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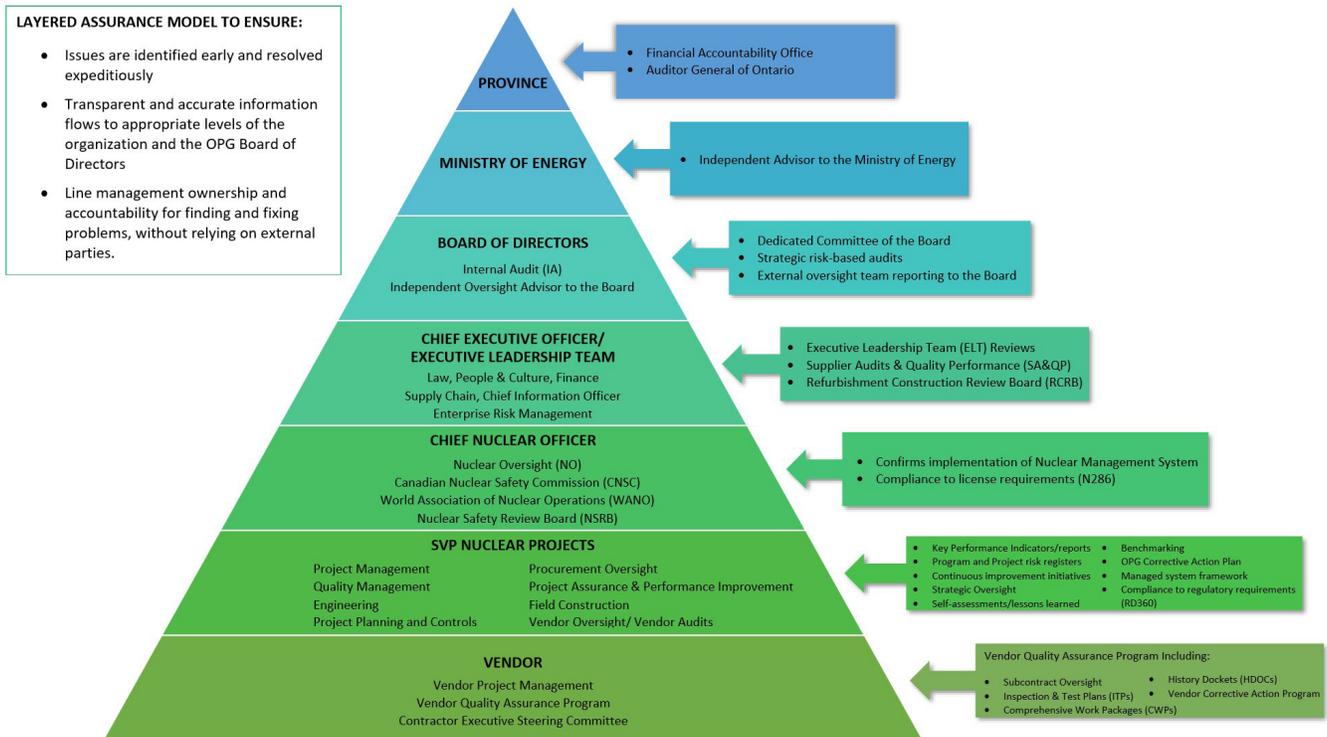
Meeting the Energy Moment: How Independent Oversight Can Restore Confidence in Large-Scale Nuclear Projects



In June 2020, Ontario Power Generation (OPG) completed its CDN\$3.4 billion refurbishment of Unit 2 at the Darlington Nuclear Generating Station on budget and on time – an historic accomplishment for the nuclear industry, despite finishing during the early stages of the COVID-19 pandemic.

This achievement set the path for the refurbishment of the remaining three units and another six CANDU units being refurbished by Bruce Power – a total investment of more than CDN\$25 billion.

One of the reasons for the success of the Darlington Refurbishment Project (DRP) was OPG’s approach to project assurance and project oversight. In 2013, Modus Strategic Solutions teamed with Burns & McDonnell to provide independent oversight for the OPG Board of Directors. However, the Independent Oversight team was just one part of OPG’s layered assurance model as can be seen in the graphic below:



The ongoing success of this project demonstrates in real, concrete terms how a robust project assurance and oversight program can improve project outcomes. Importantly, it also provides a roadmap for how the North American nuclear power industry can reduce the nagging cost and schedule uncertainty that clouds the future deployment of new nuclear technologies.

Restoring Confidence Once “Faith Has Been Compromised”: OPG’s Experience

OPG’s need to ensure oversight of the Darlington refurbishment was rooted in its responsibility to its stakeholders. The company is a Canadian Crown Corporation whose sole shareholder is the Province of Ontario. And OPG’s previous large nuclear projects had been adversely impacted by cost and schedule overruns, causing damage to the company’s reputation.

Darlington’s four units were brought into service between 1990 and 1993 at a final cost of CDN\$14.5 billion (1993 dollars). This represents almost twice the estimated final cost of CDN\$7.4 billion (1993 dollars) projected when construction started in 1981. During the construction period, Darlington experienced 11

significant schedule delays and cost increases due to labor actions, staff shortages, and unforeseen technical issues.

OPG’s next large project was the Pickering A Return-to-Service (RTS) Project. In 1997, the four Pickering A Units were laid-up and removed from service while the company focused on other priorities. In 1999, the Ontario Hydro Board of Directors approved a plan to invest CDN\$780 million to return all four units to service.

The first of these projects was Pickering Unit 4, which was beset with delays due to scope identification and poor planning. The final cost for this single unit was CDN\$1.25 billion, exceeding the budget for the entire RTS project and further undermining confidence in OPG’s ability to proceed to the next units.

OPG conducted a thorough, independent root cause assessment¹ of these overruns and during 2003-2004, the province engaged a committee, the Pickering A Review Panel, to identify what went wrong. This panel concluded the cost overruns were



ultimately the responsibility of the OPG Board and senior management in failing to exercise their oversight responsibilities.

Before receiving approval for the remaining units, the panel recommended “that the OPG Board of Directors ensure that the governance model for returning any of the remaining units to service include enhanced, independent oversight of project management decisions.”

A successor panel, the OPG Review Committee, was appointed by the province to further review plans for the RTS Project’s next phase. Similarly, this committee determined, “If the Pickering A Unit 1 project goes ahead, the government, as shareholder, should set up a process to ensure ongoing oversight. Given the recent history of cost overruns, taxpayers deserve this additional protection of their interests.”

OPG followed these recommendations. It instituted a rigorous independent oversight model that verified the project team’s planning basis, budget and schedule for the RTS of Unit 1. Once the project was approved, the Board of Directors utilized independent oversight through the entirety of Unit 1 to validate the work the project team performed, and to identify any risks and accountabilities for issues.

Unit 1 met its approved cost and schedule targets, completing in 12 months at a cost of CDN\$975 million. Pickering A RTS Units 2/3 were ultimately cancelled due to deteriorated plant condition. However, OPG was able to restore public confidence with its performance on Pickering A Unit 1 RTS.

In 2009, OPG was given approval to proceed with the Darlington Refurbishment Project, a complex, 10-year megaproject with an expected cost of CDN\$12.8 billion. This project entails, among

other things, refurbishing all four CANDU reactors at the Darlington Nuclear Generating Station.

This project was planned over a seven-year period before the first phase began. The planning period was structured around a rigorous phase gate process² that clearly laid out requirements for developing and supporting the basis of the project’s estimate, which was jointly developed by OPG and its key vendor partners. Modus and Burns were an essential part of the phase gate

In 2018, an audit of the project by the Office of the Auditor General of Ontario praised OPG for establishing “a clear accountability structure” through which “Project timelines and costs are being managed, monitored and publicly reported on a regular basis and corrective actions are being taken when issues arise.”

process. As OPG management developed the cost estimates and project schedule, it leveraged support from a multi-layered assurance and oversight process.

All of the data generated from this upfront and ongoing oversight was synthesized for senior management and the board through regular, detailed reports, oral presentations, and key metrics so that decisions could be made in a timely manner based on high-quality information.

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In June 2020, the first unit, Unit 2, was returned to service. The work involved 24 million work hours and finished just as the Canada and the rest of the world were in lockdown from COVID-19. Despite the challenges, Darlington finished on budget and virtually on time.

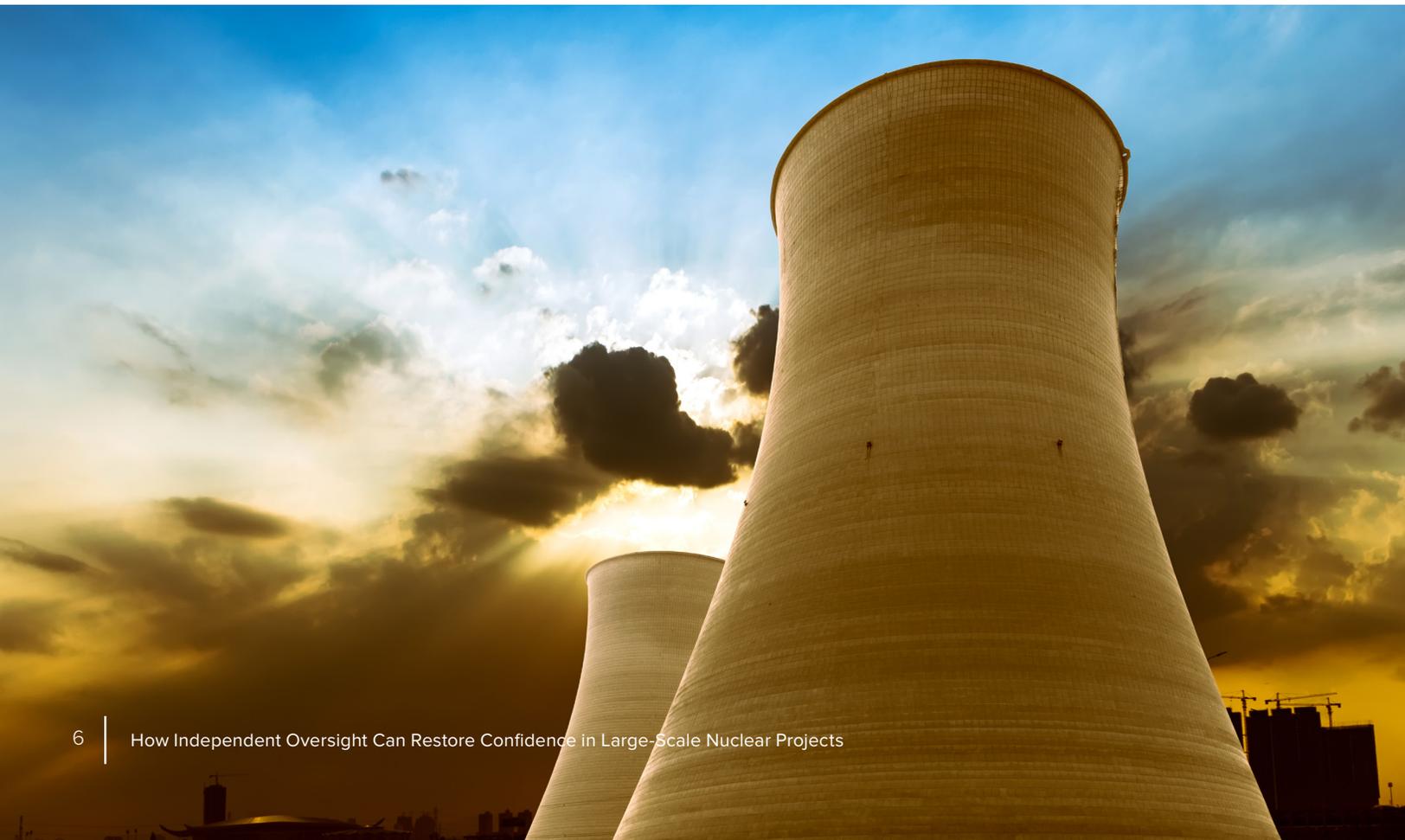
Nuclear Projects: Getting Past Poor Cost and Schedule Performance

Large nuclear capital projects and megaprojects are inherently risky ventures that often experience cost overruns and schedule delays. In particular, the US nuclear industry has been marred by poor cost and schedule performance in building the current fleet. This has created a seemingly indelible lack of confidence in the industry's ability to deliver on its promises.

There is an urgent need for the nuclear industry to reduce cost and schedule

uncertainty and build confidence from all stakeholders. A recent US Department of Energy report titled Restoring America's Competitive Nuclear Energy Advantage focused on the importance of nuclear power as a matter of national security and establishes preserving and expanding the entire US nuclear enterprise as a priority. The future of nuclear power in the United States will likely depend on delivering on cost and schedule expectations for new technologies such as Small Modular Reactors (SMRs) and Advanced Reactors (ARs).

The stakes are high. So, what can the industry learn from OPG's experience to move beyond past performance issues and meet the current moment?



Why Are Nuclear Projects Plagued by Overruns and Delays?

Many causes of megaproject overruns and delays are the same regardless of the project industry. Significant root causes include:

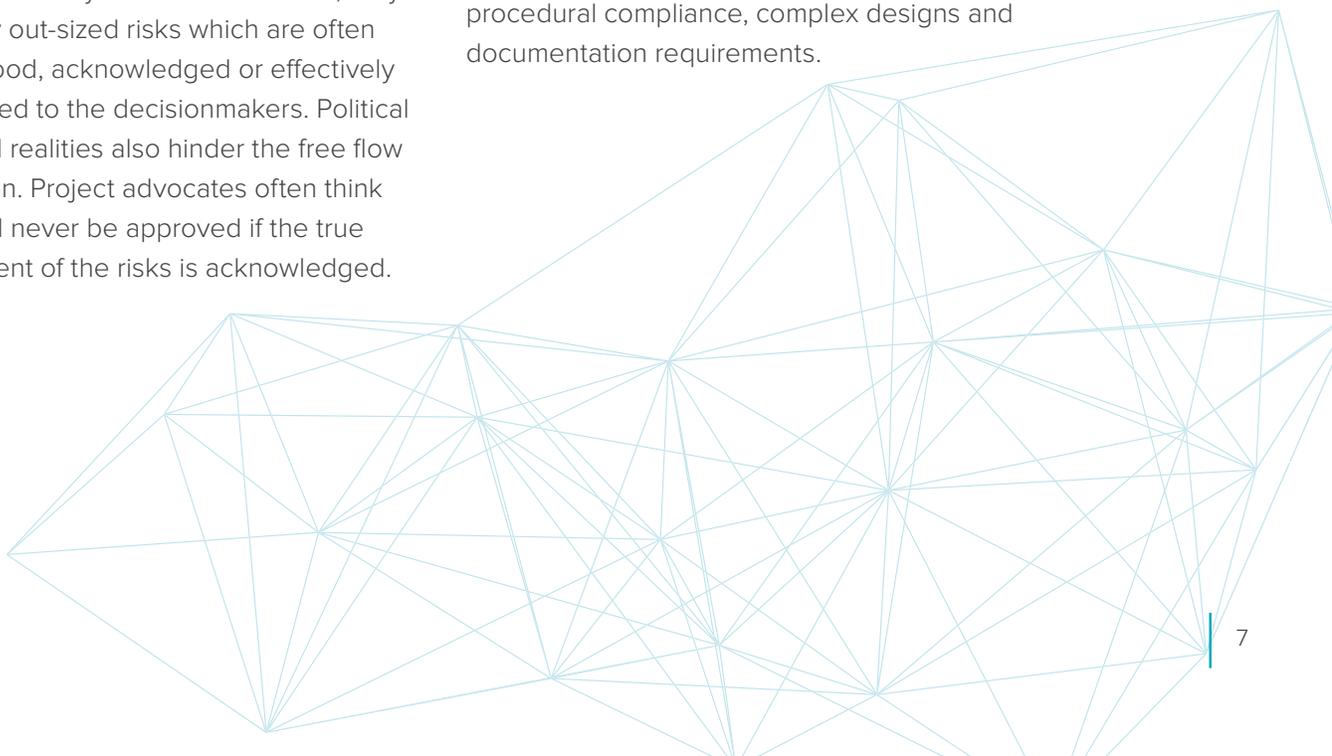
- » Incomplete design at the start, resulting in weak estimates and premature construction.
- » Inadequate time, funding, or leadership commitment to rigorously plan megaprojects.
- » Owners and contractors that succumb to “optimism bias” that squelches bad news.
- » Decisions that are clouded by organizational and personal self-interest.
- » Failure to fully integrate all project organizations and work activities.
- » Poorly constructed project controls tools and inadequate analyses of project status data, resulting in late problem identification and poor communication of problems.

Because megaprojects by their very nature are characterized by their size and scale, they always carry out-sized risks which are often not understood, acknowledged or effectively communicated to the decisionmakers. Political and financial realities also hinder the free flow of information. Project advocates often think a project will never be approved if the true financial extent of the risks is acknowledged.

For example, at its inception, a \$5 billion first-of-a-kind project may reasonably carry a probabilistic risk of an 80-100% cost increase. Simply acknowledging that fact at the outset might immediately make the project inviable. But failing to do so may mean that, years later when the costs emerge, the public can feel it was sold a bill of goods.

Additionally, front-end planning often lacks the needed detail to produce accurate cost and schedule estimates. This is often because of inadequate early project funding for planning. These funds are often not justified because the planning occurs prior to full sanctioning of the project. As a result, the potential cost and schedule outcomes have a large range of variability. Project management may be motivated or pressured to agree that the project costs will not exceed a previously approved budget number before the baseline budget and schedule bases are fully known and understood.

The nuclear industry must deal with additional challenges and risks that are unique to nuclear projects. Particularly if a management team has limited relevant nuclear experience, these can be difficult to assess or quantify. Such risks include the length of nuclear projects, regulatory changes, strict procedural compliance, complex designs and documentation requirements.





Independent Oversight Guards Against Adverse Project Outcomes

Corporate boards and senior executives have fiduciary responsibility to provide oversight and financial accountability when undertaking a large capital project. However, many boards lack the internal expertise necessary to provide oversight or to make timely, critical decisions related to these complex projects.

With independent oversight, experts provide reliable and objective observations and opinions regarding project risks and mitigation recommendations. Seasoned professionals who have demonstrated expertise in nuclear project management and possess the skills to effectively interface with stakeholder executives and project team members establish a

foundation of trust, credibility, and respect from the project and executive team members. They then provide independent examination of cost, schedule and risk development.

The main benefits of independent oversight for megaprojects include:

Utilizing lessons learned from experienced personnel. All megaprojects require numerous highly talented, experienced personnel, who are usually difficult to find. This is particularly true with nuclear projects. A strong and open-minded leadership team that is eager to proactively consider current best practices and historical lessons is critical. Independent oversight gives senior management a valuable verification that best practices and lessons learned are being applied.

Identifying and dealing with issues early. Independent oversight provides a mechanism for accountability, helping to bring problems to the surface in a timely manner so they are easier to address.

Having an independent verification of the causes and effects of poor productivity can often lead to simple, cost-effective mitigation strategies.

Contextualizing performance and risk. In addition to identifying issues, independent project oversight can help provide context for identified or realized risks. Prudent risk management includes planning for worst-case scenarios. But, as noted earlier, identifying the worst possible outcomes has the potential to scare stakeholders away from the project altogether. Independent experts can provide critical examination and context for the risks presented by these projects at the outset.

Enabling timely access to information. Independent oversight provides the project's management with unfettered information. Accurate, timely information allows management to make solid decisions that are rooted in reality and keep the long-term health of the project in mind.

And when things go wrong, as they inevitably will, the timing of mitigation options can be the most important factor for saving money in the long run. Independent oversight teams can contribute to critical delivery risk identification and mitigation actions, which may have been missed by project teams.

WHAT IS EFFECTIVE INDEPENDENT OVERSIGHT?

Many project owners large and small have implemented “project oversight” on their projects—and yet still experience significant challenges leading to significant cost and schedule overruns. Not all oversight is equal, and in fact, some oversight, if done poorly, can hinder or distract the project team or even hide real project risks.

Companies have sometimes employed something akin to “oversight light,” a single person or small oversight team whose sole purpose is to show the board, a regulatory or governmental body that there is oversight in place, thereby establishing the project's prudence.

The problem with this model, however, is that the oversight reports may be limited, only

highlighting obvious issues or promoting only good news. This type of oversight is also only given limited access to project documents and project participants, making it difficult to highlight true project risks that may be overlooked by the project team.

The ideal independent oversight team is one that has proven, successful experience working together in performing project oversight. Effective oversight should be a specialized service where a cadre of individuals with demonstrated project oversight experience apply their knowledge and advice to the project team and stakeholder executives. Independent oversight experts must have the proper demeanor and experience to develop mutual trust with project personnel, who in turn become comfortable soliciting the independent input on project challenges and issues.

Independent oversight should not be disruptive or adversarial. The point of independent oversight is to create a cooperative “safe” space with the free exchange of ideas and advice. It should not be used to rate or grade the project management team. Nor should independent oversight be used as a decision-making entity that interferes with the authority of the designated project management team.

To ensure independence from the project team, the independent oversight team should report directly to the corporate executive or board of directors. This is important to directly connect the oversight team to the fiduciary obligation of the executive or board. This relationship also enables the oversight team to have needed access to project information and resources.

OPG's Darlington Refurbishment Assurance and Oversight Provides a Model for Large Nuclear Projects

As noted, OPG's history with prior megaprojects, as well as its role as a publicly owned utility, created the need and context for developing a robust assurance and oversight model. OPG engaged a team of subject matter oversight experts including Modus and Burns, focused on specific areas in an efficient and sufficient manner, contributing to comprehensive oversight.

Following are the critical aspects of OPG's assurance plan:

- » OPG structured its oversight and assurance entities and activities to provide visibility for its multiple stakeholders.
- » OPG's oversight and assurance activities provide all stakeholders with unfettered information, enabling solid decision-making and preventing problems from growing beneath the surface.
- » OPG meshed internal and external assurance activities with processes for contractor accountability and contract performance.
- » OPG established how lessons learned from oversight and assurance activities will benefit the remaining phases of the Darlington Refurbishment project.
- » OPG's independent oversight team, project management, and executives worked proactively and openly to achieve a constructive relationship that allowed candid dialog, facilitating balanced and non-intrusive oversight activity.

OPG ensured that the project oversight function was in place during the planning phase so that the right policies and practices would guide the project; baseline schedules and budgets were properly developed; and major contracts were established.

On the Darlington Refurbishment Project, the external oversight teams would confirm the factual basis of their opinion with the project management team, and the project oversight team would then provide an objective, candid report of project status and concerns to senior executives or the board, which would accompany a brief presentation in a board session, where questions and details could be discussed.

Once the execution phase ramped up, the project oversight team focused on a variety of project activities as depicted in the table on the following page.

In addition to its oversight teams, OPG had a very robust internal audit function as well as an internal project assurance team. Balancing the demands of these functions was necessary to reduce the potential burden from "audit fatigue" that many projects of this type encounter.

As a result, OPG determined that it was best to consolidate and leverage the experience of the oversight team and make their findings and recommendations available to the internal auditors, thereby avoiding conflicting and duplicate observations. Additionally, by removing "oversight" from auditing space, it also removed the adversarial nature of reviews of the project management team.

Unit 2 was successfully completed and was restarted in June 2020. Following on Unit 2's success, OPG is fully committed to following its process to continuously improve. The lessons learned from Unit 2 were synthesized to improve the budget and schedule for the next unit. Unit 3 began its refurbishment in September 2020.

OPG Independent Oversight Focus During Key Project Phases

KEY AREA	PLANNING PHASE 2013-2015	EXECUTION PHASE 2016-2020
Communication and Stakeholder Plan	Monitor reporting and communication	Monitor reporting and communication
Scope Definition	Design Maturation and Scope Definition	Monitor scope growth
Regulatory Strategy	Independent expert testimony for project approval	Ensure Regulatory Documentation for Major Decisions Independent expert testimony
Business Objectives	Development of Class 5, 4 and 3 Budgets (including contingency) Development of Level 1, 2 and 3 Schedules Engineering and Procurement Status Project Reporting and Metrics	Monitor Schedule, Cost Performance and Ensure Functionality of Project Controls Monitor Risk Management and Contingency Allocation
Organizational Design	Staffing Succession planning	Project team mentoring and suggest opportunities for performance improvements and optimization
Managed Systems	Development of Project and Corporate Governance Quality program Project Controls Systems and Earned Value Management Plan, Risk Management Plan	Governance compliance, lessons learned integration and continuous improvement
Development of Contracting Strategy/Project Delivery	Make/Buy decisions RFP and Bid Review Process Contracts with all major contractors and suppliers	Monitor Contract Management Change Order Review Claims Avoidance and Mitigation Commissioning Plan Contract Closeout Dispute Resolutions

Conclusion

Nuclear project performance suggests that commercial quality oversight is lacking. Billions of dollars and societal benefits are at risk. New nuclear project cost overruns and delays create a presumptive bias, which deters developers and investors from committing to an important piece of our future generating diversity.

Unless experienced insights and historical lessons are woven into project planning, outcomes do not change. As a result, the massive societal benefits nuclear has provided and can provide will be squandered if an important project is not successfully completed or is never authorized because of low confidence in cost and schedule projections.

The idea of independent oversight on a high-profile project can be intimidating. However, an oversight team should be thought of as unbiased participants who are there for the purpose of defending one thing – the project itself.

Effective, independent oversight is a candid, collaborative and constructive advisory contribution to project success and support for executives' oversight responsibility. By helping to identify and deal with the inevitable risks and issues early, independent oversight ultimately helps to protect the company's reputation, which is something that any company managing a megaproject should embrace.

¹ Many of the consultants for the independent assessment are current members of the Modus team that later provided oversight of the Darlington Refurbishment, discussed below.

² Defined points in the project's development when management reviews the project's readiness for moving forward and grants approval to proceed to the next phase.

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