BEFORE THE

GEORGIA PUBLIC SERVICE COMMISSION

IN THE MATTER OF: GEORGIA POWER COMPANY'S TWENTY-THIRD SEMI-ANNUAL VOGTLE CONSTRUCTION MONITORING ("VCM") REPORT	**DOCKET NO. 29849**

PUBLIC DISCLOSURE

DIRECT TESTIMONY

OF

DONALD N. GRACE P.E.

ON BEHALF OF THE

GEORGIA PUBLIC SERVICE COMMISSION

PUBLIC INTEREST ADVOCACY STAFF

NOVEMBER 24, 2020

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INTRODUCTION

Q. PLEASE STATE YOUR NAME, POSITION, AND BUSINESS ADDRESS.

A. My name is Don Grace, and I am the Vice President of Engineering for the Vogtle Monitoring Group ("VMG"). I am one of the key personnel engaged by the Georgia Public Service Commission ("GPSC") Public Interest Advocacy ("PIA") Staff since April 2018 to independently evaluate Southern Nuclear Company's ("SNC") ability to successfully manage completion of the Vogtle 3 & 4 Nuclear Project ("Project"). I have over 50 years of hands on experience in all phases of the electrical generating plant life cycle (i.e., Licensing/Permitting, Engineering, Construction, Start-up Testing and Commissioning, Operations & Maintenance, and Decommissioning) for nuclear and fossil fuel plants. I have a B.S in Marine Engineering from the U.S. Naval Academy (having graduated with distinction), an MBA from Harvard Graduate School of Business (having been awarded a fellowship) and have been a registered Professional Engineer in the field of Power Generation for over 45 years. A copy of my curriculum vitae is attached as Exhibit A.

Q. PLEASE PROVIDE ADDITIONAL INFORMATION REGARDING THE OTHER KEY VMG TEAM MEMBERS, AND THE ROLES THEY PLAY IN SUPPORTING YOUR TESTIMONY.

A. There are two additional key members of VMG that support my testimony. Mr. Dinos Nicolaou has an MBA degree and is a highly experienced Project Controls professional with

over 45 years in developing and maintaining Earned Value Management System ("EVMS") based Integrated Project Schedules ("IPS"). He has performed dozens of independent cost and schedule reviews of other major projects. Mr. Ray Bryant is a highly experienced construction management professional with over 40 years in construction management with a focus on nuclear electrical and security oversight. Mr. Bryant functions as a full-time on-site construction monitor at the Project site. Other subject matter experts are engaged on an as needed basis.

Q. WHAT ARE YOUR CRITERIA FOR SUCCESSFUL MANAGEMENT OF THE COMPLETION OF VOGTLE 3 AND 4?

A. While costs both before and since the 17th VCM Order still need to be reviewed for prudency, successful management also includes SNC's ability to safely complete the Project in a quality manner while meeting the Georgia Public Service Commission's Regulatory Approved Commercial Operation Dates ("CODs") of November 2021 for Unit 3 ("U-3") and November 2022 for Unit 4 ("U-4"), while also staying within or below SNC's Total Project Cost ("TPC") forecast of $17.1B.[1] Additionally, it involves constructing a plant with high quality allowing full operations with minimal maintenance and repairs moving forward.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE OTHER REGULATORY AGENCIES, AND SPECIFICALLY BEFORE THE GPSC?

[1] The TPC represents only capital cost and does not include financing cost. This TPC of $17.1B represents all the equity owners' capital cost (i.e., represents 100% equity ownership, and not just Georgia Power Company's 45.7% ownership, and as noted excludes all financing related costs). Also, if completed at this cost, then Georgia Power Company's cost share should be consistent with the Company's VCM 17 Regulatory Approved cost of $7.3B. Finally, $7.3B does not equal 45.7% of $17.1B, the primary reason being that there are some costs that are borne solely by Georgia Power Company.

A. I have previously provided testimony to the GPSC in Docket 29849 for the Vogtle Unit 3 and Unit 4 Project in December 2018, December 2019, and June 2020. Also, I have testified before the Mississippi Public Service Commission, the Arizona Corporation Commission, and the Arkansas Attorney General's Office. I have also testified before the Nuclear Regulatory Commission as the Chairman of the Boiling Water Reactor Owners' Group.

Q. WILL YOUR TESTIMONY INCLUDE THE IMPACTS OF COVID 19?

A. We include this only to the extent of what Georgia Power Company ("Company") has reported in this regard. More specifically, with the Company's filing of direct testimony on October 22, 2020, they noted that due to the combined impacts of poor electrical craft productivity, poor subcontractor productivity, and COVID-19 that they were starting to monitor themselves against their latest site working schedule. Per that schedule, they slipped the U-3 dates for Hot Functional Test ("HFT") (to January 2021), Fuel load ("FL") (to April 2021), and Commercial Operation Date ('COD") (to August/ September 2021), and instead of identifying these dates as being per either an "aggressive schedule" or "regulatory approved schedule" they are now identifying these dates as the "Current Site Expectation". SNC, therefore, continues to plan and work to scheduled CODs ahead of the Regulatory Approved November 2021/2022 CODs, implying at least in schedule space that they believe the impact of COVID-19 on the U-3 Regulatory Approved COD to be minimal.

Although the above is true for the impacts of COVID-19 on the schedule, with respect to cost in this same October 22nd filing the Company has estimated an additional $ 150 M to $ 250 M of cost due to COVID-19.[2]

PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY?

A. The purpose of my testimony is to utilize what is known regarding the Project's performance to date, and what is not yet known in terms of future indeterminate risks, to develop forecast ranges of the Project CODs and TPC.

Q. PLEASE PROVIDE YOUR SUMMARY CONCLUSIONS.

A. VMG concludes that the Project is still at high risk of not meeting the November 2021/ 2022 Regulatory Approved CODs, and will exhaust whatever schedule cost contingency it had hoped to use to offset an over-run of the Regulatory Approved TPC. VMG is of the opinion that the TPC of $ 17.1 B will be exceeded by $ 1.80 B to $ 2.20 B. With respect to the cost over-run, the final amount will be dependent primarily on the actual CODs and actual construction labor productivity. It appears that based on data provided by the Company, without deeper analysis, that COVID related over runs could be between $150 M to $250 M. Further, VMG continues to be of the opinion that a primary root cause of poor productivity

[2] These costs along with other cost in this testimony represent 100 percent ownership share and not Georgia Power's 45.7 percent share.

and production is due to SNC's strategy of accelerating testing prior to completion of civil work and a greater degree of the bulk construction commodities which then leads to inefficient and costly execution of construction. In addition, and was stated in VMG's prior testimony, VMG is of the opinion that SNC's decision to accelerate testing was most likely due to the realization that an optimal construction schedule, together with the required durations of testing activities, would not allow SNC to meet the Regulatory Required CODs. To the contrary, SNC erroneously concluded that deviation from normal industry practice would both (a) shorten the schedule while at the same time (b) allow for completion of the Project within the estimated TPC. Finally, and in continuation of this approach, it appears that SNC is spending whatever it takes to finish the Project as soon as possible, and that further increases of the TPC will continue to occur due to this approach.

VMG ANALYSIS OF THE PROJECT SCHEDULE

Q. PLEASE BRIEFLY SUMMARIZE VMG'S APPROACH TO ANALYZING THE PROJECT SCHEDULE.

A. Our analysis of the Project schedule first focuses on U-3 and the critical areas which are continuing to have a negative impact on the overall performance compared to the schedule. The first of these is poor construction productivity (primarily Electrical), and the second (which follows completion of construction work) is an inability to turn over systems from Construction to the ITP Group in a timely manner. We then show the numerous changes in the forecast of the remaining U-3 major schedule milestone dates, and the major risks between now and the U-3 COD. Discussion of the U-4 schedule then follows by

highlighting the major risks and opportunities between now and the U-4 COD. Based on these risks and opportunities, we conclude our assessment of the U-4 COD by continuing to assume that the U-4 COD will follow the U-3 COD by roughly 12 months.

Q. PLEASE DESCRIBE WHAT PERFORMANCE MEASURES THE COMPANY HAS IMPLEMENTED TO TRACK PROGRESS VERSUS THE U-3 REGULATORY APPROVED NOVEMBER 2021 COD SCHEDULE.

A. Historically, SNC has compared its reporting of progress versus what has been termed the "aggressive schedule". More recently it developed a performance metric that can be used in helping to trend and assess progress versus the U-3 November 2021 "Benchmark" Schedule. The primary activity to monitor is "Scheduled Electrical Work" (note: the name of this metric was recently changed to "Electrical Discipline"). Most recently (at the November 17th Monthly Project Review Meeting) the Company provided additional metrics with respect to assessing performance versus the November Benchmark Schedule. VMG has utilized all of these metrics in its assessment of the U-3 schedule that now follows.

Q. PLEASE DESCRIBE THE METRIC "ELECTRICAL DISCIPLINE", WHY IT IS IMPORTANT, AND SNC'S PERFORMANCE AGAINST THIS METRIC.

A. SNC's completion of the "Electrical Discipline" commodities continue to be a critical path limiting activity in maintaining both the construction schedule and the overall Project schedule. SNC developed the planned "Electrical Discipline" man-hours that had to be complete by the start of HFT, and by the start of FL, to support the U-3 November 2021

Benchmark Schedule. Electrical Discipline work is specifically associated with plant systems that are required for plant operation. The vast majority of this work must be completed by the start of HFT (to support pre-operational individual system tests, and integrated multiple system tests) and the balance of this work must be completed by the start of FL (to support Start-up Testing). Apart from this work, the "unscheduled electrical" is then the balance of electrical work and it does not need to be done prior to FL. Unscheduled electrical work could include items such as outlets, office lighting, etc… Further, the Georgia Power Company Nuclear Development Group ("GPC-ND") independently provides a report of the completed (i.e., "earned") Electrical Discipline work versus the planned Electrical Discipline work, with the difference representing the "Cumulative Backlog". With this approach, a positive Cumulative Backlog would be representative of being ahead of what is required to support meeting the U-3 November 2021 Benchmark COD, and a negative Cumulative Backlog would be representative of being behind the schedule required to support meeting the November 2021 Benchmark COD.

Q. PLEASE PROVIDE A SUMMARY OF HOW THE CUMULATIVE BACKLOG OF SCHEDULED ELECTRICAL WORK HAS BEEN TRACKING AND WHAT THIS INDICATES?

A. Until recently, the Scheduled Electrical Cumulative Backlog had been tracking with a relatively steady, positive variance of roughly +24K to +28K earned hours. As noted, this backlog represents being behind or ahead (as would be this case) of what is required to support meeting the U-3 November 2021 COD. At the average planned weekly rate of roughly 14K earned hours, this then reflects being roughly 2 weeks ahead of the U-3

November Benchmark schedule. However, during the week ending October 4th of this year, a major negative adjustment of 54K earned manhours was made due to over-reporting of earned hours. This resulted in an increase in the planned scheduled electrical hours going forward. This took the Cumulative Backlog to a negative of roughly (32)K man-hours. At the current planned rate of earning hours this would indicate being roughly 2.3 weeks behind the U-3 November Benchmark Schedule.

Q. CAN YOU DESCRIBE WHY SUCH A CRITICAL MEASURE CAN BE SUBJECT TO SUCH A LARGE CORRECTION AT THIS LATE STAGE OF THE PROJECT?

A. Although VMG cannot be certain as to the various reasons which could help to explain why, based on our observations to date we can offer potential reasons. More specifically, VMG believes that the extensive use of "partial releases for test" ("PRTs"; in many cases to support a nearer term schedule milestone) can lead to pulling and terminating single cables versus doing bulk pulls of all cables. This has resulted in multiple cable runs along the same cable routes which requires more man-hours. This has also necessitated engineering's development of "push/ pull" criteria for the additional cables so as to not damage the original cables; yet, we have seen Condition Reports which appear to indicate that the original cables were in fact damaged. In addition, cables are routed through wall penetrations which eventually must be sealed. Also, situations have occurred where a sealed penetration must be re-opened to permit routing of missed cables. As these examples illustrate, there is a great potential for "re-work" that most likely has not been included in the Electrical Discipline man-hour

budget, and when recognized and included in the remaining Electrical Discipline man-hours, they would increase those man-hours.

Q. WHAT DOES VMG CONCLUDE FROM ITS REVIEW OF THE ELECTRIC DISCIPLINE METRIC?

A. As of October 4, 2020, it appears that the "Scheduled Electrical" work was roughly 2.3 weeks behind the November Benchmark Plan, and that this may then put the U-3 November COD in jeopardy of delay by roughly 2.3 weeks. This is simply a "bulk measure" and does not account for the detailed planning of what is needed following this work (such as sealing of electrical penetrations) and whether this work is being done to simply provide for completion of the required bulk quantities, or whether it is being (or even can be) accomplished in a priority order that supports the overall U-3 critical path. In summary, being only 2.3 weeks behind could be an "underestimate" of how much HFT and FL might be slipping, which would then negatively impact the U-3 COD. An update regarding this metric was provided in the November 17th Monthly Project Review meeting and is included in the next section.

Q. ARE THERE ADDITIONAL METRICS THAT THE COMPANY HAS PROVIDED IN MEASURING ITSELF AGAINST THE U-3 NOVEMBER BENCHMARK SCHEDULE.

A. Just recently, at the November 17th, 2020 Monthly Project Review meeting, SNC provided additional metrics that have been developed in the same manner that has been described for the Electrical Discipline. These measures were developed for each of the Bechtel Craft and

for the Sub-contractors. All of the measures that currently indicate a negative Cumulative Backlog are displayed in Table S-1.

Table S-1; Key Metrics for Measuring Progress Against November Benchmark Schedule

Construction Craft and Subcontractor Performance vs U-3 November Benchmark			
Organization	Cumulative Backlog (Man-Hrs)	4 Week Average Performance (Man-Hrs/week)	Calculated Weeks Ahead (+) / Behind (-)
Bechtel Craft			
Electrical	[redacted]	[redacted]	- 1.3 Weeks
Instrumentation	[redacted]	[redacted]	- 9.7 Weeks
Subcontractors			
API Insulation	[redacted]	[redacted]	- 8.6 Weeks
FL FE Moran NI Fire Protection	[redacted]	[redacted]	- 14.8 Weeks
All Others	[redacted]	[redacted]	- 2.4 Weeks
NOTE: SNC commented that "Instrumentation is behind the plan but is under review for scope evaluation."			

Q. AND WHAT DOES VMG CONCLUDE BASED ON THE ABOVE DATA?

A. VMG concludes that the above metrics provide improved measures as to where the Project stands with respect to meeting the U-3 November Benchmark Schedule, and that these metrics (when considered together with our further review) support our position that it is highly unlikely that U-3 will meet a November 2021 COD.

Q. FOLLOWING COMPLETION OF CONSTRUCTION, WHAT ARE THE MAJOR ACTIVITIES AND WHAT METRIC DO YOU HAVE TO MEASURE PROGRESS IN THIS SUBJECT AREA?

A. As has been noted in our prior testimony, following completion of construction the next major activity is to turn the partial systems (which collectively constitute a lesser number of total systems) over to the ITP group for testing. We have not received a status of actual turnovers vs planned turned overs which would support the U-3 November Benchmark Schedule. However, as has been reported in our prior testimonies, we have continued to receive a status of actual turnovers versus planned turnovers in the several Aggressive Schedule Baselines that have occurred since the first Aggressive Schedule Baseline in June 2018. Further, this data is displayed in Table S-2.

Table S-2; U-3 Planned and Actual Turnovers
(Versus the Changing Aggressive Baseline Schedules)

Planned Per June 2018 Schedule Baseline	Planned Per April 2019 Schedule Baseline	Planned Per July 2020 Schedule Baseline	Actual T/O's by Oct 31, 2020
105 of 105 (100%) planned for T/O by 10/31/2020	114 of 159 (100%) planned for T/O by 10/31/2020	110 of 159 (69%) planned for T/O by 10/31/2020	42 of 159 (i.e., 26%)

Q. WHY DID THE NUMBER OF TURNOVERS INCREASE FROM 110 TO 150 IN THE JULY 2020 SCHEDULE BASELINE?

A. When work that comprise a partial system cannot be completed as planned, the work scope is sub-divided to both (a) facilitate the testing of certain work while at the same time (b) allow for the deferral of the remaining originally planned work.

Q. WHY IS THIS AN IMPORTANT METRIC, AND HOW WOULD YOU RATE THIS PERFORMANCE?

A. HFT is the next critical Project schedule milestone, and in support of HFT there are many partial systems (then comprising complete systems) that must be turned over to ITP in order to support the pre-operational system tests and pre-operational integrated multiple systems tests. Only 26% of the 159 partial systems had been turned over by October 31, 2020, which simply does not appear to support the U-3 November Benchmark Schedule.

Q. PLEASE PROVIDE A MORE COMPLETE OVERVIEW OF THE MAJOR ACTIVITIES FOLLOWING THE TURNOVER OF SYSTEMS/ PARTIAL SYSTEMS TO ITP THAT THEN LEAD TO THE U-3 COD?

A. These subsequent major activities can be characterized as follows:

1. Following turnover of systems/ partial systems to ITP, integrated total system tests and integrated tests of multiple systems (termed "Pre-Operational Tests") are performed by ITP. These are completed primarily during the Hot Functional Testing (HFT) phase.

2. In parallel, all Engineering Documentation (to document the actual "as-built" plant) is compiled; this is currently a major task (e.g., includes ASME III documentation) much of which cannot be completed until the performance of "Hot Functional Testing".

3. In parallel with the construction and test activities, other NRC requirements that must be addressed prior to Fuel Load (FL) are completed, such as implementation of many

programs/ plans (such as the "Security Plan"), staffing with Licensed Operators, etc. SNC assumes this work will not negatively impact the Regulatory Approved U-3 COD.

3. Inspections Tests, Analyses and Acceptance Criteria (ITAAC) completion notices (ICN's) are prepared and submitted to the NRC. Following submittal of all ICN's, the Company prepares a submittal to the NRC that all ICN's have been submitted, at which point the NRC reviews and following their acceptance issues a 103(g) letter (which then allows SNC to proceed with the next major milestone activity, which is FL). Finally, satisfactory completion of many of the previously described "pre-operational tests" are an absolute requirement that must be met to support NRC issuance of the 103(g) letter.

4. SNC can then start to load fuel and following fuel load it will take the reactor critical for the first time and perform "Start-up Testing". This is the first time the "total plant" (i.e., both the reactor plant and secondary steam / steam turbine electrical generator systems) are exercised at power. This "Start-up Testing" proceeds at increasing power levels up to and including 100% reactor power for a given period of time.

5. Following completion of "Start-up Testing" (which normally includes operating reliably at 100% power for a pre-determined period of time and completing associated administrative requirements, etc), U-3 will be declared to have achieved "Commercial Operations".

Q. ARE THERE ANY ADDITIONAL METRICS VMG HAS LOOKED AT IN ASSESSING THE ABILITY OF SNC TO ACHIEVE U-3 NOVEMBER BENCHMARK SCHEDULE?

A. Yes. The major remaining schedule milestones have been slipping at an increasing rate as we get nearer to the U-3 COD. This data is provided in Table S-3.

Table S-3; Announced Changes to Start of U-3 HFT & FL Schedule Milestones

Announced Changes to Hot Functional Test Start Date and Fuel Load Start Date				
	Hot Functional Test (HFT)		Fuel Load (FL)	
Report & Date	HFT Start Date	Months Slip from VCM 18	Start FL Date	Months Slip from VCM 18
Reporting Per Aggressive Schedule				
VCM 18/ Feb 28, 2018	March 2020		Oct 2020	
VCM 19/ Aug 31, 2018	April 2020	1	Nov 2020	1
VCM 20/21/ Aug 31, 2019	June 2020	3	Nov 2020	1
VCM 22/ Feb 29, 2020	Aug 2020	5	Nov 2020	1
VCM 23/Aug 31, 2020	Oct 2020	7	Dec 2020	2
Updated "more realistic" Schedule				
Company's Oct 22, 2020 Testimony; Current Site Expectation	Jan 2021	10	April 2021	6
Observations Regarding Table S-3				
1. In 2-1/2 years (i.e., 30 months between VCM 18 and VCM 23) the "Aggressive Schedule" Start of the HFT Milestone slipped 7 months. Then, less than 2 months later (i.e., on October 22, 2020), the "Current Site Expectation" forecast for this date was announced to be January 2021 (a slip of 3 months in less than 2 months).				
2. A similar observation can be made for the start of Fuel Load date; i.e., in 30 months the Aggressive Schedule date slipped 2 months; and then less than 2 months later the "Current Site Expectation" forecast of this date has slipped an additional 4 months (i.e., from December 2020 to April 2021).				
3. Following Fuel Load, the SNC's "Current Site Expectation" for U-3 COD is "August/ September 2021"; i.e., several months prior to November 2021.				

Q. AND WHAT DO YOU CONCLUDE FROM THE TABLE ABOVE?

A. VMG concludes that although the "Current Site Expectation" COD of August/ September 2021 is more realistic than any prior Aggressive Schedule COD, it is still an "Aggressive

Schedule" COD and there is a high likelihood it will not be met. Also, as the Project nears completion there is less opportunity to implement significant mitigating measures.

Q. PLEASE HIGHLIGHT THE MAJOR U-3 SCHEDULE RISKS?

A. With respect to Major Schedule Milestones, the ability to meet the November Benchmark U-3 COD is first dependent on the ability to achieve the next major milestone of completing HFT and then FL. However, as has been noted, HFT is challenged by several factors. First, the various Bechtel Craft and Subcontractors have been unable to complete work in timely manner resulting in a negative Cumulative Backlog to the U-3 November Benchmark. A specific challenge is "sealing of penetrations" being performed by a separate sub-contractor, and much of that work cannot start until certain electrical work is complete. Another challenge is the completion of sub-contracted insulation work. The "stacking of multiple craft" is a major issue. It occurs during the process of attempting to coordinate the execution of these various contractors and craft, on a tight timetable, all within the physically tight and challenging U-3 containment and the Auxiliary and Annex Buildings. This latter challenge will at some point lessen as the remaining amount of work will lessen. However, with partial system turnovers (which in itself is highly challenged), followed by concurrent construction and testing, various parties (be it construction, ITP, or Operations) will have jurisdictional control of various areas. These issues, together with having to switch large portions of the construction site from temporary power to permanent power, will cause additional issues that will further complicate the planning and execution of work.

Concurrent with the performance of HFT and the completion of the many and various systems focused, and over-all nuclear plant/ primary system focused, pre-operational tests, there is a significant amount of documentation that must be completed including submittal to the NRC, and their review and acceptance of the many ITAAC completion notices (ICN's). Closure of this issue will then allow for the NRC to issue their 103(g) letter which will allow for the start of Fuel Load. As shown previously in this testimony, there has been (and continues to be) an inability to achieve complete system turnovers, and this then reflects the difficulty in completing this documentation. To further illustrate, the July 2020 Schedule Baseline includes a planned number of partial system turnovers for October 2020 of 57, yet as of October 18th none of the 57 had been turned over.

At this point, with the loading of the fuel and taking the reactor critical, this is the first time that the nuclear plant (primary systems) and steam plant (secondary systems) will be operated at various power levels as an integral whole. The overall design of the secondary systems is as of yet unproven (i.e., it is different than the Chinese AP1000s), and there could be challenges along the way in demonstrating its operability. A recent example of this – which involved testing activities totally separate from/ within the envelope of the secondary side of the plant – was the turbine jacking oil pump system (note: this is used to lift the turbine shaft off of its bearings to facilitate turning (i.e., jacking) of the turbine which then prevents "bowing of the turbine shaft"). It was during that testing that the system design was observed to be very different from a more traditional design, and the associated problems led to significant delays of the Turbine on Gear schedule milestone, and the complete replacement of all Jacking Oil Pumps with a new design.

VMG's experience has shown that a typical time period from the start of FL to COD is more on the order of 6 months, yet the U-3 November 2021 Benchmark "Current Expectation" schedule only allows for 4 to 5 months from April 2021 (for FL) to August/ September 2021 (for COD). In light of our analyses of U-3 performance to date versus the November Benchmark COD, and these risks going forward, VMG therefore concludes that it is highly unlikely that U-3 will achieve COD by November of next year.

Q. GIVEN VMG'S CONCLUSION THAT IT IS HIGHLY UNIKELY FOR U-3 TO ACHIEVE THE NOVEMBER BENCHMARK COD, WHAT CAN YOU NOW SAY REGARDING THE U-4 SCHEDULE.

A. There have been many significant changes in the approach to planning and executing U-4, plus there have and will be many "Lessons Learned" from U-3 which at this stage VMG believes have not been fully incorporated yet into the U-4 planning. For example, with the onset of COVID-19 and the reduced level of electricians available, many of the available electricians were switched from U-4 to U-3, thus impacting the planned execution of this critical work on Unit 4. With a reduced level of electricians working on U-4, their productivity (as measured by their "Cost Performance Index") initially improved due to their being less congestion/ less challenges in executing the work that was accomplished. One apparent "Lesson Learned" from U-3, is that it appears that in planning the future U-4 electrical work, that more of this work has been planned to be completed prior to launching an aggressive testing effort. Although there are opportunities to gain from the U-3 experience, it should also be noted that there may be increased risks to U-4 above and beyond U-3. Some U-4 Safety Related components (some of which have long procurement lead

times) may have been cannibalized for use on U-3 and the replacement components may not be procured in time to support the final U-4 construction and testing schedule. Also, of critical importance is "lost procurement items" such as materials that have yet to be fully inventoried and either found or re-ordered. VMG has not yet received and analyzed answers to questions it has asked in both of these regards, but this certainly could be a significant risk to the U-4 schedule.

In addition, SNC recently reforecast the lag of the U-4 COD from the U-3 COD to be only 8 to 9 months (versus the previously planned 12 months). Note this data is taken from the October 22, 2020 testimony of Mr. Kuczynski and Abramovich wherein the "Current Aggressive Site Work Plan" forecasts a U-4 COD of June 2022, and the U-3 "Current Site Expectation" COD is August/ September 2021. This lag, therefore, is based on a more realistic (but still aggressive) schedule for U-3, and (based on all experience to date) a highly aggressive (and simply unachievable) U-4 schedule. This serves to illustrate how the lag is more likely to be greater than 8 to 9 months. In addition, an analysis provided in the October 2020 Schedule Review Package Presentation compared the durations between the U-4 major milestones in relation to how they are for U-3. This analysis indicated that the U-4 milestones have less time durations between them than what U-3 has experienced and in what U-3 has forecast in going forward. In addition, this same October 2020 Schedule Review Package indicated that based on the then (September 2020) U-4 percent complete, that this percentage in comparison to the time of U-3 having this same percent complete shows that the U-4 progress had eroded by 3 – 4 months in comparison to U-3. These facts, do not support less than a 12-month lag between the U-3 COD and the U-4 COD. In addition, our U-3 analysis indicates that the U-3 COD has a high likelihood of missing the November 2021 Benchmark date (thus allowing more time for U-4 to achieve its COD while at the same time

keeping a fixed (say 12 month) lag from the U-3 COD. At this time, and for purposes of further analysis, we have assumed that the U-4 COD will follow whatever the U-3 COD turns out to be by 12 months.

VMG Analysis of Total Project Cost (TPC)

Q. PLEASE PROVIDE A BRIEF SUMMARY OF VMG'S APPROACH TO ITS COST ANALYSES?

A. VMG first analyzed the direct construction labor CPIs to validate what VMG believes will be a reasonable range of CPIs for the overall Project. In our prior testimony we analyzed the cost impacts associated with a cumulative CPI of both U-3 and U-4 to be between 1.40 and 1.45. Due, however, to SNC's continued inability to improve performance, we have now analyzed the cost impacts for a CPI range starting at a CPI of 1.45 (VMG's current forecast cumulative CPI at Project completion) to 1.50 (so as to "envelope" what could possibly happen) and used this range as the primary basis for an updated TPC at Project completion.

The second method we utilized was to look at the dollars being spent per percent of Project completion, and then took the cost to date, and added to it the "to go percent to complete" times the "historical dollars spent per percent complete" to arrive at a TPC at Project completion. This second analysis method showed a high degree of correlation with the first method.

Finally, based on a qualitative review of the Project contingency over time and SNC's analysis of remaining risks and their potential impacts, support the TPC estimates from the two methods described above.

Q. PLEASE DESCRIBE WHAT VMG DID IN ANALYZING THE CONSTRUCTION COST PERFORMANCE INDICES (CPIs) AND HOW THOSE WERE USED TO FORECAST A TPC?

A. VMG performed the same analysis that it did in the prior VCM 22 where it forecast a cumulative CPI range for both U-3 and U-4 at Project completion, and then developed the remainder of the Project TPC estimate at completion based on these CPIs. These CPIs are cumulative to date CPIs based on a start date of October 2017 up through defined end dates as is shown in Table C-1. Also, given the cumulative nature and weightings of the past values, the higher weekly CPIs that are being currently experienced result in rather slow increases of the cumulative CPI. In spite of this, given that completion of the remaining work is getting much more difficult (note U-3 CPI for the six months of April 2020 – September 2020 is running at 1.65), they are still causing the cumulative to date CPIs to trend higher.

Although the U-4 CPI has been better than U-3 and is running at 1.36 for this same period, U-4 has longer to go and as U-4 approaches over-lapping construction work with ITP testing work the CPI trend for U-4 will very likely increase. The cumulative to date data is provided in Cost Table C-1 below, and as can be seen, VMG is forecasting final cumulative CPIs for both U-3 and U-4 at roughly 1.45.

COST TABLE C-1; U-3 AND U-4 CUMULATIVE CPI'S

October 2017- Date Shown	U-3 Cumulative CPI	U-4 Cumulative CPI
April 2020	1.37	1.33

May 2020	1.38	1.34
June 2020	1.38	1.34
July 2020	1.40	1.35
Aug 202	1.42	1.36
Sept 2020	1.44	1.36
VMG Forecast at U-3 COD	1.45	
VMG Forecast at U-4 COD		1.45

Q. GIVEN THAT YOU HAVE UPDATED THE RANGE OF CPIs UPON WHICH TO BASE AN UPDATED TPC, WHAT DOES THIS UPDATED FORECAST INDICATE?

A. Table C-2 below provides VMG's results for updating the forecast TPC at Project completion and includes estimates (based on this same methodology) resulting from our testimonies of VCM 20/21, VCM 22, and this most current forecast for VCM 23.

Table C-2; TPC/ Estimate at Completion ($B's) for Various CPIs

Analysis for	CPI=1.25	CPI=1.35	CPI=1.40	CPI=1.45	CPI=1.50
VCM 20/21	**17.5**	**17.9**			
VCM 22			**18.2**	**18.4**	
VCM23				**18.6**	**19.1**
NOTE: Above assumes U-3 and U-4 CODs of November 2021/2022. Forecast ranges of TPC's based on combinations of both CPIs, and schedule slippages, is provided in Table C-5					

Q. PLEASE DESCRIBE HOW VMG USED HISTORICAL COST PER PERCENTAGE COMPLETE DATA TO INDPENDENTLY ASSESS THE TPC?

A. This method simply does the following: (a) takes data to determine how much has been spent over a specified time period, divided by the reported percent earned over this same time period, to yield a computed dollars spent per percent complete, (b) multiplies this dollars per percent complete times the remining total Project percentage to complete (i.e., 100% - 88.6% yields 11.4% to go), which yields a forecast of the "to go costs", and then (c) adds this to the actual Project costs to date (i.e., as of September 30, 2020, was $ 14.233 B). The first time period reflects more recent Project data (i.e., the recent 6 months from April 2020 through September 2020), and the second time period reflects 12 months from October 2019, through September 2020. The results from these calculations are shown below in Table C-3. As seen, use of data more limited to the more recent past yields (as should be expected with the increasing CPIs) a higher forecast TPC at completion.

Table C-3; Forecast TPC/ Est at Completion Based on $'s Per Percent Complete

(Through Sept 2020, Project Actuals, $14.233B; & Reported % To Go, 11.4 %)

Time Period	Period Costs	Period % Complete	Cost Per % Complete	Forecast to Complete	TPC/EAC; +$14.233B
April 2020 – Sept 2020	$1.429B	2.9 %	$0.493 B	=$.493 B x 11.4 = $ 5.620 B	$ 19.853 B

Oct 2019 – Sept 2020	$2.973B	7.3 %	$0.413 B	= $.413 B x 11.4 = $ 4.708 B	$ 18.941 B

Q. PLEASE COMPARE THE RESULTS OF THE TWO METHODS.

A. Table C-4 below shows the results from both methods.

Table C-4: Reconciliation of Various TPC Forecasts to a Final Range of TPCs at Project Completion			
Method	CPI = 1.45	CPI = 1.50	
CPI Based Method	$18.6 B	$ 19.1 B	
Method	Based on Last 12 Months	Based on Last 6 Months	
$ B's per Percent Complete Method	$ 18.9 B	$ 19.8 B	

There are opposing arguments that can be made to support using one method over the other. For example, the higher cost per percent complete method is supported by the increasing complexity of completing the remaining work, the increased engineer staff to resolve the many Engineering Service Requests, etc. On the other hand, the Project is approaching the completion of construction and an environment which is more typical of a plant refueling outage, and within that environment SNCs ability to perform refueling outages in less time

than the industry average supports a more efficient operation going forward. Even then, the secondary plant (i.e., steam generator side of the plant) has not been, and cannot be except for limited operation during HFT, operated at power until the fuel is loaded. Further, the secondary plant design is different than the Chinese AP 1000 plants and SNC's operations experience with, and knowledge of the secondary plant operations, is much more limited than it is for its six operating nuclear plants because of its atypical design.

VMG has conservatively assumed that the lower range will prevail. Therefore, assuming CODs of November 2021/ 2022, for a CPI of 1.45 the forecast TPC at Project completion would be roughly $ 18.6 B, and for a CPI of 1.50 it would be $ 19.1 B.

Q. PLEASE ADDRESS THE CONTINGENCIES THAT SNC HAS BUDGETED FOR THE PROJECT, WHAT THE CURRENT STATE IS OF THOSE CONTINGENCIES, AND HOW THAT REFLECTS ON YOUR ABOVE FORECAST OF THE PROJECT TPC AT PROJECT COMPLETION?

A. Several months before the April 2019 Baseline was issued (i.e., toward the December 31, 2018 end of the VCM 20 reporting period) the Contingency budgets were as follows:

SNC Contingency	$ 800M
Bechtel Contingency	[redacted]
Schedule Cost Contingency	$ 690M
Total Cost Contingency	[redacted]

Note that the Schedule Cost Contingency is based on the savings that would accrue by achieving U-3 and U-4 CODs in the previously assumed April 2021/ 2022 timeframe (i.e., 6 months ahead of the November 2021/ 2022 dates, where these latter CODs were per the then Aggressive Schedule). Since then, all of the above SNC and Bechtel Contingencies have been allocated (i.e., used to budget for risks that have or are expected to materialize). Also, with the delay of the aggressive CODs to June 2021/ 2022, the $ 690 M Schedule Cost Contingency now stands at $ 390 M. And, because of already identified over-runs that depleted the SNC and Bechtel Cost Contingencies, the SNC contingency has been restored to $ 240 M, and inclusion of this and various adjustments have already added $ 325 M to SNC's forecast of TPC at completion (i.e., now stands at $ 17.425 B, versus $ 17.1 B). Further, this is with the contingency analysis assumed June 2021/ 2022 CODs, versus the U-3 "Current Site Expectation" COD of August/ September 2021; i.e., realistically, the schedule cost contingency is already less than the assumed $ 390 M.

Going forward, SNC is still hoping to beat the November 2021/ 2022 CODs and thereby utilize a portion of the remaining Schedule Cost Contingency for further construction cost over-runs; however, in VMG's opinion, the "Site Expectation Date" for the U-3 COD has already slipped to August/ September, and VMG believes that at the very best they could possibly make the U-3 COD Regulatory November Benchmark 2021 COD. Yet, actions have been taken to sacrifice U-4 progress for U-3 to make its date, and U-4 has roughly 2 more years until it reaches its COD. In light of all of these facts, VMG believes that an objective review of the remaining cost and schedule risks would conclude that if the Project were to achieve the November 2021/ 2022 CODs, then VMG's forecast of the TPC at Project completion is a reasonable estimate.

SUMMARY ANALYSIS

Q. HAVING ANALYZED THE SCHEDULE AND THE COST, PLEASE PROVIDE AN INTEGRATED SUMMARY OF WHAT THE RANGE OF TPCs COULD BE AT PROJECT COMPLETION BASED ON DIFFERENT ASSUMED CPIs AND CODs?

A. This is shown in Table C-5 that follows.

Table C-5; Forecast TPC at Project Completion for CODs & CPIs as Shown		
COD's	CPI = 1.45	CPI = 1.5
Nov 2021/ 2022	$ 18.6 B	$ 19.1 B
Feb 2022/ 2023	$ 18.9 B	$ 19.4 B
May 2022/ 2023	$ 19.2 B	$ 19.7 B
NOTE: The company has estimated the cost impact of COVID-19 to be roughly $ 150 M to $ 250 M, so with acceptance of this estimated cost and without COVID-19, these estimates would be reduced by that amount		

Q. PLEASE PROVIDE AN OVERALL SUMMARY OF EVERYTHING THAT VMG HAS ANALYZED?

A. A summary of what VMG has analyzed is provided below.

- VMG's independent means of assessing the TPC and CODs has relied on using raw (unanalyzed) data from both SNC and GPCND, and then trending and analyzing that data to provide a forecast estimate range of both the CODs and TPC.

- With respect to the Regulatory Approved CODs of November 2021 (U-3) and November 2022 (U-4), although possible, it is highly unlikely that they will be achieved; and, with respect to the TPC, even if the regulatory approved November 2021 / 2022 CODs are achieved, VMG forecasts that the TPC will be roughly $1.5 B to $ 2.0 B over the regulatory approved $17.1B.
- SNC's estimate of schedule delay related costs is roughly $100M per month, and the potential impacts of these schedule delay related costs on the forecast TPC at Project completion have been provided in Cost Table C-5. Further, SNC has estimated that the increased cost due to COVID-19 is on the order of $ 150 M to $ 250 M for the Project, and these numbers are included/ imbedded in the cost numbers of Table C-5.

Q. MR. GRACE, DOES THAT COMPLETE YOUR TESTIMONY?

A. Yes, it does.

Exhibit "A"

Resume of Donald N. Grace P.E.

Donald N. Grace, P.E.
Vice President, Engineering; Vogtle Monitoring Group

Education, Certifications and Professional Affiliations

- Master of Business Administration, Project Management, Harvard Graduate School of Business (Awarded Fellowship to Attend)
- Bachelor of Science in Marine Engineering and Mathematics, United States Naval Academy (Graduated Cum Laude)
- Professional Engineer (Pennsylvania), Power Generation
- Served as technical lead on Department of Energy (DOE) Reviews and Certifications of major DOE Contractors' Earned Value Management Systems (EVMS)
- Past Chairman of Boiling Water Reactor Owners' Group, and Past Chairman of the American Nuclear Society Reactor Safety Executive Committee

Career Highlights
(Expanded Details Available on Request)

- Over 50 years of hands on technical, management and executive experience with all phases of the Fossil and Nuclear Power Plant Life Cycle (design, permitting & licensing, construction, testing, start-up and commissioning, operations and decommissioning).
- Over 20 years of operating power plant experience, with 5 of the years as an officer serving aboard US Naval Nuclear Submarines and 17 years with General Public Utilities.
- Development of New Facilities – Seventeen years with an Architectural Engineering firm, Burns and Roe Enterprises (BREI), in the positions of Project Engineering Manager, Project Manager, Executive Consultant, and President of a company formed by BREI, AREVA and Duratek. Most experiences were for First of a Kind (FOAK) Nuclear Power Plant Projects and FOAK Chemical Process Projects, several of which were DOE Projects.
- Directing Major Project, Independent Reviews - As an employee of BREI, contracted by the Department of Energy (DOE) to assemble project review teams which I then directed to provide independent project management reviews of multi-billion-dollar DOE projects. Nearly all of the projects were FOAK, and the reviews were total scope reviews (i.e., reviewed ability to achieve technical objectives, within the forecast costs and schedules), and they were performed at major schedule milestones (prior to proceeding to the next project phase).
- Currently provide written and oral testimony as an expert witness to state public utility commissions in their prudency reviews of major power plant projects. Included in these reviews have been - and in some cases continue to be - the following: (a) Integrated Gasification Combined Cycle Project (IGCC, at Kemper, Mississippi), (b) Arkansas Nuclear One (a two nuclear unit site), (c) Grand Gulf Nuclear (the largest single unit nuclear plant in the US), (d) Vogtle 3 & 4 Nuclear Project (the only new active nuclear construction project in the US), and (e) the Four Corners Selective Catalytic Project (project was implemented to reduce NOx emissions at this coal fired dual unit site, where each of the still operating units is roughly 750 MW net).
- As President, BCN EcoPower (**B**eyond **C**arbon **N**eutral, **Eco**nomical **Power** Generation) working to further develop and deploy a patent pending Cryogenic Regenerative Power Cycle (CRPC) wherein cycle thermal efficiencies for large and small scale power plants and industrial facilities can be improved to over 80% with harmful emissions (including CO_2) significantly reduced or eliminated.