

**BEFORE THE GEORGIA PUBLIC SERVICE COMMISSION
GEORGIA POWER COMPANY
DOCKET NO. 29849**

**Georgia Power Company's Application to Adjust Rates to Include Reasonable and Prudent
Plant Vogtle Units 3 and 4 Costs**

**Basis for the Assertion that Redacted Portions of the Information Submitted
are Protected Trade Secrets**

In support of its Application to Adjust Rates to Include Reasonable and Prudent Plant Vogtle Units 3 and 4 Costs, in Georgia Public Service Commission Docket No. 29849, Georgia Power Company ("Georgia Power" or the "Company") has provided Information in the form of an expert technical report (the "Information"). Certain provisions of the Information are trade secrets of Georgia Power, Southern Company, Oglethorpe Power Corporation, the Municipal Electric Authority of Georgia, and the City of Dalton (collectively, the "Owners"), and their affiliates and contractors. These portions of the Information are protected under Commission Rule 515-3-1-.11.

The trade secret portions of the Information derive economic value from not being generally known to, and not being readily ascertainable by proper means by other persons who can obtain economic value from their disclosure or use. Public disclosure of the trade secret portions of the Information could give competitors and vendors an unfair advantage by showing the Company's individual components of costs, plans, schematics, designs, and models. The resulting economic harm could in turn impair Owners, Owners' affiliates and contractors, and Owners' customers.

More specifically, the trade secret portions of the Information pertaining to the proposed nuclear units that have been redacted contain commodity amounts, construction scheduling, and sensitive design information that is specific to Vogtle Units 3 and 4. The trade secret portions of the Information are considered confidential and proprietary by the Company and its contractors and are not generally known by the public. Revealing these terms would compromise the Company's ability to procure the best cost resources from fuel, labor, equipment, or commodity suppliers in future solicitations. In the event such information were released, it is likely that suppliers for future services and materials would use this Information to set the floor on negotiated pricing or that bidders in future Requests For Proposals would use the trade secret portions of the Information to set the floor in constructing their own bids, thus artificially and inefficiently setting a market price and other generation characteristics for the Company that may not be representative of the best cost or best resource that the market could offer.

Moreover, public release of the trade secret portions of the Information could have adverse economic consequences for the Company. Public release of the trade secret portions of the Information could make potential vendors unwilling or unable to conduct business with the Company. By causing proprietary information to be publicly available, even fewer vendors might be willing to sell to the Company, thus, reducing the opportunity for the Company to purchase the materials or services best suited to meeting its customers' needs, and potentially compelling the Company to deal with a vendor that does not offer the best cost option. This could cause significant

added costs to the Company and ultimately to Georgia Power's ratepayers. Additionally, potential competitors of the Company could use the trade secret portions of the Information to guide purchases from and sales to the Company, thereby gaining an unfair competitive advantage to the disadvantage of the Company's customers. Finally, competitors, investors, and other external stakeholders could use the financial data to determine non-public information on the Owners' financial assumptions, assets, liabilities, and other positions, to the detriment of the Owners, their affiliates, and their customers.

The trade secret portions of the Information are subject to extensive efforts to maintain their secrecy. Only select Georgia Power and Southern Company personnel and their legal counsel are granted access to this information. Those personnel receive access only on a "need to know" basis. If a party outside Georgia Power and Southern Company and their legal counsel are granted access to the trade secret portions of the Information, the party is required to sign a confidentiality agreement.

DOCKET NO. 29849
STATE OF GEORGIA
BEFORE THE GEORGIA PUBLIC SERVICE COMMISSION

IN RE: GEORGIA POWER COMPANY'S APPLICATION TO ADJUST RATES TO
INCLUDE REASONABLE AND PRUDENT VOGTLE UNITS 3 AND 4 COSTS

EXPERT REPORT OF TIMOTHY R. CHITESTER

September 8, 2023

ON BEHALF OF: Georgia Power Company
PREPARED FOR: Troutman Pepper Hamilton Sanders LLP
SUBJECT MATTER: Analysis of Risks Identified in VCM 17

Table of Contents

1	INTRODUCTION	4
2	SCOPE OF WORK	6
3	OVERVIEW OF THE AP1000 FLEET AND THE VOGTLE PROJECT	7
4	DOCUMENTS REVIEWED AND RESERVATION OF RIGHT TO AMEND.....	14
5	DISCUSSIONS WITH PROJECT PERSONNEL.....	15
6	SUMMARY OF CONCLUSIONS	16
7	LESSONS LEARNED.....	17
7.1	CHINA LEAD PLANTS AND VOGTLE.....	17
7.2	UNIT 3 TO UNIT 4 PERFORMANCE	20
7.2.1	Key Milestones.....	23
7.2.2	Unit 4 Annex Building	24
7.2.3	IEEE Electrical Cable.....	25
7.2.4	N&D Quantum Comparison.....	26
7.3	CONCLUSIONS ON LESSONS LEARNED	29
8	VCM 17 KEY RISKS	30
8.1	RISK TRANSITION FROM EPC	30
8.2	IDENTIFICATION OF RISK.....	32
9	ANALYSIS OF RISK 3; THE RISK THAT THE LABOR FORCE AND CRAFT WILL BE UNABLE TO MAINTAIN THEIR PRODUCTIVITY IMPROVEMENTS.....	35
9.1	INDUSTRY PRODUCTIVITY METRICS APPLIED TO VOGTLE	35
9.2	PRODUCTIVITY RISKS AT PLANT VOGTLE.....	38
9.3	EVALUATION OF VOGTLE PRODUCTIVITY.....	43
9.3.1	Degradation of Piping Productivity.....	43
9.3.2	Degradation of Electrical Productivity	45
9.4	CONCLUSIONS ON THE MATERIALIZATION OF RISK 3.....	47
10	ANALYSIS OF RISK 4; THE RISK THAT THE PROJECT WILL BE UNABLE TO CONTINUE TO MEET FOAK CHALLENGES.....	49
10.1	EMERGENT/DEVELOPMENTAL ISSUES	50
10.2	ACTUAL EFFECT OF APPLICATION OF 10 CFR 52	51
10.2.1	Overview of CFR Part 50	52
10.2.2	Overview of CFR Part 52	54
10.2.3	The License Amendment Process	57
10.2.4	Analysis of LARs at Plant Vogtle	61
10.2.5	Impacts of CFR Part 52 on Plant Vogtle	65
10.3	PCCS TANK DESIGN	66
10.3.1	Background.....	66
10.3.2	PCCS Issue Evaluation	69
10.3.3	PCCS Conclusion	70
10.4	AP1000 DC SYSTEM IEEE SEPARATION	70
11	ANALYSIS OF RISK 7; PROCUREMENT RISK:	75
11.1	THE EVOLUTION OF PROCUREMENT RISK	75
11.2	KEY COMMODITY GROWTH.....	76

11.3 TEKLA REBAR MODELING EVALUATION 77

12 ANALYSIS OF RISK 8; UNIDENTIFIED SCOPE RISK 79

12.1 SCOPE GROWTH AT PLANT VOGTLE 79

13 ANALYSIS OF RISK 12; TESTING/STARTUP RISK..... 83

14 LIST OF ATTACHMENTS..... 85

15 LIST OF APPENDICES 85

1 INTRODUCTION

1. My name is Timothy R. Chitester. I am a registered professional engineer in the United States with over 45 years of experience in the engineering, design, and construction industry. I have spent over 25 years of that time in design build roles for nuclear projects including with Bechtel Power Corporation and Stone & Webster Engineering Corporation.
2. I have actively worked on site of four nuclear power projects during construction, commissioning, and 1st fuel cycle, including filling utility roles as a supervisor of nuclear design and as a director of nuclear design. In several of these roles I have provided support to the owner/co-owners in state prudence reviews after construction completion.
3. I have provided engineering and construction services on an additional 12 nuclear plants to produce and implement engineering design basis management and modification installation management.
4. In addition, I have provided consulting services to both contractors and owners on advanced reactor, First of a Kind projects including the AP1000, ABWR, and EPR.
5. I am currently providing both advisory and consulting services on post Fukushima Station Blackout projects as well as Steam Generator replacement and Calandria Tube replacement projects.
6. During my years in the industry, I have managed a surety takeovers construction management company where I became familiar with the requirements and difference in managing a “take-over” project versus a grass roots project such as occurred with Vogtle.
7. I am recognized as a construction and consulting expert and I have testified in federal court, state court, AAA arbitration, ICDR arbitration, ICC arbitration and other international forums. I have also testified in an enforcement conference in front of NRC regional officials.
8. I confirm that, insofar as the facts stated in this Report are within my knowledge, I have made clear which they are, and I believe them to be true, and that the opinions I have expressed represent my true and complete professional opinions.
9. I understand that this Report, subject to any corrections before swearing as to its correctness, will form the basis of the evidence to be given under oath or affirmation.

10. My work has included assimilation, study and analysis of documents associated with the technical issues of the Project. This Report summarizes my effort and draws conclusions from the study and understanding of these issues.
11. My full CV is provided in Attachment 1.



Timothy R. Chitester
Partner
One Commerce Square
2005 Market Street, Suite 820
Philadelphia, PA 19103

September 8, 2023

2 SCOPE OF WORK

12. I have been asked by Troutman Pepper, counsel for Georgia Power Company (GPC), to provide an assessment on the key risks identified in Vogtle Construction Monitoring Report (“VCM”) 17 and discuss what, if any, of the key risks may have played a role in the construction completion of Vogtle Units 3 & 4, after VCM 17 was accepted by the Georgia Public Service Commission (“PSC”).
13. My Report addresses the risk associated with a sample of technical issues experienced between February 28, 2018, and August 31, 2022, which are the dates of VCM 18¹ through VCM 27,² respectively.
14. VCMs were issued by Georgia Power Company to the Commission on a semi-annual basis pursuant to O.C.G.A. § 46-3A-7(b), Commission Rule 515-3-4-.07(2)(b), and the Commission’s Final Order in Docket No. 27800. The semi-annual VCMs provided the status for Unit 3 and Unit 4 with regard to engineering and construction progress, cost, schedule, quality and compliance, and risk, amongst others.
15. Accordingly, I have performed an independent evaluation of Plant Vogtle (“Project”) Unit 3 and Unit 4, and formulated conclusions as summarized in Section 6 of my Report. My conclusions are based on analysis in accordance with my scope of work as detailed in Section 7 through Section 13 of my Report.
16. My Report does not identify or quantify specific Vogtle Project experienced schedule delays and cost increases. Prudence of cost and schedule are addressed in other expert reports by HKA experts for cost (Ms. Kimberly Reome) and schedule (Mr. Mark Gentry).

¹ VCM 18.

² VCMs 19, 20, 21, 22, 23, 24, 25, 26, and 27.

3 OVERVIEW OF THE AP1000 FLEET AND THE VOGTLE PROJECT

17. The Advanced Passive 1000 (AP1000) is a nuclear Pressurized Water Reactor (“PWR”) designed and sold by Westinghouse Electric Company (“Westinghouse”). At its heart, its design is considered to be an advancement to the technology of its predecessor, the AP600, and incorporates a class of Generation III+ reactors equipped with improved thermal efficiency, increased passive safety, efficiency-based fuel technology, and constructed within smaller, consolidated footprints.
18. This Section of my Report discusses the Westinghouse AP1000 and its emergence as a First of a Kind (“FOAK”) fleet design across the United States and abroad. As discussed later in this Report, many of the initial positions asserted by Westinghouse proved, over time, to be optimistic, at best. I will demonstrate in this Report how a number of items, identified as possible risks in VCM 17, actually materialized over the duration of Project construction.
19. Westinghouse presented the AP1000 as a solution rooted in simplification and standardization of the traditional PWR.³ The means to achieve this standardization included methods such as using the same suppliers for all engineered components, standardized building teams, an overlying organization structure to manage and determine plant configuration, and perhaps most importantly, a 100% complete design.⁴
20. What this ultimately meant was a reduction in components in comparison to conventional 1000 MW PWRs. The Westinghouse sales strategy represented the AP1000 as “the best solution for new plants”⁵ and characterized the technology as an elite and unequaled design with passive safety systems, multiple levels of defense, and advanced controls.⁶
21. The simplified plant arrangement of the AP1000 allowed the Nuclear Island to be the only Seismic Category 1 structures. This arrangement was directly adjacent to its support structures which consisted of the Turbine, Annex, Diesel Generator, and Radwaste buildings.⁷ A proximity plan comparing the older Generation II plant layout to that of the AP1000 is presented in Figure 1, below.

³ AP1000 Presentation to Nuclear Institute – Western Branch, prepared by Westinghouse Head of Stakeholder Relations, dated November 16, 2010.

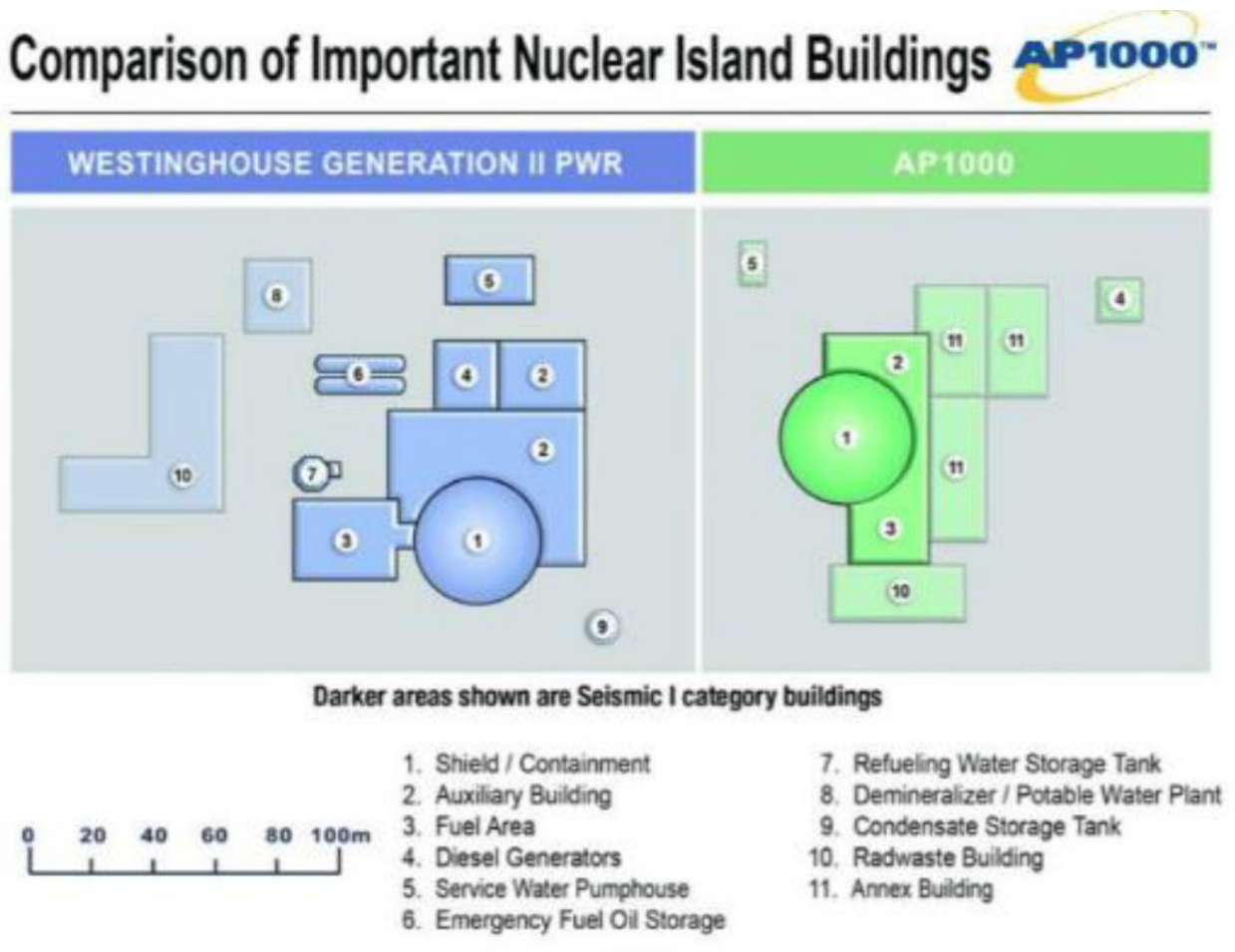
⁴ Id., p. 7.

⁵ Ibid.

⁶ [Nuclear Safety | Westinghouse Nuclear](https://www.westinghousenuclear.com/energy-systems/ap1000-pwr/safety), [www.https://www.westinghousenuclear.com/energy-systems/ap1000-pwr/safety](https://www.westinghousenuclear.com/energy-systems/ap1000-pwr/safety)

⁷ Westinghouse AP1000 Brochure, prepared by Westinghouse Electric Company, LLC., Westinghouse AP1000 Brochure.pdf, dated 2007, p. 13.

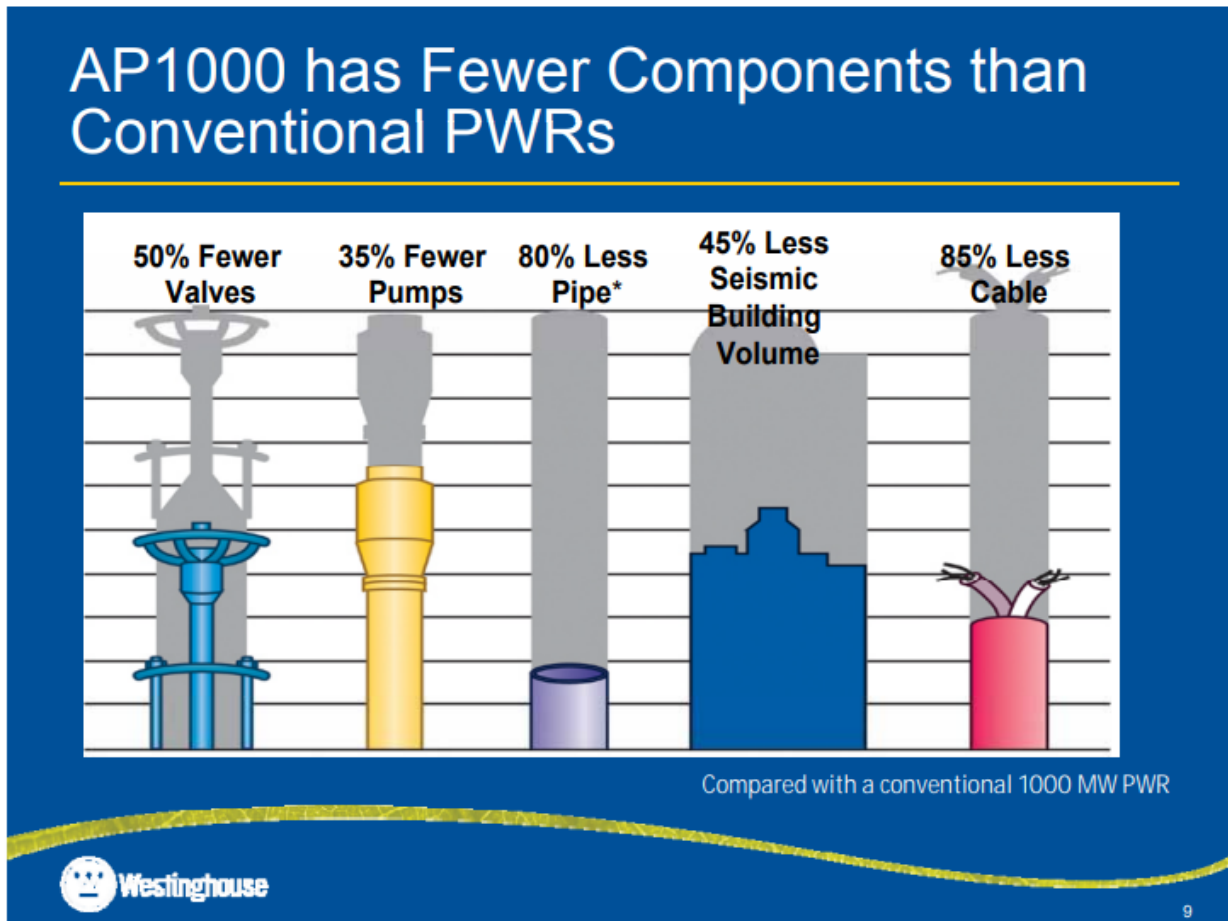
Figure 1: Building Proximity Comparison



22. In comparison to the Generation II plants, the building proximity promised to result in numerous material savings. Figure 2, below, presents an extract of these material savings as presented by Westinghouse to the Western Branch of the Nuclear Institute in November 2010.⁸

⁸ AP1000 Presentation to Nuclear Institute – Western Branch, prepared by Westinghouse Head of Stakeholder Relations, dated November 16, 2010, p. 8.

Figure 2: Westinghouse Presentation to the Nuclear Institute



23. According to Westinghouse, this component reduction, coupled with a streamlined construction attributable to a module-based construction system comprised of 300 individual components allowed the AP1000 to be built within a 36-month construction timeline.⁹ Capability developments to model the construction using advanced software was to result in an optimized and choreographed construction plan, leading to “a very high confidence in the construction schedule.”¹⁰
24. Additionally, Westinghouse’s promotional brochures characterized the AP1000 to have an “Overnight Construction Cost” designed to reduce capital costs and to be economically competitive when compared to a traditional fossil-fuel plant.¹¹ Westinghouse represented the AP1000 as a solution with economic

⁹ Id., p. 12

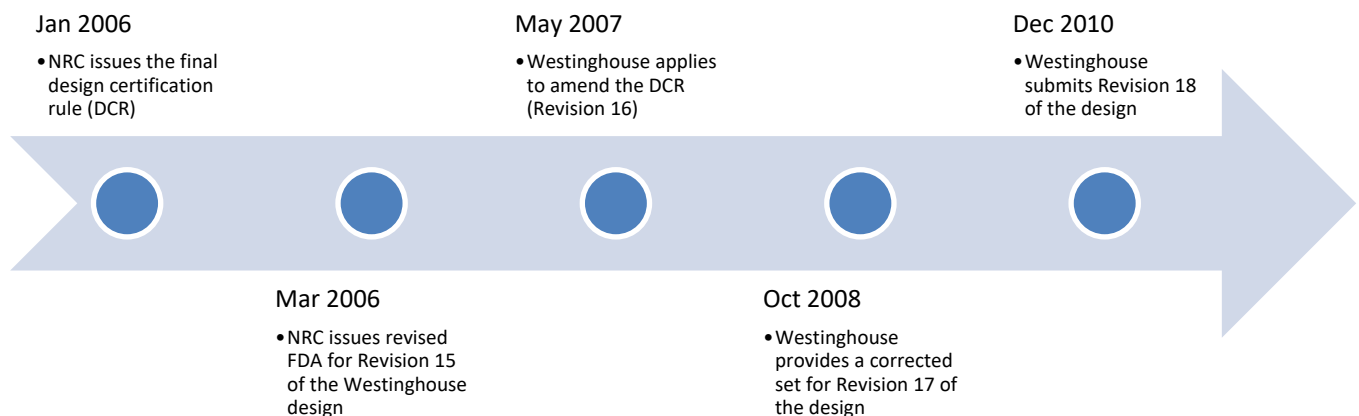
¹⁰ Westinghouse AP1000 Brochure, prepared by Westinghouse Electric Company, LLC., Westinghouse AP1000 Brochure.pdf, dated 2007, p. 13.

¹¹ Ibid.

benefits, acknowledging that the two main drivers of plant construction were the cost of construction financing coupled with the need for substantial skilled craft labor hours needed on site.¹²

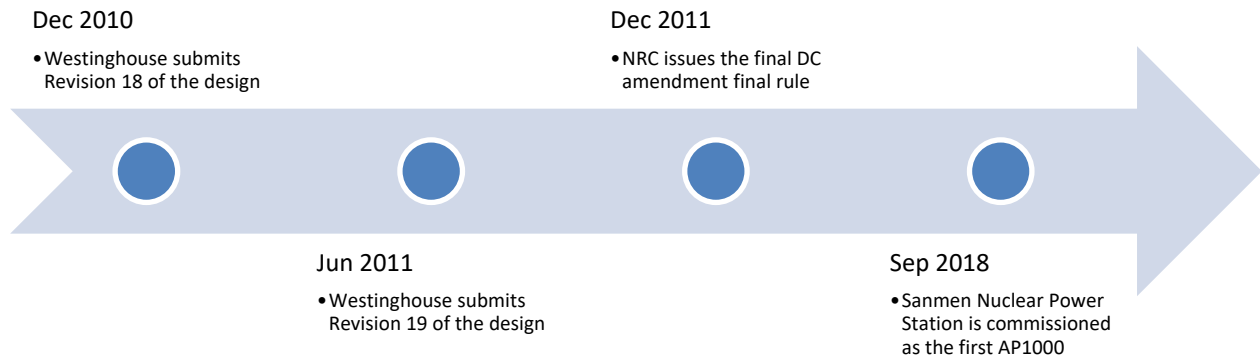
25. The Nuclear Regulatory Commission (“NRC”) approved Westinghouse’s AP1000 final design certification in December 2005. This approval allowed prospective builders to apply for a Combined Construction and Operating License specified and governed by the NRC Regulations Title 10, Code of Federal Regulations Part 52 (“10CFR52”).¹³ A chronology of the AP1000 certification to first commissioning is shown in Figure 3, below.

Figure 3: Chronology from Certification to First Commissioning of the AP1000



¹² [Nuclear Safety | Westinghouse Nuclear](https://www.westinghousenuclear.com/energy-systems/ap1000-pwr/safety), [www.https://www.westinghousenuclear.com/energy-systems/ap1000-pwr/safety](https://www.westinghousenuclear.com/energy-systems/ap1000-pwr/safety)

¹³ [PART 52—LICENSES, CERTIFICATIONS, AND APPROVALS FOR NUCLEAR POWER PLANTS | NRC.gov](https://www.nrc.gov/part-52)



26. Vogtle Units 3 and 4 represent two of the eight units in the first Fleet of AP1000 plants around the world. Southern Company's Georgia Power subsidiary, Oglethorpe Power Corporation, Municipal Electric Authority of Georgia, and the City of Dalton through Dalton Utilities share ownership interests for Vogtle Units 3 and 4. A photograph of Units 3 and 4 in July 2022 is reproduced as Figure 4 below.¹⁴

¹⁴ [WCK_8755.jpg \(6048x4032\) \(georgiapower.com\)](#), photo courtesy of Georgia Power Company.

Figure 4: Vogtle Units 3 and 4



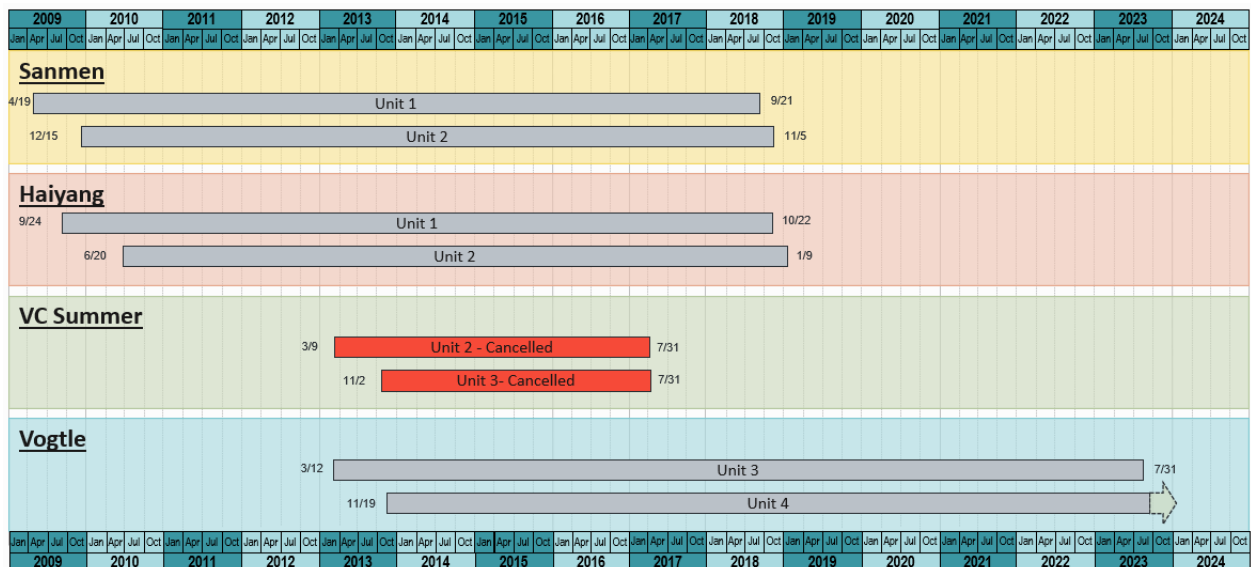
27. The FOAK AP1000 Fleet is currently comprised of eight units. Six of the units are either operational or near completion, and two units have been halted and abandoned following Westinghouse bankruptcy. Where I have referred throughout this Report to the “Fleet”, I define that to collectively indicate all eight AP1000 units. A summary overview of the Fleet is tabulated in Table 1, below.

Table 1: Westinghouse AP1000 Fleet

Westinghouse AP1000 Fleet							
Item	Plant Name	Location	Cooling Source	Units	Year Started	Operation Start	Status
1	Sanmen Nuclear Power Station	Sanmen County, Zhejiang, China	Shefan Channel	1	2009	2018	Operational
2				2	2009	2018	Operational
3	Haiyang Nuclear Power Plant	Haiyang, Shandong, China	Yellow Sea	1	2009	2018	Operational
4				2	2010	2019	Operational
5	Virgil C. (VC) Summer Nuclear Generating Station	Fairfield County, South Carolina, USA	Monticello Reservoir	2	2013	Cancelled	N/A
6				3	2013	Cancelled	N/A
7	Alvin W. Vogtle Electric Generating Plant	Burke County, Georgia, USA	Savannah River	3	2013	2023	Operational
8				4	2013	2024 (E)	Start-up Testing

28. Establishing these four sites (eight units to be constructed) as the collective Fleet, utilizing the same base design for the Nuclear Island, is particularly important for this technical evaluation. This is primarily due to the four sites progressing in parallel with the China units starting first then followed by the US units, thus allowing for lessons learned from the lead plants (China) to be applied to the follow-on plants (US). This chronology is presented in Figure 5, below.

Figure 5: Westinghouse AP1000 Fleet Construction Timeline



4 DOCUMENTS REVIEWED AND RESERVATION OF RIGHT TO AMEND

29. The observations and conclusions provided in this Report are based primarily on the relevant Project documents requested by HKA and made available and provided to HKA by Troutman Pepper.
30. To perform the evaluation, HKA was provided access to the contemporaneous project records and related documentation including but not limited to:
- Contracts and Agreements
 - Project Correspondence and emails
 - Project Reports, Presentations and Meeting Minutes
 - Industry Standards
 - Expert Reports from previous Commission hearings
 - Affidavits from previous Commission hearings
 - Technical Drawings, Specifications, and Design Documents
31. Where a specific document was relied on, it has been referenced in a footnote. A specific summary list of the footnotes is set forth in Attachment 2.
32. I reserve the right to supplement, correct or amend this Report based on any information received or learned after this Report has been issued.

5 DISCUSSIONS WITH PROJECT PERSONNEL

33. The HKA team has had discussions with key SNC and GPC Project personnel as tabulated, to the best of my recollection, in Table 2, below.

Table 2: Discussions with Key Personnel

No.	Name	Title
1	Redacted	Regulatory & External Affairs Project Manager
2		Business Operations Director
3		Engineer
4		Manager
5		Vice President of Project Controls
6		Project Oversight Director
7		Nuclear Development Regulatory Support
8		Business Operations Commercial Support Lead
9		Business Operations Commercial Manager

6 SUMMARY OF CONCLUSIONS

34. After evaluating the facts and applying generally accepted standards in the engineering and construction industry, I have concluded that:

34.1 The Lessons Learned programs created a positive feedback mechanism on the Project and contributed to improved performance on Unit 4 (Report Section 7).

34.2 A number of Key Risks, outside of SNC's control, were identified at the time of VCM 17 and materialized on the Project, (Report Section 8), including:

- Trade labor productivity (Report Section 9),
- FOAK Challenges (Report Section 10),
- Risks in Procurement (Report Section 11),
- Unidentified Scope (Report Section 12), and
- Risks during Testing/Startup (Report Section 13).

34.3 Overall, it is my opinion that the actions and mitigation undertaken by SNC to finish construction and startup of Unit 3 and Unit 4 at Vogtle were reasonable and prudent.

7 LESSONS LEARNED

7.1 CHINA LEAD PLANTS AND VOGTLE

35. In Section 3 of this Report, I discussed how the Fleet utilized the same base design for the Nuclear Island. The China units commenced first and the U.S. units, Vogtle and V.C. Summer, progressed in parallel, allowing for lessons learned (“LL”) from the lead AP1000 plants (China) to be applied to the follow-on plants (US).
36. Both the Vogtle Owners and Bechtel implemented a formal Project program for integrating the China lead plants LL into the Project’s LL database. Since Unit 3 started prior to Unit 4, the Project used LL from the China units for Unit 3. In an effort to facilitate continuous improvement, the Project also used LL from Unit 3 to apply on Unit 4.
37. Bechtel implemented LL procedure¹⁵ and program that was actively used on the Project. Bechtel defines LL as:

“Lessons Learned - Collective knowledge and experience gained from individual, project, functional, department events or items that affect, either negatively or positively, technical performance, adequacy, safety, quality, risk, schedule efficiency, or cost of work execution. Lessons Learned include successful practices, things to avoid, cautions, potential improvements based on current experience, technological information, and intelligence on suppliers, localities, and regulatory requirements.”¹⁶

38. Furthermore, the purpose of the LL procedure was to:

“Establish the requirements and process for identifying, initiating, submitting, reviewing, and sharing Lessons Learned for Vogtle Units 3 & 4 Construction Completion Project.”¹⁷

39. Bechtel’s LL procedure provides the LL responsibilities for its Project Director, Project Quality Manager, Initiator, and LL Coordinator, as well as the requirements of the Vogtle Units 3 and 4 site LL work process. LL are not limited only to those experienced on Units 3 or 4, but also include outside sourced LL. The outside sourced LL are those that are:

“... sent to Vogtle for project review to determine if the lesson is applicable to the project shall be evaluated by the appropriate function. All Lessons Learned sent for project review shall be tracked to completion. If the Lessons Learned is determined to be applicable to project, the Lessons Learned Coordinator shall be notified, and the lesson shall be institutionalized.”¹⁸

¹⁵ General Project Procedure, Lessons Learned, 26139-000-GPP-GAQ-00001, Revision 002, Effective Date June 29, 2021.

¹⁶ Id., p.1.

¹⁷ Ibid.

¹⁸ Id., p.4.

40. The outside sourced LL are reviewed to determine if they should be inputted into the Project's LL database. Condition Reports ("CRs") and Engineering Service Requests ("ESRs") are also evaluated to determine if they should be added to the Project's LL database.¹⁹

41. Similarly, SNC implemented a Construction Experience Procedure²⁰ that was actively used on the Project. SNC stated the procedure's purpose as follows:

"This procedure defines the Construction Experience (CE) program and associated roles and responsibilities. It provides direction for receiving, screening, processing, evaluating, implementing, and distributing Operating Experience (OE), Lessons Learned (LL), and CE to prevent or mitigate the occurrence of similar events at Vogtle Units 3&4. OE/CE obtained from external (industry OE/CE) and internal construction events are included in this procedure."²¹

42. SNC defined LL as:

*"**Lessons Learned** - Activities related to the act of learning from utilities, contractor, or government agencies (i.e. INPO, WANO, NRC, Construction, Operating/Construction Experience, etc.) to achieve improvements, reduce the risk of repeating mistakes, and increase the chance that successes are repeated."²²*

43. SNC addressed that "anyone can identify LL"²³ and if a LL is identified, a CR should be generated in MAXIMO.^{24 25} The LL program was used to funnel LL experienced from the AP1000 Fleet in China into Vogtle via CRs. The LL process was continuously evolving and was used as a method to help inform Project teams on previous and current issues experienced by the Fleet.

44. The flowchart in Figure 6, below, demonstrates the general process of how a LL on the lead Fleet units could develop into an E&DCR affecting the Vogtle units. If it was determined that a Chinese AP1000 LL related to the Vogtle Project, it was further evaluated to determine if a CR should be created to track the LL. If so, then a Technical Evaluation ("TE") of the CR was performed to determine if it should develop into an ESR. If it was determined that an ESR was needed, it was evaluated to determine if an E&DCR should be created. Note that at each phase, the document can either evolve into the next stage or end at its current stage.

¹⁹ Ibid.

²⁰ Southern Company Procedure, Construction Experience Program, ND-AD-VNP-004, Version 12.1, Effective Date May 1, 2020.

²¹ Id., p. 14.

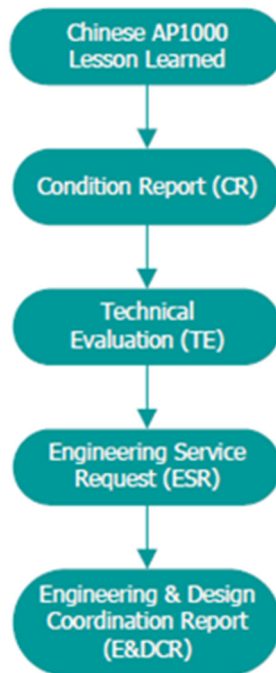
²² Id., p. 5.

²³ Id., p. 8.

²⁴ Ibid.

²⁵ MAXIMO is the Project's document management database.

Figure 6: Chinese AP1000 LL to E&DCR Process



45. Within the Project record, I have found at least 58 LL from the China projects that further evolved into CRs. A sample of the Chinese LL and their corresponding CR is shown in Figure 7 below, and more comprehensively in Appendix A.

Figure 7: Abbreviated List Chinese AP1000 Lessons Learned

Redacted

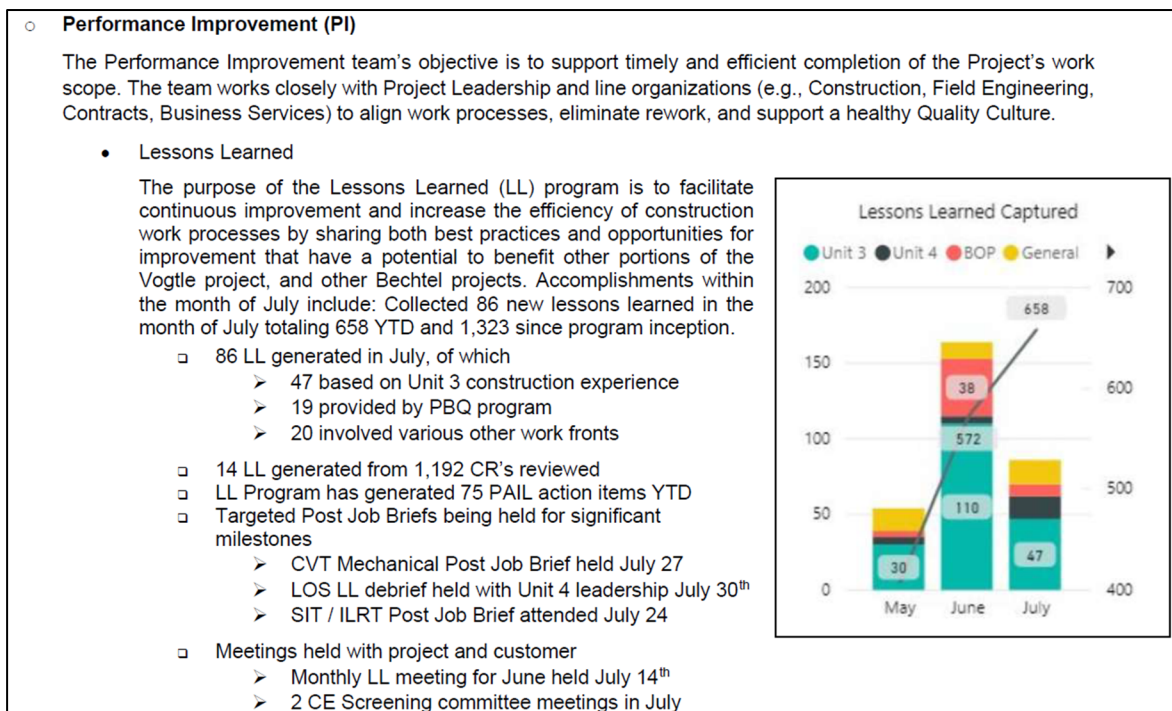
7.2 UNIT 3 TO UNIT 4 PERFORMANCE

46. I understand that in addition to its installation performance factors, Fluor's Basis of Estimate ("BOE") considered a conservative 12.5% performance improvement between Unit 3 and Unit 4, as reflected in VCM 17:

*"The Southern Nuclear ETC uses the Fluor base performance factors, which include a 12.5% performance improvement from Unit 3 to Unit 4. This improvement is conservative when compared to historical data, which has shown a 34% improvement from Unit 3 to Unit 4."*²⁶

47. The Project Monthly Status Reports ("MSRs") *Quality Status* section included updates of Bechtel's *Performance Improvements (PI)* that summarized the LL program updates by providing the total of new monthly LL, total LL year-to-date, and total LL since Project inception. For example, LL updates from the July 2020 MSR, February 2021 MSR, and August 2022 MSR are shown below in Figure 8, Figure 9, and Figure 10, respectively. The MSR updates demonstrate the LL program actively evolving over time to achieve improvements on AP1000 units.

Figure 8: LL from July 2020 MSR²⁷



²⁶ VCM 17, p. 47.

²⁷ Monthly Status Report – July 2020 (Part 1 of 2), p. 24.

Figure 9: LL from February 2021 MSR²⁸

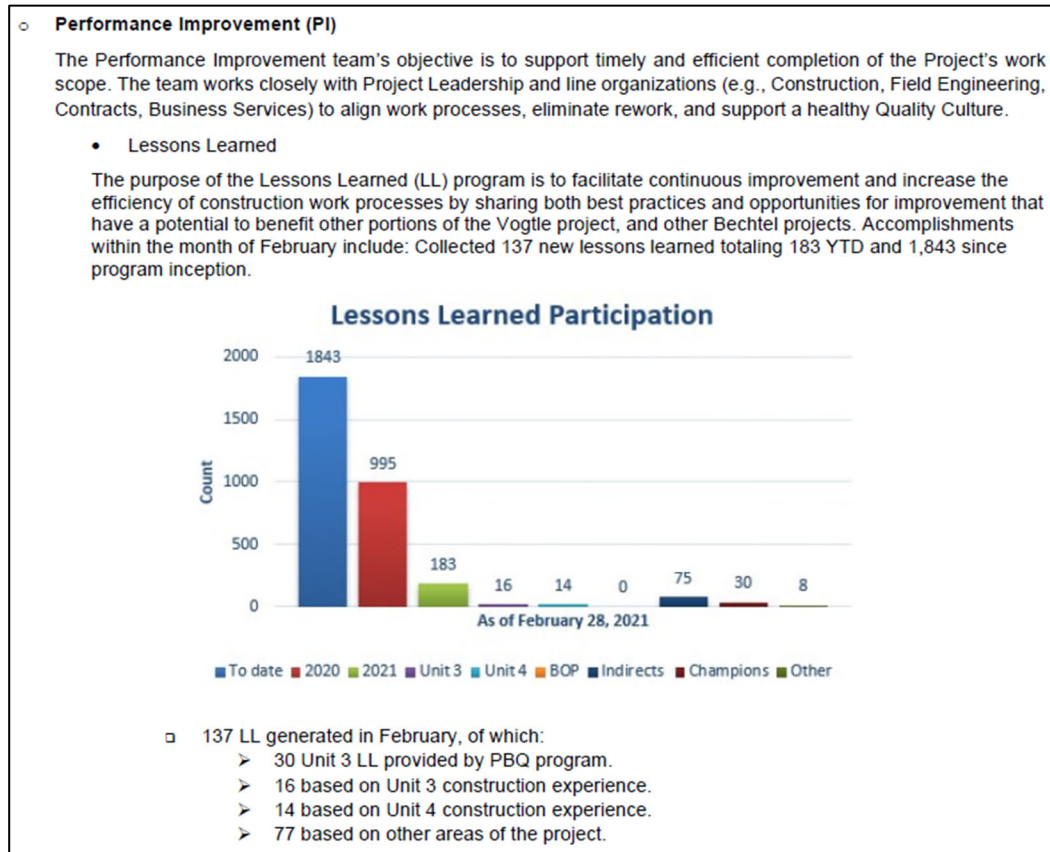
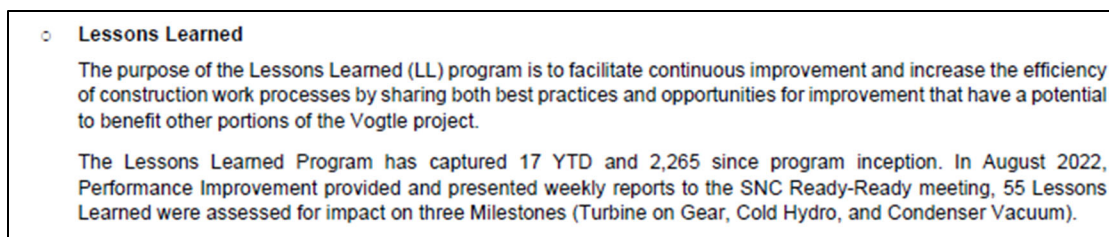


Figure 10: LL from August 2022 MSR²⁹



48. The MSRs included updates regarding using Unit 3 LL and how they were being used to help improve Unit 4 performance. I reviewed LL from the March and August MSRs between 2018 and 2022. A sample of the Unit 3 LL as they apply to Unit 4 is shown in Figure 11 below and more comprehensively in Appendix A.

²⁸ 26139-000-TC-GAM-00297 Transmittal - Monthly Status Report for February 2021 (Part 1 of 2), p. 23.

²⁹ 26139-000-TC-GAM-00387 Transmittal - Monthly Status Report for August 2022 1 of 2, p. 27.

Figure 11: Unit 3 Lessons Learned Applied to Unit 4 as Identified in Monthly Status Reports

Redacted

49. LL were also captured on a semi-annual basis within VCM 18 through VCM 27. I provide a few examples below of the LL addressed in VCMs. Refer to Appendix A for a comprehensive list of the LL captured in VCM reports.

*"The Company will continue to monitor and observe testing and start-up events at AP1000 nuclear plants in China. Lessons learned will be captured and incorporated into the Project, which will ensure any First of a Kind ("FOAK") obstacles observed in China are avoided."*³⁰

*"Construction on the Unit 4 Annex building has greatly benefitted from lessons learned on Unit 3 with construction sequences for the setting of walls and floors and efficiencies in system and equipment turnovers."*³¹

*"The Unit 4 Auxiliary Building has also gained valuable lessons learned from Unit 3, leading to the completion of several milestones."*³²

"Unit 4 continues to improve production by integrating lessons learned from Unit 3. Strategies include design and fabrication of modules outside of the Unit to reduce required activities in congested areas and allow for simultaneous progress. Additionally, Unit 4 has enhanced the commodity sequencing and installation execution by adapting the construction plan to incorporate experience gained from Unit 3 testing."

³⁰ VCM 18, p. 8.

³¹ VCM 19, p. 31.

³² VCM 20/21, p. 31.

Furthermore, the sequence of Unit 4 Project milestones has been adjusted to integrate testing experience from Unit 3.”³³

“Unit 4 personnel continue to receive training regarding IEEE-384 standards to reinforce lessons learned from Unit 3 and to bolster the Project’s focus on first-time quality for electrical installation.”³⁴

50. As of August 2022, the Project captured a total of 2,265 LL³⁵ and as of January 2023, the Project captured 2,598 LL.³⁶ I reviewed the LL and segregated them into the following building categories: Annex, Auxiliary, Containment, Shield, Turbine, Radwaste, Main Control Room, and Diesel Generator. I was also able to segregate the LL into ones related to CHT and HFT, IEEE, and other issues. Refer to Appendix A for my LL analysis segregated into categories.

51. In order to determine if Unit 3 LL improved Unit 4 Project performance, I have compared Unit 3 and Unit 4 data in key areas identified in the sample VCMs quoted above, including:

- Key Milestones
- Unit 4 Annex Building
- IEEE Electrical Cable
- N&D Quantum Comparison

7.2.1 Key Milestones

52. In order to determine if the Project record supports an improvement in the milestone dates between Unit 3 and Unit 4, I compared milestone planned start and finish dates from the June 2, 2018, baseline schedule to the actual start and finish dates from the May 26, 2023, schedule. The key milestone driving the completion of construction and achieving Fuel Load for Unit 3 and Unit 4 is the Hot Functional Test.

53. The Unit 3 HFT started on April 25, 2021 and completed on July 28, 2021 for a total actual duration of 94 days.³⁷

³³ VCM 23, p. 30.

³⁴ VCM 27, p. 23.

³⁵ August 2022 Monthly Status Report, p. 27.

³⁶ January 2023 Monthly Status Report, p. 27.

³⁷ Bechtel May 2023 Monthly Status Report, p. 3

54. The Unit 4 HFT started on March 20, 2023 and completed on May 1, 2023 for a total actual duration of 42 days.³⁸
55. The Unit 4 HFT was accomplished in less than half the time as the Unit 3 HFT and represents an effective application of Lessons Learned between the Units.

7.2.2 Unit 4 Annex Building

56. Annex Building LL identified during construction of the Unit 3 Annex Building that were applied during the construction of the Unit 4 Annex Building was one of the Project's areas of focus.
57. Key Annex Building LL are summarized below:
- Resequencing of Unit 4 work activities to improve constructability and efficiency,
 - Implementation of Unit 3 design changes to Unit 4 prior to commencement of the work,
 - Improved scaffolding planning to prevent the excessive erection and dismantling of scaffolding experienced in Unit 3, and
 - Additional QC resources to improve work buy-off efficiency.
58. For a comparison of productivity between the Unit 3 and Unit 4 Annex Building, I have focused on the larger skilled trades, namely electrical and piping bulk commodities within the buildings.
59. I have reviewed CPI indices, as further described in Section 9 of this Report, to form the basis of my evaluation. CPI indices have been extracted from multiple sources³⁹ of Scorecards up until about April 2023, which was the last Scorecard available to me at the time of this Report.
60. First, I have reviewed the data contained in the Scorecards to evaluate CPI in connection with installation of large bore piping and supports.⁴⁰ Based on this review, I have determined that piping CPI at about April 2023 is reported as 1.73 and 1.28, for Unit 3 and Unit 4, respectively.

³⁸ Bechtel May 2023 Monthly Status Report, p. 3

³⁹ I have relied on two sources for this data. For data after about March 2019, I have relied on the individual scorecard documents made available to me. These files did not exist, or otherwise were not available, prior to March 2019. For the period preceding March 2019, I have instead relied on an excel tabulation of scorecard data, imported by others and provided to me ("Scorecard Import").

⁴⁰ For purposes of this dataset, I have considered the following Scorecard categories: A/G Large Bore Pipe, A/G Large Bore Pipe Supports.

61. Second, I have reviewed the data contained in the Scorecards to evaluate CPI in connection with electrical bulk⁴¹ installation over the duration of the Project. Based on this review, I have determined that electrical CPI at about April 2023 is reported as 1.87 and 1.78, for Unit 3 and Unit 4, respectively.
62. In both cases of piping and electrical commodities, it is evident that LL during installation at Unit 3 reasonably contributed to improved installation at Unit 4. While CPI indices at both units were still higher than the target baseline of 1.0, a productivity improvement was recognized between the two units during construction of the Annex.

7.2.3 IEEE Electrical Cable

63. Construction quality issues requiring remediation work slowed primarily electrical commodity installation progress on Unit 3 beginning in early 2021. As the root cause of the issue was investigated and identified, the Project team facilitated the opportunity to reinforce LL from Unit 3 to enhance the focus of quality issues of electrical installation in Unit 4. A few of the LL related to IEEE from Unit 3 applied to Unit 4 are:

"To focus on the cable pulls between buildings and utilizing lessons learned from Unit 3, dedicated cable pulling teams have been created...The team continues to review lessons learned from Unit 3 and incorporate into the schedule and execution plans."⁴²

"Specific Crews are focused on raceway buy off on lessons learned from Unit 3, centered around IEEE 384."⁴³

"A Unit 4 productivity improvement plan is being implemented with actions assigned in engineering, procurement, and construction, based on lessons learned from Unit 3 and continued improvement processes...Specific crews are focused on raceway buy off on lessons learned from Unit 3, centered around IEEE 384, Roxtec installations and PMS installations."⁴⁴

"Lesson Learned #2022: "...cables bundles together and ty-rapped together. No cable separation... Maintain proper cable separation."⁴⁵

64. As a result of this heightened focus on quality, the Project team required all electrical resources attend specific training for IEEE installation requirements and other quality requirements, work package closure, and instrumentation installation. Rework was minimized by applying electrical terminations LL to Unit 4 as well. In addition to getting the licensing team into the field earlier and engaged with the

⁴¹ For purposes of this dataset, I have considered the following Scorecard categories: Cable, Cable Tray, Cable Tray Supports, Conduit, Conduit & Supports, Conduit Supports, and Scheduled Conduit. Electrical equipment, instrumentation and terminations have not been considered herein.

⁴² Bechtel August 2021 Monthly Status Report, p. 58.

⁴³ Bechtel October 2021 Monthly Status Report, p. 8 and Bechtel November 2021 Monthly Status Report, p. 8.

⁴⁴ Bechtel March 2022 Monthly Status Report, p. 10.

⁴⁵ CTRL0000018112.

highest-risk work on a regular basis, the team also performed targeted inspections to reduce the amount of rework, improve first-time quality, and provide early identification of resources that required additional training. As more new resources completed training and more Unit 3 resources were transferred to Unit 4, the first-time quality improved on Unit 4.

65. In order to quantify the effects of these LL, I have similarly reviewed the data contained in the same set of Scorecards to evaluate CPI in connection with installation of electrical bulk commodities⁴⁶ within the Nuclear Island.⁴⁷
66. Based on this review, I have determined that electrical CPI at about April 2023 is reported as 4.16 and 2.92, for Unit 3 and Unit 4, respectively.
67. Similar to my observations in Section 7.2.2, it is evident that LL during installation at Unit 3 reasonably contributed to improved installation at Unit 4. While CPI indices at both units were still higher than the target baseline of 1.0, a productivity improvement was recognized between the two units during construction of the Nuclear Island.

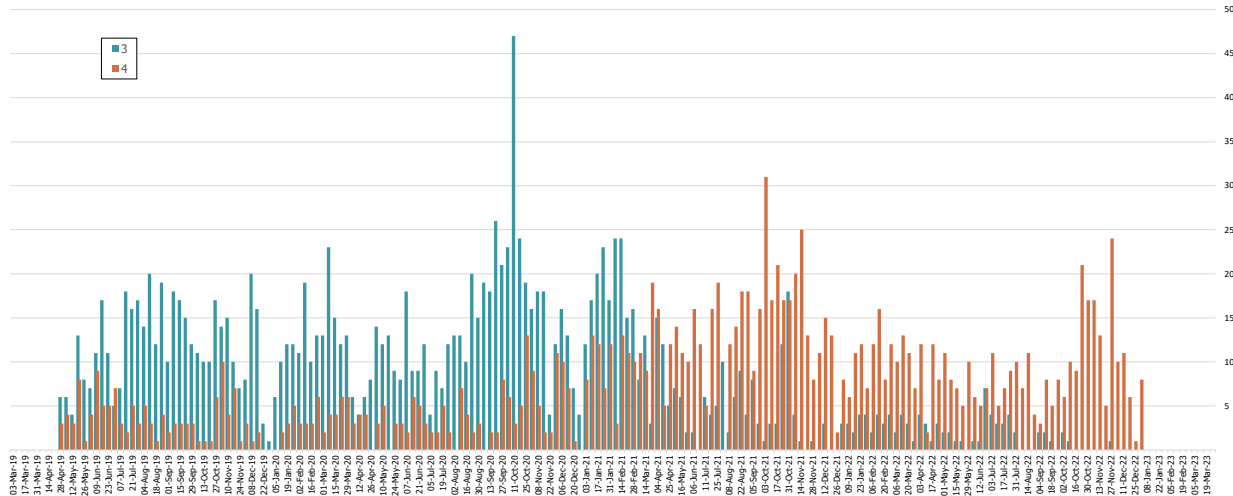
7.2.4 N&D Quantum Comparison

68. A Nonconformance & Disposition Report (“N&D”) documents construction variances to the design and requires an engineering evaluation which typically results in the nonconformance being accepted as-is or repaired. Figure 12 below shows the incremental quantity of N&Ds issued between April 2019 through January 2023 for Unit 3 and Unit 4 piping work. Refer to Appendix A for the full-scale N&D chart.

Figure 12: Unit 3 v. Unit 4 Piping N&Ds Over Time

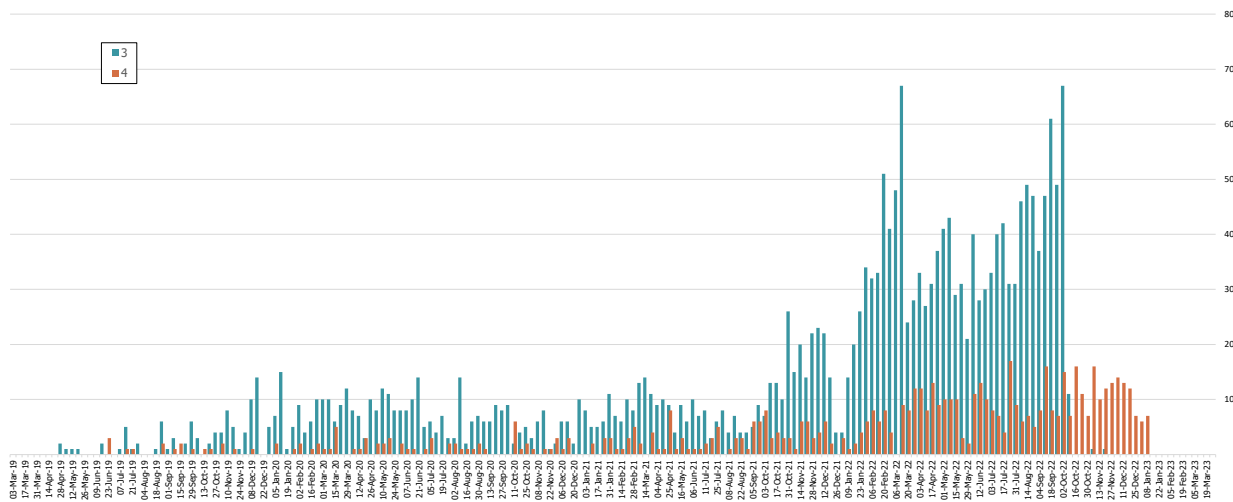
⁴⁶ For purposes of this dataset, I have considered the following Scorecard categories: Cable, Cable Tray, Cable Tray Supports, Conduit, Conduit & Supports, Conduit Supports, and Scheduled Conduit. Electrical equipment, instrumentation and terminations have not been considered herein.

⁴⁷ For purposes of this review, I have considered the Nuclear Island to consist of the Containment with Shield, and Auxiliary buildings.



69. Figure 13 below shows the incremental quantity of N&Ds issued between April 2019 through January 2023 for Unit 3 and Unit 4 electrical work. Refer to Appendix A for the full-scale N&D chart.

Figure 13: Unit 3 v. Unit 4 Electrical N&Ds Over Time



70. In Figure 13 above, piping N&Ds associated with Unit 3 and Unit 4 are shown in blue and orange, respectively. During 2019 and 2020, the quantity of N&Ds issued for Unit 3 is significantly higher than those issued for Unit 4. This period peaks with over 45 N&Ds being issued for Unit 3 in a single week. During 2021 and onwards, N&Ds issued per week for Unit 4 is noticeably less than the number of N&Ds issued per week for Unit 3 during 2019 and 2020. The lower weekly rate of N&Ds for Unit 4 compared

to Unit 3 demonstrates there were a lower rate of piping nonconformances in Unit 4 than in Unit 3 and shows the successful translation of Unit 3 piping LL to Unit 4 piping work.

71. VCM 22, dated February 19, 2020, provides an update of shifting experienced craft from Unit 3 to Unit 4 to further increase Unit 4 productivity as it approaches the Initial Energization ("IE") and Integrated Flush ("IF") milestones later that year.

"Additionally, the site team has shifted experienced craft to Unit 4 in an effort to transfer lessons learned from Unit 3 to Unit 4 and further increase production in Unit 4 as it approaches the Initial Energization ('IE') and IF milestones later this year."⁴⁸

72. The March 2020 MSR, includes an update on Unit 4 piping crews previously loaned to Unit 3 and will return back to Unit 4. The transfers will be entire crews that will be able to apply LL from Unit 3 to Unit 4 in real time:

"In September, we will have the return of the Piping crews that were loaned to Unit-3 in August to support their system turnovers and the beginning of the transfer [of] Pipefitters from Unit-3 including FNM support. The transfers will be entire crews with resources who have benefitted from having completed the same work in the past on Unit-3 and will be able to apply lessons learned in real time."⁴⁹

73. Similarly, Figure 13 above shows significantly more electrical N&Ds associated with Unit 3 than Unit 4 throughout the Project. This demonstrates that Unit 4 had significantly less electrical nonconformances than Unit 3 and that Unit 4 electrical work benefited from Unit 3 electrical LL.

74. VCM 24 provides an update that Unit 4 is applying Unit 3 LL to complete more complex work scopes more efficiently for electrical commodity installation sequencing, testing, and other work:

"Unit 4 continues to increase the focus on electrical commodity installation in support of the Initial Energization ('IE') testing milestone, which is expected to commence in the coming months. Unit 4 continues to complete complex scopes of work more efficiently through the integration of lessons learned from Unit 3. Strategies include design and fabrication of modules outside of the Unit to reduce required activities in congested areas and allow for simultaneous progress. Additionally, Unit 4 has enhanced the commodity sequencing and installation execution by adapting the construction plan to incorporate experience gained from Unit 3 testing. Furthermore, the sequence of Unit 4 Project milestones has been adjusted to integrate testing experience from Unit 3. For example, the Unit 4 Integrated Flush milestone was shifted ahead of Initial Energization and was successfully started in January 2021, so that further progress could be made on electrical commodity installation and to allow for more work fronts to remain open during this phase of the Project."⁵⁰

⁴⁸ VCM 22, p. 6.

⁴⁹ Bechtel August 2020 Monthly Status Report, p. 7

⁵⁰ VCM 24 dated February 18, 2021, pp. 28-29

7.3 CONCLUSIONS ON LESSONS LEARNED

75. The LL program actively evolved over time to achieve improvements on the Vogtle AP1000 units. The LL program was used to funnel LL experienced from the AP1000 Fleet in China into Vogtle via CRs. The LL process was continuously evolving and was used as a method to help inform Project teams on previous and current issues experienced by the Fleet. In an effort to facilitate continuous improvement, the Project also used LL from Unit 3 to apply on Unit 4.
76. The LL program reinforced LL from Unit 3 to enhance the focus of electrical installation and IEEE quality issues in Unit 4. Furthermore, Unit 4 had less electrical and piping nonconformances than Unit 3 which demonstrates Unit 4 work benefited from Unit 3 LL.
77. Based on my review of the earned and actual hours reported for installation of both piping and electrical bulk commodities at the Annex Building as well as generally within the Nuclear Island, lessons learned at Unit 3 translated successfully to Unit 4. This translation was evidenced by the improvement in labor productivity, as measured quantitatively through CPI.
78. When compared to Unit 3 milestones, Unit 4 start and finish milestone dates improved. The implemented LL program helped the Project achieve improvements, reduce the risk of repeating mistakes, and increase the chance that successes are repeated.

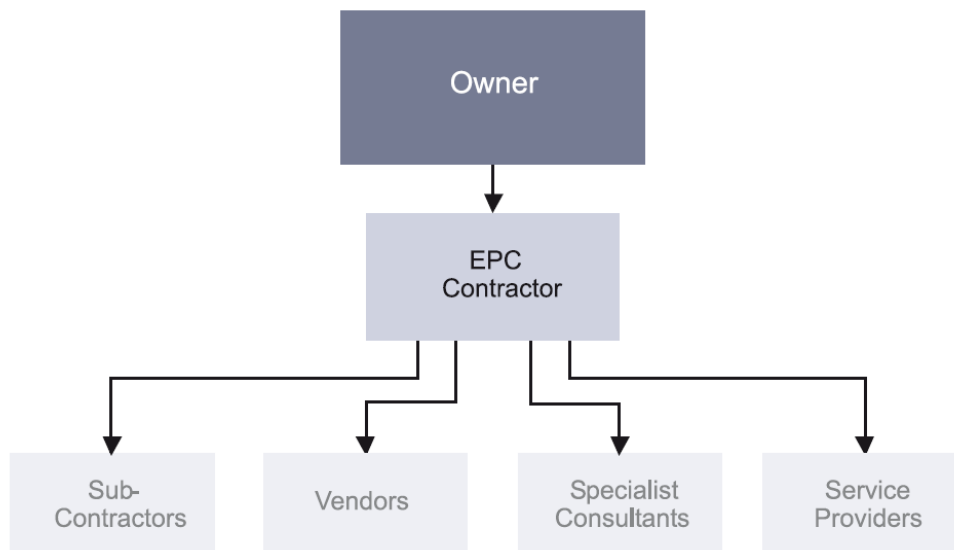
8 VCM 17 KEY RISKS

79. Regardless of the improvements identified through the Lessons Learned programs discussed in Section 7, many risks remained to be managed to complete construction of the Project. These risks were defined in VCM 17, some of which materialized and others which did not. In this Section of my Report, I discuss each of the risks identified in VCM 17 and analyze if and how they materialized on the Project.

8.1 RISK TRANSITION FROM EPC

80. In a typical EPC arrangement, the EPC contractor is the single-point of contact which is comprised of engineering, procurement, and construction activities inclusive of startup, training, acceptance and testing activities for the owner. All necessary tasks are thus handed over as “turnkey” with the EPC contractor being solely responsible for project delivery, with most of the project risk being transferred from the owner to the contractor. The EPC contractor is responsible for all sub-entities inclusive of subcontractors, vendors, specialists, and various service providers, as depicted in the figure below.⁵¹

Figure 14: Project Responsibility under EPC Contract



81. Plant Vogtle originally followed this fundamental understanding of an EPC contract where the EPC Contractor, had ultimate management responsibility for the Project.

⁵¹ 3R International Publication, *Contracting Strategies in the Oil and Gas Industry*, prepared by Carolin Schramm, Alexander Meissner, Gerhard Weidinger, dated January 2010.

82. In 2008 Georgia Power entered into an agreement with a consortium consisting of Westinghouse and Stone & Webster (“Consortium” or “WEC”) wherein the Consortium was expressly responsible for providing the engineering, procurement and construction of the Project. In doing so, the Consortium assumed all Project risk specifically associated with cost and quantity estimates considered at the time the Contract was executed.
83. Following Westinghouse Bankruptcy filing on March 29, 2017, SNC prepared the Vogtle 3&4 Transition Plan (“Transition Plan”) which outlined the plan to transition the EPC responsibilities following termination of the existing Contract.⁵² The Transition Plan defined an action strategy for each of the functional areas and identified a parallel action as follows:
- “In parallel, validation reviews are being performed on Estimate to Complete (ETC), schedule, and to-go quantities as part of the ETC.”⁵³*
84. The Transition Plan also identified and outlined the SNC functional areas for transitioning Project functions, and noted several areas such as, Construction Engineering, Procurement, and Fire Protections to be supported by Fluor and/or by WEC.⁵⁴ I note that the Transition Plan identified Work Management Inc. (“WMI”) as SNC’s Project Control services team. One of WMI’s objectives was to undertake a Quantity Verification⁵⁵ exercise wherein it would perform a verification and quantification of installed construction quantities. However, the Transition Plan does not appear to provide any additional insight on how WMI intended to quantify or address changes to quantities yet to be installed.
85. SNC subsequently hired Bechtel, changing the risk profile from a Westinghouse EPC agreement to a cost-reimbursable Bechtel construction completion agreement.
86. Based on my surety takeover experience, it is common and understandable that a take-over contractor, such as Bechtel, would not enter into an EPC or Guaranteed Maximum Price contract as the actual status of the Project including latent and patent defects, quantity take-offs and craft experience may not be fully understood.
87. Typically, the initial cost is always higher under a take-over agreement with a reimbursable-cost delivery method. More important, issues that would have been Westinghouse-responsible issues covered by an Engineer, Procure, Construct delivery method, such as cost escalation, quantity growth, productivity,

⁵² Draft Vogtle 3&4 Transition Plan, dated June 2017.

⁵³ Id., pg. 3.

⁵⁴ Id., pp. 3-4.

⁵⁵ Id., pg. 50.

and schedule prolongation, now become Owner issues under a cost-reimbursable project delivery method.

88. It is my understanding that the unit rates utilized in the Project BOE were first established by Fluor under its original contract with Westinghouse. These unit rates were used as the basis for VCM 17 and considered as the input to the Project scorecards. However, the commercial terms in the Bechtel CCA, Contract Commercial Target and Cost and Schedule Assessment were based on project unit rates developed by Bechtel from its experience in the construction of the Calvert Cliffs plant.
89. The reasonability of this approach is questionable. Although the Calvert Cliffs plant is a two loop PWR of similar size it is an old generation plant, it would not experience FOAK issues associated with Vogtle, nor would it account for the potential craft productivity issues aligned with new nuclear unit construction after a 20-to-30-year gap in nuclear construction in the US. It is uncertain to me how Bechtel accounted for these differences and based on the outcome of its performance, it is apparent that they were not successful in their planning and implementation using the specified unit rates.
90. Finally, the BOE relied on current (at VCM 17) estimated quantities in both type and volume the total risk of which would have been Westinghouse's risk as opposed to a risk born by GPC in the original contract arrangement.

8.2 IDENTIFICATION OF RISK

91. Regarding the continuation of the Vogtle Project, Section VII D of VCM 17 identifies 12 Risks to the Vogtle Project as follows:

91.1 Risk 1: The risk that Toshiba will be financially unable to meet the payment obligations of the Toshiba Parent Guaranty;⁵⁶

91.2 Risk 2: The risk that WEC will not meet its obligations under the new Services Agreement;⁵⁷

91.3 Risk 3: The risk that the labor force and craft will be unable to maintain their productivity improvements;⁵⁸

⁵⁶ VCM 17, p. 93.

⁵⁷ Ibid.

⁵⁸ Id., p. 94.

91.4 Risk 4: The risk that the Project will be unable to continue to meet FOAK challenges;⁵⁹

91.5 Risk 5: The risk that Congress will not extend the PTCs;⁶⁰

91.6 Risk 6: The risk that the DOE will be unwilling to extend and expand the Loan Guarantee;⁶¹

91.7 Risk 7: Procurement Risk;⁶²

91.8 Risk 8: Unidentified Scope Risk;⁶³

91.9 Risk 9: Stranded Technology Risk;⁶⁴

91.10 Risk 10: Fuel Risk;⁶⁵

91.11 Risk 11: Risk of Carbon Emissions Controls;⁶⁶ and

91.12 Risk 12: Testing/Startup Risk.⁶⁷

92. I have reviewed each of the subsequent VCM reports through VCM 27, which correspond to a 4-year reporting period through August 31, 2022. Specifically, I have evaluated whether the 12 risks as originally identified in VCM 17 remained to be a risk over the duration of this period. Where these risks were not discussed within the VCM reports, I have understood that to indicate that the risk was no longer a critical concern. My findings are presented in Table 3, below.

⁵⁹ Id., pp. 94-95.

⁶⁰ Id., p. 95.

⁶¹ Id., pp. 95-96.

⁶² Id., p. 96.

⁶³ Id., pp. 96-97.

⁶⁴ Id., p. 97.

⁶⁵ Id., p. 98.

⁶⁶ Ibid.

⁶⁷ Id., pp. 98-99.

Table 3: Evolution of 12 Key Risks as Identified in VCM 17

Evolution of Risks Identified in VCM 17											
Risk No.	Risk Description	VCM 17 (8/31/2017)	VCM 18 (2/28/2018)	VCM 19 (8/31/2018)	VCM 20/21 (8/30/2019)	VCM 22 (2/19/2020)	VCM 23 (8/1/2020)	VCM 24 (2/8/2021)	VCM 25 (8/31/2021)	VCM 26 (2/17/22)	VCM 27 (8/31/22)
1	The risk that Toshiba will be financially unable to meet the payment obligations of the Toshiba Parent Guaranty	X	X								
2	The risk that WEC will not meet its obligations under the new Services Agreement	X	X	X							
3	The risk that the labor force and craft will be unable to maintain their productivity improvements	X	X	X	X	X	X	X	X	X	X
4	The risk that the Project will be unable to continue to meet FOAK challenges	X	X	X	X	X	X	X	X	X	X
5	The risk that Congress will not extend the PTCs	X	X								
6	The risk that the DOE will be unwilling to extend and expand the Loan Guarantee	X	X	X							
7	Procurement Risk	X	X	X	X	X	X	X			
8	Unidentified Scope Risk	X	X	X	X	X		X			
9	Stranded Technology Risk	X									
10	Fuel Risk	X		X	X	X	X				
11	Risk of Carbon Emissions Controls	X	X	X							
12	Testing/Startup Risk	X	X	X	X	X	X	X	X	X	X

93. After evaluating the evolution of each of the above 12 risks, and after reviewing the contemporaneous Project record and discussing the risks with Project personnel, I have determined that:

93.1 Risks 1, 2, 5, and 6, did not materialize or were resolved due to actions taken by the Company.

93.2 Risks 9, 10, and 11 are future potential risks not directly associated with the completion and commissioning of the Project.

93.3 Risks 3, 4, 7, and 8 materialized and impacted the completion of the Project.

93.4 Risk 12 is a risk that has begun to materialize and as the commissioning program is finalized on Unit 3 and begins in earnest on Unit 4 additional risks may come to fruition. Some reported impact has been associated with the commissioning process for Unit 3 during and after Hot Functional Test (HFT) and will be summarized below.

94. I have referred to these five risks (3, 4, 7, 8, and 12) as Key Risks, and as such, these will be discussed in Sections 9 through 13 of this Report, below.

9 ANALYSIS OF RISK 3; THE RISK THAT THE LABOR FORCE AND CRAFT WILL BE UNABLE TO MAINTAIN THEIR PRODUCTIVITY IMPROVEMENTS

95. VCM 17 identified Risk 3 as follows:

*"Simply stated, the project execution risk encompasses the risk that the Project is unable to execute with the resources or in the timeframe that is accounted for by the current projections. Possible manifestations of this risk include an inability to reach forecasted production rates or sustain the productivity rates that are incorporated into the Southern Nuclear ETC. The risk that the Project cannot execute in accordance with the forecasted rates of production comprises a significant project execution risk. This risk also encompasses higher than anticipated rates of rework, or greater than expected design changes. Personnel factors, such as not having sufficient field engineering resources available for a period of time, also fall into project execution risk."*⁶⁸

96. In order to understand how Risk 3 could materialize on the Project after VCM 17, it is important to first review the typical industry understanding of productivity and how it changes due to Project circumstances.

9.1 INDUSTRY PRODUCTIVITY METRICS APPLIED TO VOGTLE

97. According to the Association for the Advancement of Cost Engineering (AACEi):

*"Productivity is a measurement of rate of output per unit of time or effort usually measured in labor hours. For example, cubic yards/cubic meters of concrete placed, linear feet/meters of conduit installed of pipe placed, etc. per crew hour or some other standard measure."*⁶⁹

98. As productivity is a measurement or function of rate, it follows that impacts to the rate result in impacts to productivity. AACEi further states the following:

*"[...] the direct input of work force hours can be influenced by project conditions that have an adverse effect on the output."*⁷⁰

99. Next, it is important to establish the causes or impacts by which productivity is affected, as well as the leading trade industries and bodies of knowledge that define these impacts.

100. The following items below are some of the common causes of lost productivity identified by the AACEi⁷¹:

⁶⁸ VCM 17, p. 94.

⁶⁹ AACEi Recommended Practice No. 25R-03 Estimating Lost Labor Productivity in Construction Claims, Rev. April 13, 2004, p. 2.

⁷⁰ 1996 AAC Transactions C&C.7, "Consequential Cost Effects", p. C&C.7.1.

⁷¹ AACEi Recommended Practice No. 25R-03 Estimating Lost Labor Productivity in Construction Claims, Rev. April 13, 2004, pp. 4-7. Refer to AACEi for complete list.

- Absenteeism;
- Stacking of Trades or Logistics;
- Availability of skilled labor; and
- Changes, ripple impact, cumulative impact of multiple changes and rework

101. I note specifically that it is important to address that the cumulative impact of changes, such as rework to non-conforming construction, unrelated to design, can cause impacts to productivity for many reasons.

“When numerous changes occur, there is a compounding and negative effect commonly called ‘cumulative impact.’...there can be disruptions and delays, loss of learning, trade stacking, material sourcing problems, low morale, all of which lead to significantly lower levels of productivity.”⁷²

102. Cumulative impact is also referred to as the “ripple effect”.

103. Changes unrelated to design, such as improper work planning by the contractor, can also decrease productivity, as workers may be required to turn their focus to complete new work tasks (instead of continuing to focus on completing their current work task) or be required to mobilize to a different project area.

“The continuous reassignment of a crew to work on changes and then shift back to unchanged work also reduces productivity...not only is the crew required to shift between tasks that involve different types of work, they also may be forced to shift between the location where the work is being performed...this stop-and-go work method is often further affected by the loss of a learning curve that is usually achieved by crews performing repetitive tasks.”⁷³

104. Cumulative impact:

“[...] is an unforeseeable loss of productivity typically associated with increased cost and delay to the completion of work that results from the compounding effects of an unreasonable number of change orders and other impact events.”⁷⁴

105. As such, consequential costs are those that result from a lack of productivity. These costs:

⁷² “Evaluating the Cumulative Impact of Change on Labor Productivity – an Evolving Discussion” Ibbs and McEniry December 12, 2008, p. 1.

⁷³ 2001 AACEi Transactions CDR.06 Analyzing the Cumulative Impact of Changes, p. CDR.06.4.

⁷⁴ “Great Debate: Is Cumulative Impact a Provable Reality?”, Cost Engineering, September/October 2015 – Defining CI, p. 19.

"[...] may be caused by the contractor being required to perform otherwise unnecessary work, to alter the sequence of his operations, to use inefficient methods of performance, to work in inconvenient periods of time, to perform during periods of interference, or to stop work."⁷⁵

106. Upon the project estimate development, it is Good Industry Practice for both the contractor and owner to identify potential project risks and build those risks into the productivity rate specific for each trade. The identified risks are typically included within the Basis of Estimate document. For example, working overtime, working in constrained or limited spaces, or working out of sequence are contributing factors that lower productivity.
107. Therefore, the cumulative impact of issues causing productivity loss (such as unplanned work, extreme weather conditions, out of sequence work, etc.) has a compounding effect on the overall labor productivity.
108. Construction productivity measurement is typically measured by discipline/trade (such as concrete, pipe, electrical) and by discipline task (such as layout, installation, turnover). This is because each trade (and even the trades within each trade) have different levels of productivity for the tasks they perform.
109. It is common in the construction industry to benchmark Labor Productivity using a Cost Performance Index ("CPI"). Specific to the nuclear industry, when the CPI value is less than 1.0, the Labor Productivity is performing better than planned. On the other hand, when the CPI value is greater than 1.0, the Labor Productivity is performing below the plan. When the Labor Productivity is performing at a 1.0, it is considered to be performing as planned.
110. Simply stated, CPI⁷⁶ is:

$$CPI = \frac{\text{Spent Hours}}{\text{Earned Hours}}$$

111. Productivity at Plant Vogtle was tracked on a weekly basis using the *Vogtle Project Earnings Scorecard* ("Scorecard"). These documents presented individual and cumulative data on planned and actual earnings for key quantities and labor hours across various buildings and areas for Unit 3, Unit 4, as well

⁷⁵1996 AAC Transactions C&C.7, "Consequential Cost Effects", pp. C&C.7.1 through C&C.7.4.

⁷⁶ CPI is typically calculated as Earned Hours divided by Spent Hours. This method is accepted within the industry and documented in various industry guidelines. However, within the nuclear construction industry, the inverse is true, and CPI is calculated as shown herein.

as the across the total Project. An extract from one such Scorecard presenting labor hour data taken from Unit 3 is presented in Figure 15, below.

Figure 15: Extract from Sample Scorecard, Annotated⁷⁷

Redacted

112. As shown in Figure 15 above, the cumulative CPI is shown along the column indicated with the yellow callout box. As indicated along the top, it has been computed by dividing Cumulative Spent Hours by Cumulative Earned Hours, as shown below.

$$\text{Cumulative CPI} = \frac{\text{Cumulative Spent Hours}}{\text{Cumulative Earned Hours}}$$

113. The following Section of this Report identifies the specific concerns in connection to productivity risks on the Project.

9.2 PRODUCTIVITY RISKS AT PLANT VOGTLE

114. The significance and evolution of productivity risks at Plant Vogtle were a concern from the onset of VCM 17:

*"While the Company has tried to develop the best possible estimate, the possibility of lower than expected productivity remains."*⁷⁸

⁷⁷ Project Scorecard, CTRL0000005182_2020-11-22 Vogtle SCORE CARD - FINAL_.pdf, dated November 22, 2020.

⁷⁸ VCM 17, p. 94.

115. At around February 2018, management's engagement with national labor unions to secure adequate resources are noted. VCM 18 states the following:

*"Through leadership and oversight, the labor force must be able to maintain, and in some areas, improve productivity. Additionally, efforts remain to reduce Project risk by realigning work scope at key vendors and drive consistency in work-process across the Project."*⁷⁹

116. This risk was planned to be managed through the implementation of initiatives geared towards increasing earned hours while reducing spent hours. Additionally, SNC and Bechtel commissioned productivity studies to identify specific areas of underperformance.

*"This risk has been identified as a Project execution risk that may be realized if CPI continues to increase or continues at its current rate throughout the life of the Project. It is important that the Project be able to increase the number of hours earned relative to the number of hours spent to reduce the impact of negative cost performance."*⁸⁰

117. At around August 2018, VCM 19 indicated that the Project had started to benefit from its recruitment of necessary craft labor through incentivization methods. However, timely delivery of the Project was still largely dependent on the continued increase of necessary craft labor, as indicated below:

*"The Project's ability to meet the approved schedule is dependent on numerous factors, including the increased production targets included in the current schedule, as well as **increased craft labor levels for certain disciplines** as construction work transitions from the civil phase to **mechanical and electrical phases**."*⁸¹ [emphasis added]

118. The report specifically reiterates management's concern to recruit and retain adequate levels of the necessary craft labor:

*"The inability to attract and retain the appropriately skilled craft is a risk that has been a topic of discussion among project management for some time and will continue to be watched for the foreseeable future."*⁸²

119. For the next year and up until at least August 2019, the Project continued to recruit the necessary craft labor as well as field leadership while continuing to work to increase efficiency and production. VCM 20/21 appears to be the first report to acknowledge trade-specific concerns in connection to electrical work:

*"Close attention is being paid to **electrical hours earned**, which has been challenged over the past few months, but is showing improvement in both day and night shift following improved material management and implementation of mitigation plans by Bechtel. These mitigation plans include increased electrical craft staffing, adjustments*

⁷⁹ VCM 18, p. 6.

⁸⁰ VCM 19, p. 25.

⁸¹ Id., p. 6.

⁸² Id., p. 25.

to field leadership, optimized craft allocation between Unit 3 and Unit 4, and utilization of pipefitter craft workers in electrical support roles.”⁸³ [emphasis added]

120. At around February 2020, Unit 3 entered a period of “heavy electrical, mechanical, instrumentation and controls (‘I&C’) commodity installation.”⁸⁴ As completion of these installations directly preceded numerous system turnover milestones, the concern for electrical productivity was heightened. As to this, VCM 22 states the following:

*“During the Reporting Period, actual earnings in electrical hours continued to be challenged compared to the planned earnings in the aggressive site work plan, which led to lower than planned system turnovers in Unit 3. As a result of these challenges, the site team began **shifting electrical craft resources out of congested work fronts** in Unit 3. The shift in employee resources has allowed for bulk commodity installation to increase in areas outside of Unit 3 Containment.”⁸⁵ [emphasis added]*

121. Efforts such as, “defined scoping of commodity work fronts on night shift, utilization of specialized crews to focus on specific commodity installation activities, addition of key Project leadership on night shift, and adjustment of craft work schedules during the week to allow for optimal performance”⁸⁶ further facilitated this progress.

122. At around August 2020, SNC reported a continued focus on initiatives to increase earned hours in comparison to spent hours. Additionally, during this time period, Bechtel and SNC continued to evaluate productivity studies and continued to identify underperforming areas requiring improvement.⁸⁷

123. Separately, materialization of productivity impacts had begun to arise from Covid-19. VCM 23 *distinctly identifies the following risks at about this time:*

*“The Project’s reduction in workforce during April 2020 helped to slow the spread of the pandemic on-site, but also contributed in part to the increased costs, productivity challenges and milestone schedule delays on the Project. Throughout the Reporting Period, the **impacts of COVID-19 on Project performance included high absenteeism for both craft and non-manual personnel, an inability to retain key specialty craft and non-manual personnel**, disruptions in supply chain as a result of COVID-19 measures undertaken by suppliers, and degradation of subcontractor performance.”⁸⁸ [emphasis added]*

124. According to VCM 23, a reduction of earnings was directly attributable to Covid-19 which had resulted in insufficient resources, one reported to have shrunk by 20%:

⁸³ VCM 20/21, p. 5.

⁸⁴ VCM 22, p. 25.

⁸⁵ Id., p. 6.

⁸⁶ Id., p. 25.

⁸⁷ VCM 23.

⁸⁸ VCM 23, pp. 3-4.

*“During the Reporting Period, the Project experienced a reduction in average earnings to around 105,000 hours per week from approximately 140,000 hours per week during the previous Reporting Period. The **contraction of average weekly earnings was largely attributed to the effects of the COVID-19 pandemic on resource availability.** Prior to the COVID-19 impacts on site, the Project was experiencing weekly earnings at levels consistent with the aggressive site work plan then in place for both Unit 3 and Unit 4. In April 2020, the Project team took action to mitigate the impacts of the COVID-19 pandemic through a **20% reduction in the sitewide workforce.** The reduction in workforce placed substantial pressure on the weekly average earnings.”⁸⁹ [emphasis added]*

125. Although a reduction in earnings is generally associated with a loss of schedule time, a reduction in earnings also contributes to a loss of productivity overall. One factor is the resulting cumulative effect of having work now stacked by trade and within trades to complete in a compressed schedule. Also, additional precautions and trade “spacing” will contribute to a loss of productivity.

126. As early as August 2020, Covid-19 was regarded as a risk which would continue to impact Project performance:

“As the Project progresses toward construction completion and the COVID-19 pandemic continues to impact the country, the risk remains that the pandemic will further impact the Project’s performance.”⁹⁰

127. At around February 2021, VCM 24 identified the continuation of a rising CPI, and productivity risks remained a significant concern. While it was important for the Project to increase the ratio of direct construction hours earned to spent, ongoing challenges due to disruptions from Covid-19 continued to impact Project CPI metrics. Many of the previously identified productivity improvement strategies remain ongoing with an added effort to implement Lessons Learned from Unit 3 to Unit 4, as cited below:

“In addition to these activities, the Company and Bechtel continue to identify key resources that can support Unit 4 based on knowledge and experience obtained from the successful execution of Unit 3.”⁹¹

128. At around August 2021, the full effect of electrical craft availability became evident:

“The supply of qualified electricians was constrained prior to COVID-19 and now, with increased demand from several industries, electrician availability is further constrained. Project Management has taken numerous steps to retain qualified craft and attract additional craft to the site to meet the demand.”⁹²

⁸⁹ Id., p. 29.

⁹⁰ Id., p. 30.

⁹¹ VCM 24, p. 29.

⁹² VCM 25, p. 26.

129. It should be noted that had the contractor maintained the schedule of work, much of the COVID-19 impact may have been avoided as the work was scheduled to complete prior to the major onslaught of the pandemic.

130. The labor shortage did not appear to exhibit any indication of short, or long-term, alleviation:

*"The **shortage of qualified electricians is not expected to subside** and the competition for these resources is expected to continue for the **remainder of the Project**. In addition to the potential challenges with staffing, first time quality remains an area of focus for the Project team. Higher than projected amounts of rework and construction remediation would put pressure on the Project team's ability to increase performance."⁹³ [emphasis added]*

131. In addition to existing strategies being implemented onsite, I've identified at least two additional programs designed to alleviate productivity issues: (1) the sign as you go approach and (2) the Ready-Ready strategy. These are described respectively below:

"[...] the Site team's reinforcement of the 'sign as you go' approach continues to encourage completion of documentation earlier in the construction and testing processes and improves the rate of first-time quality."⁹⁴

and,

"Additionally, the Unit 4 team implemented a 'Ready-Ready' strategy during the Reporting Period, which focuses on identifying barriers to future work activities and establishes mitigating actions to improve the team's readiness for work execution."⁹⁵

132. As described at the onset of the takeover, SNC correctly identified craft shortages to be an early risk to the Project and its success. Despite SNC's implementation of strategies geared towards the redistribution of earned versus spent hours, these shortages matured to a stage where labor productivity became increasingly impacted. These impacts were felt most notably within the electrical trade work, which was a direct predecessor to turnover and testing of systems.

133. Despite the improvements obtained through the LL program, and the hiring of a multinational experienced completion contractor, the CPI for skilled labor continued to worsen.

⁹³ Id., p. 26.

⁹⁴ VCM 27, p. 21.

⁹⁵ Ibid.

9.3 EVALUATION OF VOGTLE PRODUCTIVITY

134. One of the earliest risks to be identified in the VCM reports was the concern to source skilled craft labor. Despite its early identification and continued efforts towards mitigation, this risk remained an issue over the duration of the Project. Specifically, the lack of adequate and skilled craft labor materialized as construction work transitioned from the civil phase to the mechanical and electrical phases.
135. As such, I have first evaluated the Scorecards to determine the development of mechanical and electrical productivity as reported for the Containment Building and for the Auxiliary Building. I have then identified the types of impacts which I believe to have contributed to these productivity trends, and have related these to industry accepted guidelines, such as those discussed in Section 9.1 of this Report.
136. For all figures presented herein this Section 9.3 of my Report, two critical sets of information are shown. CPI for Unit 3 is denoted with the dashed blue line, whereas CPI for Unit 4 is denoted with the dashed gold line. Solid blue and gold lines denote cumulative actual hours for Unit 3 and Unit 4, respectively.

9.3.1 Degradation of Piping Productivity

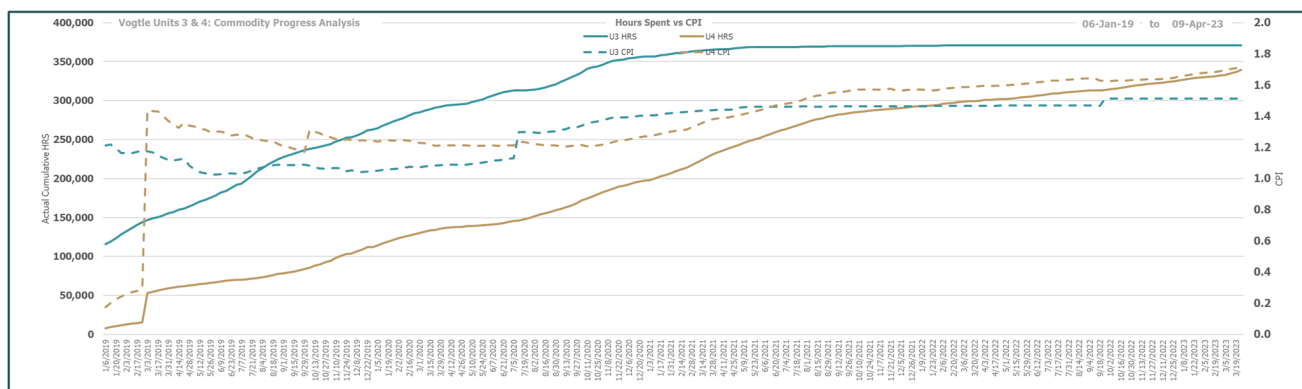
137. For purposes of this productivity evaluation, I have specifically focused on piping bulk commodities⁹⁶ within the Unit 3 and Unit 4 Containment Building and Auxiliary Building. As discussed in Section 9.1 of this Report, I have reviewed CPI indices to form the basis of my evaluation. I recognize that as at the last Scorecard, bulk installation for piping was completed and succeeded by systems turnovers. Notwithstanding, Project Scorecards do not delineate between these two data categorizations, and I have considered them jointly for purposes of my evaluation of both Unit 3 and Unit 4.
138. Based on my review of data in connection with the Containment Building, I have determined the following:
- Beginning in 2019, the CPI data shows a continuous “slow bleed” or worsening of productivity for the Containment Building. This is consistent with what I would expect for skilled trades that decrease earned hours over time, either concisely or sub-concisely, many times due to the productivity issues identified in Section 9.1.

⁹⁶ For purposes of this dataset, I have considered the following Scorecard categories: A/G Large Bore Pipe, A/G Large Bore Pipe Supports.

- At the beginning of 2019, Unit 3 piping CPI is reported to be about 1.17. Over the duration of the Project, and by about April 2023, Unit 3 CPI is reported to increase to about 1.51. This increase represents a degradation of productivity of about 29%.
- At the beginning of 2019, Unit 4 piping CPI is reported to be about 1.44. Over the duration of the Project, and by about April 2023, Unit 4 CPI is reported to increase to about 1.72. This increase represents a degradation of productivity of about 19%.

139. This comparison is presented in Figure 16, below and in Appendix A.

Figure 16: Productivity Analysis of Piping Installation at Unit 3 and Unit 4 Containment Building



140. Next, based on my review of data in connection with the Auxiliary Building, I have determined the following:

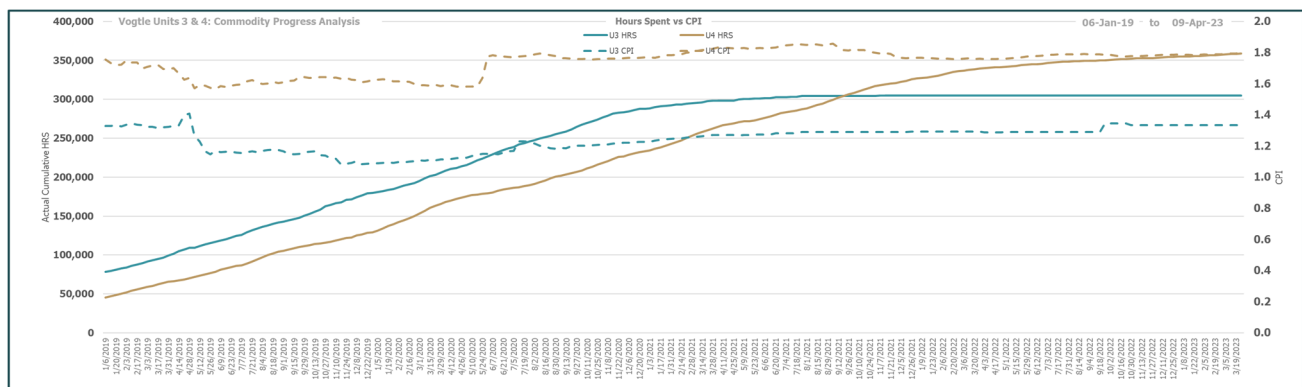
- The Auxiliary Building also shows the CPI data worsening over time although to a lesser extent than the Containment Building.
- At the beginning of 2019, Unit 3 bulk piping CPI is reported to be about 1.33. Over the duration of the Project, and by about April 2023⁹⁷, Unit 3 CPI is reported to be about 1.34. This increase represents a slight degradation of productivity.

⁹⁷ I recognize that by this time, bulk installation was completed and succeeded by systems turnovers. Notwithstanding, Project Scorecards do not delineate between these two data categorizations, and I have considered them jointly for purposes of my evaluation of both Unit 3 and Unit 4.

- At the beginning of 2019, Unit 4 bulk piping CPI is reported to be about 1.75. Over the duration of the Project, and by about April 2023, Unit 4 CPI is reported to be about 1.80. This increase represents a degradation of productivity of about 3%.

141. This comparison is presented in Figure 17, below and in Appendix A.

Figure 17: Productivity Analysis of Piping Installation at Unit 3 and Unit 4 Auxiliary Building



9.3.2 Degradation of Electrical Productivity

142. Second, I have reviewed the data contained in the Scorecards to evaluate CPI in connection with bulk electrical⁹⁸ installation over the duration of the Project. I again recognize that as at the last Scorecard, bulk installation for electrical was completed and succeeded by systems turnovers. Notwithstanding, Project Scorecards do not delineate between these two data categorizations, and I have considered them jointly for purposes of my evaluation of both Unit 3 and Unit 4.

143. Based on my review of data in connection with the Containment Building, I have determined the following:

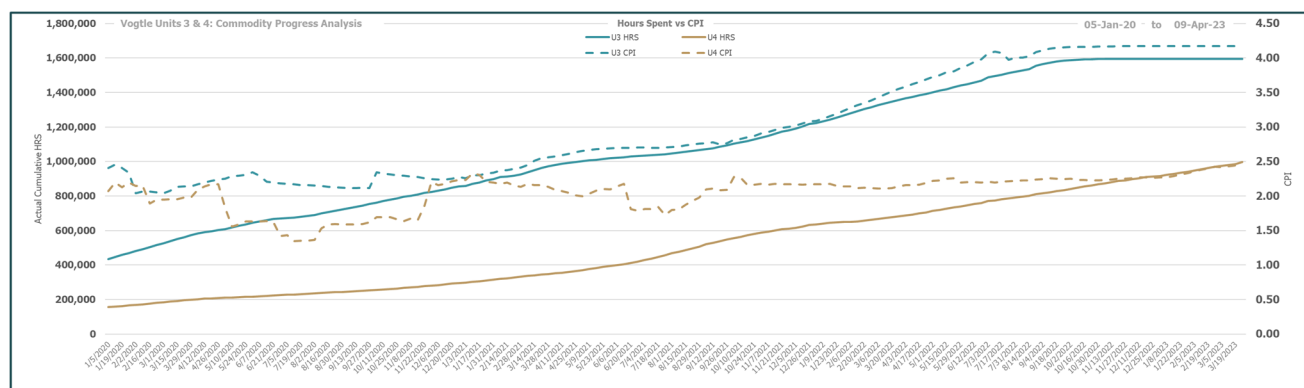
- As observed for installation of bulk piping, CPI data again shows a comparable and continuous worsening of productivity.

⁹⁸ For purposes of this dataset, I have considered the following Scorecard categories: Cable, Cable Tray, Cable Tray Supports, Conduit, Conduit & Supports, Conduit Supports, and Scheduled Conduit. Electrical equipment, instrumentation and terminations have not been considered herein.

- At about the beginning of 2020, Unit 3 bulk electrical CPI is reported to be about 2.41. Over the duration of the Project, and by about April 2023, Unit 3 CPI is reported to increase to about 4.17. This increase represents a degradation of productivity of about 73%. Based on my factual understanding of the Project, a portion of this degradation is believed to be associated with electrical rework at Unit 3.
- At about the start of 2020, Unit 4 bulk electrical CPI is reported to be about 2.08. Over the duration of the Project, and by about April 2023, Unit 4 CPI is reported to increase to about 2.48. This increase represents a degradation of productivity of about 19%.

144. The electrical comparison is presented in Figure 18, below and in Appendix A.

Figure 18: Productivity Analysis of Electrical Installation at Unit 3 and Unit 4 Containment Building

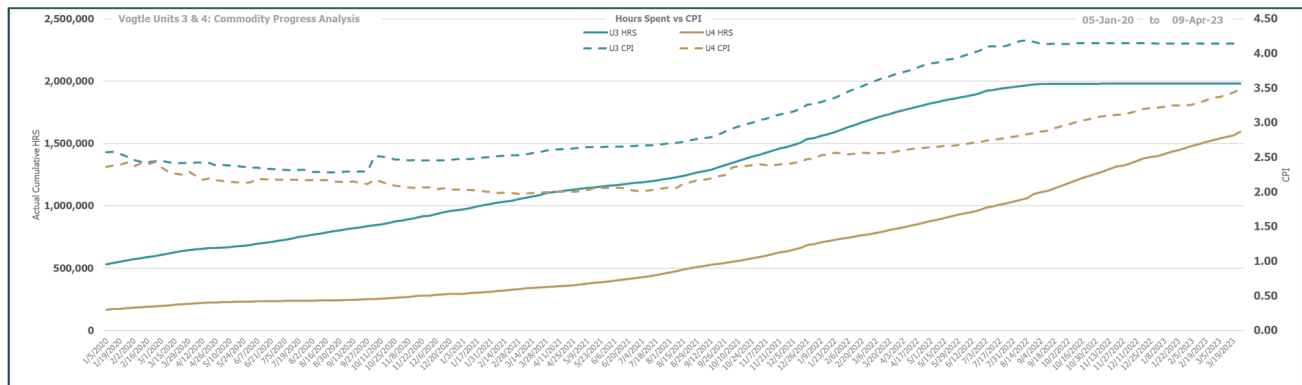


145. Finally, based on my review of data in connection with the Auxiliary Building, I have determined the following:

- Similar to bulk piping, CPI data shows worsening of productivity for the Auxiliary Building.
- At the beginning of 2020, Unit 3 bulk electrical CPI is reported to be about 2.57. Over the duration of the Project, and by about April 2023, Unit 3 CPI is reported to increase to about 4.14. This increase represents a degradation of productivity of about 61%.
- At the beginning of 2020, Unit 4 bulk electrical CPI is reported to be about 2.37. Over the duration of the Project, and by about April 2023, Unit 4 CPI is reported to increase to about 3.49. This increase represents a degradation of productivity of about 47%.

146. This comparison is presented in Figure 19, below and in Appendix A.

Figure 19: Productivity Analysis of Electrical Installation at Unit 3 and Unit 4 Auxiliary Building



9.4 CONCLUSIONS ON THE MATERIALIZATION OF RISK 3

147. Productivity is a measurement or function of rate of progress at a project, and as such, it is subject to a variety of impacts. These factors are recognized in the industry as a means to estimate productivity loss. Singular factors impact productivity individually, whereas multiple concurrent factors retain the ability to impact productivity cumulatively, often causing a knock-on or ripple effect to downstream work.

148. Based on my review of the VCM reports, the Project was subject to numerous individual and cumulative impacts or factors which, despite SNC's best efforts and its hiring of a qualified multination firm experienced with nuclear plant construction, ultimately adversely affected productivity on the Project, beyond what SNC could have reasonably anticipated.

149. Despite the improvements obtained through the Lessons Learned program,⁹⁹ numerous impacts, beyond the reasonable control of SNC continued to contribute to a decline in productivity.

150. This degradation is believed to be attributable to the very risks identified in the VCM reports, which SNC attempted to mitigate through Lessons Learned and the hiring of a multinational, experienced nuclear construction contractor. These impacts to productivity included the shortage of skilled labor, stacking of

⁹⁹ See Section 8 of this Report.

trades, logistics due to confined spaces, and eventually Covid and subsequent absenteeism of the workforce.

10 ANALYSIS OF RISK 4; THE RISK THAT THE PROJECT WILL BE UNABLE TO CONTINUE TO MEET FOAK CHALLENGES

151. FOAK design involves the first generation of a new type of technology or design. It is common for multiple projects to undergo construction around the same time, sharing similar FOAK design aspects, helping to reduce costs, as certain costs are incurred as an issue is discovered in one of the projects and then proactively addressed on the other projects before the issue is able to materialize.¹⁰⁰

152. VCM 17 identifies a number of potential FOAK risks, most notably, a delay to fuel loading as a result of ITAAC closure, licensing challenges, inadequate quality assurance documentation, or design issues.¹⁰¹

153. VCM 17 identified Risk 4 as follows:

“As with any FOAK project, a broad range of FOAK execution risks remain. One FOAK risk unique to this Project is the possibility of a delay to fuel load as a result of ITAAC closure, licensing challenges, or inadequate quality assurance documentation. One possible source of a delay is challenges in closing one or more ITAAC to enable fuel load. While 10 CFR Part 52 has limited this risk, it remains possible that it will take the NRC more time than currently anticipated to approve the fuel load, either due to an issue involving ITAAC or other issues. In addition to the closure of all ITAACs, the possibility of emergent licensing and design issues exists. There is also a potential risk of discovery of an issue that calls the quality assurance pedigree of a component into question. In this event, the nonconformance with quality assurance requirements must be dispositioned, which could result in a decision to use the component as-is or to remove and replace the component. Late discovery of quality assurance problems could delay fuel load while the problems are resolved.”¹⁰²

154. As indicated in VCM 17, my review has shown that risks associated with a FOAK Project did materialize after VCM 17 and could not have been fully anticipated and accounted for at the time of VCM 17. I have provided four examples of the type of risk associated with FOAK that did materialize as discussed below, including:

- Fleet wide emergent/developmental design issues,
- Actual effect of application of 10CFR52,
- Primary Containment Cooling System (PCCS) Tank design, and

¹⁰⁰ <https://inldigitalibrary.inl.gov/sites/sti/sti/6293982.pdf>, Section 8.1, pp. 19-20.

¹⁰¹ VCM 17, pp. 94-95.

¹⁰² Ibid.

- AP1000 DC System IEEE Separation.

10.1 EMERGENT/DEVELOPMENTAL ISSUES

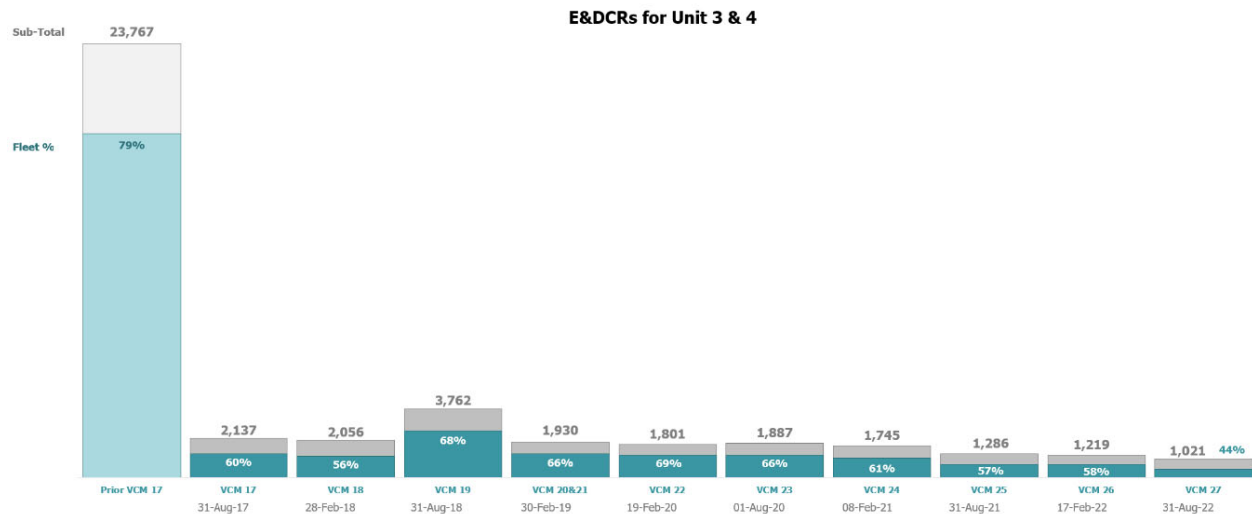
155. At VCM 17 there were over 700,000¹⁰³ documents issued by Westinghouse detailing the engineering and design of the AP1000 plant. As many of these documents were generic to the fleet, a change to one plant affected all plants in the fleet.
156. The change mechanism used throughout the life of the engineering and design program for the fleet of plants was the Engineering and Design Coordination Report ("E&DCR").
157. The E&DCR methodology originated from Stone & Webster Engineering Corporation. Having spent 17 years at SWEC I have a full understanding of the concepts and methodologies used within the E&DCR process. Namely, the E&DCR is the formal design change mechanism and is coded to reflect a given plant or plants that are impacted by its issuance.
158. For example, if a design change is initiated for Vogtle Unit 3, an evaluation is conducted to determine if that same E&DCR affects Vogtle Unit 4 and is coded appropriately. The same evaluation may determine that the E&DCR affects more than the Vogtle plants and may be a generic E&DCR that affects the fleet of plants. To a large extent I would consider the fleet E&DCRs to be FOAK issues since they are not specific to a given plant but impact the FOAK design of all plants in the fleet.
159. A total of 42,624 E&DCRs^{104,105} have been made available to me. My evaluation of the E&DCR's issued after VCM 17 shows that 11,687 E&DCRs were coded as APP indicating an impact to the fleet of plants and a potential FOAK issue. The breakdown of these E&DCRs is presented in Figure 20 below, and in Appendix A.

¹⁰³ CTRL0002232961

¹⁰⁴ As of June 22, 2023, 42,624 E&DCRs have been made available to me via the Documentum file repository. Additional E&DCRs may have been issued on the Project, however I have not been made aware of any additional files outside of this file repository.

¹⁰⁵ Of this set, 13 E&DCRs were not designated to a SV0, SV3, or SV4, thus reducing the total count to 42,611.

Figure 20: Breakdown of Fleet E&DCRs



160. As shown in Figure 20, above, E&DCRs are broken down in periods delineated by each of the ten VCM reports VCM 17 through VCM 27.¹⁰⁶ All E&DCRs preceding VCM 17 are represented in the first column at the left-most portion of Figure 20. The stacked columns present a total count of E&DCRs within a particular period for all Fleet issues in blue. Unit specific (or non-fleet) E&DCRs are presented in gray.

161. After VCM 17 the E&DCR changes represent a small percentage of the total documents issued for the Project spread over about 5 years, and well within the range that a sophisticated, experienced contractor should be able to handle without impact. Impacts that failed to be managed by the contractor could not have been anticipated by SNC.

162. During my evaluation of the E&DCRs, I noted several Fleet issues that appeared to have an impact to the schedule, the Project cost or both. It is evident that these E&DCRs affected all units, not just Plant Vogtle. As such, the presence of ongoing emergent and developmental issues indicates the materialization of Risk 4, that the Project struggled to continue to meet FOAK challenges.

10.2 ACTUAL EFFECT OF APPLICATION OF 10 CFR 52

163. The licensing and operation of all commercial nuclear power plants within the United States, are regulated by the NRC. NRC approval is required before a nuclear power plant can be built, as the NRC

¹⁰⁶ VCM reports were produced about every six months, with the exception of VCM 20/21 which covered one full year. As such, some differences in distribution of E&DCR data may have occurred in this period.

oversees construction and operation of a facility throughout its lifetime to monitor compliance with regulations.¹⁰⁷

164. The NRC's licensing process for commercial nuclear power plants is described in Title 10 of the Code of Federal Regulations (CFR).
165. In 1989, the NRC sought to improve upon the existing licensing process for nuclear power plant construction and operation (CFR Part 50), through establishment of an alternative combined licensing process (CFR Part 52).
166. This Section of my Report will describe the difference in application of 10 CFR 50 versus 10 CFR 52 and the order of magnitude of the unintended consequences in moving from 10 CFR 50 to 10 CFR 52.

10.2.1 Overview of CFR Part 50

167. CFR Part 50 (also referred to in this Report as "10 CFR 50") involved a two-step process. The CFR 50 applicant would be required to obtain both a construction permit and an operating license.
168. Upon application for construction of the plant, the NRC completes a review and evaluates the application for "completeness" (i.e., whether sufficient information was provided to support the NRC's detailed review).
169. If the construction application is accepted for further review, the NRC holds "*a public meeting near the proposed site to familiarize the public with the safety and environmental aspects of the proposed application.*" Several public meetings of this nature can be held during the review process.
170. Administrative tasks are then completed, such as filing of the application documents in the NRC database, notification of the public through press releases and social media, and publication of a notice of application receipt in the *Federal Register*.
171. The NRC then conducts a detailed review of the application, evaluating the plant design for compliance with "*all applicable regulations (10 CFR Parts 20, 50, 73, and 100).*"¹⁰⁸ There are three primary subjects of review: safety, environmental and antitrust.

¹⁰⁷ NRC "Backgrounder on Nuclear Power Plant Licensing Process" (accessible at <https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html>).

¹⁰⁸ NRC "Backgrounder on Nuclear Power Plant Licensing Process" (accessible at <https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html>).

172. The safety review includes plant characteristics such as:

- Site features (nearby population, seismology, hydrology, etc.)
- Response plans for hypothetical accidents and emergencies
- The applicant's technical qualifications for operations of the plant
- Plant discharges into the environment (e.g., radiological)

173. To reinforce compliance with safety requirements, related review processes are also conducted by the Advisory Committee on Reactor Safeguards¹⁰⁹ (ACRS) and the Atomic Safety and Licensing Board (ASLB), as part of the NRC application review.

174. Early in the licensing process, the ACRS works with the NRC and the applicant to conduct an independent safety review. The ASLB conducts a public hearing.

175. With regards to the environmental review, the NRC evaluates the environmental impacts and benefits of the proposed plant and summarizes its findings in a Draft Environmental Impact Statement. The draft statement is opened to comments by the public and appropriate government agencies, then the NRC publishes a Final Environmental Impact Statement.

176. Under CFR 50, the NRC may provide authorization for the licensee to begin some work at the site prior to issuance of the construction permit. This *"Limited Work Authorization excludes any nuclear safety-related activities."*

177. A separate application is required for the nuclear power plant operating license. A Final Safety Analysis Report must be submitted by the applicant, describing the facility's final design, operational procedures, and emergency protocols.

178. As part of the operating license review, a Final Safety Evaluation report is prepared by the NRC. The ACRS again completes an independent evaluation and provides input to the Commission.

¹⁰⁹ An independent group that provides advice on reactor safety to the NRC.

179. The NRC's publication of a *Federal Register* notice for acceptance of an operating license application provides an opportunity for the public to request a hearing. However, a public hearing is not mandatory for an operating license application.

10.2.2 Overview of CFR Part 52

180. Under CFR Part 52, a combined license is provided, that includes a construction permit and an operating license with conditions for plant operation.

10.2.2.1 Early Site Permit

181. A combined license application under CFR 52 must incorporate by reference an early site permit; otherwise, the NRC will proceed review of the application using the two-step licensing process.

182. The goal of the early site permit is resolution of “*site safety, environmental protection, and emergency preparedness issues independent of a specific nuclear plant design.*”¹¹⁰

183. The early site permit application requires the following information:

- “*site boundaries;*
- *seismic, meteorologic, hydraulic and geologic data;*
- *existing and projected future population of the surrounding area;*
- *evaluation of alternative sites;*
- *proposed general location of each plant planned to be on the site;*
- *number, type and power level of the plants planned for the site;*
- *maximum discharges from the plant;*
- *type of plant cooling system to be used;*
- *radiation dose consequences of hypothetical accidents; and*
- *plans for coping with emergencies.*”¹¹¹

¹¹⁰ NRC “Backgrounder on Nuclear Power Plant Licensing Process” (accessible at <https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html>).

¹¹¹ NRC “Backgrounder on Nuclear Power Plant Licensing Process” (accessible at <https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html>).

184. The NRC reviews the early site permit application, with safety input from the ACRS. The NRC's findings are published in a Safety Evaluation Report, Draft Environmental Impact Statement and Final Environmental Impact Statement.
185. After the NRC and ACRS complete their safety reviews for the early site permit, a *Federal Register* notice is issued for a mandatory public hearing.
186. An early site permit may or may not include limited work authorization for completion of non-safety site preparation activities prior to issuance of the combined license.

10.2.2.2 Design Certification

187. The CFR 52 process includes provisions for NRC approval and certification of standard nuclear plant design elements, referred to as "Design Certification." An application for a combined license may incorporate a Design Certification by reference.
188. The application for Design Certification must¹¹²:
- *"contain proposed inspections, tests, analyses, and acceptance criteria for the standard design",*
 - *"contain enough design information for the Commission to reach a final conclusion on all safety questions",* and
 - demonstrate compliance with the Commission's regulations.
189. The NRC summarizes the level of design development required for Design Certification as follows:

*"A design certification application should provide an essentially complete nuclear plant design, with the exception of some site-specific design features. The application presents the design basis, the limits on operation, and a safety analysis of structures, systems, and components of the facility as a whole. The scope and contents of the application are equivalent to the level of detail found in a Final Safety Analysis Report for a currently operating plant."*¹¹³

¹¹² NRC "Backgrounder on Nuclear Power Plant Licensing Process" (accessible at <https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html>).

¹¹³ NRC "Backgrounder on Nuclear Power Plant Licensing Process" (accessible at <https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html>).

190. In other words, the level of information required for an operating license application under CFR 50 (i.e., a Final Safety Analysis Report) is the same as level of information required to obtain Design Certification for aspects of the design under CFR 52.

10.2.2.3 ITAAC

191. A combined license application requires *“essentially the same information required in an application for an operating license issued under Part 50 and [must] specify the inspections, tests, and analyses that the applicant must perform. It also specifies acceptance criteria necessary to provide reasonable assurance that the facility has been constructed and will be operated in agreement with the license and applicable regulations.”*¹¹⁴
192. Operation of the facility is only authorized after the NRC has verified completion of the required inspections, tests, and analyses. The NRC must also confirm that acceptance criteria has been met. Collectively, these inspections, test, analyses, and acceptance criteria are referred to as ITAAC.
193. A mandatory hearing is also required for a combined license. The licensee must notify the NRC of its scheduled initial fuel loading date no later than 270 days in advance.¹¹⁵ A notice of intended operation will be published in the *Federal Register* at least 180 days prior to the date scheduled for initial loading of fuel.
194. Per the NRC, it *“intends to publish the notice of intended operation 210 days before scheduled fuel load, although the NRC may publish this notice up to 75 days earlier than that if the uncompleted ITAAC notifications are submitted earlier than required and certain other prerequisites are satisfied.”*¹¹⁶
195. The NRC then accepts petitions which challenge the licensee’s compliance with the acceptance criteria. Submission of hearing requests are permitted for 60 days following publication of the notice. Thus, the NRC must verify that all required construction and preoperational tasks have been completed in accordance with the ITAAC before fuel loading can be approved.

¹¹⁴ NRC “Backgrounder on Nuclear Power Plant Licensing Process” (accessible at <https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html>).

¹¹⁵ 10 CFR 52.103(a).

¹¹⁶ NRC “Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)” (accessible at <https://www.nrc.gov/reactors/new-reactors/how-we-regulate/oversight/itaac.html>)

196. The ITAAC are derived from two sources: applicable Design Certifications¹¹⁷ and site specific standards defined in the combined license (or early site permit) application.¹¹⁸
197. During construction, the licensee must maintain the ITAAC by performing all inspections, tests, and analyses, and ensuring that the acceptance criteria are met. NRC inspectors perform inspections throughout the construction process for adherence to ITAAC.
198. CFR 52 also established a thorough process for contemporaneous documentation of the ITAAC process:

***“For every completed ITAAC, the licensee must submit to the NRC an ITAAC Closure Notification (ICN)... after a licensee has completed an ITAAC and submitted the ICN, the licensee is required to report new information materially altering the basis for determining that a prescribed inspection, test, or analysis was performed as required, or finding that a prescribed acceptance criterion is met. These notifications, called ITAAC Post-Closure Notifications, must document how the licensee successfully resolved the issue.”**^{119,120} [emphasis added]*

“For any ITAAC that have not been successfully completed at least 225 days prior to the scheduled date for initial loading of fuel... [the licensee must] submit an Uncompleted ITAAC Notification stating that all inspections, tests, and analyses will be performed and the prescribed acceptance criteria will be met, and explain the licensee’s plans for completing all ITAAC that have not yet been completed.”^{121,122}

199. Uncompleted ITAAC Notifications can be used by the public in determination of the need for a hearing request.
200. Upon completion of all ITAAC, the licensee is required to submit an All ITAAC Complete notification to the NRC for verification.¹²³

10.2.3 The License Amendment Process

201. The administrative process by which licensee submittals are reviewed and accepted by the NRC is referred to as the License Amendment Process. The process is initiated via submittal of a License Amendment Request (“LAR”). According to information presented by the Nuclear Energy Institute

¹¹⁷ Certifications for the particular reactor technology used by the plant.

¹¹⁸ NRC “Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)” (accessible at <https://www.nrc.gov/reactors/new-reactors/how-we-regulate/oversight/itaac.html>)

¹¹⁹ NRC “Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)” (accessible at <https://www.nrc.gov/reactors/new-reactors/how-we-regulate/oversight/itaac.html>)

¹²⁰ 10 CFR 52.99(c)(1) and 10 CFR 52.99(c)(2).

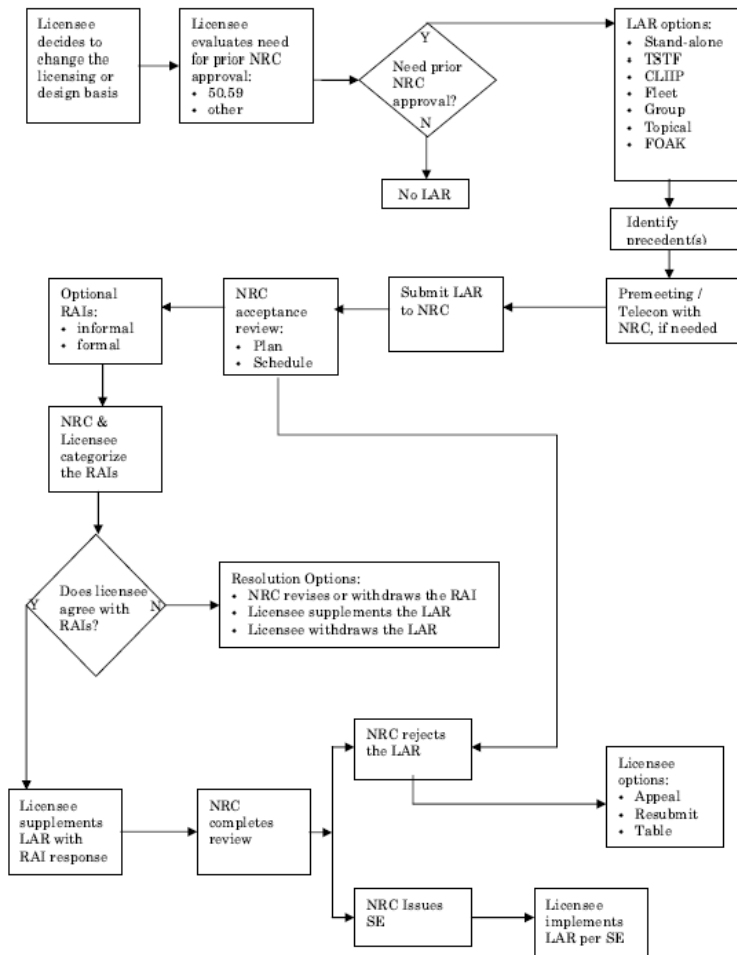
¹²¹ NRC “Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)” (accessible at <https://www.nrc.gov/reactors/new-reactors/how-we-regulate/oversight/itaac.html>)

¹²² 10 CFR 52.99(c)(3).

¹²³ 10 CFR 52.99(c)(4) and 10 CFR 52.103(g).

("NEI"), the steps to amend an operating license granted under 10 CFR 50 is presented in Figure 21, below.

Figure 21: LAR Flow Chart under 10 CFR 50¹²⁴



202. Under a combined license granted under 10 CFR 52, the Commission was similarly not permitted to, *"modify, add, or delete any term or condition of the combined license, the design of the facility, the inspections, tests, analyses, and acceptance criteria contained in the license which are not derived from a referenced standard design certification or manufacturing license, except in accordance with the provisions of § 52.103 or § 50.109 of this chapter, as applicable."*¹²⁵

¹²⁴ License Amendment Request Guidelines, [NEI 06-02, "License Amendment Request Guidelines." \(nrc.gov\)](#), prepared by Nuclear Energy Institute, dated December 2006, p. 15

¹²⁵ Subpart 52.98, NRC 10 CFR Part 52, NRC_10 CFR PART 52.pdf, p. 46

203. Specifically, Part 52.98 acknowledged that if the combined license does not reference a certified design, the process outlined in 10 CFR 50 may be applied. However, if the combined license does reference a certified design, such as one certified by Westinghouse, the process shall be governed as follows:¹²⁶

203.1 *“Changes to or departures from information within the scope of the referenced design certification rule are subject to the applicable change processes in that rule”; and*

203.2 *“Changes that are not within the scope of the referenced design certification rule are subject to the applicable change processes in 10 CFR part 50, unless they also involve changes to or noncompliance with information within the scope of the referenced design certification rule. In these cases, the applicable provisions of this section and the design certification rule apply.”*

204. Appendix D to 10 CFR 52 outlines the design certification rule for the Westinghouse AP1000 design. Specifically, Appendix D defines three *Tiers* of design information, the additional requirements and restrictions governing the same, and the process for changes and departures to these tiers including the use of LARs.

205. Part II defines three tiers of design-related information as follows:

205.1 *“Tier 1: means the portion of the design-related information contained in the generic DCD that is approved and certified by this appendix (Tier 1 information). The design descriptions, interface requirements, and site parameters are derived from Tier 2 information. Tier 1 information includes:*

1. Definitions and general provisions;

2. Design descriptions;

3. Inspections, tests, analyses, and acceptance criteria (ITAAC);

4. Significant site parameters; and

5. Significant interface requirements.”¹²⁷

¹²⁶ Ibid.

¹²⁷ [eCFR :: Appendix D to Part 52, Title 10 -- Design Certification Rule for the AP1000 Design](#), p.1.

205.2 *“Tier 2 means the portion of the design-related information contained in the generic DCD that is approved but not certified by this appendix (Tier 2 information). Compliance with Tier 2 is required, but generic changes to and plant-specific departures from Tier 2 are governed by Section VIII of this appendix. Compliance with Tier 2 provides a sufficient, but not the only acceptable, method for complying with Tier 1. Compliance methods differing from Tier 2 must satisfy the change process in Section VIII of this appendix. Regardless of these differences, an applicant or licensee must meet the requirement in Section III.B of this appendix to reference Tier 2 when referencing Tier 1. Tier 2 information includes:*

1. Information required by §§ 52.47(a) and 52.47(c), with the exception of generic technical specifications and conceptual design information;

2. Supporting information on the inspections, tests, and analyses that will be performed to demonstrate that the acceptance criteria in the ITAAC have been met; and

3. Combined License (COL) action items (COL license information), which identify certain matters that must be addressed in the site-specific portion of the Final Safety Analysis Report (FSAR) by an applicant who references this appendix. These items constitute information requirements but are not the only acceptable set of information in the FSAR. An applicant may depart from or omit these items, provided that the departure or omission is identified and justified in the FSAR. After issuance of a construction permit or COL, these items are not requirements for the licensee unless such items are restated in the FSAR.

4. The investment protection short-term availability controls in Section 16.3 of the DCD.”¹²⁸

205.3 *“Tier 2 * means the portion of the Tier 2 information, designated as such in the generic DCD, which is subject to the change process in Section VIII.B.6 of this appendix. This designation expires for some Tier 2* information under paragraph VIII.B.6.”¹²⁹*

206. Item B.5.b of Appendix D states that if there is a proposed departure from Tier 2, a LAR is required if it results in either a *“more than minimal increase in the frequency of occurrence of an accident,” “more than a minimal increase in the likelihood of occurrence of a malfunction,” or “more than a minimal increase in the consequence of an accident.”¹³⁰*

¹²⁸ Id., pp. 1-2.

¹²⁹ Id., p. 2.

¹³⁰ Id., p. 7.

207. Section 10.2.4 of this Report presents a review of LAR impacts as described by Site and Corporate Licensing in the period following VCM 17.

10.2.4 Analysis of LARs at Plant Vogtle

208. I have conducted a review of LAR impacts as described by Site and Corporate Licensing and have evaluated the relief sought or granted. This evaluation was conducted for the period following issuance of VCM 17 through to VCM 23, which was the last report to have provided an update by Site and Corporate Licensing.

209. As of February 2018, VCM 18 notes that Site and Corporate Licensing has focused efforts on obtaining NRC approval of a third LAR with the objective of reducing requirements for 190 ITAACs per Unit. The report states the following:

"A joint effort between the Initial Test Program and Operations organizations is underway to develop a LAR that would remove certain First Plant Only/First Three Plants Only tests from the Vogtle 3 and 4 scope, based on the outcome of tests conducted at the AP1000 nuclear plants being constructed in China."¹³¹

210. Table 4 below, itemizes all open LARs as of VCM 18.

Table 4: VCM 18 License Amendment Requests

VCM 18 LARs	
LAR	Description
LAR-17-002	requested volume changes to the IRWST (Amendments 81/80)
LAR-15-012 R2	requested changes to the Containment Internal Floor Module Connections (Amendments 82/81)
LAR-16-011	requested changes to the Pressurizer Surge Line Testing (Amendments 83/82)
LAR-17-003	requested changes Hydrogen Venting in Passive Core Cooling System ("PXS") Compartment (Amendments 84/83)
LAR-17-006	was a 2017 ITAAC consolidation by combining the associated Design Commitment, Inspections, Tests, Analyses and Acceptance Criteria within six categories including: "Reference" ITAAC, ASME Component and Piping ITAAC, Nuclear Island ITAAC, Equipment Qualification ITAAC, Valve Qualification ITAAC, Instrumentation and Control (I&C) and Electrical Functional Arrangement ITAAC. (Amendments 85/84)
LAR-16-027	requested changes to NDE for welds of Carbon Steel Couplers to Embedment Plates at VEGP (Amendments 86/85)
LAR-17-004	requested standardization of instrumentation setpoint nomenclature (Amendments 87/86)
LAR-17-007	requested a consistency update to the Raceway Separation Requirements in the Main Control Room ("MCR") and Remote Shutdown Room ("RSR") (Amendments 88/87)
LAR-16-019	requested slab thickness changes between Lines I to J-1 and 2 to 4 at elevation 153 feet (Amendments 89/88)
LAR-17-005	requested changes in Engineered Safety Features for Containment Vacuum Relief (Amendments 90/89)
LAR-16-018	requested changes in Automatic Depressurization System ("ADS") and IRWST Injection Block ("TSR") (Amendments 91/90)
LAR-17-013	requested changes in Fire Protection System ("FPS") piping that must remain functional following a Safe Shutdown Earthquake ("SSE") (Amendments 92/91)
LAR-17-015	requested optimization changes to Central Chilled Water System ("VWS") (Amendments 93/92)
LAR-17-011	requested a clarification of Protection and Safety Monitoring System (PMS) Interdivisional Cables in Auxiliary Building Fire Areas (Amendments 94/93)
LAR-17-014	requested Emergency Planning ITAAC Revisions (Amendments 95/94)
LAR-15-019 R2	requested the addition of two Turbine Building Sump Pumps (Amendments 96/95)
LAR-17-008	requested clarification of Raceway and Raceway System Designations (Amendments 97/96)
LAR-17-017	requested changes in Containment Air Filtration Exhaust Rooms (Amendments 98/97)
LAR-17-012 R1	requested the addition of Steam Generator System ("SGS") Thermal Relief Valves (Amendments 99/98)
LAR-16-023	requested the addition of IRWST Lower Narrow Range Level Instrumentation ("TSR") (Amendments 100/99)
LAR-17-016	requested changes to the Auxiliary building roof rebar configuration design (Amendments 101/100)
LAR-17-020	requested to add reactor trip signal on Safeguards Actuation Signal Time Delay and other miscellaneous Technical Specification Changes (Amendments 102/101)
LAR-16-033 R1	requested the resolution of Auxiliary Building wall thickness and description inconsistencies (Amendments 103/102)
LAR-17-022	requested the addition of a Residual Heat Removal Suction Relief Valve for Low Temperature Overpressure Protection ("TSR") (Amendments 104/103)

¹³¹ VCM 18, p. 27

211. I have reviewed a sample set of LARs tabulated above and have evaluated the impact of the design change alongside the licensing citations which have been referenced therein. At the highest level, it is apparent that under CFR Part 52, even relatively minor design changes require a significant level of licensing revision, review and approvals not previously required under CFR 50.

212. For example, LAR-17-004 was submitted on February 24, 2017, and amended on August 7, 2017, submitted as a request to standardize setpoint nomenclature.¹³² The objective of the request was to revise document inconsistencies among various designators (e.g., “Low-3” vs. “Low”).¹³³ An extract from the safety evaluation of the Office of New Reactors is as follows:

“By letter dated February 24, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17055C352), as supplemented by letter dated August 7, 2017 (ADAMS Accession No. ML17219A185), Southern Nuclear Operating Company (SNC or licensee) submitted license amendment request (LAR) 17-004 requesting the U.S. Nuclear Regulatory Commission (NRC or the Commission) approval for amendments the combined licenses (COLs) for Vogtle Electric Generating Plant (VEGP) Units 3 and 4, COL Numbers NPF-91 and NPF-92, respectively, regarding the changes to standardize the instrumentation setpoint nomenclature for the protection and safety monitoring system (PMS). SNC also requested related exemptions from the Commission’s regulations.”¹³⁴

213. On September 13, 2017, and following project management transition from Westinghouse to SNC and Georgia Power, SNC made a request to update the approval dates for LARs previously issued. An updated approval date of October 6, 2017 was requested for LAR-17-004, among others.¹³⁵

214. While the requested amendments required changes to the Updated Final Safety Analysis Report (“UFSAR”) as it was a departure from the DCD,¹³⁶ NRC staff determined that, *“the exemption proposed in this LAR (1) is authorized by law; (2) presents no undue risk to the public health and safety; (3) is consistent with the common defense and security; (4) presents special circumstances; (5) the special circumstances outweigh the potential decrease in safety due to reduced standardization; and (6) does not reduce the level of safety at the licensee’s facility.”¹³⁷*

¹³² Letter, Subject: Vogtle Electric Generating Plant, Units 3 and 4 – Issuance of Amendment and Granting of Exemptions RE: Standardization of Instrumentation Setpoint Nomenclature (LAR 17-004)(CAC No. RP9612), Cover Letter - Vogtle Units 3 and 4 LAR 17-004 - Standardization of Instrumentation Setpoint Nomenclature (ML17233A109).pdf, dated September 22, 2017, p. 1.

¹³³ Safety Evaluation, Safety Evaluation - Vogtle Units 3 and 4 LAR 17-004 (ML17233A122).pdf, prepared by the Office of New Reactors, p. 8.

¹³⁴ Id., p. 1.

¹³⁵ Letter, Sub: Southern Nuclear Operating Company Vogtle Electric Generating Plant Units 3 and 4 Updates to Requested Approval Dates for License Amendment Requests, Vogtle, Units 3 and 4 - Updates to Requested Approval Dates for License Amendment Requests (ML17256A629).pdf, dated September 13, 2017, p. 2.

¹³⁶ Ibid.

¹³⁷ Id., p. 10.

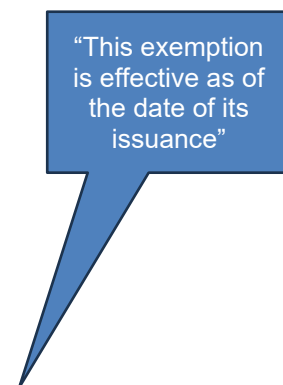
215. Ultimately, the Commission granted an exception from the Tier 1 information for Unit 3¹³⁸ and Unit 4¹³⁹ on September 22, 2017.

216. As of August 2018, Site and Corporate Licensing sought exception of NRC approval to changes made to Tier 2* material, provided the, *“Tier 2* material passes new proposed criteria to be included as a license condition.”*¹⁴⁰ The following status was noted:

“It is anticipated that this LAR will be approved during the next Reporting Period, and if approved, would reduce potential schedule impacts from Tier 2 design changes.”*¹⁴¹

217. Based on the Project contemporaneous documents, I understand that exemption from NRC approval to changes in connection with DCD information defined as Tier 1 had previously been requested in November 2016 and had been granted in February 2017 under Exemption License No. NPF-91.¹⁴² An extract of this letter is shown in Figure 22, below.

Figure 22: Exemption License NPF-91



¹³⁸ Exemption - VEGP Unit 3 LAR 17-004 (ML17233A110).pdf, dated September 22, 2017.

¹³⁹ Exemption - VEGP Unit 4 LAR 17-004 (ML17233A111).pdf, dated September 22, 2017.

¹⁴⁰ VCM 19, p. 33.

¹⁴¹ VCM 19, p. 33.

¹⁴² Exemption License No. NPF-91, Exemption from Regulations Set Forth in Appendix D of 10 CFR Part 52, dated February 28, 2017.

SOUTHERN NUCLEAR OPERATING COMPANY, INC.
GEORGIA POWER COMPANY
OGLETHORPE POWER CORPORATION
MEAG POWER SPVM, LLC
MEAG POWER SPVJ, LLC
MEAG POWER SPVP, LLC
CITY OF DALTON, GEORGIA
VOGTLE ELECTRIC GENERATING PLANT UNIT 3
DOCKET NO. 52-025
EXEMPTION FROM REGULATIONS SET FORTH IN
APPENDIX D OF 10 CFR PART 52

Exemption
License No. NPF-91

1. In a letter dated November 4, 2016, as supplemented November 16, 2016, Southern Nuclear Operating Company, Inc., (licensee) requested from the Nuclear Regulatory Commission (NRC or Commission) an exemption to allow departures from Tier 1 information in the certified Design Control Document (DCD) incorporated by reference in Title 10 of the Code of Federal Regulations (10 CFR) Part 52, Appendix D, "Design Certification Rule for the AP1000 Design," as part of license amendment request (LAR) 16-026, "Passive Core Cooling System (PKS) Condensate Return."

For the reasons set forth in Section 3.0 of the NRC staff's Safety Evaluation, which can be found at Agencywide Documents Access and Management System (ADAMS) Accession Number ML17024A307, the Commission finds that:

A. the exemption is authorized by law;

B. the exemption presents no undue risk to public health and safety;

C. the exemption is consistent with the common defense and security;

D. special circumstances are present in that the application of the rule in this circumstance is not necessary to serve the underlying purpose of the rule;

2. According to the licensee, the exemption is necessary because the special circumstances outweigh any decrease in safety that may result from standardization caused by the exemption; and

3. As explained in Section 5.0 of the NRC staff's Safety Evaluation (ADAMS Accession Number ML17024A307), this exemption meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment needs to be prepared in connection with the issuance of the exemption.

4. This exemption is effective as of the date of its issuance.

Accordingly, the licensee is granted an exemption from the certified DCD Tier 1 information, with corresponding changes to Appendix C of the Facility Combined Licenses as described in the licensee's request dated November 4, 2016, as supplemented November 16, 2016. This exemption is related to, and necessary for the granting of License Amendment No. 72, which is being issued concurrently with this exemption.

FOR THE NUCLEAR REGULATORY COMMISSION:

/s/

Anna H. Bradford, Deputy Director
Division of New Reactor Licensing
Office of New Reactors

Date of Issuance: February 28, 2017

"allows departures from Tier 1 information"

218. VCM 19 also notes receipt of the following two amendments:

"An amendment to the Pipe Rupture Hazard and Flooding Analyses which supported the 2018 ITAAC milestone"¹⁴³ and;

"An amendment to the Control Room Emergency Habitability System Technical Specifications. Additionally, a joint effort between the ITP and Operations organizations is underway to remove certain First Plant Only/First Three Plants Only tests from the Vogtle Units 3 and 4 scopes, based on the successful outcome of tests conducted at the AP1000 nuclear plants being constructed in China. The first LAR containing four First of A Kind Tests ('FOAK') was submitted to the NRC on August 3, 2018. Once reviewed and approved by the NRC, this will reduce critical path impact during testing."¹⁴⁴

219. As of August 2019, SNC reported to have received approval for the LAR that grants changes to be made to Tier 2* material without prior NRC approval. As a result, most notably, VCM 20/21 states the following:

"Approval of this LAR has already reduced schedule impacts from potential Tier 2 design changes. During the Reporting Period, Licensing facilitated the approval of a Preliminary Amendment Request ('PAR') that revised administrative aspects of ITP as described in licensing documents. Specifically, these changes included the removal of component testing as a phase of ITP to allow component tests to be completed before full jurisdictional turnover from construction. This change in turn allows for early detection of issues on various components. Licensing utilized the NRC's PAR process to avoid significant loss of efficiency related to component testing. The associated LAR*

¹⁴³ VCM 19, p. 33.

¹⁴⁴ VCM 19, pp. 33-34.

was also submitted in August 2018 and was subsequently approved in February 2019.”¹⁴⁵

220. As of February 2020, and following successful outcome of FOAK tests in Chinese AP1000 units, SNC received a LAR approval to remove all FOAK tests. Additionally, as of the reporting period, *“ITAAC teams worked together to consolidate more ITAACs and submitted three separate LARs. The NRC has reviewed and approved all LARs which results in a removal of 49 ITAAC Closure Notifications (‘ICNs’).”¹⁴⁶*

221. As of August 2020, a majority of “high complexity” LARs in connection with Fuel Load and Startup had been approved by the NRC.¹⁴⁷

222. As of February 2021, all remaining LARs in connection with Fuel Load and Startup were approved and closed out.¹⁴⁸

10.2.5 Impacts of CFR Part 52 on Plant Vogtle

223. Licensing for construction and operation of the Vogtle Plant was applied for under CFR 52, rather than CFR 50. When compared to the CFR 50 construction permit, the CFR 52 combined license involves a greater level of oversight by the NRC and increases contemporaneous documentation submission to the NRC, during construction.

224. As described above, the CFR 52 licensing requires specification and strict implementation of the inspections, tests, analyses, and acceptance criteria (ITAAC) to be performed at the facility, to ensure compliance with all applicable regulations.

225. During construction at Plant Vogtle, ITAAC requirements were rigorously applied. These requirements included ITAAC procedures to be conducted in the field, as well as extensive reporting demands. Reporting documentation was to be completed, tracked, and submitted to the NRC at each step of the ITAAC process.

226. For example, as noted above, licensees must issue detailed notifications and account for completion of each ITAAC. For any ITAAC not completed within 225 days of scheduled initial fuel loading, a notification is required that specifies plans for completion. In addition to the issuance of notices during

¹⁴⁵ VCM 20/21, p. 37

¹⁴⁶ VCM 22, p. 39

¹⁴⁷ VCM 23

¹⁴⁸ VCM 24, p. 44

progression of the ITAAC process, another type of notification is then required upon completion of all ITAAC.

227. ITAAC requirements were further exacerbated by additional requirements to address departures to various design-related information. These tiers were not defined previously in 10 CFR 50. Departures or modifications to tiers required NRC approval via a Licensing Amendment Request. While licensing exemptions were ultimately granted, the additional steps required by CFR 52, namely those necessitated by the ITAAC process, resulted in delays to integration and approval of design changes at the Project. Consequently, unforeseen global schedule impacts were experienced.

10.3 PCCS TANK DESIGN

228. The Westinghouse advanced passive PWR AP1000 is an advanced Generation III+ reactor design to its predecessor, the AP600. At its core, the AP1000 included numerous advanced passive safety systems added to an existing or slightly revised configuration.

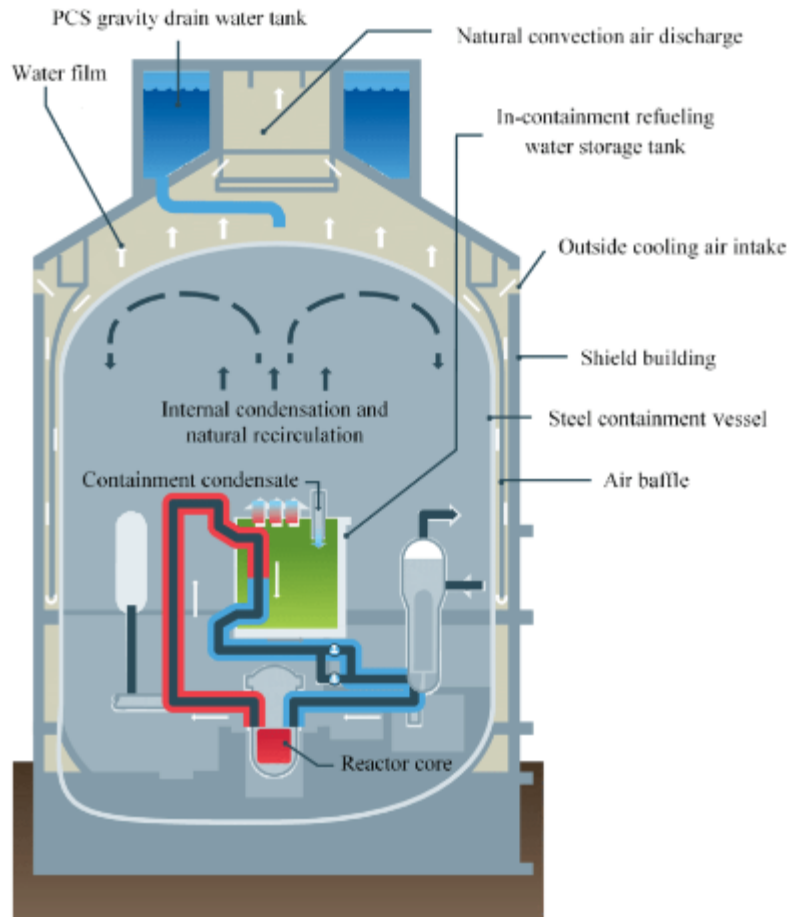
229. This configuration incorporated engineered systems for passive decay heat removal, passive safety injections, passive radiation removal among others. In all cases, these systems were first of a kind ("FOAK") system implemented in order to achieve high safety and performance and were fundamentally susceptible to engineering and installation challenges. One such system is the Passive Containment Cooling System, which I discuss herein.

10.3.1 Background

230. The Plant Vogtle Unit 3 and Unit 4 AP1000 reactors include a unique, Passive Containment Cooling System (PCCS). This system is a FOAK design for the United States.

231. The purpose of the PCCS is to cool the containment in case of an accident with mass and energy release in the containment, using water boiling, natural steam-air circulation, steam condensation and natural convection from steel containment to air phenomena as heat transfer mechanism from reactor core to outside air. A schematic of the components that support the PCCS is presented in Figure 23, below.

Figure 23: Simplified Schematic of the AP1000 PCCS



232. The PCCS system, and specifically the gravity drain water tank ("PCCS Tank") is located on top of the containment, or shield building, presented in Figure 23, above.

233. The PCCS Tank sits on top of the shield building roof. It is supported by and acts integrally with the conical roof.

234. The inside surface has a liner that functions to provide leak protection but is not required to provide structural strength to the structure. Leak chase channels are provided over the liner welds. The top elevation of the water inside the tank for the PCS has sufficient freeboard to preclude impact on the roof during the SSE. A photograph of the conical building being lifted and set into place is presented in Figure 24, below.

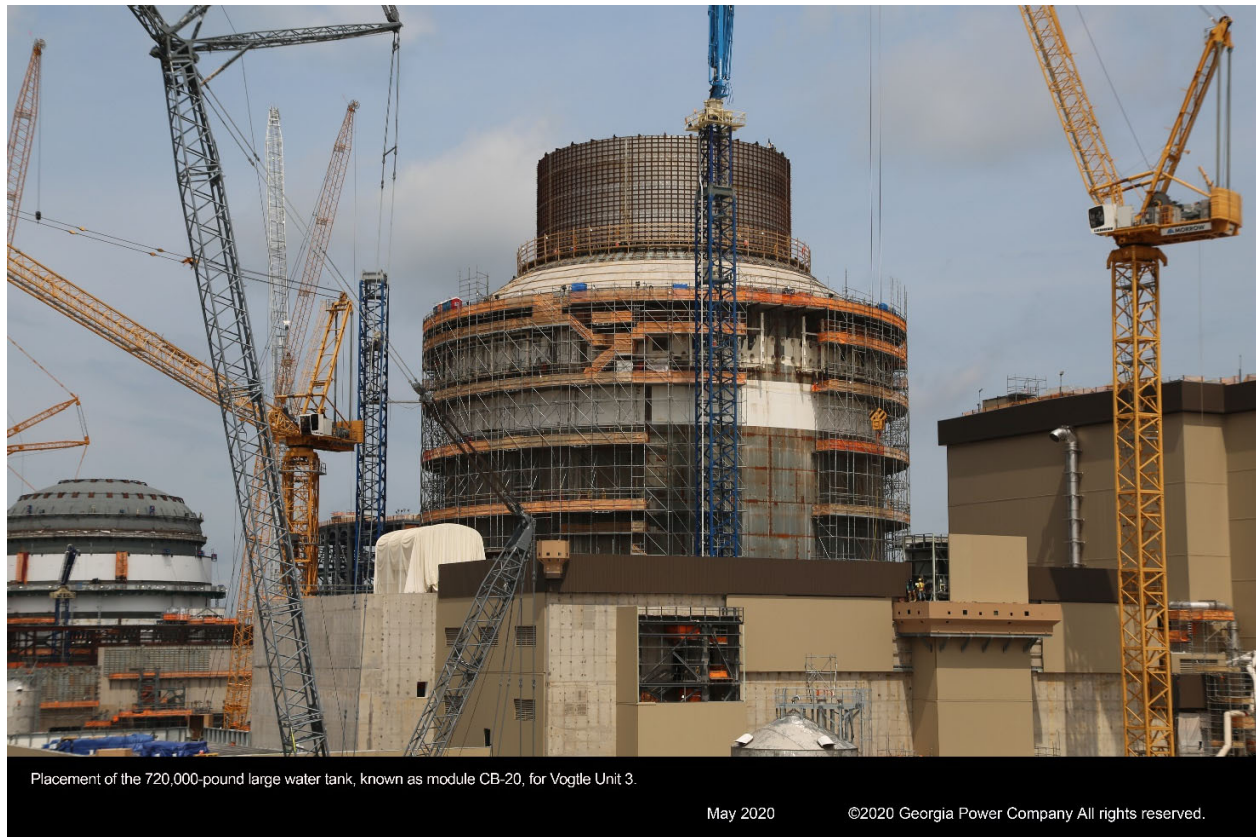
Figure 24: Photograph of the Conical Roof Being Lifted into Place



235. The PCCS Tank, often referred to as module CB-20, stands at 35 feet tall and weighs more than 720,000 pounds. CB-20 has a capacity of approximately 750,000 gallons and contains a reservoir of water ready to flow down in the unlikely event of an emergency to help cool the outside of the containment, and thus contribute to the cooling of the containment vessel itself.

236. The water can also be directed into the spent fuel pool, while the tank itself can be refilled from water stored elsewhere on site. A photograph of CB-20 being lifted and set into place is presented in Figure 25, below.

Figure 25: PCCS Tank on top of Containment Building



237. The PCCS is an integral part of the advanced heat sink design, and thus susceptible to a myriad of engineering and installation challenges in connection to both the conical roof and CB-20. These issues impacted Engineering, Craft Labor, Supervision and Management during construction.

238. Issues encountered for this system at Vogtle Unit 3 could not have been anticipated and are considered to be FOAK.

10.3.2 PCCS Issue Evaluation

239. I have identified 141 E&DCRs which relate to the PCCS, specifically CB-20 and the conical roof.¹⁴⁹

240. Based on this set of E&DCRs which relate specifically to the PCCS, I observe the following:

241. First, I removed 47 E&DCRs from the above total, as these items were created prior to VCM 17, and therefore outside of the scope and time period of my review.

¹⁴⁹ Other, additional search terms may reveal an enlarged sample set. However, these are believed to be limited and secondary.

242. Next, I removed an additional 58 E&DCRs from the above total, as these items relate specifically to Vogtle Unit 3 ("SV3"), Unit 4 ("SV4"), or both Units 3 and 4 ("SV0"). Thus, the remaining E&DCRs all indicate a nomenclature of "APP", which is used to denote issues affecting the entire Westinghouse AP1000 fleet rather than a specific unit.

243. I have broadly reviewed the final sample set of 36 remaining E&DCRs, and have determined that these documents specifically relate to, and are representative examples of, FOAK PCCS issues which likely could not have been envisaged at VCM 17.

10.3.3 PCCS Conclusion

244. Based on my review of these problems, it is evident that modifications were required to address adequate integration of the PCCS Tank with the conical roof of the Containment Building.

245. Considering that the AP1000 was the first design of its kind to locate the PCCS Tank on top of the Containment Building the integration of these two components would have likely resulted in construction challenges not previously considered.

10.4 AP1000 DC SYSTEM IEEE SEPARATION

246. As I have shown in Section 3 of this Report, Westinghouse, in marketing the AP1000 plant indicated a great reduction in bulk quantities and equipment associated with a passively safe design.

247. While it may be true that the AP1000 design requires less cable and fewer safety related sources of AC power, the greatest reduction in the bulk quantities making up the IEEE AC power systems are for quantities associated with divisions of offsite power and diesel backup power and not within the containment building itself or with the uninterruptable DC power systems needed in the event of a loss of offsite power and diesel failure.

248. As noted in Section 3 of this Report, the AP1000 is identified by Westinghouse as having 45% less seismic building volume than an older generation Westinghouse Pressurized Water Reactor ("PWR"). One of the ways the volume is diminished is by having a containment building with a smaller diameter than previous PWR plants.

249. One such PWR plant is the Calvert Cliffs Nuclear Power Plant ("Calvert Cliffs"), located on the Chesapeake Bay of Maryland's western shore. Completed in the mid-1970's, the site consists of two units, each running an approximately 850 MW Generation II, two-loop PWR. The inner radius¹⁵⁰ of these containment buildings measure just under 65 feet, or a diameter of about 130 feet.
250. In comparison, I have reviewed general arrangement drawings for the nuclear island at Plant Vogtle. Plan drawings at Redacted indicate a containment building radius of ^{Redacted} The plans indicate this radius to extend to the shell lining, an extract of which is shown in Figure 26, below.

Figure 26: Plan Extract from General Arrangement Drawings, Annotated¹⁵¹

Redacted

¹⁵⁰ As measured to the face of the shell liner.

¹⁵¹ Sheet APP-1030-P2-001, Nuclear Island General Arrangement Plan at El. 100'0" & 107'2", CTRL0002215901_NI Horizontal Building AR&P2 Drawings.pdf, prepared by Westinghouse Electric Company, LLC., dated August 2, 2019.

251. Comparing the containment buildings between Calvert Cliffs and Vogtle, it is evident that the radius of the AP1000 is about ^{Redacted} feet less than its predecessor. This translates to diametrical difference of four feet along a majority of the approximately ^{Redacted} foot height of the interior containment shield wall. While this ^{Redacted} percent delta seems nominal, coupled with the increase in divisional separation requirements for IEEE systems, space constraints became significant issue in Unit 3. For Unit 4, Lessons Learned on how to more effectively work in a confined space along with Lessons Learned with respect to the IEEE cable installation enhanced the construction completion activities.
252. There are also several other equipment/component changes in the AP1000 that contribute to the decreased space to work within the containment. For example, the In Containment Refueling Water Storage Tank (IRWST). This tank of approximately 590,000 gallons is larger than its predecessor PWR tanks and more importantly has been moved into the containment building to provide several passive cooling functions thereby decreasing otherwise working/equipment space within the building.
253. Specific to the AP1000 FOAK design, while the containment size is reduced, the number of Divisions of IEEE DC systems has increased from two to four.
254. As stated in the USNRC HRTD Manual Section 6.0, Electrical Distribution System:
- “6.6 125-vdc Electrical System
The purpose of the 125-vdc electrical system is to supply reliable, continuous Class 1E electrical power to engineered safety feature (ESF) equipment and non-safety related equipment required for startup, normal operation, and safe shutdown of the plant. The 125-vdc system provides this power for a specified time under all plant conditions, including the complete loss of offsite and onsite ac power sources.*
- 6.6.1 System Description
The 125-vdc electrical system is composed of two physically separate, electrically independent, redundant trains.”*
255. As stated in the USNRC HRTD, Section 5.3.2.2 Plant Comparisons, Electrical Systems for the AP1000:
- “The Class 1E DC power system includes **four independent divisions**. Any three of the four divisions can shut down the plant safely and maintain it in a safe shutdown condition. Each of divisions B and C has two battery banks. One of these battery banks is sized to supply power to selected safety-related loads for at least 24 hours, and the other battery bank is sized to supply power to another smaller set of selected safety-related loads for at least 72 hours following a design basis event (including the loss of all AC power). Each of divisions A and D has a single 24-hour capable battery bank only.” [emphasis added]*
256. It is my understanding that GPC has identified and absorbed costs associated with the rework of cables due to separation criteria non-conformance. However, even without the rework associated with the

separation issue, GPC could not have predicted the impact to craft labor productivity caused by a smaller containment structure and 4 divisions of separation.

257. A smaller containment structure divided into four quadrants as opposed to a larger containment structure divided into two quadrants for cable separation would impact the ability of the craft to install bulk commodities for electrical and have a ripple effect on the installation of other bulk commodities such as piping and HVAC systems.

258. As a minimum the result would be a Stacking of Trades, Concurrent Operations, Site Access that may not be adequately accounted for in the productivity unit rates estimated for Vogtle as the unit rates used in Bechtel's estimate for skilled trades were derived from an older vintage two loop PWR plant, demonstrating the ripple effect of a FOAK plant.

259. In fact, it is precisely these types of productivity impacts as described by AACeI and trade organizations such as MCAA¹⁵² which aim to establish a range of loss expressed as a percent decrease to productivity.

260. For example, two of the productivity impacts as defined by MCAA include:

- Stacking of Trades. This factor is described as follows:

*"Operations take place **within physically limited space** with other contractors. Results in congestion of personnel, inability to locate tools conveniently, increased loss of tools, additional safety hazards and increased visitors. Optimum crew size cannot be utilized."¹⁵³ [emphasis added]*

- Concurrent Operations. This factor is described as follows:

"Concurrent Operations: Stacking of this contractor's own force. Effect of adding operation to already planned equence of operations. Unless gradual and controlled implementation of additional operations made, factor will aply to all remaining and proposed contract hours."¹⁵⁴

261. It is my opinion that constrained or otherwise limited workspace due to the smaller containment building footprint constitutes a legitimate stacking and site access issue, and that based on the above, it would be common in the industry to expect an impact to productivity.

¹⁵² Refer to Section 9.1 of this Report.

¹⁵³ MCAA Change Orders, Productivity, Overtime 2004 Edition, Section Productivity, p. 77.

¹⁵⁴ MCAA Change Orders, Productivity, Overtime 2004 Edition, Section Productivity, p. 77.

262. As a FOAK issue it is reasonable to conclude that SNC, having hired an experienced multinational contractor to complete the work, could not have anticipated the exact magnitude of the impact to productivity at VCM 17.

11 ANALYSIS OF RISK 7; PROCUREMENT RISK:

263. Large scale construction projects, especially those involving FOAK designs, run the risk of experiencing major procurement risks including cost and quantity estimate busts, major design changes, manufacturing issues with long-lead components and equipment, or delayed design completion. Typically, as long-lead time components and equipment are delivered to the project site, the overall project risk for delays and increased costs is reduced.
264. VCM 17 identified potential procurement risks involving major manufacturing defects or necessary design changes to long-lead time equipment, components, or materials.¹⁵⁵ While risks associated with completion of fabrication and delivery of long-lead key equipment were minimized, manufacturing defects or design changes could still significantly affect the price and timing of delivery, putting timely Project completion at risk. Most notably, VCM 17 notes the most potential that future procurement issues may arise from vendors not performing to expectation.¹⁵⁶
265. Section 11.1 of this Report discusses risks associated with a typical EPC arrangement, and the evolution and transition of this risk following the Westinghouse bankruptcy.
266. Section 11.2 of this Report identifies key commodities for which procurement risks materialized.
267. Section 11.3 of this Report discusses issues associated with additional bulk material procurement that was necessitated by modeling of rebar and concrete as opposed to initial assessments using density criteria.

11.1 THE EVOLUTION OF PROCUREMENT RISK

268. Following transition of the Project to SNC at the beginning of January 2018, SNC assumed all risk along with the responsibility to deliver the Project, in accordance with the VCM 17 cost forecast. Upon transition, it became apparent that the Consortium severely underestimated critical bulk commodities, which set off a series of quantity verifications and adjustments led by SNC via site walkdowns. These documented adjustments revised previous estimates which were based on what was known at the time and replaced with detailed evaluations of expended progress and remaining work on the site.
269. Between about VCM 17 and VCM 20/21, SNC identified several key areas requiring scope estimate adjustments including but not limited to concrete, reinforcement, instrumentation, and unscheduled

¹⁵⁵ VCM 17, p. 96.

¹⁵⁶ Ibid.

electrical commodity installations. These adjustments led to often significant increases to quantities of materials, which SNC ultimately took responsibility to supply and furnish.

270. This method of Owner- furnished or “Free Issue” materials is a cost-savings technique whereby the Contractor receives Owner furnished bulk materials or equipment in advance to use or install over the duration of the project. By implementing Free Issue on key bulk commodities, SNC mitigated cost increases in one of two ways: 1) the materials did not include a markup which otherwise would had they been ordered by a subcontractor or vendor, and 2) savings were gained through ordering in bulk.

271. Section 11.2 identifies several of the key commodities that demonstrated the most significant procurement cost increases believed to exemplify a materialization of the procurement risk.

11.2 KEY COMMODITY GROWTH

272. Georgia Power tracked growth in procurement costs via categorized commodity codes within their Cost Performance Reports, or CPRs. Based on my understanding of these reports, commodities which led to the greatest cost growth are summarized below:

272.1 Civil, Structural, Architectural (“CSA”) – cost growth was associated specifically with structural concrete, grout, doors, relief panels and security. I understand a large majority of this cost growth was incurred during installation of equipment and electrical component work.

272.2 Electrical – significant cost growth was associated with increased quantities of conduits, fittings and glands, cables, and terminations.

272.3 Mechanical – substantial cost growth was associated with increased quantities of piping, tubing, fittings, and control rod clusters.

272.4 Other – additional cost growth was associated with replacement of damaged parts and other miscellaneous items.

273. Quantification of costs associated with these increased quantities are presented in the Expert Report of Ms. Kimberly Reome.

11.3 TEKLA REBAR MODELING EVALUATION

274. As identified in Paragraph 272.1, above, cost growth was associated with the CSA scope in connection with structural concrete work at the Project. One example of this growth is shown when reviewing how the quantity of rebar increased on the Project.

275. In order to address issues associated with additional bulk material procurement that was necessitated by modeling of rebar and concrete as opposed to initial assessments using density criteria, Tekla rebar modeling resources were brought onsite to address several issues.¹⁵⁷ These included:

- Design clashes in concrete as rebar was not part of the 3D model;
- Discrepancies between the CMC fabrication drawings and the delivered rebar which was unable to be used as per its intended purpose; and
- Onsite rebar fabrication due to complexity of the design and execution of construction planning functions.

276. Upon identification by the Area Manager, and following addition of the modeling resources, the Tekla model supported solution of the field fabrication issue at the Unit 3 auxiliary building. However, due to time constraints, the Unit 3 model was ultimately not completed.¹⁵⁸

277. Change Control Form (“CCF”) ID# 2018-185 identified SNC’s proposed solution to use the incomplete Unit 3 model as the basis of the Unit 4 model to produce detailed rebar drawings in order to facilitate the construction schedule. This was to be done by incorporating relevant E&DCRs in addition to field design changes. Based on my understanding of the issue, an alternative solution to investigate the remaining Unit 4 Auxiliary Building rebar “by hand” was not viable due a shortage of civil field engineers.¹⁵⁹

278. Ultimately, the Tekla rebar modeling team determined that an approximately 340 tons of rebar remained to be detailed.¹⁶⁰ The estimated work consisted generally of a team of four Tekla designers, in addition to several review engineers and project management over a period of about five months.¹⁶¹

¹⁵⁷ CCF ID# 2019-045, dated June 25, 2019, pg. 1.

¹⁵⁸ Ibid.

¹⁵⁹ Ibid.

¹⁶⁰ Ibid.

¹⁶¹ Id., p. 2.

279. While the issue was not deemed to have an impact to the critical path, CCF ID# 2019-045 identified and tracked this issue under Risk Event ID# 251 which had an EMV Value of just over \$1 Million, funded through credits from WECTEC commodity code A3RG, shown Figure 27, below.¹⁶²

Figure 27: Extract from CCF ID# 2019-045

Redacted

280. The emergence of the Tekla Rebar Modeling requirement is but one example of the materialization of procurement risks at the Project. As summarized in Section 11.2, above, procurement risks impacted numerous other bulk commodities in a global and persistent manner over the duration of the Project. Section 0 of my Report, evaluates a complementary but separate risk associated with scope which had altogether not been identified. To demonstrate this contrast in the materialization of this risk, I have again focused my evaluation on rebar scope growth at the Auxiliary Building.

¹⁶² Id., p. 3.

12 ANALYSIS OF RISK 8; UNIDENTIFIED SCOPE RISK

281. Unidentified scope risk relates to work required to complete the project that is not included in any of the parties' scopes because it was unknown at the onset of the project or when an estimate-to-complete (ETC) was prepared.¹⁶³ Such unknown work may include unforeseen site conditions and future design changes; or deliverables and requirements that should have been identified at the beginning of the project but were not. It is not uncommon for such unidentified scopes of work to result in significant project delays and increased project costs.
282. VCM 17 specifically identifies design changes and a difference in interpretations of applicable codes as potential causes for rework or added work not included in the ETC budget.¹⁶⁴ While VCM 17 states that while a disciplined approach will be taken to manage design changes, it acknowledges that *"the risk of unidentified work scope from factors that have not been anticipated cannot be eliminated entirely."*¹⁶⁵
283. This Section of my Report discusses commodity quantity changes and growth that was unforeseen and not predicable at the time of VCM 17.

12.1 SCOPE GROWTH AT PLANT VOGTLE

284. I have further evaluated the Project Scorecards, introduced in Section 9.1 of my Report, to determine whether the design changes (both discussed herein and experienced on the Project) materialized into actual scope growth as reflected in the contemporaneous Project records.
285. These documents presented individual and cumulative labor data on planned and actual earnings for key quantities and labor hours across various buildings and areas for Unit 3, Unit 4, as well as the across the total Project. An extract from one such Scorecard presenting key quantities taken from the Unit 3 Containment Building is presented in Figure 28, below.

¹⁶³ VCM 17, pp. 96-97.

¹⁶⁴ Ibid.

¹⁶⁵ Ibid.

Figure 28: Extract from Scorecard for Unit 3 Containment Building, Annotated¹⁶⁶

Redacted

286. I have relied on the Project Scorecards to investigate this occurrence and to form the basis of my opinion. In reviewing the data presented within these Scorecards, I have determined scope growth to be equivalent to quantity growth at the commodity level. Further, for purposes of my evaluation of the commodities, I have referred to the units of measure associated with each of the commodities.

287. Based on my review of the Project scorecards, one specific scope growth trend which should be noted is that of reinforcement, or rebar. Specifically, I observed a significant increase in rebar quantities contemplated within the Auxiliary buildings in each of the units. A summary breakdown of Unit 3 rebar quantities between about October 2017 and April 2023¹⁶⁷ is presented in Figure 29, below. While some 2017 data was available, I note that VCM 17 quantities were not loaded into the Scorecard until about January 1, 2018. As such, I have excluded 2017 quantities for this comparison.

¹⁶⁶ Project Scorecard, CTRL0000005174_2020-11-08 Vogtle SCORE CARD - FINAL_.pdf, dated November 8, 2020.

¹⁶⁷ Data presented for 2019 has been extended along the x-axis to display the monthly fluctuation in quantities within the period.

Figure 29: Unit 3 Summary Breakdown of Rebar Quantities in Tons

Redacted

288. As shown in Figure 29 above, the contemporaneous Project Scorecards indicate that rebar quantities in January 2018 were contemplated to be just over an average of about 1,500 tons. This is in comparison to quantities reaching a high of about 2,600 tons by May 2019. Over the total Project duration, rebar quantities on average reduced slightly to about 2,500 tons, which was approximately 60% greater than the tonnage considered at the start of 2018.

289. A similar scope growth trend may be observed for rebar quantities in the Unit 4 auxiliary building, presented in Figure 30, below.

Figure 30: Unit 4 Summary Breakdown of Rebar Quantities in Tons

Redacted

290. As shown in Figure 30 above, the contemporaneous Project Scorecards indicate that rebar quantities in January 2018 were contemplated to be just over an average of about 1,900 tons. This is in comparison to quantities reaching a high of about 2,800 tons by August 2020.¹⁶⁸ Over the total Project duration, rebar quantities on average remained constant at about 2,800 tons, which was 50% greater than the tonnage considered at the start of 2018.

291. Based on my evaluation of scope or quantity growth to reinforcement in both Unit 3 and Unit 4, it is evident that the Project encountered conditions that could not have been identified as at VCM 17. While VCM 17 adequately identified the risk associated with the possibility of unidentified scope growth, it did not provide an estimate of what such a growth might be. As such, a more detailed analysis of impacts leading to the increase of reinforcement within the auxiliary building is required to determine the contributing factors with specificity.

¹⁶⁸ Data presented for 2020 has been extended along the x-axis to display the monthly fluctuation in quantities within the period.

13 ANALYSIS OF RISK 12; TESTING/STARTUP RISK

292. Westinghouse presented the AP1000 as a schedule-centric solution to resolve issues with traditional PWRs that had historically longer construction and testing timelines.¹⁶⁹ The 18-month site preparation period and the 36-month site construction period was to be followed by an aggressive, 6-month testing and startup period. An extract from Westinghouse's promotional brochure is presented in Figure 31, below.

Figure 31: Westinghouse 6-Month Start Up and Testing Schedule



293. VCM 17 notes that the Owners and SNC are monitoring the four AP1000 nuclear plants being constructed in China for any problems that arise during testing and startup of these plants so that potential problems for the Vogtle plant can be proactively addressed prior to testing and startup.¹⁷⁰ Furthermore, VCM 17 acknowledges the significant differences between the Chinese plants and the Vogtle plant, stating that the *"possibility of additional or different testing and startup problems at Vogtle remains."*¹⁷¹

294. Based on my understanding of the Project and its current status, Testing and Startup risks materialized as the commissioning program was finalized on Unit 3 and still remain as a risk as the Testing and Startup program begins in earnest on Unit 4.

295. Key issues experienced on Unit 3 from HFT and after Fuel Load which ultimately contributed to schedule delay are as follows:

¹⁶⁹ Westinghouse AP1000 Brochure, prepared by Westinghouse Electric Company, LLC., Westinghouse AP1000 Brochure.pdf, dated 2007, p. 13.

¹⁷⁰ VCM 17, pp. 98-99.

¹⁷¹ Ibid.

295.1 Vibration of pipe supports associated with the Automatic Depressurization System (“ADS”);

295.2 Reactor and Turbine trips following initial criticality testing; and

295.3 Hydrogen leak in the main generator followed by planned maintenance outages.

296. The schedule impact surrounding these issues are presented in the HKA Schedule Expert report.

14 LIST OF ATTACHMENTS

Attachment 1 – Curriculum Vitae of Timothy R. Chitester, P.E.

Attachment 2 – Documents Relied Upon

15 LIST OF APPENDICES

Appendix A: Exhibits to Analysis

DOCKET NO. 29849
STATE OF GEORGIA
BEFORE THE GEORGIA PUBLIC SERVICE COMMISSION

IN RE: GEORGIA POWER COMPANY'S APPLICATION TO ADJUST RATES TO
INCLUDE REASONABLE AND PRUDENT VOGTLE UNITS 3 AND 4 COSTS

ATTACHMENTS AND APPENDICES TO EXPERT REPORT OF TIMOTHY R. CHITESTER

September 8, 2023

ON BEHALF OF: Georgia Power Company
PREPARED FOR: Troutman Pepper Hamilton Sanders LLP
SUBJECT MATTER: Analysis of Risks Identified in VCM 17

Attachments and Appendices to Expert Report of Timothy R. Chitester, P.E.
HKA Global, LLC
September 8, 2023

Table of Contents

1	ATTACHMENT 1 – CURRICULUM VITAE OF TIMOTHY R. CHITESTER.....	3
2	ATTACHMENT 2 – DOCUMENTS RELIED UPON	17
3	APPENDIX A – EXHIBITS TO ANALYSES	23

Attachments and Appendices to Expert Report of Timothy R. Chitester, P.E.
HKA Global, LLC
September 8, 2023

1 ATTACHMENT 1 – CURRICULUM VITAE OF TIMOTHY R. CHITESTER, P.E.

CURRICULUM VITAE

TIMOTHY R. CHITESTER**PARTNER****QUALIFICATIONS**

B.S., Mechanical Engineering, University of Pittsburgh, 1978
 Licensed Professional Engineer; Florida, Pennsylvania, Iowa (inactive)

MEMBERSHIPS

Member, American Society of Mechanical Engineers
 Member, Loss Executives Association
 Member, American Bar Association, Construction Forum
 Member, American Bar Association TIPS Property Law Section

PERSONAL DEVELOPMENT

Identified in "Who's Who Legal" as a leading expert witness.

PROFILE

Timothy R. Chitester is a Registered Professional Engineer with over 40 years of experience in the engineering, design and construction industry. His wide breadth of experience includes the resolution of construction disputes, construction claims, property loss and business interruption claims, as well as project design, engineering and project management.

Mr. Chitester has been directly involved in the design, scheduling, construction, and retrofit of more than 50 industrial, process, fossil fuel, hydroelectric, biofuel, and nuclear plants as both the engineer of record and the EPC contractor. He has specific experience and knowledge in scheduling and implementing industrial related projects, including oil & gas, mine operations, pipelines, distributed generation, cogeneration, combined cycle, simple cycle, district energy, new and retrofit nuclear plants and renewable energy projects. He has been responsible for the technical development, engineering and design, hiring and management of subcontractors, and operation of projects in 12 countries.

Mr. Chitester is recognized as an expert on construction claims and has testified in federal court, state court, AAA arbitration, ICDR arbitration, ICC arbitration, Canadian ADR arbitration and Chinese Arbitration Association of Taiwan arbitration relating to matters of construction management, contractor and engineer standard of care, trade use of contracts, cost, schedule, and productivity with resultant delay and disruption.

Experience - Selected Projects

Nuclear Projects:

Mr. Chitester has been retained as an expert and produced expert reports on three new vintage nuclear plants including the ABWR, EPR and AP1000 as well as several operating plants. Mr. Chitester has also provided expert opinions for the US DOJ on the construction of a Plutonium/Uranium fuel processing facility. During his career, Mr. Chitester has served both as a Manager of Nuclear Design and the Director of Nuclear design on loan to major utilities on plants under construction and entering operation.

Koeberg Nuclear Station, Cape Town, South Africa. Mr. Chitester is heading a team of Subject Matter Experts to assist the utility, Eskom, in identifying and managing risks associated with upcoming outages geared to replace the Steam Generators and increase the power output of the plant.

Confidential Project, Active Litigation. Mr. Chitester is providing consulting and expert service dealing with the addition of new diesel generators required post Fukushima to address Station Blackout considerations.

VC Summer Nuclear Power Station, South Carolina. Mr. Chitester assembled a team of experts and assisted a utility owner assess the function of the project management organization and defend a claim associated with the construction of a two unit 1,000Mw, AP1000 reactor plant that was cancelled part way through construction. Mr. Chitester's role included analysis of delay and disruption during the construction of the plant that led to the plant's ultimate cancellation.

Point Lepreau Nuclear Station, New Brunswick, Canada. Point Lepreau is a CanDu (heavy water reactor) power unit in New Brunswick which underwent a major overhaul. Mr. Chitester provided a review of the project and program management process employed by the owner and contractor for the replacement of the station's Calandria Tubes during a retrofit project. He issued an expert report for arbitration in the matter identifying cause of delay and the subsequent corrective actions that were necessary to mitigate the delay and cost escalation.

OL3 EPR, Olkiluoto, Finland. Mr. Chitester provided consulting services by managing a team of 8 schedulers in the UK and completing the full as-built schedule evaluation of the initial 26-month slip in the construction schedule for a multi-billion Euro, new vintage 1,600Mw pressurized water reactor project (EPR). Additionally, Mr. Chitester provided expert services by reviewing project feasibility reports and evaluating the original baseline schedule. He drafted the expert report/witness statement which examined the validity of the original schedule, to be used as direct testimony at the ICC Tribunal.

Lungmen Nuclear Plant, Taipei, Taiwan. Mr. Chitester provided a witness statement in the form of an expert report on the project management approach, schedule delay and standard of care of a large architect engineer and project manager involved with the design and construction on a new vintage 1,300Mw Advanced Boiling Water Reactor (ABWR) power facility. Mr. Chitester testified before an international arbitration panel on his findings in an ICC format including "hot tub" of the experts.

Clinton Power Station Seismic Dam Dredging. As the Director of Design, Mr. Chitester was responsible for the dredging of Clinton Lake to provide the correct water storage behind the underwater seismic dam used to provide cooling water to the Clinton Nuclear Power Station after a seismic event.

Fermi Unit 2, Monroe, Michigan. As the on-site supervisor of nuclear design, Mr. Chitester managed a group of 50 engineers during a required NRC shutdown and restart. His responsibilities included planning and implementing design changes with operations and maintenance to restart the unit.

Clinton Power Station, Clinton, Illinois. As the on-site director of nuclear design, Mr. Chitester managed a group of more than 100 engineers completing the design and engineering during the final construction and through the first cycle of plant operation.

River Bend Station, St. Francisville, Louisiana. As the on-site Sr. mechanical system engineer, and later advancing to the assistant superintendent of engineering, Mr. Chitester managed a group of 250 engineers and designers. He was responsible for the full support of construction, start-up and system turnover to the utility.

Grand Gulf Nuclear Plant, Port Gibson, Mississippi. Mr. Chitester was a project controls engineer (cost and schedule) and was on site during construction as a field engineer.

Project Management and Capital Project Support Services, Various Locations. Mr. Chitester had full security clearance and was rad protection trained and badged in order to provide full-time support services as the project manager for operations and outages at:

- Limerick Station Units 1 and 2.
- Peach Bottom Station Units 1 and 2.
- Brunswick Station
- Sharon Harris Station
- Robinson Station

Support included on-site outage planning and modification design and implementation during outages, power update projects for 4 units, and operation support during full power operation for all units. Additionally, Mr. Chitester has provided capital project support services for construction, operation, and outages at:

- Cooper Station,
- Salem Units 1 and 2,
- Hope Creek
- 9-Mile Point Unit 2,
- Milestone Station Unit 3

Power and Transmission & Distribution Related Projects:

Riverside Combined Cycle Energy Centre, Beloit, Wisconsin. Mr. Chitester reviewed the EPC contractors process and controls and evaluated the performance of the main electrical subcontractor. He testified in arbitration on the damages sustained by the subcontractor regarding unit prices, quantity changes, and out of scope work completed by the subcontractor.

Ichthys LNG Combined Cycle Power Plant, Northern Territories, Australia. Mr. Chitester was engaged as a consulting expert for the consortium design build contractor on the 520Mw combined cycle power plant built to supply electricity and steam for the Ichthys LNG plant. Mr. Chitester conducted analysis and worked with the quantum, delay and technical experts to refine their analysis and review the expert reports for submittal to the ICC arbitration panel.

CPV Towanic Combined Cycle, Energy Centre, Hartford, Connecticut. Mr. Chitester completed the analysis of a dispute regarding the program management associated with the erection of two Heat Recovery Steam Generators at the new combined cycle plant after the termination of the erection contractor. Mr. Chitester has provided an expert report evaluating the contractors project management and associated standard of care. Mr. Chitester opined on the delay, disruption, and cost increases associated with the erectors work and testified in AAA arbitration regarding the case.

San Juan Steam Plant Combined Cycle Repowering Units 5 and 6, San Juan Puerto Rico. Mr. Chitester provided expert services to assist in the analysis of a dispute between Abengoa Puerto Rico and the Puerto Rican Electric Power Authority regarding the repowering to a combined cycle plant of Units 5 and 6 at the San Juan Steam Plant. Mr. Chitester has provided an expert report evaluating project management, standard of care, cost of completion, contract use, delay, and specific special conditions for self-termination in Puerto Rico. Mr. Chitester has been admitted as an expert and has been deposed and has testified in the State court of Puerto Rico.

Hadera Combined Cycle, Cogeneration Station, Hadera, Israel. Mr. Chitester is currently engaged for the owner OPC Energy, in reviewing the commissioning plan of the EPC contractor in relation to a gas turbine machine failure. Mr. Chitester is also reviewing the potential insurance claim for the failed equipment and separating the claim from the EPC's potential failures in the program management process for the construction of the facility.

Kendall Station, Combined Cycle, Cogeneration Station, Boston, Massachusetts. Mr. Chitester was engaged for the owner in evaluating and preparing reports associated with the repowering of an existing steam boiler to a new combined cycle power plant. Mr. Chitester reviewed the installation of a steam condensing/cooling system for a combined cycle gas turbine, cogeneration facility with regard to the standard of care of the contractor.

Northport Power Plant, Coal Boiler vs. Combined Cycle Replacement Plant Evaluation, Northport, New York. Mr. Chitester was engaged as the technical expert developing the replacement cost and schedule to repower the 1,500Mwe Northport Power Station as either a like kind coal fired plant or a state-of-the-art combined cycle plant. Replacement cost includes potential gasification/compression. The replacement cost of the plant was in dispute and being litigated to set the tax rate the plant must pay to the local district. Mr. Chitester appeared in court to report to the judge on the case as to the status of the analysis.

Parnassus Medical Centre, Combined Cycle, Cogeneration Facility, San Francisco, California. Mr. Chitester was admitted as an expert and testified in deposition and in the Superior Court of California on a dispute involving trade use and interpretation of construction contract regarding the scheduling interpretation of what constitutes "substantial completion" as applied to the construction of a combined cycle cogeneration facility for the medical centre at the University of California.

General Electric Facility, Combined Cycle, Cogeneration, Bergen County, New Jersey. Mr. Chitester conducted the investigation for a surety for which a contractor defaulted on a combined cycle cogeneration and compressed air plant. He also facilitated plant completion and commissioning.

DOE Integrated Coal Gasification, Combined Cycle, Hazelton, Pennsylvania. As the chief mechanical engineer, Mr. Chitester oversaw the design and implementation of a DOE clean coal technology IGCC plant in eastern Pennsylvania.

Schuylkill Station, Coal to Combined Cycle, Cogeneration Plant, Philadelphia, Pennsylvania. Mr. Chitester was the Chief Mechanical engineer on the repowering of the plant from coal boilers to combined cycle to also become a cogeneration facility to supply steam to a central steam loop in the city of Philadelphia.

Bayonne Energy Centre, Simple Cycle, Bayonne, New Jersey. Mr. Chitester provided expert services including an expert report and testimony in AAA arbitration by providing opinions as to the Standard of Care employed by the engineer for Barton Malow on the EPC contract associated with the construction of the Bayonne Energy Centre. The Bayonne Energy Centre is a 512 MW dual fuel simple cycle combustion turbine peaking plant utilizing 8 Rolls Royce Trent 60 Combustion Turbines as the prime movers.

Samay I SA, Simple Cycle, Mollendo District, Peru. Mr. Chitester provided consulting and claim management services for the 4 unit simple cycle, GE combustion turbine plant, model 7FA.04 with a total output of approximately 616MW. Plant is dual fuel and can utilize LNP after regas. 3 of the plant turbines suffered damage by fractured shafts after approximately 200 hours of service

Anitec Film Production, Simple Cycle, Co-generation Plant, New Jersey. As the engineering manager, Mr. Chitester provided all project oversight and support for the design and construction of a 50Mw simple cycle STIG gas turbine co-generation application.

Textile Joao Duarte, SA, Cogeneration Plant, Barcelos, Portugal. As the project officer, Mr. Chitester oversaw the plant evaluation and energy audit, which was carried out to determine what energy savings could be achieved. A joint venture company was formed owning a newly installed cogeneration plant which supplied steam, hot water and electricity to the host facility. Installation of a 2.7 MW Ruston diesel engine including heat recovery and auxiliary equipment.

Oakwood Healthcare System, Cogeneration Facility, Dearborn, Michigan. As the project officer with full design/build responsibility, Mr. Chitester completed the redesign and retrofit of an existing co-generation facility into a peak shaving dispatched generator system. Responsibilities included the scheduling and coordination of the changeover with the acute care facility to ensure that there was no interruption in critical utility services.

Durham York Energy Centre, Biomass Boiler, Durham, Ontario, CA. Mr. Chitester was engaged as an expert in a Canadian ADR dispute between the developer of a dual boiler steam turbine power plant using municipal solid waste as the fuel and the prime joint venture contractor. The dispute revolves around scope change, delay and disruption. Mr. Chitester testified in arbitration at the Canadian Arbitration Centre in Toronto, Canada.

University of South Carolina, Biomass Boiler, Integrated Gasification Biofuel Cogeneration Plant, Columbia, South Carolina. Mr. Chitester completed the review and prepared the expert report in preparation for arbitration on the Standard of Care of the engineer of record. The expert report related to the delay in the project caused by engineering errors, which resulted in damages to the developer, Johnson Controls, Inc. Mr. Chitester testified in deposition. The plant is a simple cycle steam power plant fuelled by waste wood chips that are gasified and then fire a steam boiler and steam turbine.

Oak Ridge National Laboratories, Biomass Boiler, Oak Ridge, Tennessee. Mr. Chitester was responsible for evaluating claims against the developer, Johnson Controls, on a biofuel steam production plant, energy services performance contract. The expert report addressed requirements for boiler steam supply, delay and disruption, and change order validity from the General Contractor. Mr. Chitester testified in deposition.

Comanche Power Station, Coal Boiler Plant, Pueblo, Colorado. Mr. Chitester completed the peer review of the analysis and expert report of a delay claim and counterclaim of a grass roots super-critical coal plant. The claim revolved around the contractual basis constituting delay and multi-prime design/build contractors.

Eddystone Power Plant, Eddystone, Pennsylvania. Mr. Chitester provided modification support services for the first of its kind operating super-critical coal fuel power plant. Mr. Chitester worked as the

Project Manager to design and build performance modifications, boiler burner and control modifications and piping replacement modifications to the plant.

Homer City Power Plant, Pennelco, Homer City, Pennsylvania. Mr. Chitester provided ongoing modification support services for a large multi-unit fluidized bed boiler coal plant. Mr. Chitester worked as the Project Manager to design and build performance modifications including new boiler controls. Mr. Chitester inspected boiler components including the steam drum for end of useful life analysis.

Conowingo Hydroelectric and Muddy Run Pump Storage. Mr. Chitester was the Project Manager for modifications to the Philadelphia Electric facilities providing hydro and pump storage electric generation to the PJM interconnect.

IC Power “Run of the River” Hydroelectric Plant, Peru. Mr. Chitester provided expert services including an expert report for ICC arbitration dealing with a \$100m claim for delay and disruption on the construction of a hydroelectric plant in the Andes Mountains of Peru. Major tunnel runs were initially constructed using drill and blast and later converted to using a TBM after issues concerning geotechnical conditions. Dispute settled around the delay and disruption to the work caused by the lack of access to build roads and bridges driven by landowner issues, aboriginal issues, and environmental issues. Plant also included high voltage transmission line system which experienced the same delay and disruption issues.

Amherst Wind Farm. Mr. Chitester completed an expert report to be used for mediation of a payment, delay and damages dispute between the general contractor and BOP contractor on the erection of a 15 unit wind turbine farm for the owner, SP Amherst Wind Power LP

Bipole III 500kv Riel Conversion Station, Manitoba, Canada. Mr. Chitester provided a cost and schedule review for delay and disruption associated with the installation of synchronous condensers as part of the Riel Station. The issues were associated with the push of the work into winter work periods and the associated loss of productivity.

Interior to Lower Mainland, 500kv Transmission Line, Vancouver, BC. Mr. Chitester provided consulting and expert services and testified in Canadian ADR in Vancouver in a dispute between Flatiron Graham Joint Venture and British Canadian Hydro for the construction of a 250KM, 500kv transmission line with 660 towers. Mr. Chitester’s analysis centered around the increased cost of the Project due to delay and disruption on the project which caused losses to the contractor. The delay and disruption were analyzed to be as a result of environmental, aboriginal, private land and Crown land issues.

Bullitt Street to Chesterfield Ave, 138kv Transmission Line, Charleston, West Virginia. Mr. Chitester did an analysis of the damages summary between the parties, CW Wright Construction and AEP Transmission. AEP had terminated CW Wright and claimed added cost for completion as opposed to CW Wright’s claim for unpaid contract amounts. The case was set for Federal court and settled in mediation.

Chloe-Thorofare, 138kV Transmission Line Project, Charleston, West Virginia. Mr. Chitester did an analysis of the damages summary between the parties, CW Wright Construction and Transource West Virginia, Inc. Transource had terminated CW Wright and claimed added cost for completion as opposed to CW Wright’s claim for unpaid contract amounts. The case was set for State court and settled in mediation.

Suriname Electric Power Authority, Paramaribo, Suriname. Mr. Chitester worked with the government of Suriname and its electric power authority to analyze, scope and plan the addition of a second 308kv and 138kv power line from the existing power plants in the country to the lower voltage distribution system in the city of Paramaribo and adjacent areas.

Industrial Projects; Oil & Gas, Process and Chemical:

Confidential Client, Active Engagement, Queensland, Australia. Mr. Chitester has been retained as the “good industry practice/standard of care” expert including analysing project and construction management methodologies as it relates to actual performance on the project. Mr. Chitester is reviewing contract delivery changes that occurred from lump sum to reimbursable contracts for both the general contractor and the major subcontractors. Specific work package reviews are being conducted to determine how and if engineering deliverables and changes to IFC documents may have impacted the subcontractors’ ability to progress the work.

Confidential Client, Active Engagement, Manitoba, Canada. Mr. Chitester is reviewing and opining on the functions of the EPCM contractor with regard to technical issues, cost and schedule overruns and the supply and function of equipment for a commercial pea protein plant being constructed in North America.

Wacker Polysilicon Plant, Charleston, TN. Mr. Chitester provided expert services to evaluate the standard of care of the engineer and the resultant impact on construction of the plant. The evaluation consisted of an analysis of the earned value reporting, engineering management and application of process, isometric development and errors and omissions.

P58 Floating Production, Storage, and Offloading Vessel (FPSO), Brazil. (Includes simple cycle gas turbine power plant) Mr. Chitester provided expert services on a \$500m dispute including expert reports/witness statements using the “memorial” system for ICC arbitration. Mr. Chitester testified in ICC arbitration on the technical aspects of the completion of the project along with the schedule delay and disruption that occurred. Full gasification was included with gas compression for gas turbine duty. The FPSO included full pre-conversion, conversion, and module construction, installation, testing, startup and sail away. Mr. Chitester also reviewed work scope and completion offshore including carryover work.

P62 Floating Production, Storage, and Offloading Vessel (FPSO), Brazil. (Includes simple cycle gas turbine power plant) Mr. Chitester provided expert services including expert reports, rebuttal reports, and joint expert reports for ICC arbitration. Mr. Chitester’s scope of work included reviewing technical aspects of the completion of the project and opining on the schedule delay and disruption that occurred. Mr. Chitester testified in ICC arbitration regarding his services. The FPSO included gas compression, full pre-conversion, conversion, and module construction, installation, testing, startup and sail away. Mr. Chitester also reviewed work scope and completion offshore including carryover work.

P74 Floating Production, Storage, and Offloading Vessel (FPSO), Inhuama Shipyard, Brazil. Mr. Chitester and his team reviewed the claims and counterclaims associated with the conversion of the P74 FPSO completed at the Inhuama Shipyard. The team reviewed local content requirements and their impact on cost, local union practices, productivity issues, delay and indirect cost increases. The review centered around the contract requirements for the shipyard and facilities along with labor resource loading and contract escalation.

P76 Floating Production, Storage, and Offloading Vessel (FPSO), COSCO Shipyard, China and Inhuama Shipyard, Brazil. Mr. Chitester and his team reviewed the contractual requirement associated with the transfer of a partially converted hull to the shipyard in Brazil from the shipyard in China. Review centered around the berthing requirements between the owner and the contractor and the labor resources required to be on standby.

P75 & P77 Floating Production, Storage, and Offloading Vessel (FPSO), COSCO Shipyard, China. Mr. Chitester and his team reviewed the local content requirements, tax issues and other labor associated costs of having the P75 and P77 hulls fully converted at the China shipyard, then shipped to the integration shipyard in Brazil.

Project Liberty, Emmetsburg, Iowa. Mr. Chitester was retained by DSM North America as a Standard of Care Expert to opine on the equipment supplier and engineering involved on the first of its kind production size 2nd bale corn ethanol plant. Mr. Chitester provided an expert report and testimony regarding the process and program followed by the equipment systems designer from design concept through implementation.

MOX Fuel Fabrication Facility, DOE Savannah River Site, Aikens, South Carolina. Working for the US Department of Justice, Mr. Chitester ran a team of consultants on site of the MOX Fuel Fabrication Facility to ascertain the actual completion of the facility, repair and rework required, engineering errors & omissions, and delivery of major components. The evaluation included schedule time and cost to complete analysis and invoices to date percent complete. The purpose of the analysis was to pursue a claim against the EPC design building of the \$12B facility which was cancelled prior to completion.

MOX Fuel Fabrication Facility, DOE Savannah River Site, Aikens, South Carolina. Mr. Chitester established the extent of scope increases and the designer's Standard of Care in performance and delivery of the nuclear power plant pressure vessel (tank) designs in connection with the designer's \$1.5M claim for nonpayment of work delivered and in progress and the fabricator's \$2.2M counterclaim for breach of contract.

Project Liberty, Emmetsburg, Iowa. Mr. Chitester was retained by DSM North America Legal and Government Affairs, to review and provide an opinion concerning the Engineer Procure and Construct (EPC) Contract, dated July 12, 2012 between POET Project Liberty, LLC, "Owner", and POET Design and Construction, Inc., "Contractor or PDC", and to review and provide an opinion concerning Change Orders and Proposed Change Orders submitted by PDC. The opinions were for negotiation purposed and not an expert report submission.

Ethanol Plant Vessel Fabrication, Lakeland, Florida. Mr. Chitester completed the review of 7 projects and prepared an expert report for state court in Florida, addressing construction management, schedule, damages, and cost and completion status of the pressure vessels for 7 ethanol plants. Mr. Chitester provided expert testimony in deposition and state court.

AltraBiofuels Ethanol Plant, Carleton, Nebraska. Mr. Chitester prepared an expert report and testimony in AAA arbitration on the termination costs due to the subcontractor on a \$71M cancelled project, which was associated with the engineering and fabrication of ASME certified heat exchangers and vessels.

Maple Ethanol, Piura, Peru. Mr. Chitester completed the schedule analysis using a "windows" methodology and submitted the expert report for ICC arbitration. The plant is a large integrated plantation/ethanol distillery in the northern dessert of Peru. A rebuttal report was also prepared for ICC arbitration to contest the position of the EPC contractor claims for time and damages associated with claimed extra work, changes, and delay. Plant generated its own power using a biomass steam boiler/steam turbine generator operating in a simple cycle cogeneration mode. The plant also included an 80KM transmission line and 200KM electrical distribution system that was disrupted due to landowner, aboriginal, and environmental issues.

Tosco Refinery, Bayonne, New Jersey. Mr. Chitester provided for the takeover and completion of a multi-million dollar process piping project. He later provided litigation support for the contractor in the delay and disruption claim against Tosco for interference on the project. He oversaw the redesign and reinstallation of the steam loop throughout the refinery, in order to optimize steam use and decrease the purchase of electricity.

Colonial Pipeline, Woodbridge, New Jersey. Mr. Chitester oversaw the design and construction of a 10k gpm petroleum product compression/pumping station with 2-5,000 gpm pumps driven by 2-1,600

hp superior natural gas engines complete with low nox technology. The project was completed on an EPC basis and was paid for out of the savings generated.

Colonial Pipeline, Woodbridge, New Jersey. Mr. Chitester oversaw the design and construction of a 28k gpm petroleum product compression/pumping station with a 4,500 hp Caterpillar natural gas engine drive and low nox technology including CEMS. The project was completed on an EPC basis and was paid for out of the savings generated.

Buckeye Pipeline Company, New Jersey. Mr. Chitester oversaw the design and construction of three 3,100 gas engine driven pumps with speed increasers and tie-ins to the existing pipeline system at 1 of the Buckeye Pipeline compressor stations. System pumps aviation fuel and fuel oil from Houston Texas to Newark Airport. Gas engine pumps/compressors deleted equivalent KW and KWh from grid purchase.

Liquid Maize, LLC, Lamar, Colorado. Mr. Chitester provided ongoing program management services, including schedule development, for the construction of a new corn-based ethanol process plant located at the cattle feed yard.

ElectroSilex, Catitao Eneas, Minas Gerais, Brazil. As the project officer, Mr. Chitester reviewed the smelting operation and oversaw the evaluation in order to identify energy, productivity and maintenance improvement opportunities for reducing energy use and increasing production output. The upgrade program was paid from benefits achieved. Improvements implemented were replacement of existing refractory, addition of a new SCADA system to monitor and control the raw materials blending for the furnaces.

Bergen County Utilities Authority, Little Ferry, New Jersey. Mr. Chitester oversaw the design and construction of a resource recovery system using digester gas from wastewater treatment to fuel two 2,000 hp gas-engine driven blowers, displacing the equal consumption of electricity.

Gloucester County Utilities Authority, West Deptford, New Jersey. Mr. Chitester oversaw the design and construction of a 900 hp Waukesha engine with a 16k ACFM Hoffman blower and catalytic converter. The project was completed on an EPC basis and was paid out of the savings generated.

Vopak BORCO Terminal, Freeport, Grand Bahamas. Mr. Chitester provided expert services to assist the Bahamas Oil Refining Company, International, in mediation of a dispute related to the Jetty Improvement Project. BORCO was a Vopak owned storage terminal with a capacity of 3.4 million cubic meters for the storage and handling of crude oil, fuel oil and clean petroleum products. In addition, the terminal offers blending, transshipment and bunkering services. The dispute arose out of the delay to completion of offloading and transport facilities due to unforeseen conditions such as storm related damages

Industrial Projects; Manufacturing and Material Handling:

Kostomuksha Iron Ore Mine, Kostomuksha, Russia. The site is an open pit mine operations that extracts iron ore and processes the ore through a pelletizing plant. Mr. Chitester was the project executive in charge of the development and implementation of the retrofit of indurating furnaces and lime kiln SCR's for the Kostomuksha Iron Ore Works in the Karelian Republic of Russia.

Lake City Ammunition Plant, Independence, Missouri. Mr. Chitester provided a review of the upgrades to the facility including HVAC systems to support the manufacturing process. Mr. Chitester's evaluation related to the engineer of record's standard of care in providing upgrades that were inconsistent with the functionality of the processes and manufacturing requirements of the plant.

Tenaris Seamless Pipe Manufacturing Facility, Bay City, Texas. Mr. Chitester provided review and analysis of the impact of Barnhart Crane & Rigging's drop of a major piece of equipment for the plant

upgrades. Mr. Chitester opined on the likely impact of the actual drop vs. the claimed impact of the general contractor, Brahma Group Inc.

Ivaco Rolling Mill, Ontario, Canada. Mr. Chitester provided consulting and expert services related to the late installation and commissioning of a new caster for the plant. Issues revolved around the supply and installation of equipment from the manufacturer and the incomplete commissioning of the new facility.

Lake Erie Steel Integrated Iron and Steel Plant, Ontario, Canada. As the project officer, Mr. Chitester oversaw the design and fabrication of a new burner-mounted pivoting ladle cover, complete with automated controls, foundation, structural, piping, electrical and instrumentation systems. The cover was installed during regular operations during a 2-week period, and resulted in a 72% decrease in gas consumption.

Lake Erie Steel Integrated Iron and Steel Plant, Ontario, Canada. As the project officer, Mr. Chitester organized the drilling of test ports to measure the existing flow rates and patterns in the blast furnace cast house fan and correlate them with power measurements.

Lake Erie Steel Integrated Iron and Steel Plant, Ontario, Canada. As the project officer, Mr. Chitester oversaw the installation of a hydraulic coupling to unload the coke oven battery emission control system fan during idle periods. The system resulted in an 800 kW drop in power during idle periods.

Gerdau MRM Steel Ltd. Steel Producer, Manitoba, Canada. As the project officer, Mr. Chitester oversaw the evaluation and analysis to identify and develop methods for reducing energy consumption and increasing production on select product groups. Based on this analysis, improvements were designed and built, which increased furnace productivity by over 22%.

Beach Island Paper Mill Expansion, Aiken, South Carolina. Mr. Chitester provided a review of the standard of care employed by the contractor in the retrofit work to Beach Island that resulted in a failed fire protection system and flooding of the facility.

Rock Tenn Paper Mill, Shreveport, LA. Mr. Chitester provided an expert report and rebuttal report for a claim in defence of the paper mill with a counter claim for excess cost and delay against the contractor on a \$58m upgrade to paper machines at the Shreveport facility.

Al Udeid Airbase, Doha, Qatar. Mr. Chitester provided expert services in connection with a claim by the General Contractor and counter claim by the MEP contractor on a strategic facility project on the Al Udeid Airbase. Project includes advanced shop facilities for the fabrication and maintenance of aircraft modules for the US Air Force. He provided an expert report on the schedule delay using as-planned v as-built methodology, has testified in deposition and in arbitration using ICC format rules including the “hot tub” of experts.

Energy Services Company (ESCO), Energy Services Performance Contracts, Various. As the Sr. Vice President or project officer, Mr. Chitester completed multiple projects throughout the United States, Canada, Russia, South America, Europe and Asia, centered around developing, designing, procuring, and building “demand side” energy and simple cycle/combined cycle power projects “within the fence” or “over the fence” of industrial and military complexes. Projects were pay out of savings performance contracts completed on a lump sum turn-key basis. Projects energy, industrial commodity or power purchase agreements generally on a “take or pay” basis.

Trenton Water Works, Trenton, New Jersey. Mr. Chitester oversaw the design and construction of dual 700 hp Waukesha engines, variable speed controls, a new HVAC system, building modifications, sound attenuating enclosures, catalytic converters, and remote radiators. The project was completed on an EPC basis and was paid for out of the savings generated.

Nabisco, Fairlawn, New Jersey. Mr. Chitester oversaw the design and construction of an oil-free plant air system rated at 2000 CFM @ 90 PSIG using IR centrifugal air compressors driven by a 600 hp Caterpillar natural gas engine. The project was completed on an EPC basis and was paid out of the savings generated.

Lockheed Martin Energy Systems (LMES), Energy Services Performance Contracts, Various. Mr. Chitester provides consulting services to LMES for work associated with Lockheed's FEMP Super ESPC performance contract. Mr. Chitester reviews the development of energy performance measures and savings/capital cost calculations and develops the cash flow models for the life cycle cost of the project.

St. Agnes Hospital, Load Shaping Project, Philadelphia, Pennsylvania. As the project officer with full design/build responsibility, Mr. Chitester completed the installation of two gas engine generators to peak shave/load shape the electric usage, thereby reducing KW demand during the highest time of day rates.

Eastern Shipbuilding, Panama City, Florida. Working for the surety company, Mr. Chitester provided Project Management Oversight for all bonded work completed by the shipyard including the construction of new research vessels for the University of Miami.

Post Catastrophic Loss Recovery Projects:

Pascagoula Shipyard, Post Hurricane Katrina, Business Interruption. Mr. Chitester provided expert services in connection with a \$420m suit alleging amounts due from Insurer as a result of business loss due to schedule time required to restore the facility. Facility is a ship building operation with sophisticated modular construction each costing a minimum of \$1B. He provided an expert report that opined as to the schedule and productivity impact of the storm on the facility's ability to manufacture. Mr. Chitester testified in deposition as to the recovery schedule and business interruption productivity impact.

World Trade Center, Building 7, New York, NY. As part of the team developing the insured loss associated with the World Trade Center terrorist attack, Mr. Chitester completed the theoretical business interruption schedule for the replacement/rebuild of building number 7. Schedule analysis was presented in an expert report. Case settled prior to hearing.

Cost and Period of Restoration, Various Catastrophic Loses. Mr. Chitester has developed cost estimates and period of restoration schedules and issued reports for more than 50 losses including theoretical periods of restoration that account for business process upgrades, code upgrades, rebuilding at a different location, or not rebuilding the business at all.

Central Utility and District Energy Projects:

International Flavors and Fragrances, Dayton, New Jersey. Mr. Chitester oversaw the design and construction of a new central chilled water plant, chilled water distribution, two 500-ton (two-stage) steam absorption chillers, one 100hp natural gas-engine-driven air compressor, 1 2-cell cooling tower, new structural-steel-framed metal-clad building, the conversion of existing DX HVAC units to chilled water, and the provisions for free cooling during low-temperature periods.

Tianjin Worldwide Enterprises, Tianjin, China. Mr. Chitester developed the conceptual design, scoping audit and Investment Grade Audit (IGA) for the design and construction of an ice harvesting thermal storage plant. The plant would be used to provide chilled water for high rise office buildings in central Beijing during the peak day, when time-of-day electric rates were 4 times higher than off-peak ice making rates.

Northwind Boston, LLC, Boston, Massachusetts. As the project officer, Mr. Chitester developed the conceptual design, scoping audit and Investment Grade Audit (IGA) for the design and construction of a 19,000 ton refrigeration thermal storage plant. The plant would be used as a district energy plant to process chilled water for “loop” clients during the day in the financial district of Boston.

Dameron Hospital Association, Central Utility Plant, Stockton, California. As the owner’s representative, Mr. Chitester provided all program management services required for the construction of a new central utility plant, steam plant, and utility interconnects to the existing hospital. Responsibilities included the scheduling of the project, ordering of major equipment, and the hiring and supervision of trade contractors.

Perth and Smiths Falls Hospitals, Ontario, Canada. As the project officer with full design build responsibility, Mr. Chitester completed performance contracts for capital improvements and energy infrastructure projects for the system hospitals. This included steam trap repair and replacement, and steam system optimization.

Boston Medical Center, Boston, Massachusetts. As the project officer with full design build responsibility, Mr. Chitester completed performance contracts for capital improvements and energy infrastructure projects for the system hospitals including boiler replacement, absorption chiller replacement, steam trap upgrades, and steam system optimization.

Boston University Medical Campus, Boston, Massachusetts. As the project officer with full design build responsibility, Mr. Chitester completed performance contracts for capital improvements and energy infrastructure projects for the medical campus including boiler replacement, steam trap upgrades, and steam system optimization.

Youville Hospital & Rehabilitation Center, Cambridge, Massachusetts. Mr. Chitester oversaw the design and construction of the high to low pressure steam conversion in the central plant. This entailed a boiler and steam system retrofit that reduced the pressure of the current steam in the central plant. The completed retrofit reduced steam pressure to what was considered low pressure, thus eliminating the 24/7 code mandated staffing.

PUBLICATIONS & PAPERS

“The Effective Use of Forensic Experts in Construction Litigation”, Chapter 1, Chapter 9, American Bar Association, Forum on Construction Law, 2019

“Ten Minutes with HKA’s Tim Chitester - A frank discussion about whether a lagging nuclear power plant project can be turned around”, Engineering News Record, March 2019

“Project Delivery Methods – What Designers Love and Hate”, Florida Bar Construction Law Institute, March 2013

“Calculating the Period of Restoration Using Critical Path Method (CPM) Scheduling”, ABA Property Insurance Law Committee News, Spring 2012

“Diligence in Documentation”, Engineering News Record, March 12, 2012

“A Forensic Approach to Cost Estimating”, Fall Meeting of the ABA Construction Forum-Lessons Learned from the Economic Downturn, Miami, Florida, 2010

PRESENTATIONS & SPEAKER ENGAGEMENTS

“Builders’ Risk, Business Interruption and Other Insurance Questions”, American Bar Association, Construction Forum, Special Webinar Series, “COVID-19 Leadership Roundtable. Panel Moderator, April 28, 2020

“Projects in Distress”, Pennsylvania Institute of Certified Public Accountants, Annual Construction Section Meetings, *October 18 & 19, 2016*

“Project Distress Symptoms”, Construction Financial Management Association, *December 2015*

“Case Study of a complex Business Interruption Loss”, Insurance Professionals Miami, Latin America & Caribbean, *March 2015*

“Brazilian ADR”, International Institute of Conflict Prevention & Resolution, Annual Meeting, *February 2014*

“In the Eye of the Beholder: Project Delivery Methods from Different Points of View”, ABA Construction Law Institute, *March 2013*

“Forensic Review of Project Cost Estimates”, ABA Construction Forum, Miami, Florida, 2010

“Impact and Damages Related to Design Errors and Omissions”, Hillsborough County Bar Association, Construction Law Section-Annual CLE Course, Tampa, Florida, 2009

“Optimizing the Business Interruption Period – The Period of Restoration”, Loss Executives Association Spring Meeting, Portland, Maine, 2008

“Red Flags in Scheduling Provisions”, Hillsborough County Bar Association, Construction Law Section, Tampa, Florida, 2006

“Quantifying the Impact of Delay on Your Project - for Mechanical Contractors”, The Associated Builders and Contractors Education Conference, Weston, Florida, 2006

“Quantifying the Impact of Delay on Your Project – for Electrical Contractors”, The Associated Builders and Contractors Education Conference, Weston, Florida, 2006

“Risk Assessment and Management after a Major Loss Scenario”, Dameron Hospital Association, Stockton, California, 2006

Attachments and Appendices to Expert Report of Timothy R. Chitester, P.E.
HKA Global, LLC
September 8, 2023

2 ATTACHMENT 2 – DOCUMENTS RELIED UPON

Footnote Number	Footnote
1	VCM 18.
2	VCMs 19, 20, 21, 22, 23, 24, 25, 26, and 27.
3	AP1000 Presentation to Nuclear Institute – Western Branch, prepared by Westinghouse Head of Stakeholder Relations, dated November 16, 2010.
4	Id., p. 7.
5	Ibid.
6	Nuclear Safety Westinghouse Nuclear, www.https://www.westinghousenuclear.com/energy-systems/ap1000-pwr/safety
7	Westinghouse AP1000 Brochure, prepared by Westinghouse Electric Company, LLC., Westinghouse AP1000 Brochure.pdf, dated 2007, p. 13.
8	AP1000 Presentation to Nuclear Institute – Western Branch, prepared by Westinghouse Head of Stakeholder Relations, dated November 16, 2010, p. 8.
9	Id., p. 12
10	Westinghouse AP1000 Brochure, prepared by Westinghouse Electric Company, LLC., Westinghouse AP1000 Brochure.pdf, dated 2007, p. 13.
11	Ibid.
12	Nuclear Safety Westinghouse Nuclear, www.https://www.westinghousenuclear.com/energy-systems/ap1000-pwr/safety
13	PART 52—LICENSES, CERTIFICATIONS, AND APPROVALS FOR NUCLEAR POWER PLANTS NRC.gov
14	WCK_8755.jpg (6048x4032) (georgiapower.com), photo courtesy of Georgia Power Company.
15	General Project Procedure, Lessons Learned, 26139-000-GPP-GAQ-00001, Revision 002, Effective Date June 29, 2021.
16	Id., p.1.
17	Ibid.
18	Id., p.4.
19	Ibid.
20	Southern Company Procedure, Construction Experience Program, ND-AD-VNP-004, Version 12.1, Effective Date May 1, 2020.
21	Id., p. 14.
22	Id., p. 5.
23	Id., p. 8.
24	Ibid.
25	MAXIMO is the Project's document management database.
26	VCM 17, p. 47.
27	Monthly Status Report – July 2020 (Part 1 of 2), p. 24.
28	26139-000-TC-GAM-00297 Transmittal - Monthly Status Report for February 2021 (Part 1 of 2), p. 23.
29	26139-000-TC-GAM-00387 Transmittal - Monthly Status Report for August 2022 1 of 2, p. 27.
30	VCM 18, p. 8.
31	VCM 19, p. 31.
32	VCM 20/21, p. 31.
33	VCM 23, p. 30.
34	VCM 27, p. 23.
35	August 2022 Monthly Status Report, p. 27.
36	January 2023 Monthly Status Report, p. 27.
37	Bechtel May 2023 Monthly Status Report, p. 3
38	Bechtel May 2023 Monthly Status Report, p. 3
39	I have relied on two sources for this data. For data after about March 2019, I have relied on the individual scorecard documents made available to me. These files did not exist, or otherwise were not available, prior to March 2019. For the period preceding March 2019, I have instead relied on an excel tabulation of scorecard data, imported by others and provided to me ("Scorecard Import").
40	For purposes of this dataset, I have considered the following Scorecard categories: A/G Large Bore Pipe, A/G Large Bore Pipe Supports.

Footnote Number	Footnote
41	For purposes of this dataset, I have considered the following Scorecard categories: Cable, Cable Tray, Cable Tray Supports, Conduit, Conduit & Supports, Conduit Supports, and Scheduled Conduit. Electrical equipment, instrumentation and terminations have not been considered herein.
42	Bechtel August 2021 Monthly Status Report, p. 58.
43	Bechtel October 2021 Monthly Status Report, p. 8 and Bechtel November 2021 Monthly Status Report, p. 8.
44	Bechtel March 2022 Monthly Status Report, p. 10.
45	CTRL0000018112.
46	For purposes of this dataset, I have considered the following Scorecard categories: Cable, Cable Tray, Cable Tray Supports, Conduit, Conduit & Supports, Conduit Supports, and Scheduled Conduit. Electrical equipment, instrumentation and terminations have not been considered herein.
47	For purposes of this review, I have considered the Nuclear Island to consist of the Containment with Shield, and Auxiliary buildings.
48	VCM 22, p. 6.
49	Bechtel August 2020 Monthly Status Report, p. 7
50	VCM 24 dated February 18, 2021, pp. 28-29
51	3R International Publication, Contracting Strategies in the Oil and Gas Industry, prepared by Carolin Schramm, Alexander Meissner, Gerhard Weidinger, dated January 2010.
52	Draft Vogtle 3&4 Transition Plan, dated June 2017.
53	Id., pg. 3.
54	Id., pp. 3-4.
55	Id., pg. 50.
56	VCM 17, p. 93.
57	Ibid.
58	Id., p. 94.
59	Id., pp. 94-95.
60	Id., p. 95.
61	Id., pp. 95-96.
62	Id., p. 96.
63	Id., pp. 96-97.
64	Id., p. 97.
65	Id., p. 98.
66	Ibid.
67	Id., pp. 98-99.
68	VCM 17, p. 94.
69	AACEi Recommended Practice No. 25R-03 Estimating Lost Labor Productivity in Construction Claims, Rev. April 13, 2004, p. 2.
70	1996 AAC Transactions C&C.7, "Consequential Cost Effects", p. C&C.7.1.
71	AACEi Recommended Practice No. 25R-03 Estimating Lost Labor Productivity in Construction Claims, Rev. April 13, 2004, pp. 4-7. Refer to AACEi for complete list.
72	"Evaluating the Cumulative Impact of Change on Labor Productivity – an Evolving Discussion" Ibbs and McEniry December 12, 2008, p. 1.
73	2001 AACEi Transactions CDR.06 Analyzing the Cumulative Impact of Changes, p. CDR.06.4.
74	"Great Debate: Is Cumulative Impact a Provable Reality?", Cost Engineering, September/October 2015 – Defining CI, p. 19.
75	996 AAC Transactions C&C.7, "Consequential Cost Effects", pp. C&C.7.1 through C&C.7.4.
76	CPI is typically calculated as Earned Hours divided by Spent Hours. This method is accepted within the industry and documented in various industry guidelines. However, within the nuclear construction industry, the inverse is true, and CPI is calculated as shown herein.
77	Project Scorecard, CTRL0000005182_2020-11-22 Vogtle SCORE CARD - FINAL_.pdf, dated November 22, 2020.
78	VCM 17, p. 94.
79	VCM 18, p. 6.
80	VCM 19, p. 25.

Footnote Number	Footnote
81	Id., p. 6.
82	Id., p. 25.
83	VCM 20/21, p. 5.
84	VCM 22, p. 25.
85	Id., p. 6.
86	Id., p. 25.
87	VCM 23.
88	VCM 23, pp. 3-4.
89	Id., p. 29.
90	Id., p. 30.
91	VCM 24, p. 29.
92	VCM 25, p. 26.
93	Id., p. 26.
94	VCM 27, p. 21.
95	Ibid.
96	For purposes of this dataset, I have considered the following Scorecard categories: A/G Large Bore Pipe, A/G Large Bore Pipe Supports.
97	I recognize that by this time, bulk installation was completed and succeeded by systems turnovers. Notwithstanding, Project Scorecards do not delineate between these two data categorizations, and I have considered them jointly for purposes of my evaluation of both Unit 3 and Unit 4.
98	For purposes of this dataset, I have considered the following Scorecard categories: Cable, Cable Tray, Cable Tray Supports, Conduit, Conduit & Supports, Conduit Supports, and Scheduled Conduit. Electrical equipment, instrumentation and terminations have not been considered herein.
99	See Section 8 of this Report.
100	https://inldigitallibrary.inl.gov/sites/sti/sti/6293982.pdf , Section 8.1, pp. 19-20.
101	VCM 17, pp. 94-95.
102	Ibid.
103	CTRL0002232961
104	As of June 22, 2023, 42,624 E&DCRs have been made available to me via the Documentum file repository. Additional E&DCRs may have been issued on the Project, however I have not been made aware of any additional files outside of this file repository.
105	Of this set, 13 E&DCRs were not designated to a SV0, SV3, or SV4, thus reducing the total count to 42,611.
106	VCM reports were produced about every six months, with the exception of VCM 20/21 which covered one full year. As such, some differences in distribution of E&DCR data may have occurred in this period.
107	NRC “Backgrounder on Nuclear Power Plant Licensing Process” (accessible at https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html).
108	NRC “Backgrounder on Nuclear Power Plant Licensing Process” (accessible at https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html).
109	An independent group that provides advice on reactor safety to the NRC.
110	NRC “Backgrounder on Nuclear Power Plant Licensing Process” (accessible at https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html).
111	NRC “Backgrounder on Nuclear Power Plant Licensing Process” (accessible at https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html).
112	NRC “Backgrounder on Nuclear Power Plant Licensing Process” (accessible at https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html).
113	NRC “Backgrounder on Nuclear Power Plant Licensing Process” (accessible at https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html).
114	NRC “Backgrounder on Nuclear Power Plant Licensing Process” (accessible at https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/licensing-process-fs.html).
115	10 CFR 52.103(a).
116	NRC “Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)” (accessible at https://www.nrc.gov/reactors/new-reactors/how-we-regulate/oversight/itaac.html)
117	Certifications for the particular reactor technology used by the plant.
118	NRC “Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)” (accessible at https://www.nrc.gov/reactors/new-reactors/how-we-regulate/oversight/itaac.html)

Footnote Number	Footnote
119	NRC "Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)" (accessible at https://www.nrc.gov/reactors/new-reactors/how-we-regulate/oversight/itaac.html)
120	10 CFR 52.99(c)(1) and 10 CFR 52.99(c)(2).
121	NRC "Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC)" (accessible at https://www.nrc.gov/reactors/new-reactors/how-we-regulate/oversight/itaac.html)
122	10 CFR 52.99(c)(3).
123	10 CFR 52.99(c)(4) and 10 CFR 52.103(g).
124	License Amendment Request Guidelines, NEI 06-02, "License Amendment Request Guidelines." (nrc.gov), prepared by Nuclear Energy Institute, dated December 2006, p. 15
125	Subpart 52.98, NRC 10 CFR Part 52, NRC_10 CFR PART 52.pdf, p. 46
126	Ibid.
127	eCFR :: Appendix D to Part 52, Title 10 -- Design Certification Rule for the AP1000 Design, p.1.
128	Id., pp. 1-2.
129	Id., p. 2.
130	Id., p. 7.
131	VCM 18, p. 27
132	Letter, Subject: Vogtle Electric Generating Plant, Units 3 and 4 – Issuance of Amendment and Granting of Exemptions RE: Standardization of Instrumentation Setpoint Nomenclature (LAR 17-004)(CAC No. RP9612), Cover Letter - Vogtle Units 3 and 4 LAR 17-004 - Standardization of Instrumentation Setpoint Nomenclature (ML17233A109).pdf, dated September 22, 2017, p. 1.
133	Safety Evaluation, Safety Evaluation - Vogtle Units 3 and 4 LAR 17-004 (ML17233A122).pdf, prepared by the Office of New Reactors, p. 8.
134	Id., p. 1.
135	Letter, Sub: Southern Nuclear Operating Company Vogtle Electric Generating Plant Units 3 and 4 Updates to Requested Approval Dates for License Amendment Requests, Vogtle, Units 3 and 4 - Updates to Requested Approval Dates for License Amendment Requests (ML17256A629).pdf, dated September 13, 2017, p. 2.
136	Ibid.
137	Id., p. 10.
138	Exemption - VEGP Unit 3 LAR 17-004 (ML17233A110).pdf, dated September 22, 2017.
139	Exemption - VEGP Unit 4 LAR 17-004 (ML17233A111).pdf, dated September 22, 2017.
140	VCM 19, p. 33.
141	VCM 19, p. 33.
142	Exemption License No. NPF-91, Exemption from Regulations Set Forth in Appendix D of 10 CFR Part 52, dated February 28, 2017.
143	VCM 19, p. 33.
144	VCM 19, pp. 33-34.
145	VCM 20/21, p. 37
146	VCM 22, p. 39
147	VCM 23
148	VCM 24, p. 44
149	Other, additional search terms may reveal an enlarged sample set. However, these are believed to be limited and secondary.
150	As measured to the face of the shell liner.
151	Sheet APP-1030-P2-001, Nuclear Island General Arrangement Plan at El. 100'0" & 107'2", CTRL0002215901_NI Horizontal Building AR&P2 Drawings.pdf, prepared by Westinghouse Electric Company, LLC., dated August 2, 2019.
152	Refer to Section 9.1 of this Report.
153	MCAA Change Orders, Productivity, Overtime 2004 Edition, Section Productivity, p. 77.
154	MCAA Change Orders, Productivity, Overtime 2004 Edition, Section Productivity, p. 77.
155	VCM 17, p. 96.
156	Ibid.
157	CCF ID# 2019-045, dated June 25, 2019, pg. 1.
158	Ibid.

Footnote Number	Footnote
159	Ibid.
160	Ibid.
161	Id., p. 2.
162	Id., p. 3.
163	VCM 17, pp. 96-97.
164	Ibid.
165	Ibid.
166	Project Scorecard, CTRL0000005174_2020-11-08 Vogtle SCORE CARD - FINAL_.pdf, dated November 8, 2020.
167	Data presented for 2019 has been extended along the x-axis to display the monthly fluctuation in quantities within the period.
168	Data presented for 2020 has been extended along the x-axis to display the monthly fluctuation in quantities within the period.
169	Westinghouse AP1000 Brochure, prepared by Westinghouse Electric Company, LLC., Westinghouse AP1000 Brochure.pdf, dated 2007, p. 13.
170	VCM 17, pp. 98-99.
171	Ibid.

Attachments and Appendices to Expert Report of Timothy R. Chitester, P.E.
HKA Global, LLC
September 8, 2023

3 APPENDIX A – EXHIBITS TO ANALYSES

Redacted

Redacted

Redacted

Redacted

Redacted

Lessons Learned Identified In VCMs				
VCM	Unit	VCM Date	Subject	Excerpt
17	4	8/31/2017	The status of Quality and Compliance, Engineering, Procurement, Construction and Start Up.	Lessons learned continue to be captured during first time evolutions for Unit 3 and incorporated into Unit 4 execution. o Modularization of the Unit 4 Annex Building steel floors allowed for more efficient process in installing the supplemental steel that will support piping, HVAC equipment, electrical conduit and cable trays. o Large structural steel modules were painted in sections during pre-assembly to progress with additional work fronts after installation. o Construction joint prep has been simplified to prevent time consuming re-work.
20/21	4	8/30/2019	Unit 4 - Construction Schedule Performance	Construction has applied lessons learned from Unit 3 by building small room modules in parallel to bulk civil work being performed. This allows Unit 4 to set room modules in one activity and complete areas more efficiently than in Unit 3.
22	4	2/19/2020	PROJECT RISK: The risk that construction is unable to meet the current schedule even with sufficiently qualified resources available.	Unit 4 is in the stage of civil and bulk commodity installation and is beginning to enter the system turnover phase as it prepares for IE later this year. To address potential impacts to productivity, the Project continues to implement lessons learned from Unit 3 by assembling key modules outside of the congested work areas to reduce impacts of congestion, adjusting sequencing and execution of key direct and subcontractor construction activities (i.e. concrete pours, panel sets, coatings, and HVAC installation), and shifting experienced resources from Unit 3 to Unit 4.
22	4	2/19/2020	Unit 4 - Nuclear Island	Unit 4 has continued to benefit from lessons learned on Unit 3, including the early setting of the IHP, pre-assembly of the MCR roof and other areas of the Auxiliary Building, and modularization of the Shield Building panel courses.
23	4	8/1/2020	The risk that construction is unable to achieve the current aggressive site work schedule, even with sufficiently qualified resources available.	Unit 4 continues to improve production by integrating lessons learned from Unit 3. Strategies include design and fabrication of modules outside of the Unit to reduce required activities in congested areas and allow for simultaneous progress. Additionally, Unit 4 has enhanced the commodity sequencing and installation execution by adapting the construction plan to incorporate experience gained from Unit 3 testing. Furthermore, the sequence of Unit 4 Project milestones has been adjusted to integrate testing experience from Unit 3.
23	4	8/1/2020	Construction - Unit 3 Nuclear Island	As Unit 4 prepares for turnover of the Main Control Room for testing, lessons learned from Unit 3 continue to improve efficiency on Unit 4, such as the pre-fabrication of Room 501 above the Main Control Room, which was outfitted with structural steel, electrical raceway, pipe, and HVAC ductwork before being placed, a significant improvement from Unit 3. Further improvements included the pre-fabrication and placement of the Main Steam Isolation Valve module, continued fabrication of rebar curtain walls and continued modularization of the Shield Building panels.
24	4	2/18/2021	The risk that construction is unable to achieve the Unit 3's current site work plan and Unit 4's aggressive site work schedule, even with sufficiently qualified resources available.	Unit 4 continues to increase the focus on electrical commodity installation in support of the Initial Energization ("IE") testing milestone, which is expected to commence in the coming months. Unit 4 continues to complete complex scopes of work more efficiently through the integration of lessons learned from Unit 3. Strategies include design and fabrication of modules outside of the Unit to reduce required activities in congested areas and allow for simultaneous progress. Additionally, Unit 4 has enhanced the commodity sequencing and installation execution by adapting the construction plan to incorporate experience gained from Unit 3 testing. Furthermore, the sequence of Unit 4 Project milestones has been adjusted to integrate testing experience from Unit 3. For example, the Unit 4 Integrated Flush milestone was shifted ahead of Initial Energization and was successfully started in January 2021, so that further progress could be made on electrical commodity installation and to allow for more work fronts to remain open during this phase of the Project.

Lessons Learned Identified In VCMs				
VCM	Unit	VCM Date	Subject	Excerpt
25	4	8/31/2021	The risk that construction is unable to achieve the assumed production for both Units, even with sufficiently qualified resources available.	Unit 4 continues to increase the focus on electrical commodity installation in support of the IE testing milestone completion, IF milestone and the upcoming Open Vessel Testing ("OVT"). Unit 4 continues to complete complex scopes of work more efficiently by implementing lessons learned from Unit 3. Strategies include design and fabrication of modules outside of the Unit to reduce required activities in congested areas and allow for simultaneous progress, construction sequencing, and addressing issues found on Unit 3 earlier in the construction and testing process. Additionally, Unit 4 has enhanced the commodity sequencing and installation execution by adapting the construction plan to incorporate experience gained from Unit 3 testing. Furthermore, the sequence of Unit 4 Project milestones has been adjusted to integrate testing experience from Unit 3. Unit 4 personnel have also been provided enhanced training regarding IEEE-384 standards to reinforce lessons learned from Unit 3 to bolster the Project's focus on first-time quality for electrical installation. Management continues to take steps to safely increase the number of craft in targeted disciplines to support Unit 3 and Unit 4 scopes of work. Increasing electrical commodity installation in Unit 4 remains a challenge due to regional and national labor constraints. Collectively, Management continuously evaluates available options as part of selecting the best strategies to maintain focus on the Project's goal of completing Vogtle Units 3 and 4 in a safe and quality manner.

Redacted

Redacted

Redacted

Redacted

Redacted

Redacted

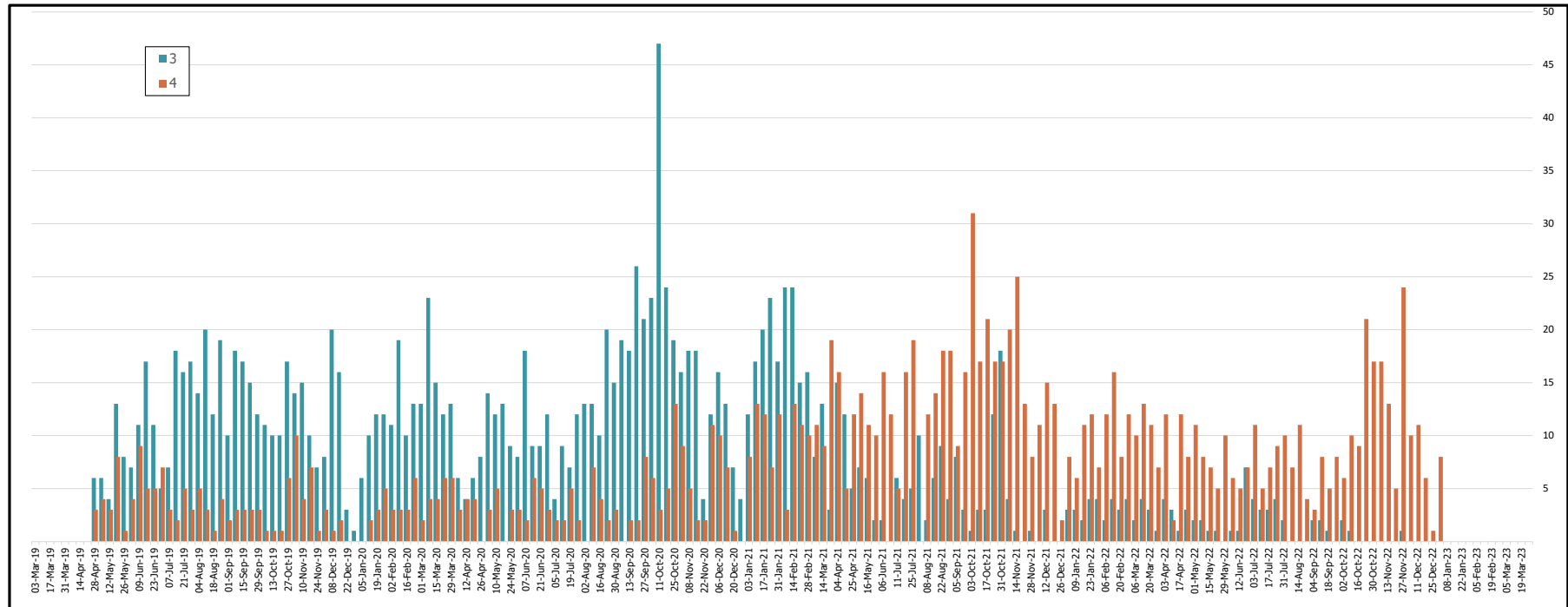
Redacted

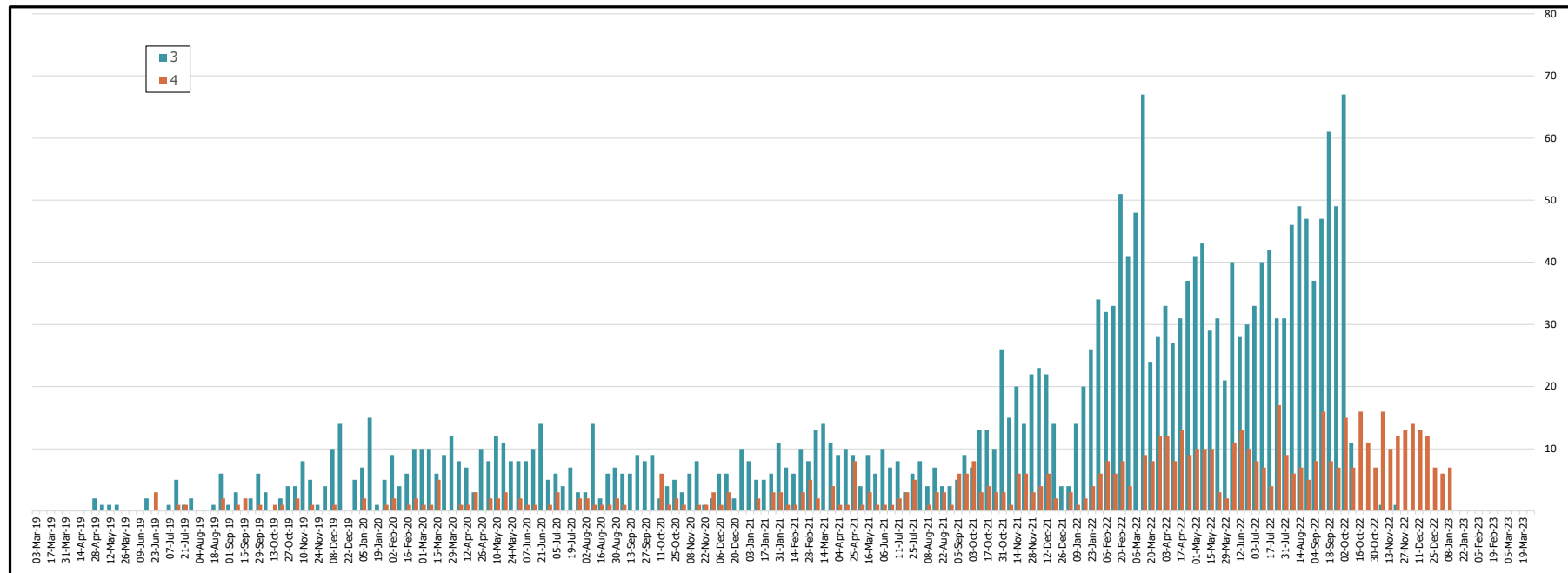
Redacted

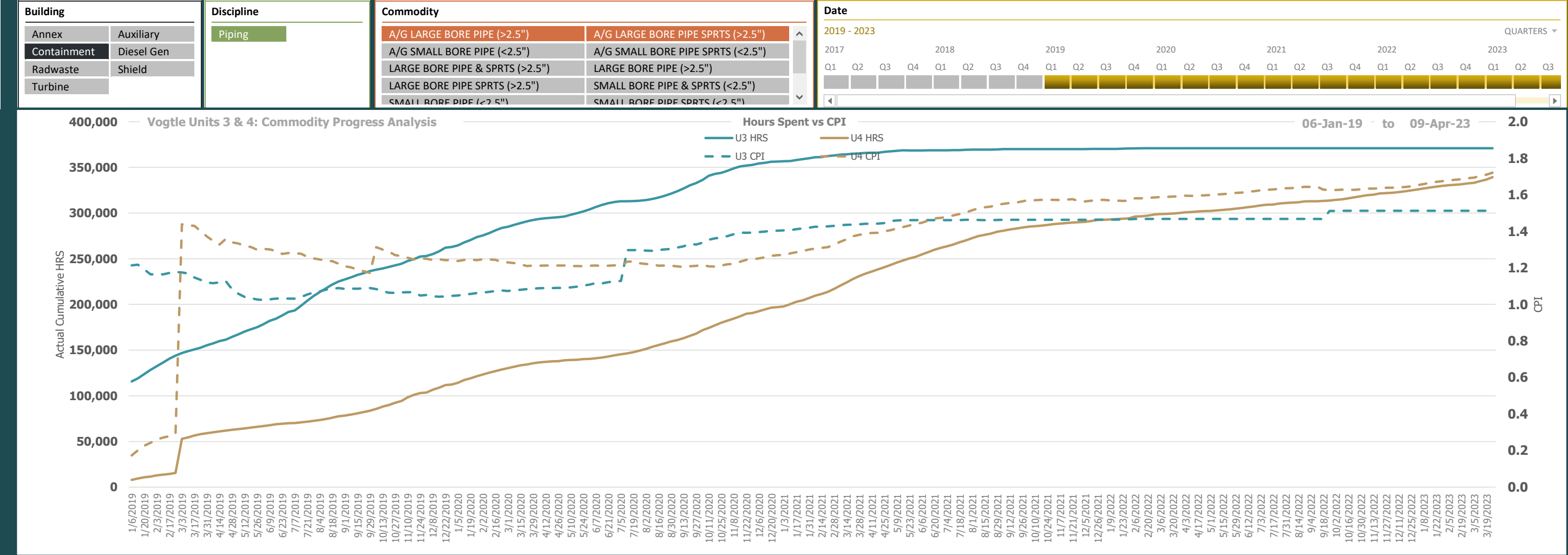
Redacted

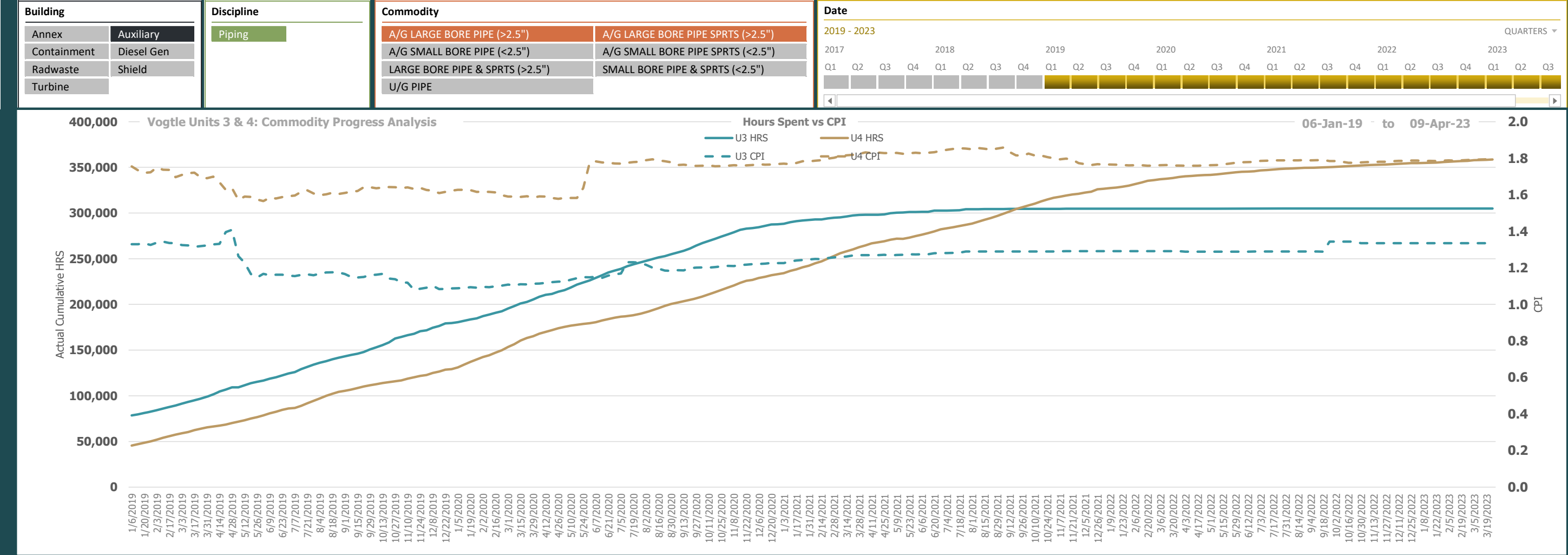
Redacted

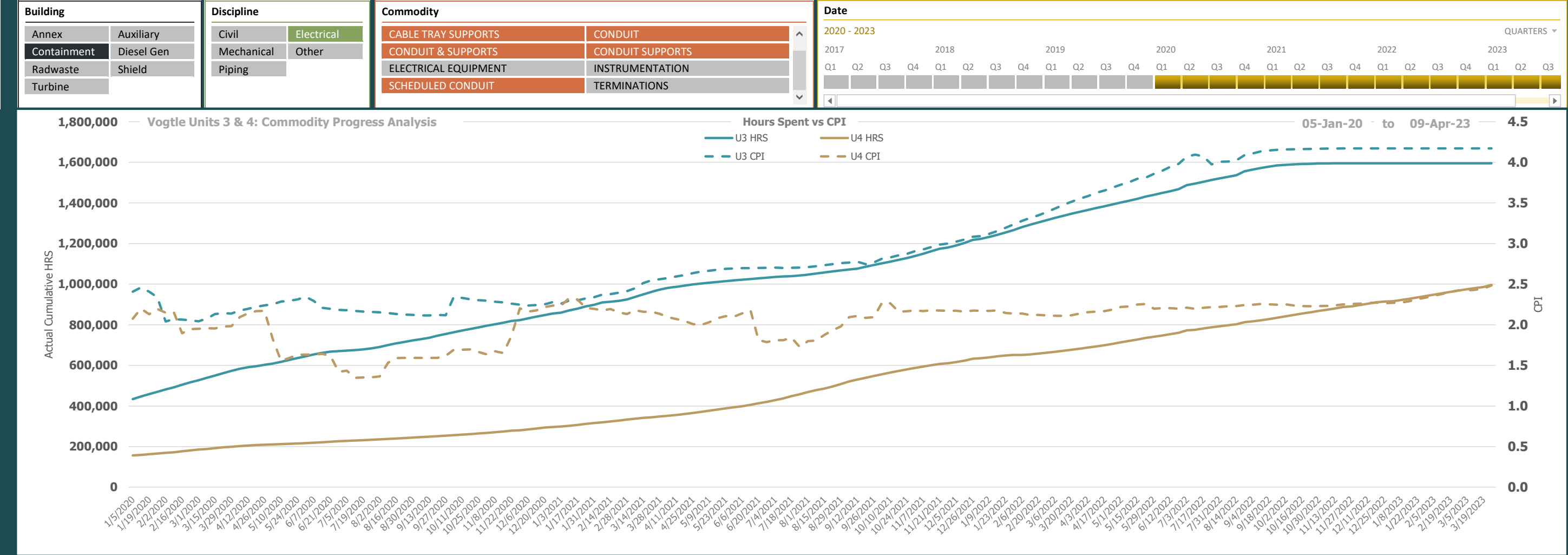
Redacted

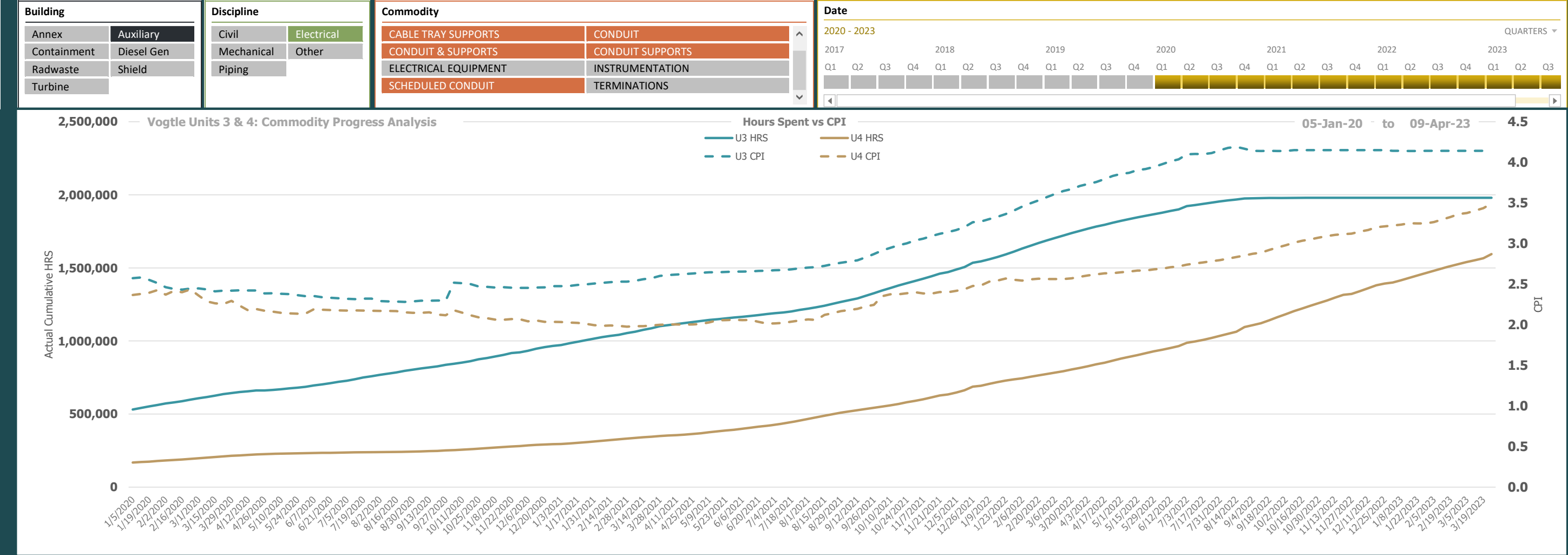












E&DCRs for Unit 3 & 4