

**BEFORE THE
GEORGIA PUBLIC SERVICE COMMISSION**

**IN THE MATTER OF GEORGIA
POWER COMPANY'S TWENTIETH
AND TWENTY-FIRST SEMI-ANNUAL
VOGTLE CONSTRUCTION
MONITORING REPORT**

PUBLIC DISCLOSURE

DOCKET NO. 29849

DIRECT TESTIMONY

OF

DON GRACE

**ON BEHALF OF THE
GEORGIA PUBLIC SERVICE COMMISSION
PUBLIC INTEREST ADVOCACY STAFF**

NOVEMBER 22, 2019

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Exhibits:

1. Exhibit A: Don Grace Resume

1 INTRODUCTION

2
3 **Q. PLEASE STATE YOUR NAME, POSITION, AND BUSINESS ADDRESS.**

4
5 A. My name is Don Grace, and I am the Vice President of Engineering for the Vogtle
6 Monitoring Group (“VMG”). I am one of the key personnel engaged by the Georgia
7 Public Service Commission (“GPSC”) Public Interest Advocacy (“PIA”) Staff since April
8 2018 to independently evaluate Southern Nuclear Company’s (“SNC”) ability to
9 successfully manage completion of the Vogtle 3 & 4 Nuclear Project (“Project”). I have
10 over 50 years of hands on experience in all phases of the electrical generating plant life
11 cycle (i.e., Licensing/Permitting, Engineering, Construction, Start-up Testing and
12 Commissioning, Operations & Maintenance, and Decommissioning) for nuclear and fossil
13 fuel plants. I have a B.S in Marine Engineering from the U.S. Naval Academy (having
14 graduated with distinction), an MBA from Harvard Graduate School of Business (having
15 been awarded a fellowship) and have been a registered Professional Engineer in the field
16 of Power Generation for over 45 years. A copy of my curriculum vitae is attached as
17 Exhibit A.

18
19 **Q. PLEASE PROVIDE ADDITIONAL INFORMATION REGARDING THE OTHER**
20 **KEY VMG TEAM MEMBERS, AND THE ROLES THEY PLAY IN**
21 **SUPPORTING YOUR TESTIMONY.**

22

1 **A.** There are two additional key members of VMG that support my testimony. Mr. Dinos
2 Nicolaou has an MBA degree and is a highly experienced Project Controls professional
3 with over 45 years in developing and maintaining Earned Value Management System
4 (“EVMS”) based Integrated Project Schedules (“IPS”). He has performed dozens of
5 independent cost and schedule reviews of other major projects. Mr. Ray Bryant is a
6 highly experienced construction management professional with over 40 years in
7 construction management with a focus on nuclear electrical and security oversight. Mr.
8 Bryant functions as a full-time on-site construction monitor at the Project site. Other
9 subject matter experts are engaged on an as needed basis.

10

11 **Q. WHAT ARE YOUR CRITERIA FOR SUCCESSFUL MANAGEMENT OF A**
12 **PROJECT LIKE VOGTLE 3 AND 4?**

13

14 **A.** It includes SNC’s ability to safely complete the Project in a quality manner while meeting
15 SNC’s forecast Commercial Operations Dates (“CODs”) of November 2021 for Unit 3
16 and November 2022 for Unit 4, while also staying within or below SNC’s Total Project
17 Cost (“TPC”) forecast of \$ 17.1 B.¹

18

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

21

¹ This TPC of \$ 17.1 B represents all of the equity owners’ cost (i.e., represents 100% equity ownership, and not just Georgia Power Company’s 45.7% ownership, and excludes all financing related costs).

1 A. I have previously provided written testimony to the GPSC regarding the Project in
2 November 2018, and oral testimony in December 2018. Also, I have testified before the
3 Mississippi Public Service Commission, the Arizona Corporate Commission, and the
4 Arkansas Attorney General’s Office. I have also testified before the Nuclear Regulatory
5 Commission, in my capacity as the Chairman of the Boiling Water Reactor Owners’
6 Group.

7
8 **PURPOSE OF TESTIMONY**

9
10 **Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY?**

11
12 A. The purpose of my testimony is to first describe how VMG utilized data provided by either
13 SNC /or Georgia Power Company (“GPC”) to perform independent analyses of the
14 Project Schedule and Cost. Based on these analyses, I will then provide VMG’s
15 conclusions regarding the Project Schedule and Cost.

16
17 **Q. PLEASE PROVIDE YOUR SUMMARY CONCLUSIONS.**

18
19 A. With respect to the aggressive target CODs of May 23, 2021 and May 23, 2022, it is
20 VMG’s opinion that these dates cannot be achieved. With respect to the Commission
21 Approved CODs of November 2021 and November 2022, unless performance improves
22 significantly, those dates are significantly challenged.

1 With respect to the TPC, assuming the current performance trends continue the \$17.1B
2 may be exceeded. The degree to which it will be exceeded relies on two primary factors;
3 i.e., (a) schedule delay costs, which the Georgia Power Nuclear Development Group has
4 advised us are estimated to be \$100M per month, and are related primarily to the ability to
5 complete construction work at the planned rate, and (b) poor Project productivity related
6 costs, which are dependent on the degree to which SNC's Project performance does or
7 does not improve.

8
9 **Q. PRIOR TO EXPLAINING THE SCHEDULE AND COST ANALYSES THAT**
10 **VMG HAS PERFORMED, ARE THERE ANY OTHER ISSUES THAT YOU**
11 **WANT TO FIRST ADDRESS?**

12
13 A. Yes. I would like to note that in addition to our summary conclusions regarding the Project
14 Schedule and Cost, we find that the April 2019 Baseline does not represent a reasonable
15 plan for implementing and executing Project activities and reporting on the progress of the
16 Project. The primary reason for our determination that the April 2019 Baseline is
17 unreasonable, among others, is that the Integrated Project Schedule ("IPS") is too
18 aggressive and the assumed commodity installation unit rates (electrical, piping, supports,
19 etc.) are not based on what craft labor ("Craft") has been able to achieve to date.
20 Furthermore, we see no indication that SNC will be able to sufficiently improve
21 performance of craft labor to achieve the unit rates assumed in the April 2019 Baseline.

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In analyzing the “to date” actual IPS performance, we focused primarily on the Unit 3 Construction and Initial Test Program Phases and then address the over-all Project Schedule (to include Unit 4 and Balance of Plant (“BOP”). The totality of these analyses is then used to reach our final conclusion that the current Commission Approved November COD’s will not, if the current schedule performance continues, be achieved.

Turning now to an overview perspective of the total remaining schedule:

- a) The initial engineering and design efforts are for the most part complete, and through August 2019 the over-all Project is reported by SNC to be 80.5 % complete.
- b) After construction completion of systems and ITP testing of each system, the Project will be approaching the last 11 to 12 months of the Schedule at which point integrated system tests are performed (e.g., Integrated Leak Rate Test of the Containment, and Hot Functional Testing).
- c) With successful completion of the above tests, including completion of the design-specific pre-operational tests and a Nuclear Regulatory Commission finding in accordance with 10 CFR 52.103(g) that all the acceptance criteria in the “Inspections, Test, Analysis and Acceptance Criteria” (“ITAAC”) in Appendix C

1 to the Unit 3 Combined License (COL) are met, the final 5 to 6 months of the
2 Schedule consists of Fuel Loading plus Startup Testing and Commissioning
3 activities leading to Commercial Operations.

4
5 d) The above schedule activities apply separately to Unit 3 and to Unit 4, and the
6 currently planned schedule lag between the Unit 3 & 4 plant COD's is 12 months.

7

8 **Bulk Commodity Unit Rates**

9

10 In October 2017, Bechtel estimated the amounts of construction bulk commodities
11 remaining and started reporting progress in completing construction of these commodities.
12 In June 2018, a schedule baseline was established, referred to hereafter as the June 2018
13 Baseline, and in April 2019, a revised schedule baseline was established, referred to
14 hereafter as the April 2019 Baseline. One of the primary focuses of these baselines was
15 Direct Craft labor construction efforts and the utilization of "planned bulk commodity unit
16 rates" and crew sizes to determine the schedule durations required to complete the various
17 construction activities. The construction activities are then logically linked to the ITP
18 system testing activities, which are then logically linked to the final 11 to 12 months of
19 integrated system test activities leading to fuel load, Startup Testing and Commissioning,
20 and ending with Commercial Operations. The final product of this scheduling effort is the
21 Integrated Project Schedule ("IPS"). Further, the planned Direct Craft construction effort

1 that is integral to the IPS is the basis against which the Direct Craft Construction effort is
2 measured.

3
4 With respect to quantities, there were no significant changes. With respect to the Unit
5 Rates, however, the data presented in Table 1 below raises concerns regarding the decision
6 to use installation rates significantly lower than the experienced rates, and the
7 reasonableness of the resultant durations used and the impacts that this has on
8 Performance Monitoring and Reporting.

9
10 In analyzing the data of Table 1, the installation unit rates experienced (from October
11 2017 through March 2019 and October 2017 through September 2019) are in most cases
12 significantly greater than the Planned Rates assumed in the April 2019 Baseline. The
13 Table below compares the experienced rates prior to the April 2019 Baseline (column 3)
14 to those planned in the April 2019 Baseline (column 4) and then compared to the current
15 actual rates (column 5).

16

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Table 1

Vogtle Unit 3; Planned and Actual Bulk Commodity Installation Rates				
Bulk Commodity	Unit of Measure	Actual Rates October 2017 – March 2019	Planned Rates in April 2019 Schedule Baseline	Actual Rates October 2017 – Sept 2019
		Column 3	Column 4	Column 5
Piping				
Large Bore Pipe	Hours / LF	████	████	████
Large Bore Pipe Supports	Hours / each	████	████	████
Small Bore Pipe	Hours /LF	████	████	████
Electrical				
Conduit	Hours / LF	████	████	████
Cable Trays	Hours / LF	████	████	████
Cable Tray Supports	Hours / each	████	████	████
Cable	Hours / LF	████	████	████
Terminations	Hours / each	████	████	████
Bases of Above Rates				
1. Actual Rates, October 2017 – March 2019: Equals hours spent divided by quantities earned and was derived from numbers in the Bechtel March 2019 Updated Monthly Status Report page 142.				
2. Rates Used in April 2019 Schedule Baseline: Planned Hours divided by new baseline quantities and was derived from the Bechtel April 2019 updated monthly status report, page 145.				
3. Actual Rates, October 2017 – Sept 2019: Again, equals hours spent divided by quantities earned, and was derived from the Bechtel September 2019 Updated Monthly Status Report pages 200.				
4. "LF" denotes "Linear Foot"				

3

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6

Q. BASED ON THIS ANALYSIS, WHAT ARE YOUR CONCLUSIONS?

- 1 A. Since the planned unit rates directly impact planned schedule durations, VMG concludes
2 the following:
3
- 4 1. The IPS schedule durations to complete the work are not achievable (i.e., durations
5 are much shorter than required).
6
 - 7 2. Since the Cost and Schedule Performance Indices are directly related to the
8 planned, unreasonable unit rates in the IPS, the benchmark performance metrics
9 used in reporting the performance of the critical construction Direct Craft labor
10 efforts are less meaningful.
11
 - 12 3. The recently established April 2019 Baseline does not represent an achievable
13 plan, nor does it provide a meaningful basis for performance monitoring and
14 thereby it does not represent an effective tool for updating forecasts of the Project
15 COD's and TPC. The Company itself refers to the 2019 Baseline as a strategy and
16 admits that they continue to use it as such even when it may look unachievable or
17 aggressive. (Transcript, Abramovitz, p. 60).
18
 - 19 4. When developing the new April 2019 Baseline in early 2019 SNC should have
20 assumed more realistic unit rates that were better aligned with actual craft
21 production when establishing unit rates for the April 2019 Schedule Baseline.
22

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Table 2

Unit 3 Over-all Cost and Schedule Performance vs April 2019 Schedule Baseline							
Man-Hours	Monthly Data (Since Establishing the April 2019 Schedule Baseline)						Cum to Date Starting with April 2019 Baseline
	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	
Planned	162,579	292,699	398,494	352,982	368,663	464,276	2,039,693
Earned	179,575	248,165	284,137	220,507	285,959	288,109	1,506,452
Actual Spent	307,326	308,049	440,636	351,863	421,062	470,311	2,299,247
SPI	0.91	1.18	1.40	1.60	1.29	1.61	1.35
CPI	1.71	1.24	1.55	1.60	1.47	1.63	1.53
1. Except for the April 2019 Planned value, all other data is derived from project reporting (ref: Updated Bechtel Monthly Status Score Card Reports).							
2. Since an April Planned Value was not reported, VMG simply derived what it would have to be to reconcile to the above planned numbers. The SPI for April was also not reported, and was then calculated by VMG from the April Planned Hours divided by the April Earned Hours to be 0.91.							

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Q. WHAT CONCLUSIONS DO YOU DRAW IN ANALYZING THE DATA OF TABLE 2?

A. VMG concludes actual performance versus the April 2019 Baseline is unfavorable to the point that one could conclude that the April 2019 Baseline itself is not an achievable plan. The cumulative SPI of 1.35 suggests that it takes 1.35 months to earn progress that was planned for one month. Also, the cumulative CPI of 1.53 suggests that it is taking one and a half hours to complete one hour of planned earned work. The Company has stated that they expect another re-baseline in the near future. (Transcript, Haswell, p. 58).

1 **Planned and Actual Production Rates for**
2 **Critical Piping and Electrical Bulk Commodities**

3
4 **Q. ARE THERE SPECIFIC BULK COMMODITIES THAT ARE MOST CRITICAL**
5 **TO FINISHING THE PROJECT AS SOON AS POSSIBLE, AND HAVE YOU**
6 **ANALYZED PRODUCTION RATES FOR THOSE COMMODITIES?**

7
8 A. Yes. Electrical bulk commodities are lagging the most and are well behind planned April
9 2019 Baseline production goals. In terms of the Unit 3's planned hours and actual earned
10 hours, through October 2019, these electrical efforts are 397,633 hours behind plan and on
11 average these same efforts are continuing to fall behind at a rate of 25,000 hours per week.
12 At these rates we conclude that SNC is already 16 weeks (i.e., over 3.5 months) behind
13 schedule. This back-log, when added to already planned future work, is then contributing
14 to what is addressed later as a "future bow wave" of work.

15
16 **Q. IN ADDITION TO THE ABOVE ELECTRICAL COMMODITY INSTALLATION**
17 **DATA, PLEASE PRESENT YOUR ANALYSIS AS IT RELATES TO AN IMPACT**
18 **ON THE FORECAST OF UNIT 3'S COD?**

19
20 A. VMG first looked at what schedule durations would be using the historical production
21 rates (bulk construction work performed since October 2017 through March 2019) and
22 compared them to schedule durations resulting from the productivity rates established in

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the April 2019 Baseline. From this we derive the ratio of these durations for the commodities analyzed and we call this the “Schedule Duration Factor”. These results are provided in Table 3.1.

Each schedule duration factor indicates that for every hour of planned activity identified in the April 2019 Baseline for the selected commodity, the actual time to perform that activity (based on experience to date) can be found by taking the planned time and multiplying it by the Schedule Duration Factor.

Table 3-1

Schedule Duration Factors If Experienced Unit Rates Were Used vs April 2019 Baseline Unit Rates						
Selected Commodity	Unit of Measure	Planned Unit Rates (per April 2019 Schedule Baseline)	Actual Historical Unit Rates; Oct 2017- Mar 2019	Schedule Duration Factors i.e., Actual Historical Rates ÷ Baseline Rates	Remarks	
Piping						
Large Bore Pipe	Hours/LF	████	████	████	For all the selected commodities (less Large Bore Pipe Supports & Conduit), use of experienced based unit rates would have required more effort (and increased schedule durations) from what was provided in the April 2019 Baseline; see Note below.	
Large Bore Pipe Supports	Hours/each	████	████	████		
Small Bore Pipe	Hours /LF	████	████	████		
Electrical						
Conduit	Hours/LF	████	████	████		
Cable Trays	Hours/LF	████	████	████		
Cable Tray Supports	Hours/each	████	████	████		
Cable	Hours/LF	████	████	████		
Terminations	Hours/each	████	████	████		
Note: Using Large Bore Pipe as an example, if an activity in the April 2019 Baseline was planned to require 100 hours to complete, use of the experienced based productivity unit rate would indicate that the activity should have been planned for ██████ (vs 100 hours). This explains why the Schedule Performance Indices for Piping and Electrical commodities are so high, and why work in these areas is significantly “lagging the plan”.						

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The data in the table clearly shows that it is taking SNC considerably more time to install most commodities than SNC has assumed in its April 2019 Baseline.

From the start of our Independent Monitoring role, we believed the strategic approach used by SNC to expedite the start of testing activities prior to completing civil and more bulk commodity construction would lead to increased craft congestion and schedule conflicts in the field. As such, performance metrics would then become even more unfavorable. For this reason, we took a snapshot of what these same statistics would show for the one week ending September 29, 2019. That data is presented in Table 3.2 below.

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Table 3.2

Schedule Durations Impact/ Factor					
Selected Critical Commodity	Unit of Measure	(a) Unit Rate (per April 2019 Schedule Baseline)	(b) Actual Rates for Week Ending Sept 29, 2019	(c) Oct 2017-Mar 2019; Schedule Duration Factor (ref: Table 3.1)	Recent Week Ending 9/29 Schedule Duration Factor; i.e., (b) ÷ (a)
Piping					
Large Bore Pipe	Hours / LF	██████████	██████████	██████████	██████████
Large Bore Pipe Supports	Hours / each	██████████	██████████	██████████	██████████
Small Bore Pipe	Hours / LF	██████████	██████████	██████████	██████████
Electrical					
Conduit	Hours / LF	██████████	██████████	██████████	██████████
Cable Trays	Hours / LF	██████████	██████████	██████████	██████████
Cable Tray Supports	Hours / each	██████████	██████████	██████████	██████████
Cable	Hours / LF	██████████	██████████	██████████	██████████
Terminations	Hours / each	██████████	██████████	██████████	██████████

NOTE:

- Blue color coding indicates that the schedule durations (based on actual experienced unit rates), for each of the two indicated time periods are exceeding those schedule durations assumed within the April Schedule Baseline. For large bore pipe, as an example, if 100 hours were planned for a crew to complete an activity, given the average time to install large bore piping (over the time period Oct 2017 – March 2019) it would have taken the crew ██████████ to perform the work. Fast forward to the one week ending Sept 29th, the trend worsened (i.e., would have taken ██████████, and therefore a proportionately longer period of time to complete).
- Green color coding represents the areas where performance was in line with respect to the unit rates planned within the April 2019 Baseline.

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Q. WHAT DO YOU CONCLUDE FROM THIS ANALYSIS OF THE CRITICAL BULK CONSTRUCTION COMMODITIES?

1 A. We conclude that since the establishment of the April 2019 Baseline, the man-hours that it
2 is taking to complete construction of the more critical bulk commodities is much greater
3 than what was planned. From this same data in Table 3.2, a majority of the items show a
4 continued negative trend which we believe will result in significant delays of the Units 3
5 and 4 COD's beyond the aggressive May 23, 2021/2022 COD's, and potential delays
6 beyond the November 2021/2022 COD's.

7

8 **Q. BASED ON YOUR SCHEDULE ANALYSIS SO FAR, IS IT NOT TRUE THAT**
9 **SIMPLY ADDING MORE CRAFT LABOR COULD HELP TO SHORTEN THE**
10 **SCHEDULE DURATION?**

11

12 A. Yes, but only to a point. To illustrate, if adding more craft labor alone would shorten the
13 schedule duration, the Project would do so (Project is presently attempting this approach)
14 and it would not have had to slip the target COD's for the April 2019 Baseline from what
15 they were in the prior June 2018 Baseline. However, when continuing to simply add labor
16 you get to a point where more craft is unproductive and not conducive to completing work
17 in an efficient and timely manner.

18

19 **Q. DO YOU THINK THE NEGATIVE PERFORMANCE TRENDS CAN BE**
20 **SIGNIFICANTLY IMPROVED?**

21

1 A. VMG believes that significant improvements cannot be achieved in the near term to either
2 recover lost schedule, or to even achieve the planned rate of construction work. Reasons
3 supporting this belief are as follows:

4
5 1. It is noted that there is a recent (dated October 5, 2019) “Vogtle Unit 3 and 4 Near
6 Term Electrical Production and Productivity Improvement Plan.” However, this is just
7 one of several plans that have been developed and implemented since VMG has been
8 monitoring the Project, with none to date having achieved significant improvements.

9
10 2. With a near term increase in concurrent construction of bulk commodities and ITP
11 testing activities (ref: next section regarding Construction Turnovers to ITP), there will
12 be more situations where construction cannot proceed due to limited personal access,
13 if for example, a hydro test is being performed. Even without this added complexity,
14 as construction work continues work areas will become more congested. This
15 congestion is a typical occurring trend as construction progresses, it is termed
16 “stacking of trades”. In addition to Bechtel and ITP attempting to plan and execute
17 their work, multiple subcontractors will also be doing the same.

18 3. As is explained in the next section regarding turnovers from Construction to ITP, the
19 turnover dates keep getting slipped into the future. This, with no significant change in
20 the planned aggressive April/ May COD for Unit 3, results in further compressing the
21 over-all schedule. The highly compressed schedule, together with an April 2019

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Baseline plan that is not considered achievable, then complicates planning and execution of the work which then results in less than optimal planning of the work.

Further evidence of VMG’s conclusions regarding the increased complexities of work planning and execution is apparent in the following report and example:

- Comments made in the July 22 – August 17, 2019 study of work conducted by Vitale, Inc wherein they note:

“ [REDACTED] ”

- In the “Engineering Deep Dive” presentation on September 27, 2019, a situation was highlighted wherein field routing of conduit supports, conduit, cable, and cable terminations were all completed, and equipment was powered. Subsequently, piping was to go through the area but could no longer be routed as planned, and re-engineering of re-routed piping of supports and piping were required to provide for alternate construction, all of which “impacted Condensate System, Circulating Water System and Potable Water System Scope for near term turn-over.” In VMG’s opinion, proper planning of the field routed electrical work would have included a constructability review and check of the 3-D plant model,

1 in which case the routing of the piping should have been observed and this
2 situation should have been avoidable.

3

4

Unit 3 Construction Turnovers to ITP

5

6 **Q. PLEASE DESCRIBE THE CONSTRUCTION TURNOVERS TO ITP AND THE**
7 **RELEVANCE TO THE COD.**

8

9 A. Toward the end of physical construction there are construction tests which must take
10 place. After construction's performance of certain tests, and after completion of the
11 required engineering and construction documentation, a System or Partial System, is then
12 turned over to ITP. ITP then performs what are in essence "component" and "System
13 Tests".

14

15 The ability to turnover systems to construction was addressed as an issue in my prior
16 November 2018 testimony. With an inability to achieve these turnovers as planned during
17 the prior June 2018 Baseline, and not wanting to delay the Unit 3 COD, most of these
18 turnovers are now planned to occur over a compressed time period thus making the
19 previously identified problem even more serious. Quantification of the delays, and the
20 continued inability to perform as planned, are provided in Table 4 which follows.

21

Q. DESCRIBE THE TURNOVER DATA PROVIDED IN TABLE 4, AND VMG'S ANALYSIS OF THAT DATA.

A. In Table 4 VMG has identified the partial systems that had been scheduled for turnover in support of the major schedule milestone identified as Integrated Flush, and for each has listed the planned turnover dates per the June 2018 Baseline and per the April 2019 Baseline. VMG has also indicated if, and if so when, the actual turnover has occurred. Finally, the data end date for identifying actual turnovers is October 19, 2019.

As can be seen from the table, planned turnover dates for these nearer term turnovers slipped an average of 153 days from the June 2018 Baseline to the April 2019 Baseline, and the performance to date in meeting the April 2019 Baseline dates has slipped by 47 days and continues trending negatively.

Table 4

	Partial System Turnovers In Support of Integrated Flush (Data Date Oct 19, 2019)	Planned T/O Date Per		Days Slip from Prior Baseline	Actual T/O Date	Days Slip from April 2019 Baseline
		June 2018 Schedule Baseline	April 2019 Schedule Baseline			
1	U3 – PLS-3 System Partial Turnover to Testing	16-Dec-18	27-Jun-19	193	27-Aug-19	61
2	U3 – PLS-2 System Partial Turnover to Testing (IF)	23-Oct-18	2-Jul-19	252	28-Jun-19	-4
3	U3 – SFS-1 System Turnover to Testing (IF)	26-May-19	28-Jul-19	63	14-Aug-19	17
4-A	U3 – RCS-1 System Partial Turnover to Testing (IF); plus RCS-1-E (Below)	19-Jun-19	7/29/2019; 11/27'19	161	Missed	> 72
5	U3 – RNS-1 System Turnover to Testing (IF)	21-May-19	4-Aug-19	75	Missed	> 76
6-A	U3 – PXS-1 System Partial Turnover to Testing (IF)	30-May-19	8/5/2019; 10/31/19	154	Missed	> 75
7	U3 – WLS-1 System Partial Turnover to Testing (IF)	21-Apr-19	20-Aug-19	121	Missed	> 60

8-A	U3 – CVS-1 System Turnover to Testing (IF); plus CVS-1 E Containment (below)	30-Jun-19	8/27/2019; 10/28/19	120	Missed	> 53
9	U3 – SWS-1 System Turnover to Testing (IF)	7-Jun-19	7-Oct-19	122	Missed	> 12
10	U3 – IDS-1 System Turnover to Testing (IF)	18-Jun-19	24-Oct-19	129		
11; 8-B	U3 – CVS-1 System Turnover to Testing (IF) Containment Electrical	A later sub-div of CVS-1	28-Oct-19	NA		
12; 6-B	U3 – PXS-1 System Partial Turnover to Testing (IF) Containment Electrical	A later sub-div of PXS-1	31-Oct-19	NA		
13	U3 – CCS-1 System Partial Turnover to Testing (to support SFS, RNS, & CVS Testing, (IF)	23-May-19	6-Nov-19	167		
14-A	U3 – WRS-1 System Turnover to Testing (IF); plus WRS-1-X1 (below)	17-Jun-19	11/8/2019; 11/15/19	141		
15; 20-B	U3 – CAS-1 (SA) System Partial Turnover to Testing (IF) South Aux	A later sub-div of CAS-1	13-Nov-19	NA		
16; 14-B	U3-WRS-1-X1 (1A) System Turnover to Testing (Exceptions)	Deferred Exceptions from WRS-1	15-Nov-19	NA		
17	U3 – PLS-4 System Partial Turnover to Testing (IF)	16-Apr-19	16-Nov-19	214		
18-A	U3 – ECS-2 System Partial Turnover to Testing (IF); plus ECS-2-E (next item)	3-Jul-19	11/23/2019; 11/25/2019	145		
19; 18-B	U3 – ECS-2 System Partial Turnover to Testing (IF) Containment Electrical	A later sub-div of ECS-2	25-Nov-19	NA		
20-A	U3 – CAS-1 System Partial Turnover to Testing (IF); plus line item 15; 20-B above	15-Jul-19	11/27/2019; 11/13/19	135		
21; 4-B	U3 – RCS-1-E System Partial Turnover to Testing (IF) Containment Electrical	A later sub-div of RCS-1	27-Nov-19	NA		
22	U3 – PLS-5 System Partial Turnover to Testing (IF)	20-Mar-19	4-Dec-19	259		
Average Day Shift of 153-day slip (from June 2018 Schedule Baseline to April 2019 Schedule Baseline); as computed from original 16 Partial Systems in June 2018 Schedule Baseline; i.e., planned date slips averaging over 5 months in a period of 10 months				153 Days		
				Average Days Slip from April 2019 Schedule Baseline to Actual T/O Date	> 47; and growing	

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Q. YOU HAVE SHOWN THAT WITH CONTINUAL SLIPS OF UNIT 3 ACTIVITIES THE TIME TO COMPLETE REMAINING ACTIVITIES CONTINUES TO BE COMPRESSED. FOR THIS SAME PHASE OF THE PROJECT WHERE MORE

1 **PARTIAL SYSTEMS ARE TO BE TURNED OVER FROM CONSTRUCTION TO**
2 **ITP, CAN THE SITUATION BE IMPROVED?**

3
4 A. VMG does not believe the situation can be improved. As stated previously, the ability to
5 turnover systems from construction to ITP was highlighted as a problem in our prior
6 November 2018 testimony, and as has just been explained the situation has become more
7 serious. Of particular note in this latter regard is that in the very near term the sheer
8 number of turnovers is planned to increase dramatically. In addition, and as is explained
9 later in the section titled “Complexity of Planning & Executing Future Work”, additional
10 work is continually being repackaged and delayed into the future, which then adds to the
11 required number of turnovers. In spite of these added complexities it is also important to
12 highlight what was stated in my previous November 2018 testimony regarding SNC’s
13 strong operating record. As such, SNC is working to assure that proper technical controls
14 are put in place so that in spite of the everchanging methods to plan the work, the finished
15 plants are constructed in a manner which documentation shows is consistent with the
16 design. They should therefore function within the bounds of operations as required by the
17 NRC licensing basis document titled “Final Design Safety Analysis Report”. However,
18 and as is explained later in our schedule analyses, these processes have become very
19 complicated, and we question – from a planning/ project controls perspective -- the ability
20 of SNC to effectively keep up with all the changes that are continuing to be made to the
21 planned work.

22

1 **Q. BASED ON WHAT VMG HAS ANALYZED REGARDING THE TURNOVER OF**
2 **PARTIAL SYSTEMS FROM CONSTRUCTION TO ITP, WHAT IS YOUR**
3 **SUMMARY CONCLUSION?**

4
5 A. VMG concludes that the over-aggressiveness of the April 2019 Baseline is not achievable
6 and there will be continued further slips in the turnover dates from the baseline planned
7 dates.

8
9 **Complexity of Planning & Executing Future Bow Wave of Increasing Work**

10
11 **Q. PLEASE COMMENT ON THE COMPLEXITIES OF PLANNING AND**
12 **EXECUTING A FUTURE BOW WAVE OF INCREASED WORK.**

13
14 A. First, and as has been already briefly mentioned, by “bow wave” of increased work we
15 mean taking work planned for completion at an earlier date and then re-planning/ adding it
16 to already planned future work. The means by which SNC is deferring work and how
17 these procedures further complicates the over-all planning and execution of that work are
18 detailed as follows:

- 19
20 1. As noted previously, the contractor is not turning over complete systems to ITP, but
21 “Partial Systems” wherein multiple “Partial Systems” then comprise each total system.

1 Within the partial systems there are then multiple work packages that comprise the
2 partial system.

3
4 2. As work for completing partial systems has continued to lag the plan, and as a near
5 term major schedule milestones approach, the Project has employed various means to
6 still meet the nearer term milestone (e.g., “Start of Integrated Flush”). The various
7 means are as follows:

8
9 a) Identify work package “exceptions”² and defer that work for later completion.
10 Depending on the number and magnitude of the associated work scopes being
11 deferred, these deferred work packages may be planned as single future scopes of
12 work, or several of the deferred work packages may be bundled into an additional
13 partial system (as was done for line item “16; 14-b” identified in the prior Table 4
14 for the Unit 3 WRS (Radioactive Waste System), Partial System (designated as
15 WRS-1). To further illustrate, often times permanent power is not yet available
16 (due to lagging electrical work) to perform an activity such as stroking a valve or
17 starting a motor, so the “exception process” then defers the permanent power and
18 adds “temporary power” to allow testing of the component. These deferred work
19 packages are bundled into a newly created further sub-division of the original
20 Partial System, and the newly created partial system carries an “E” designator

² An “exception” represents a Construction Work Package (or a collection of Construction Work Packages) that was originally planned for completion by a specified date in the current (now April 2019) baseline, but a decision was subsequently made to not complete that work by the specified date (but by a later date).

1 (where “E” denotes electrical). As can be seen by this example, this complicates
2 both current planning and execution of work, and also does the same for the work
3 that is being deferred. As a further example of how it complicates the work, with
4 permanent power to a motor, protection of that motor and associated power is
5 provided through a Motor Control Center (“MCC”), so engineering approval of the
6 means of providing the temporary power is required, plus this all creates additional
7 work that had not been originally planned.

8 b) Use of the Partial Release for Test (“PRT”) procedure, wherein the following
9 actions take place:

- 10 • Jurisdictional Control of a portion of the Partial System is temporarily turned
11 over to ITP; this means that control of this portion of the system (e.g., in terms
12 of equipment “lock outs and tag outs”)³ is turned over to ITP and they can then
13 perform a limited test. Again, this process complicates the planning and
14 execution not only of current work, but also future work.
- 15 • This process also results in two additional “hand-offs” of Jurisdictional Control
16 (i.e., with a PRT there is a hand-off to ITP, and then back again to
17 Construction) thus adding to the complexity of properly controlling work
18 package management.
19

³ This process is absolutely necessary and must be properly controlled in order to protect both personnel and equipment.

1 **Q. REGARDING THE EXCEPTION PROCESS, HAVE YOU ATTEMPTED TO**
 2 **CAPTURE THE EXTENT TO WHICH ORIGINALLY PLANNED WORK IS**
 3 **BEING DEFERRED?**

4
 5 A. Yes, and this is shown in Table 5 which illustrates the above points for only a portion of
 6 those systems that the April 2019 Baseline had planned for turnover through October
 7 2019.

8 **Table 5**

Table 5: Unit 3 “Creation of Bow Wave” of Work Deferred into the Future (Data as of Oct 2019)		
Example: Partial Systems which (per the Apr 2019 Baseline) Already Were, or Are, Planned for Turnover to ITP Prior to October 31, 2019		
Partial System & Associated Major Schedule Milestone	Number of Original Work Packages (WP’s)	Number of WP Exceptions
Integrated Flush		
RCS-1	■	■
PXS-1	■	■
WLS-1	■	■
CVS-1	■	■
SWS-1	■	■
IDS-1	■	■
<i>CVS-1E</i>	■	■
<i>PXS-1E</i>	■	■

For the Last two items (shown in italics), each was included in their associated original Partial System within the June 2018 Schedule Baseline, but were subsequently further sub-divided out as separate Partial Systems in the April 2019 Schedule Baseline. Also, as the forecast T/O dates near, the exceptions most likely will increase.

9
 10 As an example of what can be seen from the above table, Partial System PXS-1 originally
 11 was comprised of ■ Work Packages, subsequently a decision was made to package ■
 12 of these Work Packages into a separate PXS-1E Partial System which was then given a
 13 later planned date for completion, and of the remaining ■ Work Packages (i.e., ■ –

1 █) there are an additional █ that have been ‘Excepted’ and re-planned for a later
2 completion date.

3
4 **Q. WHAT ARE VMG’S CONCLUSIONS REGARDING THIS PART OF YOUR**
5 **SCHEDULE ANALYSES?**

6
7 **A.** Our conclusions are as follows:

- 8
9 1. In an attempt to meet a major milestone (such as the “Start of Integrated Flush”),
10 extreme efforts are being taken to both (a) defer originally planned work (through
11 “Exceptions”) and to (b) authorize limited testing (through the “Partial Release for
12 Test” process, which in some cases can serve to defer originally planned tests) – which
13 then results in a large degree of variance from the April 2019 Schedule Baseline.⁴
14
15 2. In light of the above practices, VMG concludes that it has become very difficult to
16 keep up with a timely and effective updating of the Schedule Baseline.
17
18 3. As such, it is virtually impossible to accurately analyze variances and it is therefore
19 difficult to predict what the actual COD’s will be.
20

⁴ There is nothing improper about deferring work that is not necessary to meet a major milestone. The point, however, is that the baseline plan is not being met, and more appropriate measures of progress going forward will be whether Integrated Flush is completed on time, and the extent to which the deferred work can be effectively integrated with the already planned future work.

1 **Q. HAVE YOU ANALYZED THE SCHEDULE BEYOND THE UNIT 3 ITP TO AND**
2 **THE UNIT 4 SCHEDULE?**

3
4 A. For the Unit 3 schedule, we have not done a detailed analysis beyond the Unit 3
5 Construction and Construction turnover to ITP (i.e., have not analyzed in detail the
6 subsequent activities leading to the Unit 3 Fuel Load and COD). We have, however, done
7 a limited review of both the Unit 3 Schedule beyond Construction turnover to ITP, and
8 also the Unit 4 Schedule, and for purposes of this analysis have accepted the durations
9 shown in those schedules. At this time, the general rationale for not delving into the
10 schedules in greater detail and for now accepting those schedule durations is as follows.

11
12 1. VMG finds the Unit 3 Schedule to be overly aggressive, and that the Unit 4 Schedule
13 (in terms of durations by phase) to be roughly equal to the Unit 3 Schedule. Further,
14 whatever improvements are possible for Unit 4 based on Unit 3 lessons learned are
15 assumed to be offset by the overly aggressive current schedule. In addition to the
16 over-aggressiveness of the Unit 3 Construction and ITP phases, the one-year duration
17 between Units (when compared to the roughly two-year average duration at the more
18 recent dual unit sites across the nation) is also believed to be aggressive (note: Units 1
19 and 2 at Vogtle were 2 years apart as well).

20
21 2. SNC decreased the duration from Hot Functional Test (“HFT”) to COD from what
22 was a 12-month duration to 11 months. The current Nuclear Regulatory Commission

1 continue to face which will limit significant improvements to performance. Our high-
2 level summary analysis starts by first assuming that nearly all of the Construction effort
3 must be completed by the “Mechanical Completion” date (which is the same date for the
4 Major Schedule Milestone “Start Hot Functional Testing” and is mid-June 2020). In
5 Table 6, we show the SPI during the period of the June 2018 Schedule Baseline (i.e., July
6 2018 through March 2019), the SPI during the period of the current April Schedule
7 Baseline (i.e., April 2019 through September 2019), and the combined SPI measuring
8 actual schedule performance vs the actual plans for each of these periods. This combined
9 SPI is roughly 1.4, which means that for every month (say 30 days) of planned work, the
10 amount of work not completed is equivalent to 12 days of work.

11 **TABLE 6**

Baseline	Period	Man-Hours		Period SPI
		Planned	Earned	
June 2018	July 2018 - March 2019	3,268,543	2,280,543	1.43
April 2019	April 2019 - Sept 2019	2,039,693	1,506,452	1.35
Combined	July 2018 - Sept 2019	5,308,236	3,786,995	1.40

13
14
15 VMG then reviewed the time frame from the start of the July 2018 Schedule Baseline to
16 mid-June 2020 and computed that to be 23.5 months. If we then apply the SPI of 1.4 to
17 this 23.5-months duration of Construction work, this results in extending the date for the
18 start of Hot Functional Testing by nearly 10 months (i.e., 0.4 x 23.5). Finally, with no
19 changes in the subsequent schedule, the COD for Unit 3 would be delayed by roughly 9.5
20 months (from the nearly equal aggressive April/ May 2021 COD’s of the June 2018 and
21 April 2019 Baselines, to the February/ March timeframe of 2022).

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Q: CAN YOU ADD TO YOUR ANALYSIS TO PROVIDE A BASIS FOR THE UNIT 4 NOVEMBER 2022 COD ALSO BEING AT SIGNIFICANT RISK?

A: That is difficult to assess at this point. VMG’s opinion, however, is that even with the Lessons Learned in planning and executing the Unit 3 work it is questionable that the assumed 1-year duration between the Unit COD’s can be maintained or decreased. For example, the average duration between COD’s at US dual unit nuclear plant sites has been roughly 2 years (as was the case for Vogtle 1 and 2). Further, one would think that in light of the Unit 3 issues, the Unit 4 plan would not simply be a time slipped near replicate of the unachievable Unit 3 plan but would attempt to first plan for completion of more of the bulk construction effort prior to the start of testing.

Q: SO, TO BE CLEAR, VMG’S OPINION – IN LIGHT OF THE DETAILED UNIT 3 SCHEDULE ANALYSIS AND ABOVE COMMENTS REGARDING THE UNIT 4 SCHEDULE -- IS THAT BOTH THE NOVEMBER 2021 AND NOVEMBER 2022 COD’S ARE AT SIGNIFICANT RISK.

A: Yes, that is correct.

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Cost Analysis and Conclusions

Q. VMG’S ANALYSIS OF THE PROJECT TOTAL PROJECT COST AND WHAT VMG MIGHT ESTIMATE THE TPC TO BE AT PROJECT COMPLETION.

A. VMG sees the main challenges to meeting the TPC of \$ 17.1 billion⁵ are both unfavorable Production Efficiencies and the Schedule delay. With regard to unfavorable production efficiencies, we have a measure of that with the craft labor CPI’s, and with respect to Schedule VMG will include the cost impacts of schedule delays later within this discussion.

Q. PLEASE DESCRIBE YOUR ANALYSES OF UNFAVORABLE PRODUCTION EFFICIENCIES.

A. What we have done in the first part of our cost analysis is to focus on potential cost impacts due to the currently unfavorable production efficiencies and at what cost – unless significant improvements are made – the final TPC may be. This analysis uses the April 2019 Baseline as a benchmark, which forecasts COD’s of May 23, 2021/ 2022. This first part of our analysis, therefore, excludes consideration of the Schedule Contingency for a

⁵ GPC share is \$7.3 billion

1 delay of the COD's beyond these dates, but schedule delay is then considered after this
2 first part of the analysis within VMG's further analyses.
3 Table 7 identifies major Cost Categories which when summed total the TPC of \$ 17.1
4 billion. Also, all of the "Project" identified cost numbers for the "to go" period starting in
5 July 2018 and ending with the Unit 4 COD of November 2022 were taken directly from
6 the SNC Project Management Board meeting slides dated October 30, 2019.

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Table 7



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Not visible from Table 7 is the major components of Construction Cost, which are identified in The Bechtel August Monthly Report (Section 6) as "Craft" (which consists of Direct Labor) and Field Non-Manuals (which consists of Craft Management and other Bechtel support staff). Both of these components vary directly with the CPI. Further, the Bechtel budgeted costs for these numbers reflect a CPI of 1.0. Our detailed analysis,

1 therefore, simply takes the “Project Current EAC” costs from Table 7 and adjusts them by
2 adding the adjustments that VMG calculated for the various CPI’s (reference Table 8 for
3 computation of adjustments as calculated from the Bechtel data). To illustrate, for a CPI
4 of 1.25, adding \$ [REDACTED] to the Project Current EAC of \$ [REDACTED] yields \$ [REDACTED]
5 [REDACTED]. In addition to analyzing at a CPI of 1.25, VMG also analyzed (and repeated this
6 same process) for CPI’s of 1.35 and 1.50.

7
8 **Table 8**

Cost Categories within Bechtel August Monthly Report & Base \$ millions ⁶ to Adjust		Adjustment to the Table 7 (\$ millions) “Project Current EAC’s” for CPI’s of			
Cost Category	Base ⁵ \$ M's	1.0	1.25	1.35	1.5
Craft	[REDACTED]	0	[REDACTED]	[REDACTED]	[REDACTED]
Field Non-Manuals	[REDACTED]	0	[REDACTED]	[REDACTED]	[REDACTED]
Total Amount of Adjustments		0	[REDACTED]	[REDACTED]	[REDACTED]

9
10 **Q: IS THERE ANYTHING ELSE YOU WOULD LIKE TO ADDRESS PRIOR TO**
11 **MOVING ON TO VMG’S CONSIDERATION OF SCHEDULE DELAY**
12 **RELATED COSTS?**

13 A. Yes, in our analysis thus far we have accounted for Construction Risks by considering
14 CPI’s based more on Project experience and how it would be difficult to achieve
15 significant improvements to that experience. Further, the costs of Table 7 assume the
16 aggressive May 23, 2021/ 2022 COD’s are met. Also, by considering CPI’s as we have,
17 we have accounted – to a large degree – for continuing construction risks. As noted in

⁶ Due to Bechtel’s “To Go” budget covering a longer period of time than the “Project To Go Budget”, this [REDACTED] factor was necessary to align the Bechtel Cost Budget with the Project’s Cost Budget.

1 Table 7, however, we have not accounted for any changes to the other cost categories, and
 2 for that reason have included an assumed additional 10% contingency for those cost
 3 categories across all CPIs. That contingency value is an additional \$ [REDACTED] for all CPI's.⁷
 4 This then results in a VMG line item (corresponding to the Project "Total Site Working
 5 Plan"; reference line 6 of Table 7) of \$ [REDACTED] (CPI of 1.25), \$ [REDACTED] (CPI of 1.35), and
 6 \$ [REDACTED] (CPI of 1.5). As one final note, to arrive at a TPC, the prior costs (prior to July
 7 2018) of \$7,880M need to be included in all scenarios. To summarize, please refer to
 8 Table 9. Also, note that no schedule contingency is included in the analysis thus far in
 9 that this analysis assumes meeting the aggressive target May 23, 2021/ 2022 COD's.

10 **Table 9**

VMG Cost Analysis; Summary Cost Table (\$ M's) While Meeting May 23, 2021/ 2022 COD's					
Cost Category	To Go Costs; \$ M's (July 1, 2018 - Completion)				Remarks
	\$ M's	CPI			
		1.25	1.35	1.5	
"Project's" Current EAC (for Construction)	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
VMG Construction Adjustments	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
VMG Adjusted Construction Cost	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	Equals "Project's Current EAC (for Construction) plus VMG Adjustments"
All Other To Go Costs	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
VMG Contingency	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	
VMG Total "To Go" Costs	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	Equals sum of Italicized Text \$ M's and corresponds to Project's "Total Site Working Plan" line item 6 of Table 7.
+ Prior Costs	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	Add to obtain "TPC"
= "s VMG TPC Range	[REDACTED]	[REDACTED]	[REDACTED]	[REDACTED]	Equals sum of Bolded Text \$ M's

11 ⁷ For each of the CPI scenarios of Table 7, VMG Contingency was calculated at 10% of (Subcontractors + All Other Cost), and for each of the three CPI scenarios it equals \$ [REDACTED].

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Q. WITH RESPECT TO VMG’s ASSUMED COST CONTINGENCY OF 10% ON ALL BUT THE CONSTRUCTION COSTS, ARE THERE SPECIFIC ITEMS THAT YOU HAVE IDENTIFIED REGARDING WHAT THESE MAY BE, AND WHY YOU HAVE THEN ASSUMED 10% OF THESE COSTS?

A. Yes, there are specific issues, with primary among them being Subcontracts, and the Deferred “Bow Wave” of work.

With respect to Subcontracts, these include both Bechtel Managed and SNC Managed. For Bechtel Managed, 10 of 27 already have CPI’s greater than 1.0 and Bechtel reporting shows an additional \$ [REDACTED] for Subcontracts. For SNC Managed Subcontracts, SNC is reporting a higher than budget EAC. Also, as the normally experienced “stacking of craft” issue starts to manifest itself during the latter stages of construction, this, in conjunction with the concurrent construction and testing efforts, will only exacerbate the efficiency of the many subcontractors’ simultaneous efforts.

With respect to the Deferred “Bow Wave” of Work, the additional engineering and administrative support efforts to break out systems into subsystems, identify and defer “excepted work”, to package and control “partial releases for test”, and the efforts to re-plan and then execute all of these activities, all have the potential to increase the EAC above what has been budgeted.

1 **Q. PLEASE PROVIDE AN INTEGRATED ANALYSIS OF THE COMBINED**
2 **IMPACTS OF BOTH PRODUCTION INEFFICIENCIES AND SCHEDULE**
3 **DELAYS?**

4
5 A. First recall that our Cost Analysis thus far is based on looking at the baseline plan for
6 meeting the aggressive May 23, 2021/ 2022 COD's and therefore includes no "Schedule
7 Contingency" (which is consistent with the IPS of the Project's April 2019 Baseline).

8
9 Based on this approach, VMG then assumed the SNC provided schedule delay cost of
10 \$100M/ month in developing an integrated analysis of the combined effects of production
11 inefficiencies and schedule delays. An integrated summary analysis of the potential
12 impact of both of these factors on the project TPC is provided in Table 10.

13 **Table 10**
14 **Overall Project Cost Summary**

VMG Analysis of TPC's (\$ M's) For Various CPI's and COD's				
COD's	CPI's			Remarks
	1.25	1.35	1.50	
May 23, 2021/ 2022	\$16,951	\$17,222	\$17,630	Represents current April 2019 Schedule Baseline aggressive May 23, 2021/ 2022 COD's
Nov 2021/ 2022	\$17,491	\$17,762	\$18,170	Represents Commission Approved COD's and is derived by adding the "Project" estimated \$540M Schedule Contingency into the above values.
NOTE: If one were to assume that the "Project" estimated \$100 M/ month schedule delay costs are accurate, to obtain costs beyond the November 2022/ 2023 dates one would simply add \$100M per month to each of the three costs represented by each of the CPI's. VMG believes, however, that this estimate of \$100M per month warrants further review, especially as the project proceeds beyond Unit 3 Mechanical Completion.				

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Q. IS IT CORRECT TO ASSUME, THAT BASED ON YOUR ANALYSIS, EVEN IF THE COMMISSION APPROVED NOV 2021/ 2022 COD'S WERE MET, IT IS POSSIBLE THAT THE \$17.1B TPC WILL BE EXCEEDED?

A. That is correct, primarily due to the challenge of achieving their overall CPI goals, which VMG understands to be 1.25 for Unit 3, and 1.20 for Unit 4.

Q. IT IS ALSO CORRECT TO ASSUME THAT IF THE \$17.1B IS NOT TO BE EXCEEDED, AND IF THE OVERALL PROJECT CPI WERE 1.25, THE PROJECT MAY NEED TO FINISH EARLIER THAN THE NOV 2021/ 2022 COD'S?

A. Yes; based on our current analysis as depicted in the above table, with the COD's having to occur roughly three months prior to the Nov 2021/ 2022 dates (i.e., to save roughly \$300M in schedule related costs, thus reducing the \$17,491M figure to less than \$17,100M).

Q. MR. GRACE, DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does

Education and Certifications

**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)**

**US Naval Polaris Missile Officer School, US Naval Submarine School,
US Naval Nuclear Power School, and US Naval Scuba Diver School**

Professional Engineer (Pennsylvania), Power Generation

Career Highlights

- **Fifty years of hands on technical, management and executive experience with all phases of the Plant Life Cycle (design, licensing, construction, start-up and testing, commissioning, operations and decommissioning). Also, highly experienced in performing economic analyses of projects, facilities, and processes.**
- **Development of New Facilities – Seventeen years of experience with a major U.S. 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. Nearly all of these experiences entailed First of a Kind (FOAK) projects which involved new Nuclear Power Plant Projects and FOAK Chemical Process 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). Subsequently, and as an independent consultant, was contracted by DOE to work as the technical lead working as part of DOE teams that reviewed and certified DOE contractors Earned Value Management Systems. Reviews per the 32 criteria of ANSI Standard 748.**
- **Upgrades to Operational Facilities – Seventeen years of experience with General Public Utilities (GPU) in designing, constructing new or modified systems, testing, training plant**

operators and turning systems over to plant operations. Also, worked with the Nuclear Regulatory Commission (NRC) and state environmental agencies in support of the nuclear and fossil plant licensing and permitting activities.

- **Economic and Costing Studies:** Performed many such studies, examples of which include developing a return of investment model for the DOE Waste Management Office, computing asset value for an existing operating power plant, computing component costs of power plants generating electricity, computing component costs of fabricating nuclear fuel (did this for Westinghouse).
- **Skilled Communicator:** Highly experienced in analyzing and presenting complex technical and economic issues to executive levels of various government agencies (e.g., US Nuclear Regulatory Commission, US Department of Energy, Thai Government, International Atomic Energy Agency, and Public Utility Commissions), and responding to questions in articulate and professional manner.

Prior and Current Project Experiences **(A Partial Listing)**

- **BREI, GPU, and Independent Executive Consultant project experiences have included:**
 - **President of a company created from merging personnel from BREI, Duratek (a nuclear waste management company), and AREVA (a fabricator of nuclear fuel), and contracted to the DOE to design, construct, and operate facilities for disposing of depleted uranium hexafluoride (a by-product of the uranium enrichment process). Project entailed utilizing a patented, FOAK chemical process for taking uranium hexafluoride (UF₆) gas, and converting it to Uranium Oxide (UO_x) with usable Hydrofluoric Acid (HF) as a by-product. Two full scale facilities were designed, have been constructed, and are functioning at the Paducah, KY and Portsmouth, OH uranium enrichment facilities.**
 - **Director of a Nuclear Power Feasibility Study conducted for the nationalized electric utility of Thailand (EGAT) and the Thai government. Study entailed evaluation of commercially available Nuclear Power Plant alternatives, estimates of their capital costs, operating costs, and forecasts of their bus bar costs (in terms of Levelized Cost of Electricity); plant licensing/construction/start-up schedules all leading to licensed**

plant operations; evaluation of nuclear safety issues and risks; and approach to educating and training of personnel. Study entailed evaluation of various commercially available nuclear plant types (i.e., a Boiling Water Reactor, as proposed by Japan/ Hitachi; and four separate types of Pressurized Water Reactors, as proposed by (1) Toshiba/ Westinghouse, (2) Japan/ Mitsubishi, (3) France/ AREVA, and (4) Korea/ KEPCO. Also involved economic studies of alternative electrical energy sources.

- **Executive Consultant / Director of DOE Project Independent Reviews:** The DOE, in pursuit of improved management practices, established an office independent of those managing major DOE projects (i.e., established the Office of Engineering and Construction Management). They then contracted with BREI and others to perform full scope (i.e., technical, cost and schedule) reviews of its projects. All major projects (i.e., larger dollar values) were assigned to BREI, and I assembled the required personnel expertise and directed all of these reviews. Example projects (most of which are FOAK) that were reviewed include the following:
 - **Yucca Mountain Project:** This is the highly political project of the first facility to permanently store High Level Wastes (from both DOE facilities, and mostly Spent Nuclear Fuel from operating nuclear plants). Included in this effort was the first project Life Cycle Cost Estimate.
 - **The National Ignition Facility at Lawrence Livermore Laboratory:** This project consists of 192 high energy pulse laser beams, all fired at the same time at a target the size of a bee-bee. Its purpose is to do research regarding fusion reactions in support of predicting the performance of fusion weapons as they age. The facility is now operational, but actual costs greatly exceeded the budget and schedule, and it is still not functioning at the desired level.
 - **The Mixed Oxide Fuel Facility (MOX Facility) at the Savannah River Site.** This project is based on a French technology and its purpose is to take plutonium from excess nuclear weapons and combine plutonium oxide with uranium oxide to make fuel for commercial nuclear reactors.
 - **The Neutrino Project at Argonne National Laboratory:** This project consists of an accelerator located at Argonne (in the Chicago area) shooting neutrinos through the earth's

crust to a target located in a mine shaft in Minnesota, to study the properties of neutrinos.

- **Numerous Site Cleanup Projects:** During the cold war many of the materials for nuclear weapons were developed via reactors and other facilities, and with the primary criteria being schedule, environmental controls (although somewhat effective) were not nearly as strict as they are today. As a result, there are numerous “legacy wastes” in need of treatment and / or disposal. Cleanup projects reviewed include: (a) Fernald, (b) Rocky Flats, (c) Mound, (d) Oak Ridge, (e) Brookhaven National Laboratory, (f) the Nevada Test Site, (g) Pantex, (h) the Savannah River site, (i) the Hanford Site, and (j) Idaho National Laboratory.
- **Director for the Oyster Creek Nuclear Power Plant Safety and Reliability Upgrade Program:** Valued at over one billion dollars (in current year dollars). Work over a roughly 10-year period included nearly 100 separate projects which were largely the result of Three Mile Island Lessons Learned, NRC Appendix R (fire protection related requirements), required upgrades to the Torus (i.e., part of the containment), and plant reliability projects. Efforts resulted in keeping oldest publicly financed U.S. Nuclear Power Plant operational (had – until September 2018 -- been operating since December 1969).
- **Project Engineering Manager for the Modular High Temperature Gas Cooled Reactor First-of-a-Kind Project.** Contracted to the DOE, the objectives of this FOAK project were to produce tritium in support of U.S. Department of Defense missions, and to demonstrate a new commercial reactor technology.
- **Project Operations Manager for the Accelerator Production of Tritium Project:** This was another DOE contracted FOAK project whose mission was also to produce tritium in support of DOD missions. Project was valued at three billion dollars.
- **Served as the first utility elected Chairman of the Boiling Water Reactor Owners’ Group (BWROG),** and in working with GE, other nuclear industry groups, and the BWR owners developed generic design upgrades to address NRC identified safety issues.
- **Served as on-site manager during completion of construction and demonstration testing of a FOAK proof of concept chemical process for disposing of chemical weapons.**

- **Worked as a team with Cost Plus Consulting, a certified Appraiser, and legal-council, to develop Fitzpatrick Nuclear Station asset values. Working through legal-council, the ultimate client consisted of local municipality taxing authorities, with their objective being to receive favorable and fair taxing of the facilities within their jurisdiction.**
- **Early in my career, I worked in the GPU Plant Licensing Group, and worked with legal-council, state and federal environmental groups, the Nuclear Regulatory Commission and nuclear and fossil plant personnel to develop, implement and maintain acceptable liquid discharge permits (i.e., National Pollution Discharge Elimination System; NPDES permits) and air emissions permits.**
- **Also early in my career I worked within the Comptroller's Office and performed economic analysis of the various elements of a power plants costs (i.e, Fixed, Variable, Fuel, and Recovery of Capital Costs). This was done for fossil and nuclear plants. Also, worked with coal fired plant personnel to develop and implement Corrective Maintenance and Preventative Maintenance Programs.**
- **US Navy, Nuclear Plant Operations Experience: Five years as a submarine naval officer in the U.S. Nuclear Navy as a nuclear trained and qualified Engineering Officer of the Watch (equivalent to a commercially licensed Nuclear Plant Senior Reactor Operator). Also served as Weapons Officer responsible for operational readiness of Polaris-missile and torpedo weapons systems.**

Positions Held

- **US Navy: Served as a naval officer aboard submarines for 5 years following graduation from the US Naval Academy. Positions included engineering department head, weapons officer, and stood watches as Officer of Watch and Engineering Officer of the Watch. Retired from service as a Lieutenant, Sr. Grade (O-3).**
- **General Public Utilities: In 17 years held positions of increasing responsibility, several of which are summarized below (and for which the roles and responsibilities are also described):**
 - **Lead Licensing Engineer: Responsible for licensing and permitting activities for a pressurized water reactor nuclear plant and several coal fired plants.**

- **Senior Analyst, working for the Comptroller:** Analyzed the component costs of the company's generating plants. Also, did efficiency studies of how plant outages were conducted, and working with fossil plant personnel developed and implemented corrective maintenance and preventative maintenance program.
- **Project Engineering Manager:** Responsible primarily for Electrical and Instrumentation & Controls Upgrades to a Boiling Water Reactor (BWR) Nuclear Plant.
- **Director, Engineering Projects:** Responsible for all major projects (both capital, and O&M) for a BWR Nuclear Plant. Also, responsible for developing, prioritizing, and managing the over-all capital budget.
- **Burns & Roe Enterprises, Inc (BREI):** In 17 years with BREI positions of increasing responsibility, several of which are summarized below.
 - **BREI Site Manager** (working at Aberdeen Proving Grounds, for proof of concept testing of a new method of treating/ disposing of Chemical Weapons).
 - **Project Engineering Manager** (for the Modular High Temperature Gas Cooled Reactor (MHTGR) Project).
 - **BREI Site Manager** (working with Booz Allen Hamilton, in support of the DOE Office of Waste Management, in Germantown, Md.)
 - **Project Operations Manager** (for the Accelerator Production of Tritium Project).
 - **Project Manager and Executive Consultant** (for the Independent Project Management Reviews of Major DOE Projects)
 - **Director, Thailand Nuclear Feasibility Study**
 - **President & Project Manager, Uranium Disposition Services, Inc.**
- **Management Consulting Services:** For the past 14 years have had my own consulting company, and have served in various capacities either on my own (Grace Management Consulting Services, LLC) or as part of other consulting companies, on many assignments, some of which are summarized below:

- **Worked in support of a General Electric (GE) proposal to the DOE: The effort resulted in the award of a contract to the GE team to pursue fuel reprocessing studies in support of the Global Nuclear Energy Partnership initiative of the U.S. Government.**
- **Worked under contract to NuScale in support of their development of a “Small Modular Reactor” proposal to the DOE: The effort resulted in NuScale’s initial receipt of a contract award to further pursue the effort.**
- **Working under contract to the DOE, functioned as part of a team of personnel reviewing and certifying major DOE contractors Earned Value Management Systems against the criteria of ANSI Std 748**
- **Worked with Cost Plus Consulting (CPC, LLC) in support of providing a bottoms-up estimate of what it would cost today to build the Fitzpatrick Nuclear Plant. Also, developed a report of that same cost, based on the forecast cost and schedules of other US Nuclear Plants under construction. This was in support of local tax jurisdictions efforts to improve the asset valuation for purposes of securing increased tax revenues.**
- **More recently, as an independent consultant with Critical Technologies Consulting (CTC, LLC), have independently reviewed power plant projects and operations for clients as discussed below.**
 - **Mississippi Public Utility Staff: In support of the CTC role as independent monitor for the Kemper Integrated Combined Cycle (IGCC) project, performed monthly reviews of the project, provided monthly updates of the project status, and provided written and oral expert witness testimony to the Mississippi Public Service Commission in support of rate proceedings.**
 - **Arizona Corporate Commission: Working again with CTC, led and developed a review of the technical, cost and schedule performance of the Four Corners Selective Catalytic Reduction Project, and then provided written and oral testimony in support of rate proceedings to reflect the project being in-service.**
 - **Georgia Public Service Commission (GPSC) Staff: Currently working as a member of a CTC team contracted by the GPSC Staff to serve as the Independent Monitor for the on-going Vogtle Units 3 & 4 Nuclear Project. In this role, perform periodic reviews of performance and both written and oral testimony as an expert witness during the semi-annual reviews of the project by the Georgia Public Service Commission.**