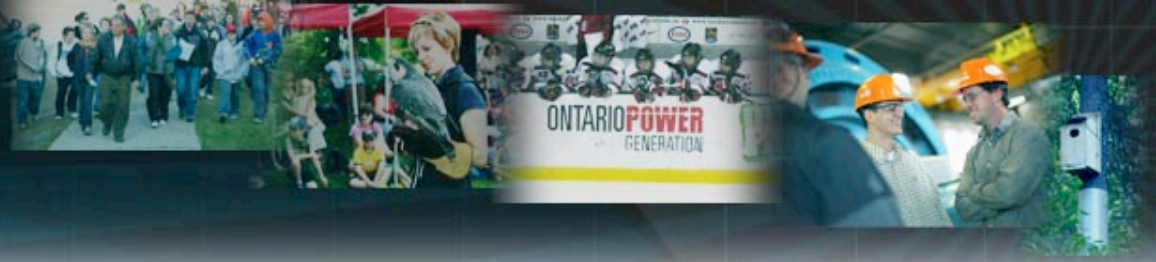


Retube Waste Processing Building (RWPB)

- A new dedicated RWPB is planned to perform the waste reactor component processing and packaging operations for the RFR of all four Darlington units. This approach was adopted due to the limited space available in the Darlington reactor vaults. In addition, the use of a dedicated facility for this purpose provides better functionality, increased productivity, improved reliability, and enhanced ALARA and safety compared with performing these same operations in the reactor vaults.
- The separate RWPB also decouples reactor core component processing and packaging from critical path activities in the reactor vault.

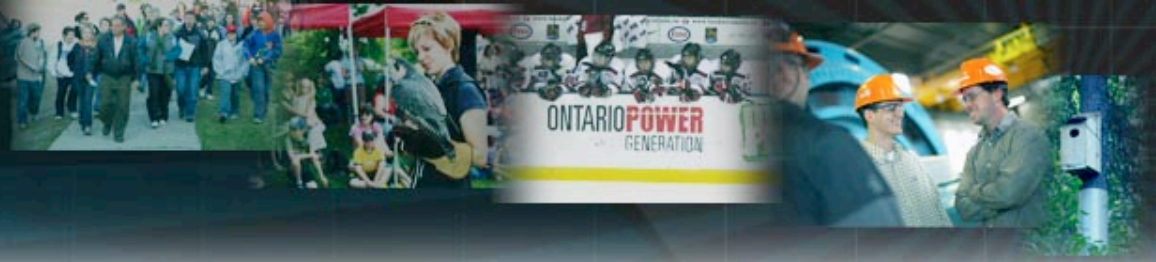
Turbine/Generator

- Removal, Inspection and/or replacement of
  - Turbine
  - Generator
  - Excitation Controls
  - Moisture Separator Reheater
  - Turbine Controls
  - Auxiliary Systems



Steam Generator

- Primary and Secondary side inspections/repairs
- Primary Side Tube Removal (PSTR) and metallurgical examination of pulled tubes
- Primary side divider plate visual inspection & leakage measurement
- Secondary Side Waterlancing
- Installation of seven additional access ports on each SG is required to support the existing Life Cycle Management Plan and allow additional access for waterlancing, potential chemical cleaning, and foreign material retrieval at areas other than the tubesheet.



Balance of Plant (BOP)

- The following is a high level summary of the major Balance of Plant Scope

Area	High Level Work Description
Primary Heat Transport + Auxiliaries	PHT Motor/cabling replacement, pump overhaul (contingency), Emergency Service Water to PHT tie (Modification)
Shutdown Cooling	Installation of a new alternate Shutdown Cooling heat sink
Valves	Valve overhaul/replacement in Heat Transport, Moderator and SDC systems. Other miscellaneous work.
Containment	Vault Vapour Recovery System component replacement and installation of new button up valves
Regulating	Flux detector and adjuster rod replacement.
Filter Bypass Modifications	Modifications to verify no bypassing across filters on various station systems.

Summary of Nuclear Refurbishment RP Strategy

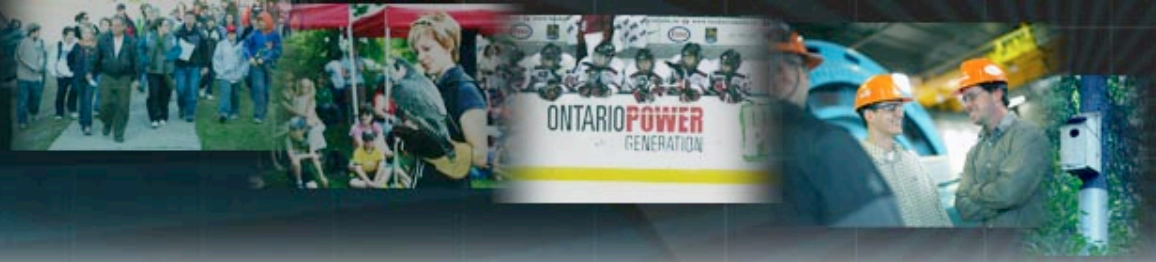
- Protect the license while working to simplify and reduce costs - top and bottom line.
- Use the existing OPG Radiation Protection Program.
  - Pursue improvement opportunities, such as re-zoning, tele-dosimetry, reduce or eliminate PPE, and other adjustments of the program.
- Use the existing RP Qualifications system
  - Supply BTU RPC coverage for all NR contractors and sub-contractors, as required.

Summary of Nuclear Refurbishment RP Strategy

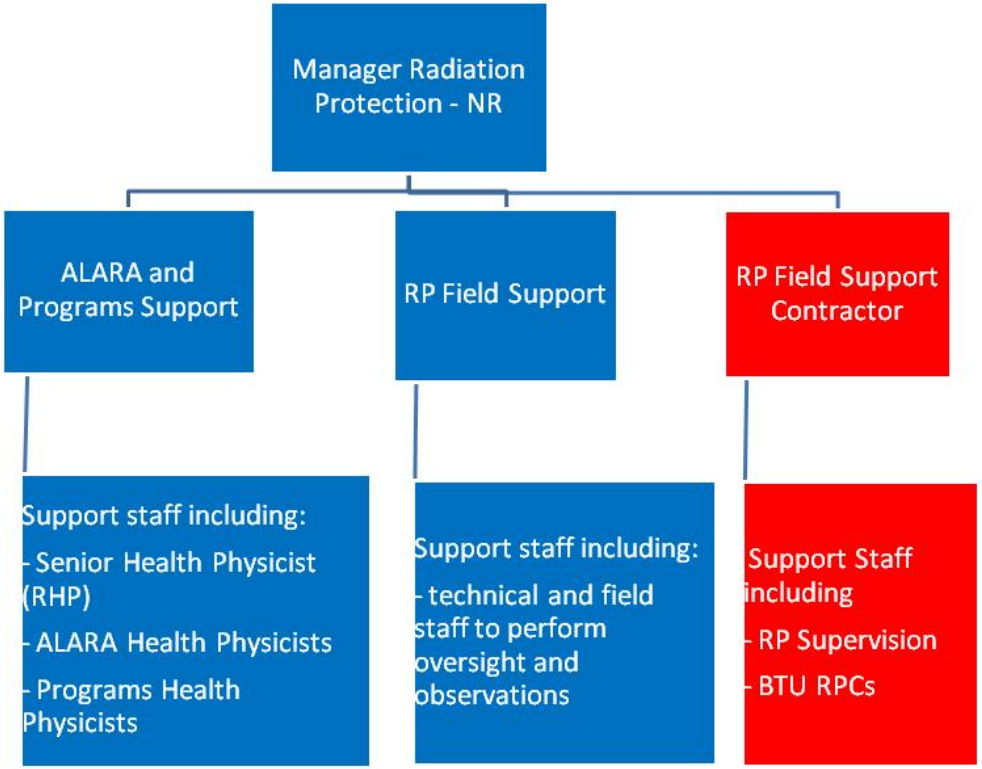
- BTU RPC Coverage provided a central contract company to hire, train, schedule, and Supervise the needed RPCs.

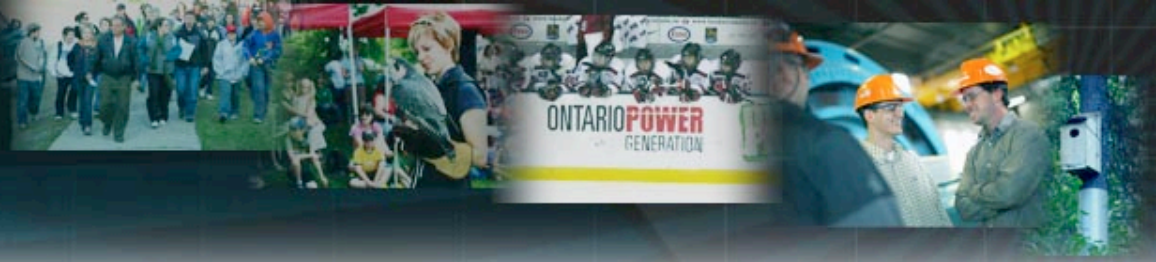
- BTU RPCs will report through NR-RP line but will be embedded and aligned with the project work crews.

- RP Department supports and provides oversight of the RP Services Contractor to ensure a high level of radiation safety.



RP Support for ALARA and Programs

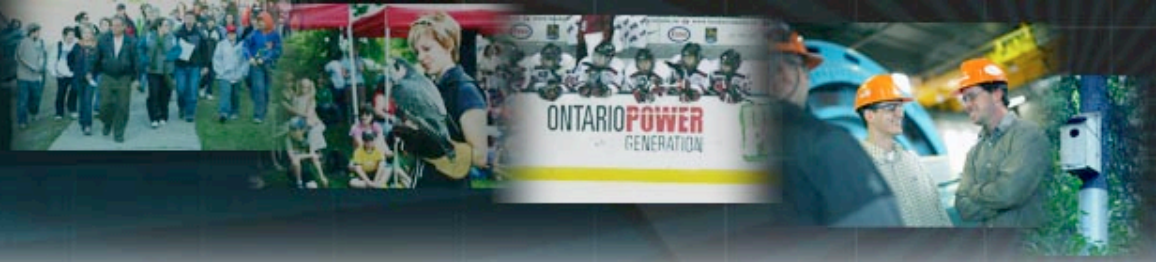




RP Issues and Initiatives

COMS/Tooling review

- Currently we are providing a lot of support for the Tooling and Design review and modification processes.
- OPEX from Point Lepreau/Bruce Power indicates that RP involvement in tooling design at the earliest possible stage is critical to ensure RP related issues are identified and mitigated well before NR execution.
- Refurbishment RP is participating directly in Tool Proving and Factory Acceptance Testing.



RP Issues and Initiatives

Reactor Auxiliary Bay (RAB) Rezoning Analysis

- In 2013, completed an assessment of options for rezoning the RAB areas to better align with refurbishment work activities. OPEX from Bruce Power indicates this modification would be beneficial for worker flow and contamination control

- The proposed RAB rezoning collapses Zone 3. This will control contamination closer to the source, improve worker efficiency, achieve cost savings from a simplified contamination control, and achieve cost savings from reducing the number of RP instrument required.

RP Issues and Initiatives

Use of OPEX

- The NR RPD has performed Benchmarking Visits of BP and Pt Lepreau and has utilized this OPEX in the development of our Radiation Protection Strategies and approaches.

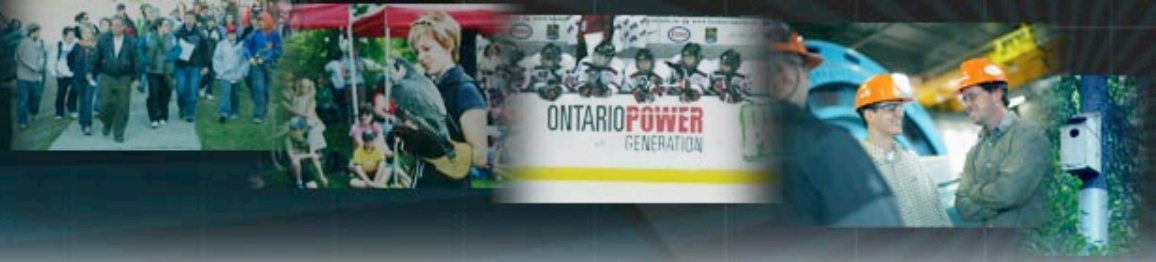
- Also benchmarked the provision of professional RP Services for large projects outside of Canada. Sweden and UK.

- Recently, a benchmarking visit to Davis-Besse was performed, as they had just completed a Steam Generator replacement project, which involved a high number of Radiation Technicians.

RP Issues and Initiatives

Source Term Analysis

- A Source Term Analysis assessment is being performed in 2014.
- Considers alpha emitters, and will also identify other nuclides to be concerned with.
- The analysis will aid in developing
  - Baseline monitoring for Refurbishment workers
  - Dosimetry modifications (if any) for Refurbishment work
  - RPPE requirements for different phases of the Refurbishment Execution
  - Communication to workers/contract staff on the basis for selection of RPPE.

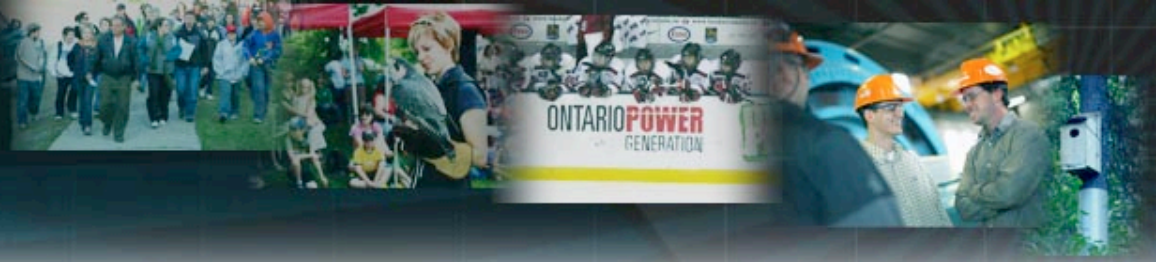


RP Issues and Initiatives

Vault Access and Loading

RP is supporting these efforts as required related to:

- Breathing air limitations
- Additional breathing air headers
- Egress limitations
- Amount of service air
- Minimize airborne tritium levels
- Air-lock doors open
- Minimize the need for plastic suits



RP Issues and Initiatives

Mock-up Training

- A full-scale DNGS Reactor Mock Up facility has been constructed and is in service. This facility simulates the work environment a worker would find in the vault as much as possible.
- Refurbishment RP is ensuring this includes the various RP aspects such as RPPE expected to be use for that work.

STAND-ALONE MOCK-UP SEGM
STATIONED OUTSIDE OF THE
MOCK-UP, GIVE EASY ACCESS TO INTE
COMPONENTS FOR EASE OF TRA

DARLINGTON ENERGY COMPLEX REACTOR VAULT MOCK-UP AND RE-TUBE AND FEEDER REPLACEMENT (RFR)

As famed football coach Vince Lombardi once said, "Practice doesn't make perfect, only perfect practice makes perfect." In the select world of nuclear reactors, consider it a mantra, for nothing goes forward unless every minute detail has been perfectly orchestrated and approved. In 2011, Aecon Nuclear reached that level of achievement on a nuclear fuel channel mock-up and replacement project. Now the team's earlier success has helped pave the way to the big leagues at Ontario Power Generation's Darlington facility. Here, a massive 480-fuel-channel mock-up and larger overall scope have opened the doors for Aecon to prove just how perfect practice makes you.


ONTARIO POWER
GENERATION