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Darlington Refurbishment Program Contracts, Schedule and Costs

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Agenda

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- Major Contracts
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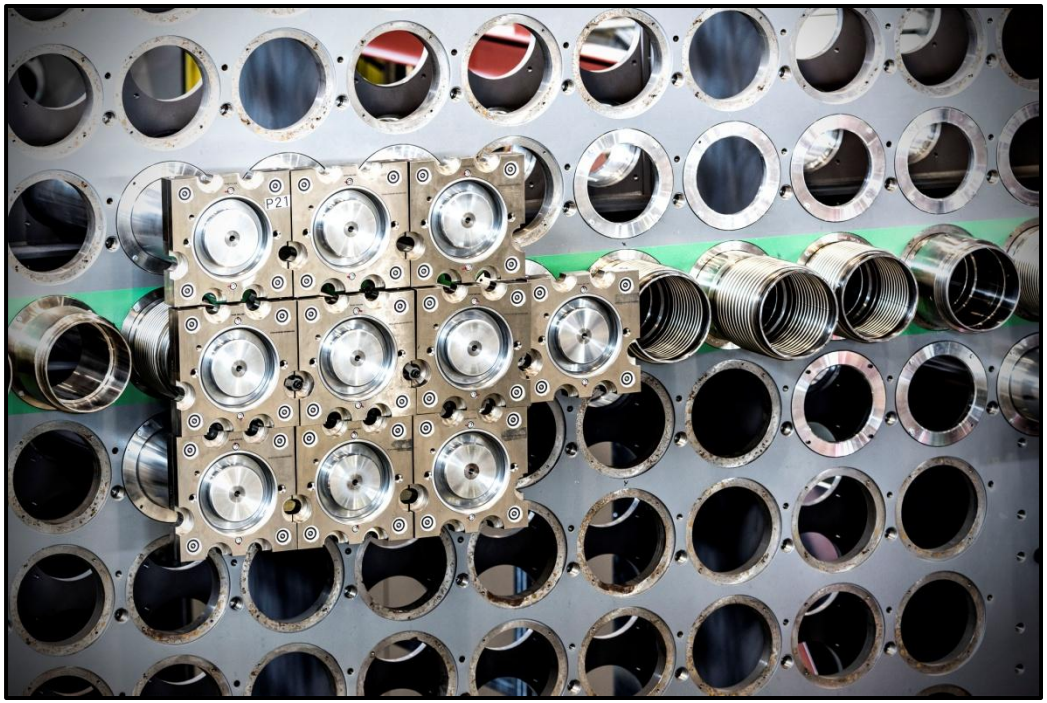

Background and Overview

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Background on Darlington Refurbishment Program (DRP)

- DRP is a multi-year, multi-phase megaprogram to enable safe and reliable operation of the station until approximately 2055
- DRP includes the replacement or rehabilitation of life-limiting components as well as upgrades to meet regulatory requirements
- Refurbishment of the four units will take place over a total span of 112 months, including 40 months for Unit 2 from October 2016 to February 2020. All four unit refurbishments will be complete by February 2026
- Based on the Release Quality Estimate (RQE) approved by OPG's Board of Directors, OPG has a high level of confidence in the DRP cost estimate of $12.8B, which includes contingency, capitalized interest and escalation

DRP is a Megaprogram

- A **program** is comprised of multiple individual projects

- **Megaprograms** are defined by their complexity, lengthy duration, significant budgets, and multiple suppliers and contractors that require coordination
  - The individual projects have varying degrees of interdependency with one another and require understanding of the interfaces
  - Individual projects may constitute a megaproject on their own
  - Over the extended duration of execution, factors can and will change
  - Megaprogram management must adjust repeatedly to many competing forces to maintain control over the project environment as it evolves

- **DRP is a megaprogram:** It is complex from an engineering and construction perspective, has a lengthy duration, and there are multiple suppliers and trade contractors, with multiple stakeholders

- Recognizing that DRP is a megaprogram, OPG developed an extensive list of lessons learned from other large projects and incorporated these into its planning

Incorporation of Lessons Learned

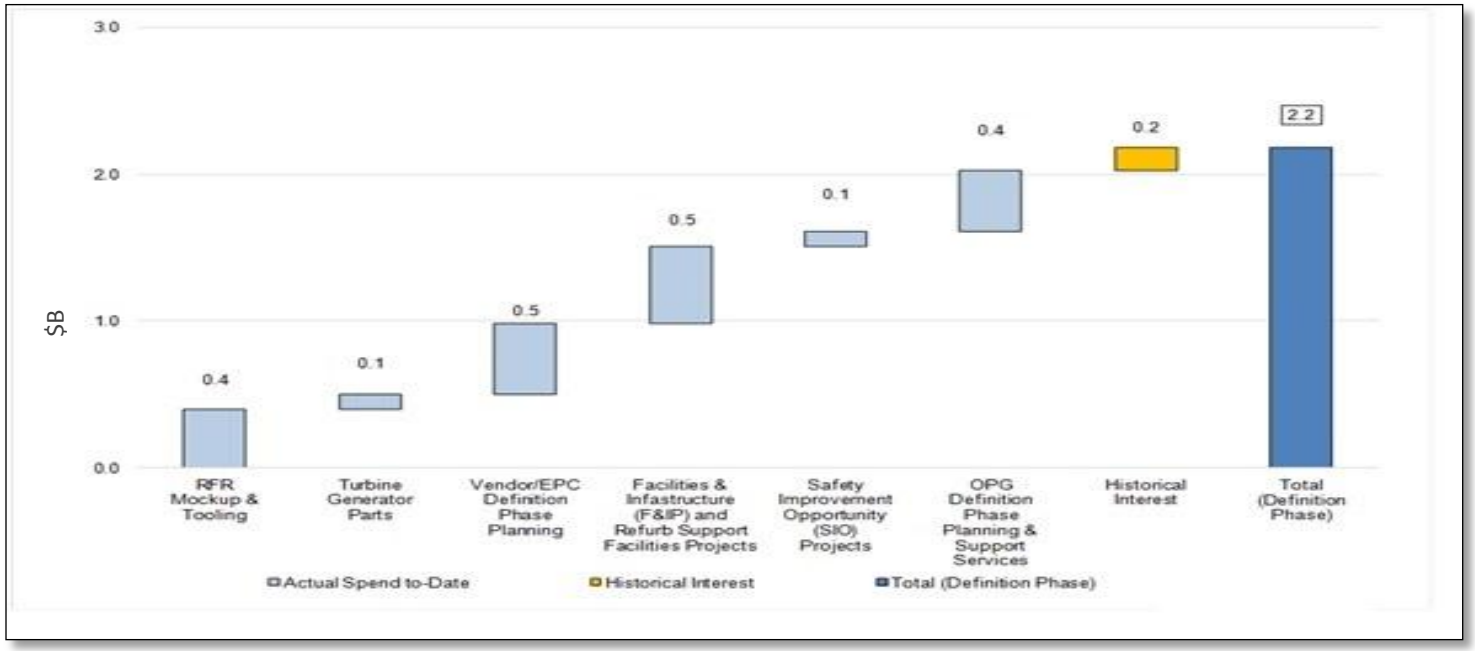
- Plan the work well ahead of the first scheduled unit shutdown
- Clearly define scope and minimize subsequent changes
  - Obtain the required regulatory approvals early and establish scope to address identified gaps
  - Conduct an in-depth plant condition assessment to understand the full scope of the Program and avoid surprises
- Complete engineering prior to execution
- Ensure tooling is compatible and that workers are well-trained on the tooling, before starting work in the reactor on critical path (e.g., reactor mock-up)
- Have adequate facilities and infrastructure in-place
- Employ contractors to execute the fieldwork while the owner retains overall Program management
  - Select the right contract partners and align to a common goal
- Build an integrated team capable of managing the Program
- Commit to attracting skilled and knowledgeable people, and to their training and development
- Structure the schedule to allow completion of entire evolutions on one unit before starting the evolutions on the next, allowing lessons learned to be applied in real time
- Ensure sufficient schedule and cost contingency to accommodate Program risk
- Set up independent oversight – trust through verification

Major Execution Work Bundles

- Retube and Feeder Replacement (RFR)
  - Reactor components that reach end of their service life are being replaced
- Turbine Generator
  - Perform extensive preventative maintenance on the Turbine Generator, including an upgrade of the control system to modern configurations
- Steam Generator
  - Steam Generator cleaning provides enhanced performance for the future. Access ports will be installed to improve inspection capabilities
- Defueling and Fuel Handling
  - Maintaining and upgrading the fueling machines to provide better reliability and performance, and defuel the reactor
- Balance of Plant
  - As part of the station lifecycle management program, modifying and replacing a wide variety of plant equipment that is approaching the end of service life or is difficult to repair on a fueled reactor

Definition Phase Expenditures

- During the Definition Phase, in addition to planning for the Execution Phase, many key facilities and other pre-requisites were completed, including:
  - Reactor mock-up
  - RFR tool development, fabrication, and testing
  - Facilities and Infrastructure Projects
  - Safety Improvement Opportunities (regulatory commitments)
  - In-station upgrades and modifications to support or enable refurbishment
  - Procurement of long-lead parts and on-boarding of critical resources



See: Ex .D2-2-4, Figure 1

Current Status

- Definition Phase concluded at end of 2015
  - Performed detailed planning to determine the high confidence schedule and cost estimates for Unit 2 and remaining three units to arrive at the RQE
  - A comprehensive assessment of risks and contingencies required to mitigate these risks has been completed
- Now in Execution Phase – breaker open in 22 days (October 15, 2016)
- Baseline working schedule has been established
- All major contracts awarded with vendors now finalizing work plans, on-boarding staff, training and preparing for their execution
- Facility and Infrastructure Projects (F&IP) and Safety Improvement Opportunities (SIO) projects are either complete or well underway
- OPG resources, organization and processes necessary to execute Unit 2 refurbishment safely, on time and on budget, are in place
- The DRP is currently on time and under budget



Major Contracts

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Commercial and Contracting Strategy

- OPG made a strategic decision to retain control over the DRP and chose a multi-prime EPC (engineering, procurement and construction) contracting model
    - Different procurement methods, contracting strategies and pricing models apply to the major work packages to address varying degrees of complexity, uncertainty and need for collaboration
    - Rather than award a single project management contract to one contractor, multiple prime contractors are working on the Program– each with distinct expertise and contracts
    - OPG is the integrator between the various prime contractors and sets the standards for how the Program is planned and managed
    - Incentives and disincentives align all parties to a common goal
    - EPC model ensures that handoffs between engineering, procurement and construction are effective

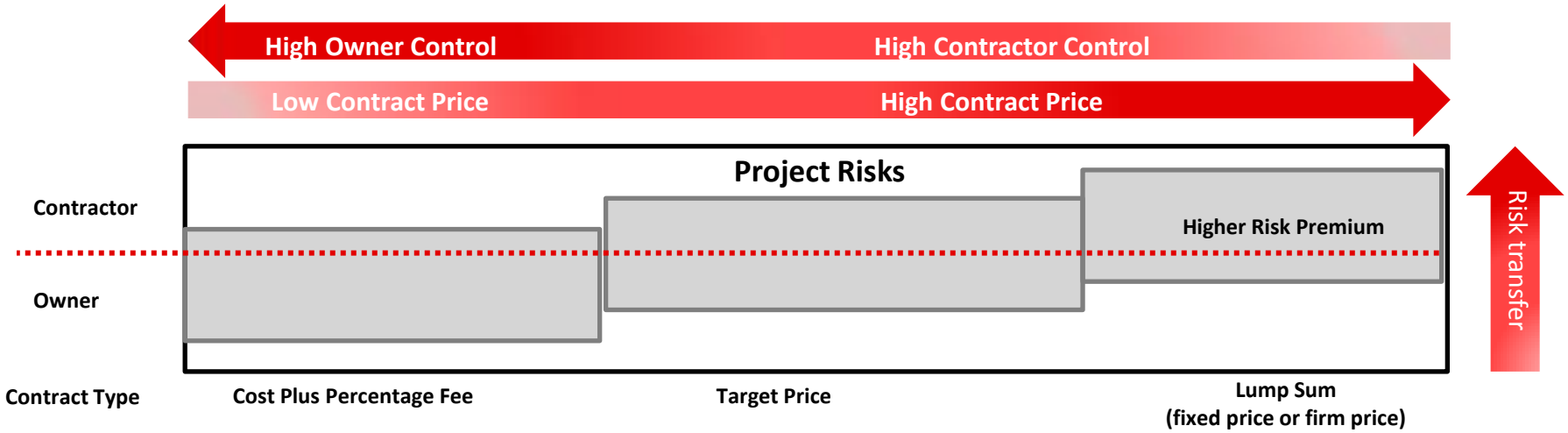
Contract Summary

- The main contracts entered into by OPG with respect to the DRP are as follows:

Agreement	Counterparty	Value
Refurbishment Retube and Feeder Replacement	SNC/AECON JV	$3.4B
Turbine Generators Engineering Support and Equipment Supply	Alstom	$333M
Turbine Generators Fieldwork	SNC/AECON JV	$284M
Steam Generators Inspections and Maintenance	BWXT/ CANDU Energy JV	$110M
Balance of Plant	multiple contractors (under OPG's Extended Services Master Services Agreement (ESMSA))	$783M
Fuel Handling Powertrack Refurbishment	ES Fox (under OPG's ESMSA)	$126M
Defuel hardware, software and services	GE Hitachi	$23M

Pricing Models

- In contracting the various work packages, OPG implemented different pricing models to optimize risk transfer and value-for-money
  - *Fixed pricing* is used for highly definable tasks where control over the work is in the hands of a contractor
  - *Cost plus % Fee* is used where work is complex and not highly definable, and where the owner is required to have control over the work
  - *Target Price* provides strong commercial incentives, similar to fixed pricing, but still allows the owner to have control over certain aspects of the work



Target Price Model

- The negotiated Target Price is a jointly developed estimate of the cost of work for a defined scope plus a negotiated Fixed Fee for overheads, profit and risks

- Vendors are paid actual costs plus the Fixed Fee based on the locked scope of work with rigid controls for change orders
- Fixed Fee is capped
- Parties share savings below targets and overruns above targets
- The cost incentives/disincentives mechanism is structured to achieve alignment of contractor interest and limit cost increases and schedule delays
- A target schedule (total days) is set to perform the work, and is also subject to incentives/disincentives

Target Price Model

Cost of Work (estimated)

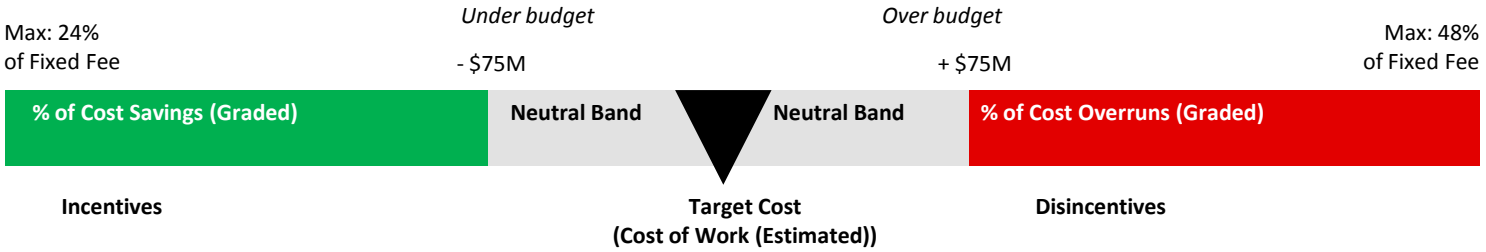
- The Cost of Work estimate was generated through rigorous planning and estimating efforts for each scope of work
- For example, in order to develop the Cost of Work estimate for RFR:
  - OPG, working with the contractor, conducted a vetting process to establish the estimate, which included a detailed review of the elements of the estimate comprised of estimate validation, assessment of gaps, and comparisons to benchmarks
  - OPG used comprehensive work packages, combined with actual durations from the testing of tools at the reactor mock-up and benchmarked information from other refurbishments
  - OPG and the contractor jointly engaged an expert review panel to conduct an independent review of the contractor's base cost estimate
- Actual cost of work is determined in alignment with the estimate and is fully auditable by OPG

Fixed Fee

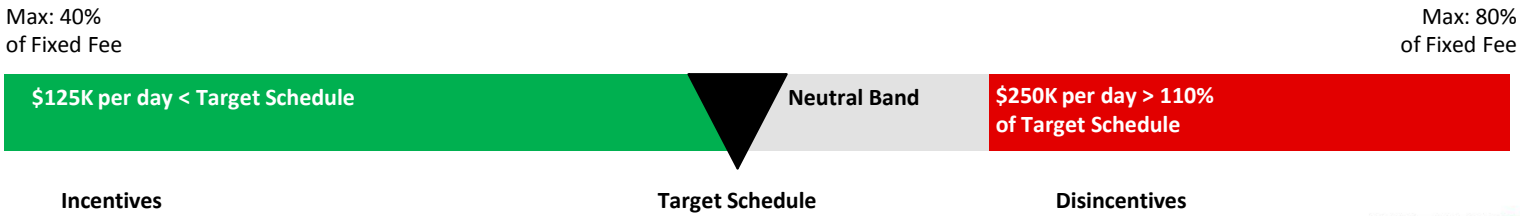
- Fixed Fee is the negotiated fee OPG will pay the vendor as compensation for overheads, profit and risks
- The financial incentives/disincentives mechanism is based on the actual cost of work

Target Price Model in RFR Contract

- Cost incentives/disincentives in Execution Phase:
  - Work completed for an amount lower than the Target Cost outside of the Neutral Band – contractor shares in the savings with OPG to a maximum of 24% of the Fixed Fee
  - Work for an amount higher than the Target Cost:
    - Contractor works without additional Fixed Fee
    - Beyond the Neutral Band ($75 Million), OPG receives a disincentive payment to a maximum of 48% of the Fixed Fee



- Schedule Incentives/Disincentives in Execution Phase:
  - Schedule delays beyond the Neutral Band (> 10% of target schedule) - OPG receives a disincentive payment of $250K per day to a maximum combined 80% of Fixed Fee
  - Ahead of schedule – Contractor receives $125K per day to a maximum combined 40% of Fixed Fee



See: Ex .D2-2-3, Figure 3

RFR Contract – Illustrative Example

- This table presents an illustrative example of the mechanics of the RFR contract incentive and disincentives in a 10% cost overrun scenario

			% Contractor Cost Overrun = 10%				
#	Category ($ Million)	Contract Costs	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Definition Phase Target Cost (Incl RWPB)	185	204	19	0	19	204
2	Definition Phase Fixed Fee	74	81	7	7	0	74
3	Definition Phase Incentive/ Disincentive	0			3	(3)	(3)
4	Execution Phase Target Cost	1,667	1,834	167	0	167	1,834
5	Execution Phase Fixed Fee	492	541	49	49	0	492
6	Execution Phase Incentive/ Disincentive	0			18	(18)	(18)
7	Mock-up Fixed Price	38	42	4	4	0	38
8	Non-target Reimbursable Costs	6	7	1	0	1	7
9	Tooling Fixed Price	375	413	38	38	0	375
10	OSM with Fee(estimate)	579	637	58	0	58	637
11	Goods with Fee(estimate)	48	53	5	0	5	53
12	Total	3,464	3,810	346	119	227	3,691

See: Ex .D2-2-3, Chart 4

- In this illustrative example, the same % cost overrun is applied to all components. In reality each component in each phase may have a cost overrun or an underrun
- To simplify the example, beyond the neutral band, it uses a disincentive percentage of 20% rather than the sliding scale in the contract



Questions

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Planning

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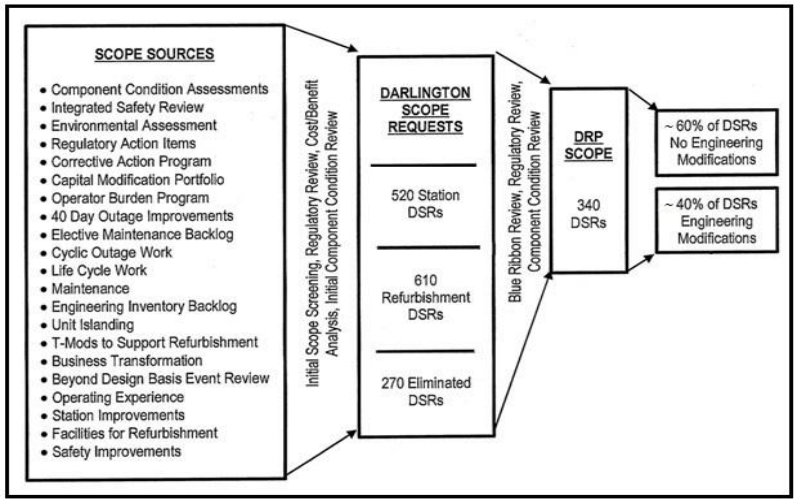
Investment in Planning

Scope	• OPG commenced refurbishment planning in 2008 to fully assess the condition of the plant and complete regulatory studies to determine total scope and timing • Design engineering is complete for all Unit 2 scope
Cost Estimating	• Documented the basis of estimate and assumptions for major cost elements in accordance with Class 3 estimate quality requirements as defined by AACE
Schedule	• Developed an integrated Level 2 schedule for the Program and an integrated and resource loaded Level 3 schedule for Unit 2
Risk and Contingency	• Performed a comprehensive review to identify and assess all known and foreseeable risks, to develop mitigation plans and quantify residual risk
Release Quality Estimate	• Over six years of effort culminated in the development of the release quality estimate • Independent reviews were performed to validate results

Scope Definition



See: Ex .D2-2-5, Figure 1

- Fully assessed all potential refurbishment scope
- Conducted a scope rationalization process, including reviews by the Program Scope Review Board, CNSC (for finalizing regulatory scope) and the Darlington Nuclear Refurbishment Scope Review Panel
- The final DRP scope is 340 Darlington Scope Requests (DSRs)
  - Station DSRs are required for maintenance and operation of Darlington during both refurbishment and post-refurbishment; many do not require a refurbishment outage
- The DRP scope was organized using a work breakdown structure and assigned to project bundles

Cost Estimating

- Cost estimate development followed AACE Recommended Practices including the following steps:

    1. Identifying the scope of work, constraints and assumptions
    2. Completing engineering and determining resource and material requirements
    3. Quantifying the resources required, including labour and non-labour resources
    4. Applying costs to the resources
    5. Adjusting or factoring pricing based on project environment

- OPG obtained specialized personnel with experience conducting the work, including independent estimating professionals

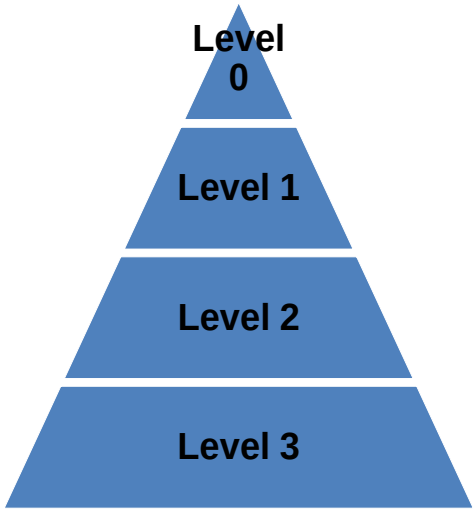
- Use of the reactor mock-up added rigor to the estimates through use of actual durations from the tool testing

Schedule Development

- Developed a fully integrated program schedule that integrates project schedules of the major work bundles
- Schedule includes:
  - Scope of work
  - Key activities' start and finish dates, duration, and resources
  - Sequence and logical interrelationship of activities and milestones
  - Identification and optimization of the critical path
  - Incorporates risks and includes duration contingencies
  - Methods for determining Earned Value to measure progress of work
- Will allow regular monitoring and updating to track performance, initiate corrective actions and to plan and manage priorities, opportunities and threats

Multi-level Scheduling

- Multi-level scheduling approach allows control at the appropriate level of the organization
  - The lower the level, the greater the level of detail
  - OPG as owner performs project management and control using Levels 0 to 2
  - Level 3 typically controlled by contractors and/or OPG groups performing the work
  - Contractors may have level 4 and 5 schedules for day-to-day work control and field supervision



Level 0: Nuclear Program Milestone Schedule (PMSS), controlled by OPG Senior Management.

Level 1: Nuclear Program Integrated Master Schedule (PIMS), controlled by OPG Senior Management. Program Level 1 contains all Control Accounts from all Projects as well as for Program Management work.

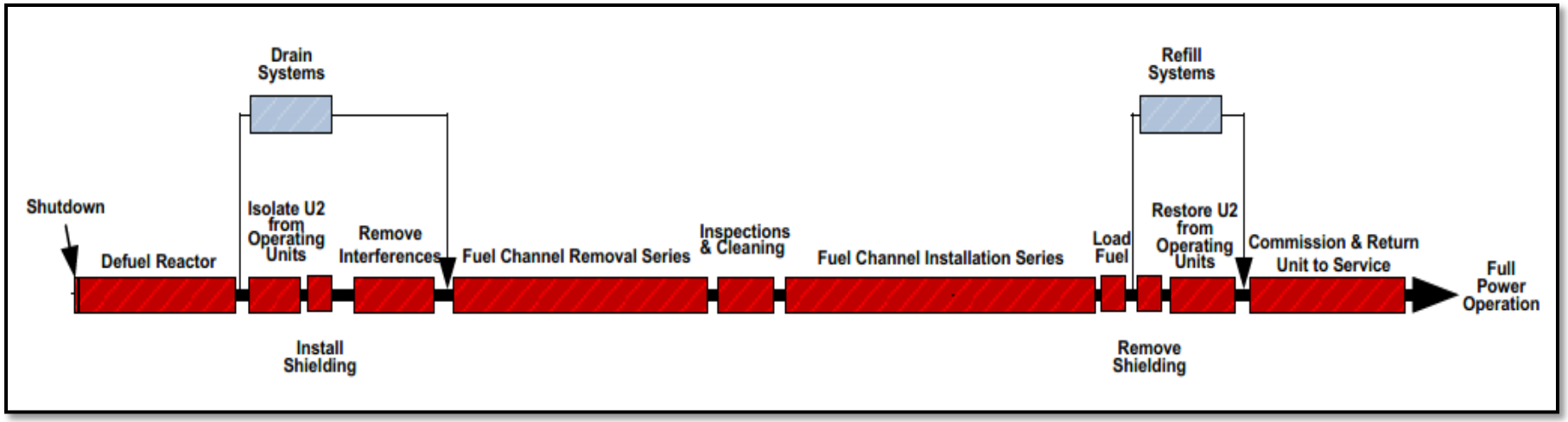
Level 2: Nuclear Program Coordination & Control Scheduled (C&C), controlled by OPG Nuclear Program/Project teams. Program Level 2 contains all Work Packages in the Program and they are interrelated.

Level 3: Nuclear Project Detailed Production Schedules (PDPS), controlled at the project level, by contractors or OPG (for OPG executed projects).

See: Ex .D2-2-6, Figure 1

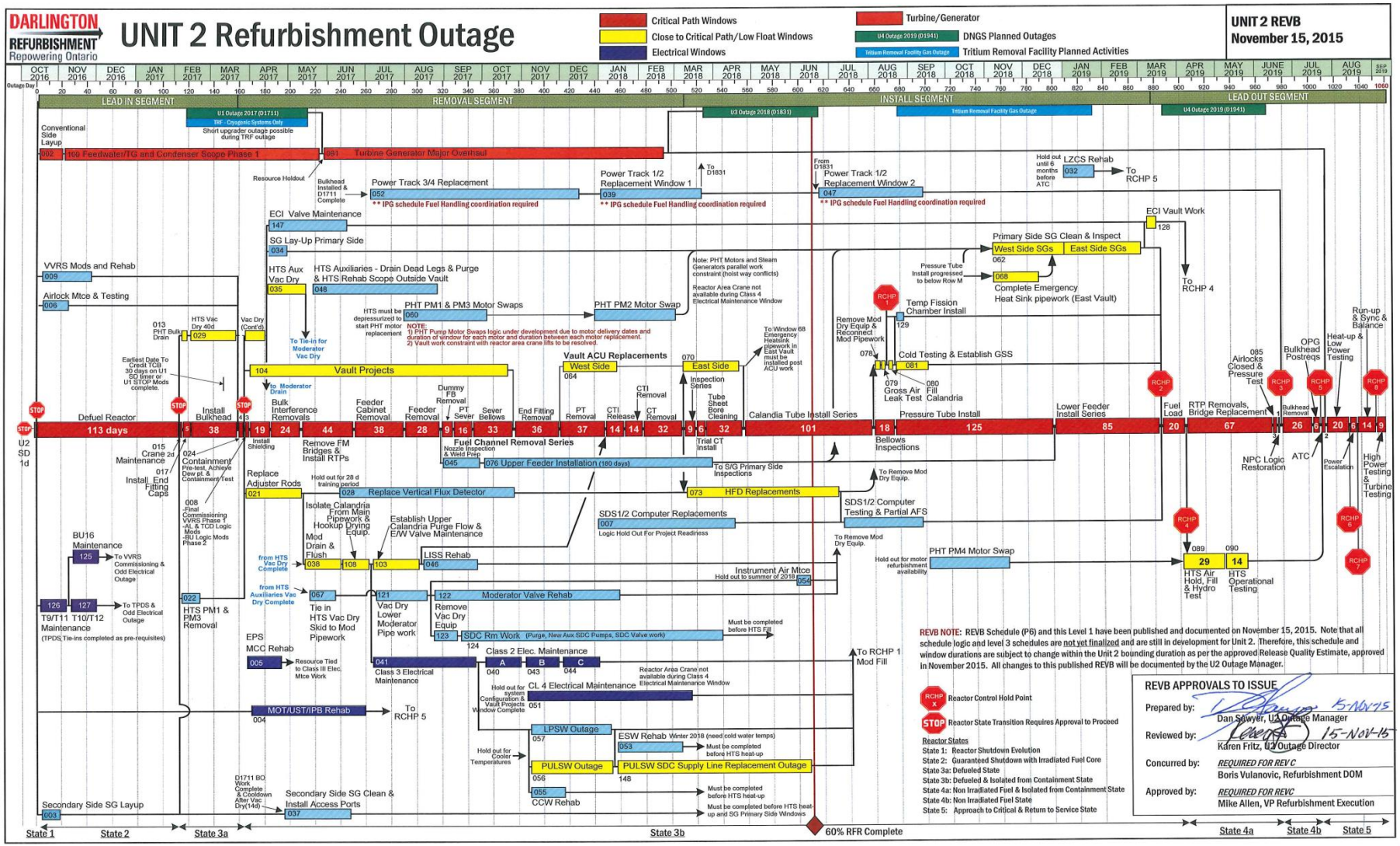
Simplified Unit 2 Schedule

- The Release Quality Estimate yielded a high confidence schedule for Unit 2 of 40 months and 112 months for all four units
- The high confidence schedule includes contingencies for risks – this is the schedule against which success will be measured



See: Ex .D2-2-6, Figure 2

Level 1 Schedule



See: Ex .D2-2-6, Attachment 1

Risk Identification and Assessment

- OPG identified and classified risks and developed the contingency component of the DRP estimate based on industry best practices

- Risks were identified and assessed for the projects within the major work bundles; program risks were also identified and assessed. Mitigation plans were developed as appropriate

- Risks were classified under three categories:

    1. **Cost estimating uncertainty** is the possibility that the costs of the projects are more or less than the applicable estimates
    2. **Schedule estimating uncertainty** is the possibility that the actual schedule durations for the projects are more or less than the estimated durations
    3. **Discrete risks** are the incremental cost and schedule impacts if specific risk events were to occur and include:
        - Project specific risks such as delays to procurement of a specific component for a specific project
        - Program risks that could impact the DRP in an overarching manner, such as the availability of sufficient skilled trades resources to execute the work

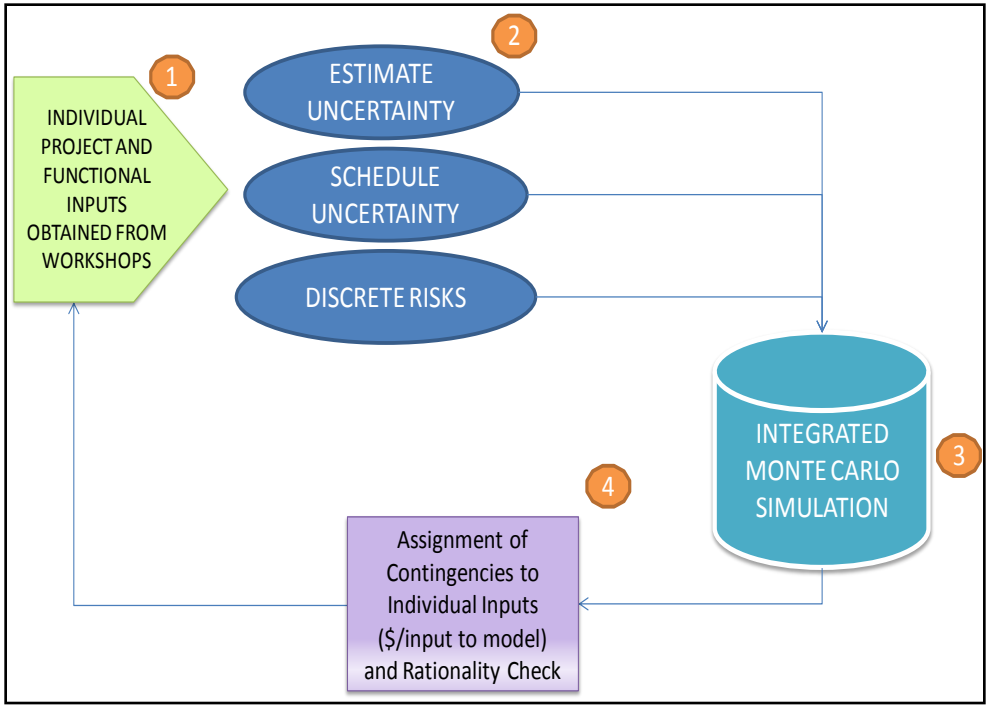
- OPG's risk management process requires active risk mitigation. Oversight is in place to ensure that this is occurring

Contingency Development

- Contingency is an amount added to an estimate to allow for items, conditions or events, for which the state, occurrence or effect is uncertain and that experience shows will likely result, in aggregate, in additional costs
- Contingency is generally included in most estimates, and is expected to be expended
- OPG's contingency development process followed AACE Recommended Practices
- Owners establish contingency levels based on an acceptable risk level, degree of uncertainty, and the desired confidence levels for meeting baseline requirements
- When used to absorb the impacts of uncertainty, contingency is a form of risk mitigation
- The determination of the amount of contingency is integral to the estimating, scheduling and risk management process of a project or program
- Active and transparent monitoring of contingency allocations provides OPG with visible oversight on how risks are impacting the Program

Contingency Development Process

- OPG's detailed contingency development process is shown in the following schematic:
  1. Detailed inputs were collected from project bundles and functions
  2. An evaluation of the three categories of risks was undertaken
  3. Performance of an integrated cost and schedule Monte Carlo simulation
     - Monte Carlo simulation is a probabilistic, computational technique that simulates execution of the project thousands of times, accounting for potential realization of risk events and uncertainties, taking into account probabilities and impacts
     - The simulation results are integrated to estimate amount of contingency required at specific confidence levels
  4. Management reviews the results to validate the overall adequacy of the contingency estimate, and to establish the required confidence level for inclusion into the RQE



See: Ex .D2-2-7, Figure 1

Contingency Estimates

Project	Estimate Class (at time of RQE)	Project Contingency ($M)	Program Contingency ($M)	Total Contingency ($M)
RFR	2	236	381	617
Turbine Generator	2-3	195	23	218
Steam Generators	2	20	0	20
Fuel Handling and Defueling	3	25	38	63
Balance of Plant	3-5	230	0	230
F&IP and SIO	1-3	42	34	76
Project Execution and Operations and Maintenance	N/A	58	222	280
Unallocated Program Contingency	N/A	0	202	202
Total Contingency ($B)	-	**$0.8B**	**$0.9B**	**$1.7B**

See: Ex .D2-2-7, Chart 1

- OPG has included $1.7B (2015$) of contingency in its RQE of $12.8B. Of that amount, $694.1M (2015$) was allocated to Unit 2
- Project contingency is for risks and uncertainties localized to projects; managed by project directors
- Program contingency is for overarching risks managed at the executive level
- Low probability, high consequence risks outside of the control of the Program are not included in the contingency amounts. If these occur, management would evaluate the impact on the Program and make a recommendation to the Board of Directors on the appropriate response

Simplified Breakdown of DRP RQE

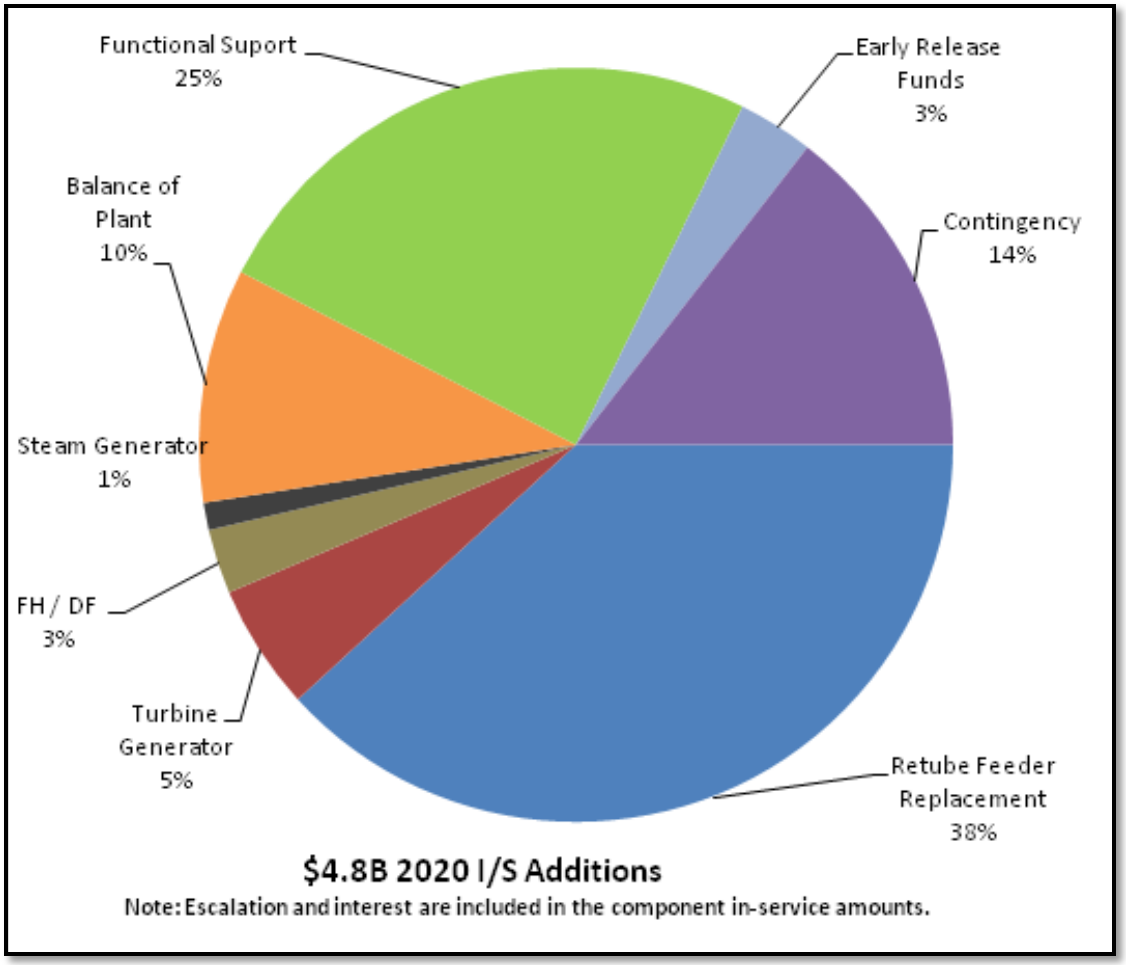
- Release Quality Estimate of $12.8B was approved by OPG's Board of Directors on November 13, 2015
- Minister of Energy announced endorsement of the DRP on January 11, 2016

Program Component	RQE Total Cost (Billion $)	RQE Total Cost (%)
Major Execution Work Bundles	5.54	43
Safety Improvement Opportunities	0.20	2
Facilities & Infrastructure Projects	0.64	5
OPG Functional Support	2.23	17
Early Release Funds	0.11	1
Contingency	1.71	13
Interest & Escalation	2.37	19
Total Cost Estimate	**12.8**	**100**

See: Ex .D2-2-1, Chart 1

Unit 2 In-service Amount

- Of the $12.8B, $4.8B is forecast to be placed into rate base with Unit 2 in-service in February 2020
  - Includes Unit 2 costs, Definition Phase costs and common costs



See: Ex .D2-2-1, Figure 1

Program Execution

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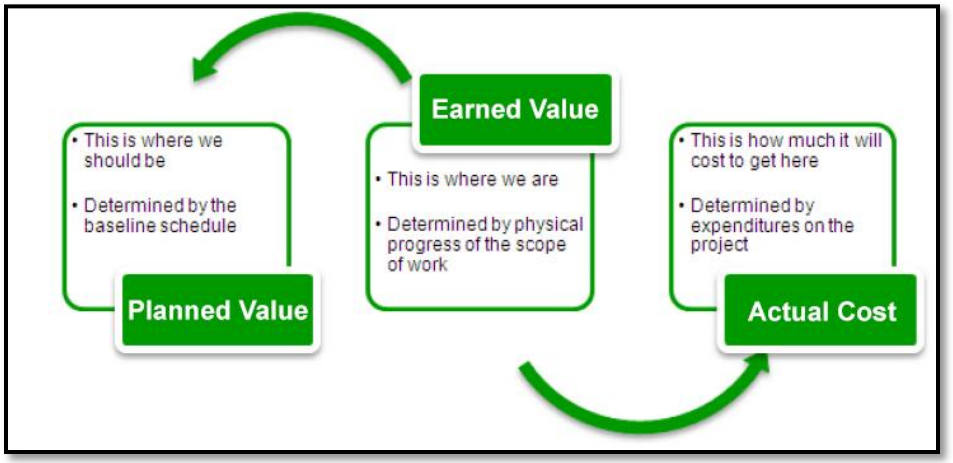
OPG as the Owner

- OPG retains overall responsibility for the Program, controls the integrated schedule and deliverables and is the license holder and design authority for the plant. Its functions include:
  - **Project Management Teams** - these teams are responsible for management, oversight and delivery of specific major work bundles
  - **Program Support Functions** - support the major work bundles and the DRP as a whole in areas such as engineering, procurement and oversight
    - Provide the required support, coordination, integration, and oversight of the work that will be performed by the Project Management Teams and external contractors
  - **Execution Support Functions** - support the execution of the fieldwork
    - Fieldwork is conducted by contractors
    - Project Execution Support provides support for construction execution, quality management, and purchase and delivery of parts
    - Work Control / Project Office integrates and controls the individual unit outage and execution schedules and ensures all deliverables are known, communicated and completed in accordance with expectations
    - Operations and Maintenance Function is the “custodian” of the operating units in the plant, ensuring that refurbishment work does not adversely impact the operating units

Performance Monitoring

- OPG uses an Earned Value Management methodology, a standard project management technique for quantifying and measuring project progress and performance
- Allows for continuous analysis of progress achieved against plan
- Allows management to implement strategies should the project track "off-plan", including managing allocation of contingencies

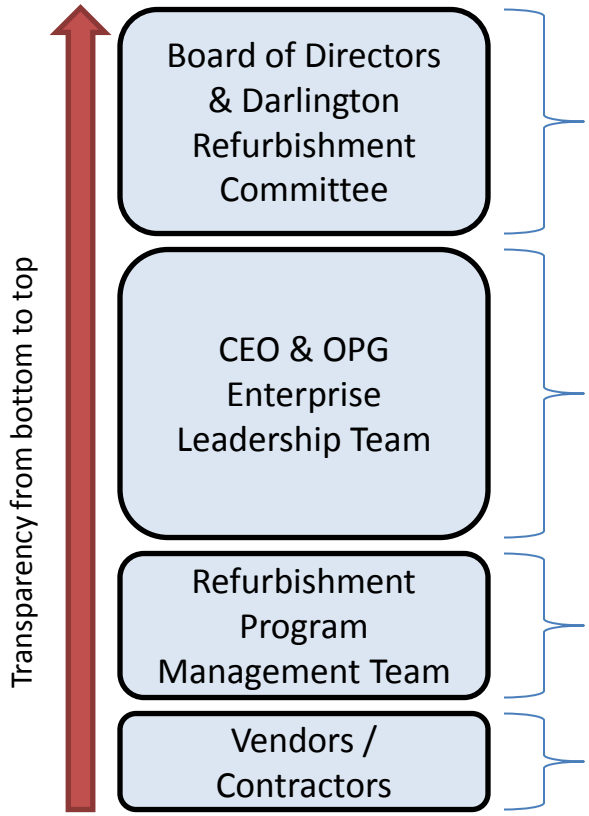


See: Ex .D2-2-9, Figure 1

- Cost performance is measured using industry metrics at the program, project and functional levels using the following metrics:
  - Schedule Performance Index (SPI): A measure of progress achieved compared to planned progress (SPI = Earned Value / Planned Value)
  - Cost Performance Index (CPI): measure of the value of work completed compared to actual cost incurred (CPI = Earned Value / Actual Cost)
  - Cost Variance: Difference between budgeted value of work performed and the actual cost of that work (Cost Variance = Earned Value – Actual Cost)
  - Schedule Variance: Difference between budgeted value of work planned and the actual cost of work performed (Schedule Variance = Planned Value – Earned Value)

Oversight and Assurance

- OPG has developed and implemented an assurance model that is comprised of several layers of oversight to ensure that issues are identified early and resolved expeditiously, and that transparent and accurate information flows up to the Board of Directors



- Examines each of the major elements supporting a successful refurbishment through the appropriate committees, including the Darlington Refurbishment Committee
- The Darlington Refurbishment Committee has independent oversight support to evaluate accuracy and completeness of information provided by management, and to determine if management is effectively identifying and resolving issues

- The CEO ensures that the programs and approach to management and execution of the Program are appropriate, and that the Enterprise Leadership Team is properly applying other company-wide support
- A Refurbishment Construction Review Board is in place to provide advisory services to OPG's SVP Nuclear Projects, Chief Nuclear Officer and CEO
- The Chief Nuclear Officer, through the Nuclear Management System, ensures the effective assessment and oversight of the DRP
- OPG's Internal Audit function provides additional validation and assurance

- Ensures that the resources, processes, programs and reports are in place to promptly identify deficiencies and trends, and correct those conditions and underlying causes

- Provide direct supervision and oversight of project work



Conclusion

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OPG is Ready to Execute

- OPG is ready to execute the DRP and to succeed, because of:
  - Exhaustive preparation
  - Clear definition and understanding of the scope
  - Development of comprehensive and detailed cost and schedule estimates
  - Completion of detailed design engineering for Unit 2 scope prior to breaker open
  - The experience and judgment of the Program leadership team and staff
  - The robust risk management process employed
  - The comprehensive oversight
  - Everything will not go perfectly; it never does on a megaprogram. However, the people and processes are in place to make the necessary corrections to address issues as they arise