George A. Lippard
Vice President, Nuclear Operations
803.345.4810

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U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555-001

Dear Sir / Madam:

Subject: VIRGIL C. SUMMER NUCLEAR STATION (VCSNS) UNIT 1
DOCKET NO. 50-395
OPERATING LICENSE NO. NPF-12
MITIGATING STRATEGIES ASSESSMENT (MSA) REPORT SUBMITTAL

References:

1. NRC Letter, *Request for Information Pursuant to Title 10 of Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.13, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident*, dated March 12, 2012 [ML12053A340]
2. SCE&G Letter, *South Carolina Electric & Gas Company (SCE&G) Flooding Hazard Reevaluation Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Flooding Aspects of Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident*, dated March 12, 2013 [ML13073A114]
3. SCE&G Letter, *South Carolina Electric & Gas Company (SCE&G) Supplemental Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding the Flooding Aspects of Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident*, dated August 22, 2013 [RC-13-0118]
4. NRC Letter, *Virgil C. Summer Nuclear Station, Unit 1 (VCSNS) – Request for Additional Information (TAC No. MF1112)*, dated January 30, 2014 [ML14023A740]
5. SCE&G Letter, *South Carolina Electric & Gas (SCE&G) Response to NRC Request for Additional Information Associated with Near-Term Task Force Recommendation 2.1, Flooding Reevaluation*, dated March 26, 2014 [ML14093A320]
6. NRC Letter, *Virgil C. Summer Nuclear Station, Unit 1 – Staff Assessment of Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanism Reevaluation (TAC No. MF1112)*, dated December 23, 2014 [ML14356A002]
7. NRC Staff Requirements Memorandum to COMSECY-14-0037, *Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards*, dated March 30, 2015 [ML15089A236]
8. NRC Letter, *Coordination of Requests for Information Regarding Flooding Hazard Reevaluations and Mitigating Strategies for Beyond-Design-Basis External Events*, dated September 1, 2015 [ML15174A257]

9. Nuclear Energy Institute (NEI), Report NEI 12-06 [Rev 2], *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*, dated December 2015 [ML16005A625]
10. U.S. Nuclear Regulatory Commission JLD-ISG-201-01, Revision 1, *Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events*, dated January 22, 2016 [ML15357A163]
11. NRC Letter, *Virgil C. Summer Nuclear Station, Unit 1 – Supplement to Staff Assessment of Response to 10 CFR 50.54(f) Information Request – Flood-Causing Mechanisms Reevaluation (CAC No. MF1112)*, dated November 3, 2015 [ML15296A377]
12. SCE&G Letter, *Report of Full Compliance and Final Integrated Plan in Response to March 12, 2012, Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order EA-12-049) for Virgil C. Summer Nuclear Station Unit 1*, dated October 31, 2016 [ML16307A390]

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued Reference 1 to request information associated with Near-Term Task Force (NTTF) Recommendation 2.1 for Flooding. One of the Required Responses in Reference 1 directed licensees to submit a Flood Hazard Reevaluation Report (FHRR). For VCSNS Unit 1, the FHRR was submitted on March 12, 2013 (Reference 2) and supplemented on August 22, 2013 (Reference 3). Additional information was requested by the NRC in Reference 4, and SCE&G provided the additional information in Reference 5. Per Reference 6, the NRC considers the reevaluated flood hazard to be "beyond the current design/licensing basis of operating plants."

Concurrent with the flood hazard reevaluation, VCSNS Unit 1, developed and implemented mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events." In Reference 7, the NRC affirmed that licensees need to address the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis (BDB) external events, including the reevaluated flood hazards. This requirement was confirmed by the NRC in Reference 8. Guidance for performing mitigating strategies flood hazard assessments (MSFHAs) is contained in Appendix G of Reference 9, endorsed by the NRC in Reference 10. For the purpose of the MSFHAs and Reference 8, the NRC termed the reevaluated flood hazard, summarized in Reference 11, as the "Mitigating Strategies Flood Hazard Information" (MSFHI). Reference 9, Appendix G, describes the MSFHA for flooding as containing the following elements:

- Section G.2 – Characterization of the MSFHI
- Section G.3 – Comparison of the MSFHI and FLEX Design Basis (DB) Flood
- Section G.4.1 – Assessment of Current FLEX Strategies (if necessary)
- Section G.4.2 – Assessment of Modifying FLEX Strategies (if necessary)
- Section G.4.3 – Assessment of Alternate Mitigating Strategies (if necessary)
- Section G.4.4 – Assessment of Targeted Hazard Mitigating Strategies (if necessary)

In Reference 11, the NRC concluded that the "reevaluated flood hazard information, as summarized in the Enclosure to Reference 11, is suitable for the assessment of mitigation strategies developed in response to Order EA-12-049" for VCSNS, Unit 1.

The enclosure to this letter provides the Mitigating Strategies Assessment for Flooding for VCSNS, Unit 1.

The current FLEX strategies can be successfully implemented for both flooding scenarios applicable to VCSNS: a) FHRR Local Intense Precipitation (LIP) event (localized Probable maximum precipitation event) and the FHRR Probable Maximum Flood (PMF) for the adjacent Monticello Reservoir. The Mitigating Strategies Flood Hazard Information (MSFHI) is not bounded by the Current Design Basis flood. However, the FLEX DB flood parameters for both the LIP and PMF were set equivalent to, and therefore bound, the MSFHI. The MSA for VCSNS, Unit 1, concludes that the existing FLEX strategies (Reference 12), procedures, and equipment are not adversely impacted by the MSFHI under any of the applicable flood-causing mechanisms.

This letter contains no new regulatory commitments. If you have any questions regarding this report, please contact Bruce L. Thompson at (803) 931-5042.

I certify under penalty of perjury that the foregoing is true and correct.

12/22/16 — Executed on

FOR — George A. Lippard

TS/GAL/rp
Enclosure: 2016 Mitigating Strategies Assessment for Flooding

c: K. B. Marsh
S. A. Byrne
J. B. Archie
N. S. Carns
J. H. Hamilton
S. M. Shealy
W. M. Cherry
C. Haney
S. A. Williams
L. K. Gibson
M. O. Valentin
NRC Resident Inspector
K. M. Sutton
NSRC
RTS (CR-12-01078, CR-12-01098)
File (815.07)
PRSF (RC-16-0170)

VIRGIL C. SUMMER NUCLEAR STATION (VCSNS) UNIT 1

ENCLOSURE

2016 Mitigating Strategies Assessment for Flooding

Table of Contents

1.0 Executive Summary

This Mitigating Strategies Assessment (MSA) evaluates the impact of the reevaluated flood hazard on FLEX strategy implementation.

The Virgil. C Summer Nuclear Station Unit 1 (VCSNS) FLEX design basis (DB) flood was set to be equivalent to the Flood Hazard Reevaluation Report (FHRR) Local Intense Precipitation (LIP) event (localized Probable maximum precipitation event) and the FHRR Probable Maximum Flood (PMF) for the adjacent Monticello reservoir.

The Mitigating Strategies Flood Hazard Information (MSFHI) is not bounded by the Current Design Basis (CDB) flood. However, the FLEX DB flood parameters for both the LIP and PMF were set equivalent to, and therefore bound, the MSFHI.

The MSA for VCSNS concludes that the existing FLEX strategies, procedures, and equipment are not adversely impacted by the Mitigating Strategies Flood Hazard Information (MSFHI) under any of the applicable flood-causing mechanisms.

2.0 List of Acronyms

- BDB – Beyond Design Basis
- BDBEE – Beyond Design Basis External Event
- CDB – Current Design Basis
- ELAP – Extended Loss of AC Power
- FIP - Final Integrated Plan
- FLEX DB – FLEX Design Basis (flood hazard)
- FHRR – Flood Hazard Reevaluation Report
- LIP – Local Intense Precipitation
- LUHS – Loss of Ultimate Heat Sink
- MSA – Mitigating Strategies Assessment
- MSFHI – Mitigating Strategies Flood Hazard Information (from the FHRR and MSFHI letter)
- NTTF – Near-Term Task Force
- PMF – Probable Maximum Flood (related to nearby Streams, Rivers, Reservoirs)
- PMP – Probable Maximum Precipitation
- RAI – Request for Additional Information

3.0 Background

Purpose

On March 12, 2012, the NRC issued Reference 1 to request information associated with Near-Term Task Force (NTTF) Recommendation 2.1 for Flooding. One of the Required Responses in Reference 1 directed licensees to submit a Flood Hazard Reevaluation Report (FHRR). The VCSNS FHRR was submitted on March 12, 2013 (Reference 2). NRC requested additional information (RAI) on the FHRR on January 30, 2014 (Reference 3). On March 26, 2014, VCSNS submitted responses to the NRC's RAIs (Reference 4). On December 23, 2014, the NRC provided Staff Assessment of the FHRR (Reference 5) and determined that VCSNS has provided sufficient information in response to the 50.54(f) letter (Reference 1). On November 3, 2015, the NRC provided a Supplement to the Staff Assessment (Reference 6) for VCSNS and concluded that (a) the reevaluated flood hazards results for LIP and PMF from Monticello Reservoir are not bounded by the current design-basis flood hazard, (b) additional assessments of plant response will be performed for the local intense precipitation and PMF, and (c) the reevaluated flood-causing mechanism information is appropriate input to additional assessments of evaluations of plant response, as described in the 50.54(f) letter and COMSECY-15-0019, including the assessment of mitigation strategies developed in response to Order EA-12-049.

Concurrent to the flood hazard reevaluation, VCSNS developed and implemented mitigating strategies in accordance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design - Basis External Events". In Reference 7, the Commission affirmed that licensees need to address the reevaluated flooding hazards within their mitigating strategies for beyond-design-basis (BDB) external events, including the reevaluated flood hazards. This requirement was confirmed by the NRC in Reference 8. The NRC has determined that the reevaluated flood hazard is "beyond the current design/licensing basis of operating plants" (Reference 8).

Guidance for performing the Flooding MSA is contained in Appendix G of Reference 10, endorsed by the NRC in Reference 9. Appendix G of reference 10 describes the Flooding MSA as containing the following elements:

- Section G.2 – Characterization of the MSFHI
- Section G.3 – Basis for Mitigating Strategy Assessment
- Section G.4 – Assessment of Current FLEX Strategies (if necessary)
- Section G.5 – Performance Criteria for Flood Protection Features (if necessary)
- Section G.6 - Documentation

Site Description

The VCSNS site is the equivalent of a dry site as defined in Regulatory Guide (RG) 1.102, *Flood Protection for Nuclear Power Plants*. There are no major potential external sources that could result in flooding on site. The site is protected from flooding and wave run-up on the north side from the adjacent Monticello Reservoir by a properly designed exterior revetment barrier consisting of an embankment with protective stone riprap. The normal water elevation of Monticello Reservoir is 425.0 feet while site grade around the plant is typically at 435.5 feet. Plant grade is raised to 438 feet directly adjacent to the embankment at Monticello Reservoir creating, in effect, a minor levee referred to as the North Berm. The North Berm, including the elevation and riprap protected embankment, are designed to protect the site at a maximum elevation of 437.5 feet from postulated storm water-related flood conditions, plus wave run-up, from Monticello Reservoir, as described in Chapter 2 of the Final Safety Analysis Report (FSAR).

The Monticello Reservoir is the nearest body of water to the site, and serves as the source of cooling and makeup water for the VCSNS. Monticello Reservoir has a surface area of about 6,800 acres and a storage volume of about 400,000 acre-feet at the normal maximum water surface elevation of 425.0 feet.

The Service Water Pond (SWP) is a Seismic Category 1 impoundment constructed adjacent to Monticello Reservoir that is physically separated by Seismic Category 1 dams and natural land masses. The SWP supplies water for the Service Water System under normal and emergency operations. The interconnecting pipe, through the operation of a butterfly isolation valve, permits the SWP to be supplied from Monticello Reservoir. For normal operating conditions, the Monticello Reservoir and SWP levels will fluctuate between elevations 420.5 feet and 425.0 feet.

In summary, the CDB flood hazard levels for VCSNS are as follows:

<u>Flooding from Monticello Reservoir PMF:</u>
Monticello Reservoir normal maximum still water level is 425.0 feet, NGVD 29 (FSAR, Section 2.4.10). Maximum water level during PMF, with wind storm surge and wave setup is defined as 436.6 feet, NGVD 29. The North Berm top is at design elevation 438.0 feet.

A conservative design basis assumption is that no water is released from the Fairfield Hydro station during the event. The controlled normal maximum reservoir still water level is assumed to be at elevation 425.0 feet. If water were released by Fairfield Hydro station, the water level would be less than 425.0 feet.

Flooding from the Service Water Pond (SWP) PMF:
SWP normal maximum still water level is 422.0 feet, NGVD 29 (FSAR, Section 9.2.5.3.2.3.a). Maximum water level during Probable Maximum Flood (PMF), with wind storm surge and wave setup, is defined as 433.6 feet, NGVD 29. The West Embankment top is at design elevation 435.0 feet. The other dams forming the SWP have top design elevations of 438.0 feet.

The SWP is designed to preclude being flooded, or drained, by Monticello Reservoir. An interconnecting pipe is the only hydraulic connection between the SWP and Monticello Reservoir. This pipe is fitted with a butterfly isolation valve that is locked closed during normal operation (FSAR Sections 2.4.8 and 9.2.5).

Local Intense Precipitation (LIP):
LIP, defined as the greatest hourly depth of rainfall during the 6-hour PMP, has been determined to build up to elevation 436.15 feet on the site assuming no flow in the storm inlets and storm sewer pipe system (completely blocked) before overland flow allows surface runoff to flow off the plant site perimeter away from the main plant buildings (FSAR, Section 2.4.3.1.3).

The centerline elevation of the roads surrounding the perimeter of the plant area is at 436.0 feet. The overflow capacities of the surrounding roads act as weirs up to elevation 436.0 feet, resulting in a maximum ponding elevation of 436.15 feet during the 6-hour PMP (FSAR, Section 2.4.3.1.3).

Broad River Flooding:
Flooding from the Broad River was not considered due to the elevation difference from the river to the site. Nominal site grade of 435 feet is 150 feet above the Broad River flood plain.

FLEX Strategy Overview

The objective of the FLEX Strategies is to establish an indefinite coping capability in order to 1) prevent damage to the fuel in the reactors, 2) maintain the containment function and 3) maintain cooling and prevent damage to fuel in the Spent Fuel Pool (SFP) using installed equipment, on-site portable equipment, and pre-staged off-site resources. This indefinite coping capability will address an ELAP (i.e., loss of off-site power, emergency diesel generators and any alternate AC source, but not the loss of AC power to buses fed by station batteries through inverters) with a simultaneous LUHS. This condition could arise following external events that are within the existing design basis with additional failures and conditions that could arise from a BDBEE.

The plant indefinite coping capability is attained through the implementation of pre-determined strategies (i.e., FLEX strategies) that are focused on maintaining or restoring key plant safety functions. The FLEX strategies are not tied to any specific damage state or mechanistic assessment of external events. Rather, the strategies are developed to maintain the key plant safety functions based on the evaluation of plant response to the coincident ELAP/LUHS event. A safety function-based approach provides consistency with, and allows coordination with, existing plant Emergency Operating Procedures (EOPs). FLEX strategies are implemented in support of EOPs using FLEX Support Procedures (FSPs).

The strategies for coping with the plant conditions that result from an ELAP/LUHS event involve a three-phase approach:

Phase 1 – Initially cope by relying on installed plant equipment and on-site resources.

Phase 2 – Transition from installed plant equipment to on-site BDB equipment.

Phase 3 – Obtain additional capability and redundancy from off-site equipment and resources until power, water, and coolant injection systems are restored.

The duration of each phase is specific to the installed and portable equipment utilized for the particular FLEX strategy employed to mitigate the plant condition.

The strategies described in Reference 11 are capable of mitigating an ELAP/LHUS resulting from a BDBEE by providing adequate capability to maintain or restore core cooling, containment, and SFP cooling capabilities. Though specific strategies have been developed, due to the inability to anticipate all possible scenarios, the strategies are also diverse and flexible to encompass a wide range of possible conditions. These pre-planned strategies, developed to protect the health and safety of the public, are incorporated into VCSNS EOPs in accordance with established EOP change processes.

VCSNS's FLEX strategy only considers flooding from the LIP event, as reevaluated and documented in the FHRR (Reference 2) and RAI (Reference 4) submittals. The other flood causing mechanisms, PMF from Monticello Reservoir, SWP, and Broad River, do not result in flood levels on-site as the site is protected by elevation from the flood hazards, and is therefore not a design consideration for FLEX strategy development.

The following description of the Impact of external flooding is taken from the VCSNS Final Integrated Plan (FIP) Document (Reference 11), Section 2.6.2:

> *"The VCSNS site is susceptible to brief water build-up due to a local intense precipitation event. FLEX equipment is stored either within structures designed to protect the equipment from the flood elevations or above the flood elevation calculated by the site external flooding analysis. Local ponding onsite due to local intense precipitation (i.e. probable maximum precipitation or PMP) event was a design consideration in selection of storage locations, equipment connections, and deployment routes"*

4.0 Characterization of the MSFHI (NEI 12-06, Rev 2, Section G.2)

Characterization of the MSFHI is summarized in Table 1 of Reference 5, the Flood Hazards Reevaluation Report for VCSNS (Reference 2) and amended submittal (Reference 4). A more detailed description of the MSFHI, along with the basis for inputs, assumptions, methodologies, and models, is provided in the following references:

- LIP: See Section 4.2.1 of Reference 2, Attachment 1.
- Flooding in Streams and Rivers: See Section 4.2.2.1, 4.2.2.2., and 4.2.2.3 of Reference 2, Attachment 1.
- Dam Breaches and Failures: See Section 4.2.2.4 of Reference 2, Attachment 1.
- Storm Surge: See Section 4.2.2.5 of Reference 2, Attachment 1.
- Seiche: See Section 4.2.2.6 of Reference 2, Attachment 1.
- Tsunami: See Section 4.2.2.7 of Reference 2, Attachment 1.
- Ice-Induced Flooding: See Section 4.2.2.8 of Reference 2, Attachment 1.
- Channel Migration or Diversion: See Section 4.2.2.9 of Reference 2, Attachment 1.
- Combined Effects (including wind-waves and run-up effects): See Section 4.2.2 and 4.2.10 of Reference 2, Attachment 1.
- Other Associated Effects (i.e. hydrodynamic loading, including debris; effects caused by sediment deposition and erosion; concurrent site conditions; and groundwater ingress): See Reference 4, RAI No. 7 Response.
- Flood Event Duration Parameters (i.e. warning time, period of site preparation, period of inundation, and period of recession): See Reference 4, RAI No. 6 Response.

As discussed in Reference 2, the flood hazard reevaluation showed that only the LIP and the PMF from the nearby Monticello Reservoir and SWP (floods along the shores of enclosed bodies of water, shore location) were determined to be the plausible flood-causing mechanisms which also bound any other mechanisms The VCSNS site is protected from the PMF flood-causing mechanism by permanent, passive, earthen

berms and embankments which provide sufficient flood protection. Therefore, the only flood mechanisms which is evaluated for impact on the FLEX Mitigating Strategies is the LIP flood causing mechanism. Parameters for the LIP flood-causing mechanism, including associated effects and flood event duration parameters, are described in detail in Reference 2 and Reference 4.

In Reference 6, the NRC concluded that the reevaluated flood hazards information (i.e. MSFHI), as summarized in the Enclosure to Reference 5 and Reference 6, is suitable for the assessment of mitigating strategies developed in response to Order EA-12-049 for VCSNS.

5.0 Basis for Mitigating Strategy Assessment (NEI 12-06, Rev 2, Section G.3)

VCSNS's FLEX DB is based on the FHRR (Reference 2) and response to the NRC's request for additional information dated March 26, 2014 (Reference 4). As shown in Table 1, all aspects of the FLEX DB are equal to the MSFHI flood parameters. Therefore, the FLEX DB completely bounds the MSFHI and no further assessment of FLEX is required or included.

Table 1 – Local Intense Precipitation Flood Parameter Comparison

Flood Scenario Parameter		Plant's Current Design Basis	FLEX Design Basis	MSFHI	Bounded(B) or Not Bounded (NB)
Flood Associated Level and Effects	1. Max Stillwater Elevation (ft. MSL)	436.15	437.5	437.5	B
	2. Max Wave Run-up Elevation (ft. MSL)	N/A	N/A	N/A	N/A
	3. Max Hydrodynamic (lb/ft)/Debris Loading (lb)	N/I	See note	See note	B
	4. Effects of Sediment Deposition/Erosion	N/I	See note	See note	B
	5. Other associated effects (identify each effect)	N/A	N/A	N/A	N/A
	6. Concurrent Site Conditions	N/A	N/A	N/A	N/A
	7. Effects on Groundwater	N/I	See note	See note	B
Flood Duration	8. Warning Time (hours)	N/A	24 hours	24 hours	B
	9. Period of Site Preparation (hours)	N/A	12 hours	12 hours	N/A
	10. Period of Inundation (hours)	N/I	7 hours	7 hours	B
	11. Period of Recession (hours)	N/I	17 hours	17 hours	B
Other	12. Plant Mode of Operations	Any	Any	Any	B
	13. Other Factors	N/A	N/A	N/A	N/A

N/A = Not Applicable N/I = Not Included

The note numbers below correspond to the parameter number in the table.

1. Elevations vary around the site. See Reference 2 and Reference 6, Table 4.0-2.
2. Consideration of wind-wave action for the LIP event is not explicitly required by NUREG/CR-7046 and is judged to be a negligible because of limited fetch lengths and flow depths.
3. The hydrodynamic and hydrostatic loads are bounded by the design basis maximum tornado wind and seismic loads. The debris load for the LIP event is assumed to be negligible due to the absence of heavy objects at the plant site and due to low flow velocity, the factors combination of which could lead to a hazard due to debris load. Additionally, the water depth around the buildings due to LIP are relatively shallow.
4. Significant erosion is not expected for the LIP flood due to flow velocities below 2 fps for the majority of the site area. Similarly, the relatively low velocities and flow depths are not expect to have the power to transport sediment and cause significant deposition during the LIP flood. See Reference 4, RAI No. 7 Response.
5. None
6. PMP/LIP is not associated with antecedent or concurrent events that would impact implementation of preventive measures. See Reference 4, RAI No. 7 Response.
7. See Reference 4, RAI No. 7 Response.
8. None
9. None
10. See Reference 4, RAI No. 6 Response
11. See Reference 4, RAI No. 6 Response
12. None
13. None.

6.0 Conclusions

The current FLEX Strategies, as defined in the VCSNS FIP (Reference 11), can be successfully implemented for all flood-causing mechanisms applicable to VCSNS. The reevaluated flood hazard parameters, from the FHRR (Reference 2), which were used to develop the FLEX Implementation Strategies and are equivalent to the MSFHI. The MSA for VCSNS concludes that the existing FLEX strategies, procedures, and equipment are not adversely impacted by the MSFHI under any of the applicable flood-causing mechanisms.

7.0 References

1. NRC Letter, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident; dated March 12, 2012 [ML12053A340]

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11. VCSNS Unit 1, Report of Full Compliance Letter and Final Integrated Plan in Response to the March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events (Order Number EA-12049), dated October 31, 2016 [ML16307A390]