REMAINING UNITS CONTINGENCY

1.0 OVERVIEW

This exhibit recaps OPG's process for developing contingency and describes the process for controlling and approving the use of contingency that was extensively discussed in EB-2016-0152.[1] This exhibit also summarizes the contingency allocations to Units 3, 1, and 4 (the "Remaining Units").

2.0 CONTINGENCY DEVELOPMENT

Determining the amount of contingency is an integral step to the planning, estimating, scheduling and risk management processes of any project. The Association for the Advancement of Cost Engineering ("AACE"), a leading authority in the area of cost engineering, management and estimation, defines "contingency" as an amount that is 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. The AACE definition states that "contingency is generally included in most estimates, and is expected to be expended."[2] The Project Management Institute, a leading professional membership association for the project, program and portfolio management profession, explains that contingency allowances are part of the funding requirements for a project, and included in the cost baseline (or budget) to account for identified risks.[3]

OPG's approach and process for developing contingency has not materially changed since EB-2016-0152.[4]

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[1] In EB-2016-0152, OPG described the comprehensive and robust risk management system for the Program, and how that process was a key input into the determination of the amount of contingency included in the Release Quality Estimate ("RQE") (see EB-2016-0152, Ex. D2-2-7). OPG also explained the contingency development process and provided the amount of contingency that was included at the time of RQE for the entire Program, as well as a breakdown of the contingency across the five Major Work Bundles for Unit 2.

[2] "Cost Engineering Terminology", Recommended Practice 10S-90, AACE International, WV, rev. 2007.

[3] Project Management Institute, *Guide to the Project Management Body of Knowledge (PMBOK Guide)*, 6th ed., 2017, Section 7.2.2.6 at p. 245.

[4] EB-2016-0152, Ex. D2-2-7.

Contingency is typically estimated using statistical analysis informed by experience-based judgment and considers only residual (post-mitigated) risk exposures. The contingency estimate is developed through a detailed evaluation of: (1) the uncertainties in estimating cost and schedule; and (2) discrete risks relating to cost and schedule. This process relies upon the use of both qualitative and quantitative methods, including development of a risk register to evaluate potential risks, their consequences and probabilities of occurrence, and performance of an integrated cost and schedule Monte Carlo simulation. Attachment 1 provides a recap of the Monte Carlo simulation methodology. This process of risk identification and classification, and development of the contingency amounts through a detailed evaluation of the above factors, has continued through the development of the Units 2 and 3 Execution Estimates ("U2EE" and "U3EE"), and will be used to produce the Units 1 and 4 Execution Estimates.

OPG's contingency estimate is developed based on the following inputs: (1) cost uncertainty; (2) schedule uncertainty; and (3) discrete risks. These inputs are explained below:

1. *Cost estimating uncertainty* is the possibility that the costs of the projects are more or less than the applicable estimates, taking into consideration the estimate classification of the base project cost (excluding discrete risk events).
2. *Schedule estimating uncertainty* is the possibility that the actual schedule durations for the projects are more or less than the estimated durations (excluding discrete risk events).
3. *Discrete risks* are the incremental cost and schedule impacts to the project if risk events were to occur. These include risks that are specific and applied to individual project bundles, such as delays to procurement of a specific component for a specific project, as well as global Program risks that could impact the DRP in an overarching manner.

Once probabilities and consequences are assigned to these risks, a Monte Carlo simulation is run. The output of the Monte Carlo simulation is a probability distribution of cost estimate outcomes, as well as a probability distribution of schedule duration outcomes.

The contingency development process described above is an iterative process: (1) cost estimates for project bundles and functions are continually updated, as are the uncertainty

ranges around those estimates and the probability distributions; (2) schedule duration estimates and uncertainty ranges are also continually updated, as are the probability distributions; (3) the risk register is continually updated as new discrete risks are identified or previously identified risks are retired; probabilities and consequences associated with those risks are continually re-assessed based on experience on the previous unit(s), or based on newly emerging information.

As each of the Remaining Units' estimates are updated, usually at the point where the specific unit's cost and schedule estimates need to pass through a Phase Gate (see Ex. D2-2-3, Attachment 1 for OPG's Phase Gate Governance), the Monte Carlo simulation is re-run in order to develop the latest modelled estimate of the contingency required to assure a certain confidence level in executing the project. This modelled contingency forms an input into management's judgement of the amount of contingency required to develop a high confidence estimate.

Once the high confidence contingency estimate is developed, OPG either allocates contingency at the project level, or retains the contingency at the Program level. Project contingency is derived from the individual discrete risks and cost uncertainties specific to the scope of work on a given project and is managed by project directors. Project risks have a localized project impact if they occur. Program contingency is derived from overarching Program risks managed at the executive level that could impact the overall Program, and may require Program-wide response.

There are a number of low probability, high consequence events that could impact the Remaining Units, and which are beyond the ability of the project to manage or mitigate. These events are not modelled and, therefore, not included in the contingency amounts determined using the approach described above. The low probabilities associated with these types of events would mean that they would not contribute significantly to the contingency amounts determined using the probabilistic assessment methods described above and in Attachment 1.

At the time of the RQE, Management had compiled a list of such events and OPG had provided examples in EB-2016-0152 (see Ex. D2-2-7). The examples provided were: 1) force majeure; 2) a significant labour disruption, including a shortage of trades labour to execute the work; 3) changes in the political environment; 4) an international nuclear accident or incident (Fukushima-type event), and 5) unforeseen changes to financial and other economic factors, e.g., escalation or interest rates significantly higher than those assumed in developing the estimate for the Remaining Units. In EB-2016-0152,[5] OPG had also noted that, if such an event were to occur, Management would need to evaluate the impact of the event on the cost and schedule for the Program and provide a recommendation to the OPG Board of Directors for approval on the appropriate response.

Such an event has occurred with the COVID-19 pandemic. The COVID-19 pandemic and the Government of Ontario's state of emergency declaration on March 17, 2020 in response to it, which mandated physical distancing and the closure of everything but essential services, could not have been reasonably foreseen in planning for the DRP. Therefore, there was no modelling of such an event, and no amount included in the initial contingency developed for the Program. Management responded by assessing the potential impact of the COVID-19 pandemic on the DRP, based on available information, and ultimately sought and received OPG Board of Directors approval to continue with the Remaining Units' refurbishments with a four-month deferral of the start dates of each of the Remaining Units. While OPG has estimated the approximate cost impact to the DRP as a result of the four-month deferral, given the inherent uncertainty associated with the on-going pandemic, its ultimate impact on the DRP cannot be forecasted (Ex. D2-2-7).

3.0 CONTINGENCY AMOUNTS

Detailed evaluation of cost and schedule uncertainties and discrete risks enables OPG to determine the appropriate amount of contingency required for the Remaining Units.

[5] EB-2016-0152, Exhibits L04.3-6 EP-013 and L04.3-2 AMPCO-071, part (c).

In EB-2016-0152, OPG had provided evidence, supported by its expert witness, that, given the scale and complexity of the Program and the fact that it is a mega-program, the appropriate level of contingency for the Program was that amount which equated to a 90% confidence in cost and schedule estimates.[6] The OEB, in its Decision and Order in EB-2016-0152, agreed with OPG that the 90% confidence level and the associated contingency required was the appropriate amount to use for both planning and ratemaking purposes:

> The OEB accepts that P90 is a reasonable contingency factor for this project. The P90 factor was determined by OPG based on a statistical modelling of risks identified by OPG. As such, the P90 contingency amount should form part of the approved DRP-related in-service amounts. The OEB does not agree with the arguments put forth by some parties that the contingency level should be set differently for planning and ratemaking purposes. The OEB finds that if setting a contingency budget at the P90 level is appropriate from a planning perspective it is logical that it is also appropriate to approve that level of contingency for recovery in rates.[7]

In this application, OPG is proposing setting payment amounts on the same basis for the Remaining Units as the OEB approved in the last application.

3.1 Base Estimates and Contingency Amounts

As the Program continues from the execution of the first unit's refurbishment to the last unit's refurbishment, the accuracy of the base estimates of cost and schedule (also referred to as "point estimates") are expected to improve as actual experience on the prior unit(s) is built into these base estimates.[8] In addition, cost and schedule uncertainties are expected to decrease (both in number and in the expected probabilities and consequences associated with the remaining uncertainties). Similarly, the number of discrete risks are expected to be fewer and the probabilities and consequences of the remaining discrete risks are expected to lessen. Taken together, these changes are expected to translate into an increase in base or

[6] EB-2016-0152, Tr. Volume 1, Feb 28, 2017, p. 33, lines 15-21.
[7] Ontario Energy Board, Decision and Order, EB-2016-0152, Ontario Power Generation, Inc., Application for payment amounts for the period January 1, 2017 to December 31, 2021, December 28, 2017, p. 38.
[8] Ex. D2-2-5, Program Schedule, for specific examples of how the actual experience on Unit 2 was used to inform the updated base duration estimates for particular work activities or scopes of work.

point estimates, and a decrease in the amount of contingency required to achieve a particular confidence level in achieving a desired cost and schedule outcome.

In Ex. D2-2-3, OPG provides a detailed explanation of its Lessons Learned process and examples of Strategic Improvements that have been, or are being, implemented for the Remaining Units. In addition to having executed the Unit 2 refurbishment, the application of Lessons Learned and Strategic Improvements provides increased certainty in OPG's point estimates of cost and schedule. This increased certainty translates into smaller ranges around the point estimates of cost and schedule for the various projects that make up the Program. These smaller ranges are inputs to the Monte Carlo simulation and result in a smaller derived contingency amount for a 90% confidence level.

3.2 Remaining Units' Contingency Amounts

The total contingency amount required for the Remaining Units, at a 90% confidence level, was derived in the initial two iterations of the U3EE. The remaining unspent contingency amount included in the in-service amounts for the Remaining Units is $647M.[9] This contingency amount represents approximately 10% of the Remaining Units' estimate, including contingency. This percentage is within the range of cost estimate uncertainty associated with a Class 2 estimate per AACE guidelines. Class 2 estimates have a range of -5% to -15% to +5% to +20%.

3.2.1 Factors Driving Reduced Contingency Need

The Remaining Units' unspent contingency amount of $647M is 49% of the $1,312M that was initially allocated to Units 3, 1, and 4 at RQE. The reasons for this reduction in required contingency include that, having completed Unit 2, and having implemented a robust Lessons Learned process along with targeted Strategic Improvements, OPG now has: (1) higher confidence in its project cost point estimates; (2) higher confidence in its point estimates of schedule durations; and (3) fewer forecast discrete risks and lower forecast impacts from certain of the remaining discrete risks.

[9] Ex. D2-2-7, Chart 1.

Factors contributing to this higher confidence in the project cost point estimates and point estimates of schedule durations are as follows:

1. Cost estimates: Cost estimates for repeated scope on the Remaining Units are now more certain because the work has been executed on Unit 2 and detailed costs are available. The causes of cost overruns or cost savings on Unit 2 have been analyzed in detail and appropriate adjustments were made to the point estimates for projects on the Remaining Units. In addition, Lessons Learned have been, or are being, applied to all projects' work packages. The effect of these changes is a reduction in cost uncertainty and an associated reduction in the amount of cost contingency required, compared to the estimate at RQE and U2EE.

2. Schedule duration: Schedule duration estimates for all work packages are now more certain than at RQE and U2EE. Every critical path duration has been adjusted based on Lessons Learned and to include the impact of Strategic Improvements. Delays have been analyzed in detail and those which are not expected to be repeated have been excluded from the Remaining Units' schedules. In addition, adjustments have been made to productivity assumptions based on Unit 2 experience. The effect of these changes is a reduction in schedule uncertainty and an associated reduction in the amount of schedule contingency required, compared to earlier estimates.

3. Discrete risks: A large number of discrete risks have been retired, or if not fully retired, have been assessed with reduced probability and consequence estimates as compared to RQE and U2EE. Examples include:

- Material manufacturing and delivery – the manufacturing and delivery process is now mature and issues have been addressed; for example, the majority of the Owner Supplied Materials for Unit 3 are on-site or already manufactured, therefore costs are known / committed and the risk is retired;
- Goods and Consumables – there is a better understanding of the volume and price of goods and consumables based on the Unit 2 experience; and,

- Discovery work – there is a reduced risk of discovery work, having completed Unit 2 and achieved a better understanding of the condition of those components that could not have been inspected before breaker open.

In summary, a lower contingency amount is needed to maintain 90% confidence in schedule and cost estimates for the Remaining Units as compared to RQE and U2EE because of the impact of utilizing smaller uncertainty ranges for cost and schedule estimates as inputs to the Monte Carlo modelling for the Remaining Units than was used at RQE and U2EE, a reduced number of discrete risks, and a lower probability of occurrence and lower consequences for the majority of the remaining discrete risks.

A breakdown of the remaining unspent contingency amount for Unit 3 is provided in Chart 1.

Chart 1

Breakdown of Remaining Unit 3 Contingency Amounts

Program Element	Contingency ($M)
	Unit 3
RFR (includes Unit Islanding)	46
Turbine Generator	20
Fuel Handling/Defueling	10
Steam Generator	8
Balance of Plant (includes Special Projects, Shutdown Layup and Refurbishment Support Facilities)	29
Subtotal Major Work Bundles	**112**
Program/Functions/Schedule*	**126**
Total Remaining Contingency	**238**
*includes all contingency interest	

The contingency amounts including interest and escalation which remain unspent for Units 1 and 4 are $215M and $194M, respectively.

As discussed above, low probability, high consequence events that could impact the Remaining Units, and which are beyond the ability of the project to manage or mitigate,

including the COVID-19 pandemic, are not factored into the development of the above contingency amounts.

3.3 Control and Approval of Contingency Usage

Authorization of the use of contingency funds is controlled through the Refurbishment Change Control Process.[10] Each contingency request requires an explanation of the risk or uncertainty element that has been realized. At the time of RQE, all contingency requests were channelled through the Change Control Board ("CCB").

In 2016, a decision was made to allow the Senior Project Directors of each of the Major Work Bundles to release contingency to the projects under their responsibility up to $5 million per risk event.[11] This decision was made in order to increase agility in managing emergent project changes. The authority required to approve the release of contingency escalates for higher amounts. If the contingency request exceeds the authority of the Senior Project Director, then the requested change is subject to the review and approval of the CCB. All requests for Program contingency, as well as contingency allocated to the Functions,[12] must continue to be presented to the CCB for review and approval, as the associated risks and uncertainties are applicable to the entire Program, rather than individual Major Work Bundles.

In the event that any contingency remains unused at the end of the Program, the favourable revenue requirement amount will be recorded in the Capacity Refurbishment Variance Account and returned to ratepayers in a future proceeding.

[10] OPG-MAN-00120-0016 Project Integrated Change Control and NK38-NR-PLAN-09701-10001 Darlington Refurbishment Project Planning and Controls Program Management Plan.

[11] EB-2016-0152, Ex. L4.3-1 Staff-058.

[12] Functions are work groups within OPG's Program and Execution Management and Support organizations that provide a broad range of support to the Program, including oversight, coordination, and integration among the various contractors and ongoing station operations.

ATTACHMENTS

Attachment 1: Explanation of Monte Carlo Simulation

Attachment 1: Monte Carlo Simulation

Contingency is typically estimated using statistical analysis informed by judgment based on past experience and considers only residual (post-mitigated) risk exposures.

Monte Carlo simulation is a computerized mathematical technique that simulates the execution of a project thousands of times, accounting for potential realization of discrete risk events and project uncertainties based on the probability distribution function and the consequence of each risk. The technique builds models of possible results by substituting a range of values for any factor that has inherent uncertainty. The model is then used to calculate the results in an iterative manner, involving thousands of iterations, each using a different set of random values from the probability distribution functions.[1] The output provides decision makers with a range of possible outcomes for the project and the associated probabilities that those outcomes will occur. The discrete probability distribution of outcomes often takes a shape similar to an inverted bell; therefore, are often referred to as “Bell” curves. The cumulative version of these probability distribution of curves, often takes a shape similar to an “S”; therefore, are often referred to as “S” curves. Using these “S” curves, the amount of contingency required to be added to the base cost estimate to obtain a certain level of confidence can be determined. This quantitative result is used as an input to determine the amount of contingency required at different confidence levels for both the project schedule and project cost.

OPG uses @Risk, a leading risk analysis software tool from Palisade Corporation, an internationally recognized leader in this field. @Risk is a tool which facilitates the running of a Monte Carlo simulation, based on the risk inputs. At the time of RQE, OPG had also retained a risk modelling subject matter expert from Palisade to assist in the architecture and robustness of the model and to oversee the simulation.

[1] Palisade Corporation, *Monte Carlo Simulation* <http://www.palisade.com/risk/monte_carlo_simulation.asp>.

The results of the Monte Carlo simulation are an important, but not the sole input into the determination of the appropriate level of contingency to be included in the project estimate in developing, say, a 90% confidence estimate. The judgement of the project staff, project management, project executive management and OPG's executive management are also important inputs. Ultimately, the confidence level in achieving a certain schedule and cost outcome, and validation of the overall adequacy of the contingency estimate required to achieve that outcome is informed both by the quantitative results of the Monte Carlo simulation and by management judgement.