VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

April 14, 2022 | 10 CFR 50.90

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

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Docket Nos.:	50-280/281
License Nos.:	DPR-32/37

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2
LICENSE AMENDMENT REQUEST FOR NRC APPROVAL OF METHODOLOGY CHANGE AND RECLASSIFICATION OF THE TURBINE BUILDING AS A TORNADO RESISTANT STRUCTURE

Pursuant to 10 CFR 50.90, Virginia Electric and Power Company (Dominion Energy Virginia) requests an amendment to the Surry Power Station (SPS) Units 1 and 2 Subsequent Renewed Operating Licenses DPR-32 and DPR-37. NRC approval is requested to designate the SPS Units 1 and 2 Turbine Buildings as tornado-resistant structures in the SPS Updated Final Safety Analysis Report (UFSAR) under a different methodology and acceptance criteria than those defined for the other SPS tornado resistant (i.e., Tornado Criterion "T") structures. The new methodology and acceptance criteria are considered a change to a method of evaluation that requires prior NRC approval per 10 CFR 50.59(c)(2)(viii). No changes to the Technical Specifications (TS) are required by this license amendment request (LAR). The technical basis for the proposed change is provided in Attachments 1 and 2. Upon NRC approval of the LAR, the SPS UFSAR will be updated to reflect the reclassification of the Units 1 and 2 Turbine Buildings as tornado resistant structures based on the new methodology and acceptance criteria. A mark-up of the planned SPS Units 1 and 2 UFSAR changes is provided in Attachment 3.

Dominion Energy Virginia has evaluated the proposed amendment and has determined it does not involve a significant hazards consideration as defined in 10 CFR 50.92. The basis for this determination is included in Attachment 1. We have also determined operation with the proposed change will not result in a significant increase in the amount of effluents that may be released offsite or a significant increase in individual or cumulative occupational radiation exposure. Therefore, the proposed amendment is eligible for categorical exclusion from an environmental assessment as set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment is needed in connection with the approval of the proposed change.

The LAR has been reviewed and approved by the SPS Facility Safety Review Committee.

Dominion Energy Virginia requests approval of the proposed amendment by January 31, 2022 with a 90-day implementation period.

If you have any questions or require additional information, please contact Mr. Gary D. Miller at (804) 273-2771.

Respectfully,

Douglas C. Lawrence
Vice President – Nuclear Engineering and Fleet Support

Commitment made in this letter:

1. Upon NRC approval of the LAR, the SPS Units 1 and 2 UFSAR will be updated to reflect the reclassification of the Turbine Buildings as tornado resistant structures based on the new methodology and acceptance criteria.

Attachments:

1. Discussion of Change
2. Configuration of the Outriggers to the Service Building
3. Mark-up of SPS Units 1 and 2 UFSAR Planned Changes

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Mr. Douglas C. Lawrence, who is Vice President - Nuclear Engineering and Fleet Support, of Virginia Electric and Power Company. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 14th day of April, 2022.

My Commission Expires: Jan 31, 2024

Kathryn Hill Barret
Notary Public
Commonwealth of Virginia
Reg. No. 7905256
My Commission Expires January 31, 2024

Kathy H. Barret
Notary Public

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Attachment 1

DISCUSSION OF CHANGE

Virginia Electric and Power Company
(Dominion Energy Virginia)
Surry Power Station Units 1 and 2

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DISCUSSION OF CHANGE

1 SUMMARY DESCRIPTION

Pursuant to 10 CFR 50.90, Virginia Electric and Power Company (Dominion Energy Virginia) requests an amendment to the Surry Power Station (SPS) Units 1 and 2 Subsequent Renewed Operating Licenses DPR-32 and DPR-37. NRC approval is requested to designate the Turbine Building as a tornado-resistant structure in the SPS Updated Final Safety Analysis Report (UFSAR) [1] under a different methodology and acceptance criteria than those defined for the other SPS tornado-resistant (i.e., Tornado Criterion "T") structures. Classification of the Turbine Building as a tornado-resistant structure is supported by an evaluation that uses a new methodology and acceptance criteria to demonstrate that partial collapse of the Turbine Building structure above the operating deck elevation is expected under tornado wind loads, but the operating and mezzanine decks will remain stable. The stability of the Turbine Building operating and mezzanine decks provides tornado protection for safe shutdown and non-isolable water source components located in the Turbine Building basement. Additionally, partial building collapse of the Turbine Building structure during a tornado will not damage any adjacent Tornado Criterion "T" structures or protected components housed therein.

The new methodology and acceptance criteria being used to change the tornado classification of the Turbine Building to a tornado-resistant structure are considered a change to an element of the method of evaluation that requires prior NRC approval per 10 CFR 50.59(c)(2)(viii).

2 DETAILED DESCRIPTION

2.1 Turbine Building Design

The Turbine Building houses the steam turbines and main generators, as well as other auxiliary equipment and piping systems for SPS Units 1 and 2. The structural framing of the Turbine Building consists primarily of a steel superstructure (i.e., the Turbine Building Steel Superstructure, or TBSS) that supports several concrete slabs at various elevations. Within this document, the term, "Turbine Building," will be used when referring to the operating plant structure and the acronym, "TBSS", will be used when referring to the analytical model of the Turbine Building steel structure and reinforced concrete slabs of the operating and mezzanine decks that provide protection to the safe shutdown and non-isolable water source components in the basement. The primary reinforced concrete slab is the operating deck at elevation 58'-6". Below the operating deck is the mezzanine floor and basement. The mezzanine floor consists of concrete slabs and walkways at various elevations including 27'-0", 29'-6", and 35'-0". The basement level sits below grade (26'-6") at elevation 9'-6".

The SPS Turbine Building is not designated as a Seismic Category I or Tornado Criterion "T" structure; however, it contains safety-related and non-isolable water source components located in the basement. Additionally, one side of the Turbine Building is connected to the Service Building which also houses safety-related equipment. Turbine Building columns C7, C8, C9, and C10 on the north side of the building are laterally supported by steel outriggers (braces) that extend to the Service Building roof. These outriggers are made of steel W-Sections and are connected to the Turbine Building columns from the south side and the roof of the Service Building on the north side (See Attachment 2).

2.2 Current Licensing Basis

Table 15.2-1, "Structures, Systems, and Components Designed for Seismic and Tornado Criteria," of the SPS UFSAR does not designate the Turbine Building as a tornado-resistant (i.e., tornado Criterion "T") structure; however, a note alongside this table entry reads, "*By design, building collapse will not damage any Class I structures and components during earthquake or tornado-resistant structures and components during tornado.*" The original design basis calculation conservatively assumed that under the loads due to a maximum tornado wind speed of 300-mph along the east-west direction, only columns C-6, C-7, C-8, C-9 and C-10 would remain standing with their bracings and struts still intact along C-line on the north side of the TBSS. The other steel members of the TBSS and roof trusses were conservatively assumed to fail. Note that columns C-7, C-8, C-9 and C-10 each have outriggers, which laterally brace these columns to the top of the Control House of the Service Building. The statement included in the above cited note, "*... building collapse will not damage any Class I structures and components during earthquake or tornado-resistant structures and components during tornado,*" was not quantitatively justified in the original design basis calculation. However, this statement was qualitatively addressed in correspondence between the Architect/Engineering firm for SPS (Stone & Webster Engineering Company – SWEC) and Virginia Electric and Power Company (VEPCO) during and after preparation of the design basis calculation cited above. The correspondence indicates that "engineering judgement" was used to justify the above cited note indicating that no damage would occur to the safe shutdown equipment in the basement of the Turbine Building and the adjacent tornado-resistant Service Building.

SPS Specification, entitled "Design Data Structural Work Combined Turbine and Service Building for Surry Power Station," was originally issued on April 25, 1967. The scope of this specification included the Service Building, which would later be classified, in part, as a Tornado Criterion "T" structure. As such, the Turbine Building was originally subject to certain tornado structural design criteria similar to what is required today for Tornado Criterion "T" structures. The maximum tornado wind speed was listed as 300 mph in this original specification.

On June 26, 1967, revised SPS Specification, entitled "Design Data for Earthquake and Tornado Requirements for Structural Work for Surry Power Station," was issued and superseded the April 25, 1967 version. As indicated by the revised title, the scope of the revised specification was extended to all structures and components at SPS that had to be evaluated for their ability to withstand tornado effects. Other major revisions included the adoption of the plastic design methodology per Part 2 of AISC Specification, 6th Edition [8] and the requirement for structures to withstand "short-term tornado loadings, including tornado generated missiles." The discussion of tornado generated missiles in this specification was limited to the local effects of the 12.1-inch diameter, 40-foot long, 50-pound per cubic foot (pcf) wooden telephone pole traveling at 150-mph on site. Later, in response to a question from the Atomic Energy Commission, VEPCO confirmed that it would use a higher maximum tornado wind speed of 360 mph, as opposed to 300 mph, for structural evaluation consistent with other nuclear licensee applications.

On October 18, 1967, the second revision of SPS Specification was issued to supersede the June 26, 1967 version. The major revision was the reference to the revised list of structures and components that were to be "checked".

By letter dated December 1, 1967, SWEC informed VEPCO that safe shutdown equipment is "... considered to be adequately protected by virtue of its location in the basement of the turbine building and by intervening, miscellaneous structural members." This conclusion was based on "good engineering judgement". No engineering rigor was provided to defend this judgement.

In a subsequent letter sent to VEPCO dated April 24, 1968, SWEC referenced a list of structures and components they planned to "check" with respect to their design to meet seismic and tornado criteria. The "Turbine Building" was included in the list with a similar note, "Check that building collapse will not damage any Class I structures and components during earthquake or tornado-resistant structures and components during tornado." The SWEC letter also confirmed that the Turbine Building is classified "N/A" with respect to "Earthquake Criterion" and "Tornado Criterion," which means the Turbine Building is not subject to the same tornado structural design criteria as currently listed for Tornado Criterion "T" structures in SPS UFSAR, Section 15.2.3, "Tornado Criteria".

No further correspondence between SWEC and VEPCO could be located that specifically explained how the Turbine Building design was checked to comply with the above cited note in SPS UFSAR, Table 15.2-1. As such, it can only be assumed that "good engineering judgement" was applied at the time and still prevails today. The use of engineering judgement was not uncommon at the time SPS Units 1 and 2 were licensed.

SPS UFSAR, Section 15.2.3, specifies the existing licensing basis tornado characteristics as follows:

- Rotational wind velocity = 300 mph
- Translational velocity = 60 mph
- Pressure drop of 3 psi in 3 seconds
- Overall diameter = 1200 ft
- Radius of maximum winds = 200 ft

Based on the above, structures that are designed to resist tornadoes shall withstand the licensing basis maximum tornado wind speed of 360 mph (i.e., 300 mph rotational velocity + 60 mph translational velocity). The Turbine Building was not originally designed as a tornado-resistant structure; therefore, the original design basis calculation assumed partial building collapse under a 300 mph tornado wind load, and as stated above, "good engineering judgement" was used to justify that collapse of the Turbine Building would not damage safe shutdown equipment in the basement of the Turbine Building.

2.3 Reason for the Proposed Change

Dominion Energy Virginia identified that the existing design basis calculation for the Turbine Building considers a maximum tornado wind speed of 300 mph versus the 360 mph tornado wind speed stated in the SPS UFSAR [1]. Engineering judgement was cited by the Architect/Engineer as the basis for assuring protection of safe shutdown equipment in the basement of the Turbine Building, as assumed in the design basis calculation, under the loads due to the 300 mph maximum tornado wind speed. Since the time of original licensing, it was recognized that certain components located in the basement of the Turbine Building are non-isolable water sources, which, if damaged, could flood other safe shutdown components located in the adjacent Tornado Criterion "T" Emergency Switchgear Room, which is a part of the Service Building. Technical justification is needed to demonstrate that the Turbine Building, evaluated under a different methodology and acceptance criteria than other tornado Criterion "T" structures, can provide adequate tornado protection and be qualified as a tornado-resistant structure. Therefore, further analysis was needed to confirm that under maximum tornado wind loads, the Turbine Building continues to provide protection to the safe shutdown and non-isolable water source components located in the basement of the Turbine Building and will not adversely impact the adjacent tornado-resistant Service Building Control House.

2.4 Description of the Proposed Change

The proposed change replaces the existing Tornado Criterion "N/A" classification for the Turbine Building in SPS UFSAR, Table 15.2-1, with a new Tornado Criterion "T+" classification, which indicates that the Turbine Building is a tornado-resistant structure, evaluated under a different methodology and acceptance criteria than those considered for the other Tornado Criterion "T" structures. The new methodology and acceptance criteria, proposed for evaluation of the Turbine Building, include the use of a 250 mph maximum tornado wind speed and nonlinear static finite element analysis methodology and acceptance criteria for evaluation of the TBSS. The analysis demonstrates that during a tornado, partial building collapse of the TBSS is expected above the operating deck elevation; however, the operating and mezzanine decks will remain stable such that the Turbine Building continues to provide tornado protection for safe shutdown and non-isolable water source components located in the basement of the Turbine Building and does not damage the adjacent tornado-resistant Service Building Control House.

The maximum tornado wind speed of 250 mph is supported by results from recent studies on design tornado wind speeds; specifically, studies documented in NUREG/CR-4461, Rev. 2 [2], which informed Regulatory Guide (RG) 1.76, Rev. 1 [3]. These studies propose a maximum tornado wind speed of 200 mph for SPS corresponding to an annual tornado exceedance probability of 10^{-7}, which was the basis for the 360 mph tornado wind speed in RG 1.76, Rev. 0 [5] that was developed using the limited tornado data available at the time of its publication. Therefore, the basis for reducing the maximum wind speed from 360 mph to 250 mph for purposes of affirming the design of one structure at SPS is justified. The proposed maximum tornado wind speed includes margins above what would be the recommended tornado wind speed for the design of a new facility using the latest regulatory guidance. Therefore, a 250 mph maximum tornado wind speed will preserve the design margin and assure acceptable levels of protection for the health and safety of the public. The applied margin also envelopes ongoing activities by the National Institute of Standards and Technology (NIST) to develop new tornado hazard maps [4], as recognized by the NRC in their periodic review [6] of RG 1.76, Rev. 1 [3].

The new structural analysis for the TBSS, under the reduced tornado wind speed, uses a state-of-the-art, nonlinear, finite element modeling approach for determining the limit state capacity of a steel structure in accordance with acceptance criteria that satisfy applicable industry codes. The nonlinear analysis evaluates the stability of the operating and mezzanine decks of the TBSS such that no damage would occur to the safe shutdown and non-isolable water source components located in the basement of the Turbine Building. Standard building codes typically limit structural behavior within the linear elastic range and would therefore not be able to capture the nonlinear behavior or predict partial building collapse of the TBSS under such a severe environmental loading condition. Results from the new structural analysis, under the loads due to a 250 mph maximum tornado wind speed, confirm that the TBSS, as currently designed and configured, provides an acceptable level of protection for the safe shutdown and non-isolable water source components located in the basement of the Turbine Building and will not damage the adjacent tornado-resistant Service Building.

3 TECHNICAL EVALUATION

3.1 Basis for the Maximum Tornado Wind Speed of 250 mph

The proposed License Amendment Request (LAR) changes the tornado classification of the Turbine Building to a tornado-resistant structure using a different analytical methodology and acceptance criteria than those used for the other SPS tornado-resistant structures. Results based on the new analytical methodology and acceptance criteria demonstrate that the Turbine Building continues to protect safe shutdown and non-isolable water source components located in the basement of the Turbine Building and will not damage the adjacent tornado-resistant Service Building under a 250 mph maximum tornado wind speed. The proposed maximum tornado wind speed of 250 mph is supported by recent research documented in NUREG/CR-4461, Rev. 2 [2] - used as a reference for RG 1.76, Rev. 1 [3] - as well as the latest research by NIST [4] in the development of the new tornado risk maps, which are currently under consideration for adoption into ASCE 7-22, "Minimum Design Loads and Associated Criteria for Buildings and Other Structures." The proposed change in methodology and acceptance criteria does not aim to adopt tornado design requirements from RG 1.76, Rev. 1 [3]. Instead, RG 1.76, Rev. 1 [3] and the other pertinent sources of tornado wind research were used as the basis of comparison to justify the use of a 250 mph maximum tornado wind speed for the design of the Turbine Building in lieu of the 360 mph maximum tornado wind speed used for other tornado-resistant structures (i.e., Tornado Criterion "T" structures), as described in the SPS UFSAR.

NUREG/CR-4461, Rev. 2 [2] used a tornado database that includes information recorded from more than 46,800 tornado segments occurring from January 1, 1950 through August 31, 2003. NUREG/CR-4461, Rev. 2 [2] is also the basis for tornado wind design characteristics (including tornado wind speed and tornado intensity regions) presented in NRC RG 1.76, Rev. 1 [3]. Following the guidance per NUREG/CR-4461, Rev. 2 [2], a tornado wind speed of 200 mph would be recommended for Region 2, where SPS is located, corresponding to an annual exceedance probability of 1.0×10^{-7}(see Table 1). Since this research is the basis for RG 1.76, Rev. 1 [3] , that guidance would make the same recommendation in terms of the design tornado wind speed.

Table 8-1. Recommended Tornado Design Wind Speeds

	Wind Speed (mph)		
Design Probability (yr^{-1})	Region 1	Region 2	Region 3
1.0×10^{-5}	160	140	100
1.0×10^{-6}	200	170	130
1.0×10^{-7}	230	200	160

Table 1 - Excerpt from NUREG/CR-4461, Rev. 2

As noted in NRC's periodic review of RG 1.76 [6], it is recognized that there are various industry reviews in progress to assess the methodology for defining tornado risk, and that some ongoing activities may result in identification of technical and regulatory issues that may necessitate future updates to RG 1.76, Rev. 1 [3] to account for treatment of tornados. Specifically mentioned in [6] is research by NIST to develop new tornado hazard maps for the United States [4]. Results from the recent NIST research [4] in developing the updated tornado hazard maps were reviewed for their potential impact to RG 1.76, Rev. 1 [3]. Per [4], these new risk maps are being considered for adoption into ASCE 7-22.

Based on RG 1.76, Rev. 1 [3], the current recommended tornado design wind speed for SPS (i.e., Region II) is 200 mph. However, a maximum tornado wind speed of 250 mph was chosen to provide margin in light of the potential changes to the tornado hazard maps based on the recent NIST research [4]. Using the latest NIST hazard risk map for a 100,000 square foot effective plan area [4], it is evident that a 250 mph tornado wind speed bounds the updated NIST results for a 10,000,000-year return period.

3.2 Treatment of Tornado Missiles for Analysis of the TBSS

SPS UFSAR, Section 15.2.3, provides the following structural design criteria, "*The design assumes maximum wind forces and partial vacuum to occur simultaneously with the impact of either of the missiles singly.*" However, this structural design criteria specifically relates to Tornado Criterion "T" structures, which are designed not to fail during the design tornado as defined in SPS UFSAR, Table 15.2-1. However, SPS UFSAR, Table 15.2-1, does not designate the Turbine Building as a tornado-resistant (i.e., tornado Criterion "T") structure. Therefore, based on review of the SPS Specification and design basis calculation, the scope of the note alongside Table 15.2-1 for the Turbine Building applies only to tornado winds.

If the effect of tornado missiles were to be combined with tornado wind loads, they will not lead to global collapse of the Turbine Building or adverse impact on the safe shutdown and non-isolable water source components in the basement of the Turbine Building and the adjacent Service Building for the following reasons: 1) TBSS has many redundant members such that local damage from a single impact of the typical wooden telephone pole tornado missile would not initiate progressive collapse of the TBSS leading to global instability of the operating and mezzanine decks (note that SPS Specification determined the 1-ton automobile type missile was not limiting with respect to the telephone pole type missile); and 2) any secondary missiles created by local damage due to the above-described wooden telephone pole at the operating deck would be intercepted by the mezzanine deck, which would prevent the telephone pole and any secondary missiles from damaging safe shutdown and non-isolable water source components in the basement of the Turbine Building. In certain locations of the mezzanine deck, the presence of 2-foot-thick reinforced concrete slabs provide adequate physical protection against the local effects (i.e., penetration) from tornado missiles to safe shutdown and non-isolable water source components located in the basement of the Turbine Building. In other areas of the Turbine Building basement where no physical tornado missile protection can be provided, potential adverse effects from tornado missile strikes to the safe shutdown and non-isolable water source components have been evaluated by the Tornado Missile Risk Evaluator (TMRE) methodology and determined to be acceptable. Therefore, qualitative deterministic and quantitative probabilistic justifications have been provided for analytically uncoupling tornado missile effects from tornado wind loads.

3.3 TBSS Analysis

Using the tornado wind speed of 250 mph that was discussed in Section 3.1, a three-dimensional (3-D) nonlinear finite element modeling approach was employed to evaluate structural performance of the TBSS under the applied tornado wind load. The 3-D finite element model included realistic member stiffnesses, material plasticity, and P-Delta (large deflection) effects. Design basis tornado wind loads, deadweight, and live loads due to the impact of falling roof members were applied.

Results of the nonlinear finite element analysis demonstrate that the safe shutdown and non-isolable water source components located in the basement of the Turbine Building, as well as the adjacent safety-related Service Building, will not be damaged if the Turbine Building is subjected to loads from a 250 mph maximum tornado wind speed applied in any of the four (4) cardinal directions. The analysis predicted a roof-collapse scenario in which the roof structure was collapsing due to the yielding of the upper portion of the columns at the operating deck elevation. The analysis conservatively assumed that the entire roof steel structure collapses, simultaneously, on top of the operating deck concrete slab. The analysis demonstrated that the remaining TBSS, including the operating and mezzanine decks, was stable and would provide adequate protection to the safe shutdown and non-isolable water source components located in the basement of the Turbine Building, and that the partial collapse of the TBSS roof structure would not damage adjacent, Criterion "T" structures and the safe shutdown equipment housed therein.

3.3.1 Method of Analysis

3.3.1.1 Roof Structure Collapse Scenario

The SPS TBSS consists of a steel frame with various concrete slabs. The roof structure portion of the steel frame above the operating floor at elevation 58'-6" is largely unsupported laterally. Preliminary evaluations indicate that because these steel members are directly exposed to the tornado winds and are significantly more flexible than the rest of the structure, buckling may occur in many of the members. As a result, this evaluation concluded that the TBSS roof structure would collapse during the postulated tornado wind event.

The roof collapse scenario consists of the roof structure folding over due to yielding of the upper columns where they connect to the operating floor at the 58'-6" elevation. The impact of the falling roof structure onto the operating deck slab is conservatively accounted for by adding a distributed weight across the operating floor with a dynamic load factor of two (2) applied to the entire roof structure dead weight. This methodology is intended to capture the global effects of the entire weight of the steel roof structure and both overhead cranes falling onto the operating floor.

Collapse of the TBSS roof structure does not directly impact the safe shutdown and non-isolable water source components located in the basement of the Turbine Building, since they are protected by the remaining portion of the TBSS. To account for the combined static and dynamic effects of the collapsed roof structure, the remaining portion of the TBSS was evaluated for wind loads from the maximum 250 mph tornado wind speed, as well as the live load, with dynamic amplification caused by the collapsing roof.

While the effect of the roof collapse on the Service Building was not explicitly evaluated, the safety-related equipment within the Tornado Criterion "T" Service Building is adequately protected from tornado loading. These structures are robustly designed to protect safety-related equipment from tornado loads including tornado missiles. Therefore, the falling steel members from the Turbine Building roof that may impact the Service Building will not damage any safety-related equipment housed within the Service Building Control House, due to their relatively low impact energies, when compared to the impact energy from SPS licensing basis tornado missiles.

3.3.1.2 Finite Element Modeling Approach

To evaluate the effect of tornado wind loads of 250 mph, a 3-D finite element model of the TBSS was developed using ANSYS, which is a general-purpose finite element program. The model includes the concrete and steel members that significantly contribute to the stiffness and structural stability of the Turbine Building. Steel beams and columns were modeled using 2-node, 3-D beam elements, while concrete elements were modeled using 3-node and 4-node shell elements. Steel and concrete connections were modeled using 3-D spring elements with translational and rotational degrees of freedom. A true-stress, true-strain curve for carbon steel was developed based on the method provided in Section VIII, Division 2 of the ASME Boiler and Pressure Vessel Code [11] and using the design basis ASTM A36 material strength and properties [12]. Realistic elastic stiffness was used for the reinforced concrete elements. Nonlinear static finite element analyses, including P-Delta effects, were performed to evaluate the structure under a 250 mph maximum tornado wind speed applied in any of the four (4) cardinal directions.

3.3.1.3 Applied Loads

Consistent with the approach stated in the SPS Specification, the analysis conservatively assumes siding failure above 150 mph to ensure that the following two (2) loading conditions have been verified: 1) loads due to the 150 mph wind that acts on the entire external building sail area (i.e., treating the siding as intact), and 2) loads from the 250 mph tornado wind that act on exposed structural steel members and equipment (i.e., treating the siding as removed from the building).

A preliminary analysis showed that the loads due to the 250 mph tornado wind case with siding removed is more limiting and bounds the loads from the 150 mph tornado wind case with the siding intact. The TBSS was only analyzed under the effect of the maximum tornado wind speed of 250 mph. Additionally, the loads due to the differential pressure do not apply because under tornado wind loads, all metal siding and roofing of the Turbine Building will come off and the Turbine Building will be vented.

Based on the equation in Section 15.2.3 of the SPS UFSAR [1], the maximum tornado wind speed of 250 mph corresponds to a nominal wind pressure of 160 pounds per square foot (psf). Using the nominal wind pressure of 160 psf and applicable drag coefficients from ASCE 3269 [13], the wind forces on steel and reinforced concrete members (including the concrete curbs surrounding the concrete slabs on the mezzanine floor) are estimated and applied to the members based on their exposed area. Additionally, large pieces of equipment on the operating and mezzanine floors, including feedwater heaters, flash evaporators, and moisture separators are conservatively assumed to stay attached to supporting steel members on the operating and mezzanine floors and therefore contribute to the sail area. The resulting wind loads were applied to the steel members which support the equipment. Appropriate drag coefficients were determined based on the size and shape of the equipment and were considered in their applied wind load calculations. The shielding provided by the turbine pedestals and condensers, as well as from the major steel girders exposed to the wind, was accounted for in the analysis.

In addition to the tornado wind loads, equipment dead load from the moisture separators located on the operating floor and the flash evaporators located on the mezzanine platform was applied to the structural steel members supporting the equipment. The flash evaporators transfer lateral wind load reactions to the mezzanine deck framing. These large pieces of equipment are conservatively assumed to stay intact during a tornado wind event and thus contribute to the applied dead and wind loads to the structure.

Tornado wind loads and equipment dead loads are combined with the roof collapse load. As discussed in Section 0, the steel members above the operating floor and the two (2) Turbine Building overhead cranes that are located just below the roof and supported by columns and girders around the perimeter of the building are conservatively assumed to fall on top of the operating floor in a postulated roof collapse scenario. The total weight of the steel above the operating floor is 1,960 kip, and the total weight of both cranes is 841.2 kip, resulting in a total weight of the falling members of 2801.2 kip. A dynamic load factor (DLF) of 2.0 was applied to this total weight to account for dynamic effects of the roof collapse resulting in an applied weight of 5602.4 kip. This weight is distributed to the operating floor concrete slab and the steel members supporting grating on the operating floor based on the area of each region.

3.3.1.4 Acceptance Criteria

The acceptance criteria requires that the SPS Turbine Building mezzanine and operating decks remain stable under a 250 mph tornado wind speed. For the purpose of this assessment, collapse is precluded if the following criteria are satisfied:

- The steel superstructure is considered to remain stable and not collapse if the lateral drift of the operating floor is less than 1% of the operating floor height (i.e., vertical distance of the operating floor from the basement).
- The following acceptance criteria are used to evaluate steel members of the Turbine Building:
  - To ensure members are within their ultimate strength design limit, the maximum tensile stresses from the model are used to calculate the strain in the beams. This strain is compared to the minimum elongation of carbon steel to evaluate the margin to failure.
  - Geometric nonlinearities due to large deflection and P-Delta effects and plasticity are also included in the model. As such, failure due to buckling is included in the analysis.
- Composite reinforced concrete stress is limited to the concrete compressive strength to ensure that the slab remains intact. Slab shear stresses are also evaluated to ensure the slab has sufficient shear capacity.
- Connections were evaluated against criteria in AISC 6th and 7th Editions [8] [9] (for evaluation of bolts), and AISC 15th Edition [10] (for evaluation of coped-members' connections) to ensure they remain intact.

3.3.2 Results of Structural Analysis

3.3.2.1 Building Stability

Based on the analysis results, the maximum lateral drift ratio of the operating floor slab (elevation 58'-6") was found to be smaller than the acceptable drift ratio (i.e., the ratio of the lateral displacement of the operating floor to the vertical distance from the operating floor to the basement) of 1% (i.e., 0.70% for the East wind and even smaller for other wind directions.) Therefore, the TBSS is demonstrated to remain stable and not collapse under a 250 mph maximum tornado wind speed. The analytical techniques utilized in this analysis also demonstrate the lateral stability of each member, since plasticity and P-Delta effects are included.

3.3.2.2 Steel Member Stability

The maximum combined true tensile stress (i.e., axial plus bending) in steel beams was estimated to be 59.6 ksi (note that this is the true stress and shall not be compared directly to the material ultimate strength, which is provided in terms of engineering stress). This maximum stress is equivalent to a true strain of approximately 0.097 in/in using the stress-strain curve for A36 carbon steel that is developed based on the guidance from Ref. [11]. The minimum elongation of ASTM A36 is 0.20 in/in [12]. Therefore, the maximum strain ratio (actual/allowable) for the steel tensile stress is 0.485 and thus acceptable.

Steel member buckling is considered in the analysis by applying P-Delta effects; therefore, the combined compressive stresses are shown to be acceptable through model convergence of the equations of static equilibrium. From the analysis results, the maximum stresses in the Turbine Building columns for the limiting case (East wind) were found to be smaller than their ultimate strength design limit, and thus acceptable.

3.3.2.3 Concrete Evaluation

The equivalent membrane plus bending stress in concrete elements for the limiting case (East wind) is below the compressive strength with a stress ratio of 0.79. The analysis showed the maximum stress is highly localized and does not persist through the thickness of the shell. Additionally, the analysis results indicated the maximum shear stresses exceed the shear capacity of the concrete alone only at highly localized areas on the operating floor. These localized exceedances will not cause gross failure of the concrete floor since any excessive load would be redistributed into the more ductile rebar and surrounding steel.

3.3.2.4 Joint Stress Evaluation

The joints that connect beams to columns and other beams were separately evaluated in detail. The beam-to-beam joints in the model consist primarily of web-to-web I-beam joints and web-to-flange I-beam joints that were conservatively treated as doubly coped connections, and the coped beam segment is subject to reaction forces extracted from the finite element model. These connections were evaluated according to the guidance provided in Ref. [10] for doubly-coped connecting elements and accounting for the combined effects of bending moment, shear, and axial forces. Additionally, bolt tensile and shear strengths, as well as their interaction, were evaluated using Ref. [8] and Ref. [9]. Results of the evaluation indicate the maximum interaction ratio from the coped section, bolt shear, and bolt tension analysis to be 0.96, 0.78, and 0.58, respectively, under the effect of the limiting wind load (East wind). Therefore, all joints are concluded to be acceptable.

Results from analysis of the TBSS under the 250 mph tornado wind speed conclude that the acceptance criteria in Section 3.2.1.4 are met, and, thus, the operating and mezzanine decks will remain stable. Therefore, the Turbine Building poses no damage to safe shutdown and non-isolable water source components located in the basement of the Turbine Building under tornado wind loads and will not adversely affect adjacent Tornado Criterion "T" structures (i.e., Service Building Control House).

4 REGULATORY EVALUATION

The proposed LAR changes the tornado classification of the Turbine Building to a tornado-resistant structure under a different methodology and acceptance criteria than those stated for the other SPS tornado-resistant structures to justify that the Turbine Building continues to protect safe shutdown and non-isolable water source components located in the basement of the Turbine Building and will not damage the adjacent tornado-resistant Service Building under tornado wind loads. The following regulatory requirements have been reviewed and a No Significant Hazards Consideration Determination has been performed as discussed below.

4.1 Applicable Regulatory Requirements/Criteria

10 CFR Requirements/ General Design Criteria (GDC): General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," of 10 CFR 50, Appendix A requires that structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as tornadoes without loss of capability to perform their safety functions. GDC 2 also requires that the design bases for these structures, systems, and components shall reflect: (1) appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area, with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated, (2) appropriate combinations of the effects of normal and accident conditions with the effects of the natural phenomena, and (3) the importance of the safety functions to be performed.

In addition, GDC 4 states, in part, that "Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. These structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles... that may result from equipment failures and from events and conditions outside the nuclear power unit."

The GDC included in Appendix A to 10 CFR Part 50 did not become effective until May 21, 1971. The Construction Permit for SPS Units 1 and 2 was issued prior to May 21, 1971; consequently, SPS was not subject to GDC requirements [14]. Additionally, the Turbine Building is not a tornado Criterion "T" structure according to the SPS UFSAR. However, SPS UFSAR Section 1.4.2, "Performance Standards," and Section 1.4.40, "Missile Protection," meet the intent of GDC 2 and GDC 4, respectively. The Turbine Building meets the intent of GDC 2, in general, because partial collapse of the Turbine Building under the effects of the tornado wind will not damage any tornado-resistant structures or components. The Turbine Building also meets the intent of GDC 4, in general, because safe shutdown and non-isolable water source components in the Turbine Building basement are either physically protected by 2-foot-thick reinforced concrete slabs against tornado missile effects or the levels of the risk due to tornado missile impacts are acceptable based on TMRE methodology. Therefore, the Turbine

Building meets the requirements of SPS UFSAR Sections 1.4.2 and 1.4.40, that are generally consistent with the intent of GDC 2 and GDC 4, respectively.

RG 1.76, "Design Basis Tornado for Nuclear Power Plants," Rev. 0 [5], published in April 1974, describes three (3) tornado regions within the contiguous United States and describes a design basis tornado acceptable to the regulatory staff for each of the three regions to meet the intent of GDC 2 and GDC 100 of 10 CFR 50, Appendix A. Tornado regions and the maximum tornado wind speed for each region in RG 1.76, Rev. 0 [5] are adopted from the WASH-1300 study [7] by the U.S. Atomic Energy Commission. SPS is in Region I of the tornado intensity regions map with a maximum tornado wind speed of 360 mph according to RG 1.76, Rev. 0 [5]. The tornado wind speed of 360 mph is consistent with the existing licensing basis tornado for the Turbine Building. However, WASH-1300 [7] and thus RG 1.76, Rev. 0 [5] tornado design wind speeds were based on limited meteorological data from 1971 and 1972 available at the time of issuance of the study. Therefore, as discussed above, the proposed LAR changes the maximum tornado wind speed from 360 mph to 250 mph based on results from more recent reports that used more comprehensive data.

NUREG/CR-4461, "Tornado Climatology of the Contiguous United States," Rev. 2 [2], published in February 2007, provided maps that show distribution of tornado events and design wind speeds based on characteristics of tornadoes reported in the contiguous United States from January 1950 through August 2003. According to this report, SPS is in Region 2 with the design basis tornado wind speed of 200 mph. Results from this report are used to justify the reduction of the maximum tornado wind speed for the Turbine Building from 360 mph to 250 mph.

RG 1.76, "Design Basis Tornado for Nuclear Power Plants," Rev. 1 [3], provides updated design basis tornado wind speeds based on Rev. 2 of NUREG/CR-4461 [2]. Consistent with NUREG/CR-446, Rev. 2 [2], the Turbine Building is in Region II and has a maximum design basis tornado wind speed of 200 mph (Reference Figure 1 and Table 1 of RG 1.76, Rev. 1 [3]). Results from this report are used to justify the reduction of the design basis tornado wind speed for the Turbine Building from 360 mph to 250 mph.

4.2 No Significant Hazards Consideration Determination Analysis

Virginia Electric and Power Company (Dominion Energy Virginia) requests an amendment to the Surry Power Station (SPS) Units 1 and 2 Subsequent Renewed Operating Licenses DPR-32 and DPR-37, respectively. The proposed LAR changes the existing Tornado Criterion of the Turbine Building to indicate that the Turbine Building is a tornado-resistant structure, evaluated under a different methodology and acceptance criteria, for providing protection to the safe shutdown and non-isolable water source components located in the basement of the Turbine Building without adversely impacting the adjacent tornado-resistant Service Building under the maximum postulated tornado wind loads.

Dominion Energy Virginia has evaluated the proposed change using the criteria in 10 CFR 50.92 and determined that the proposed change does not involve a significant hazards consideration. The following information is provided to support a finding of no significant hazards:

1. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No

   The proposed LAR changes the tornado classification of the Turbine Building to indicate that the Turbine Building is a tornado resistant structure, evaluated under a new methodology and acceptance criteria. The new methodology and acceptance criteria include consideration of the maximum tornado wind speed of 250 mph for evaluation of the Turbine Building, and the use of nonlinear static finite element analysis methodology and acceptance criteria.

   The existing maximum tornado wind speed of 360 mph corresponds to an annual exceedance probability of 10^{-7} based on older tornado data that were used in WASH-1300 [7] and RG 1.76, Rev. 0 [5]. The same annual exceedance probability of 10^{-7} for the design basis tornado corresponds to a 200 mph tornado wind speed based on the more recent tornado data that were used in the development of NUREG/CR-4461, Rev. 2 [2], and RG 1.76, Rev. 1 [3]. Therefore, the annual exceedance probability of the proposed 250 mph maximum tornado wind speed is smaller than 10^{-7}. The nonlinear analysis methodology that was used for evaluation of the TBSS provides a realistic representation of material and member behavior and is checked against acceptance criteria from applicable industry code requirements. Under the proposed change, the design functions of the SPS Turbine Building are not changed. The operating deck and mezzanine floor of the Turbine Building remain stable, and no damage will occur to safe shutdown and non-isolable water source components in the basement of the Turbine Building or the adjacent Tornado Criterion "T" structure (i.e., Service Building Control House). The proposed change does not implement plant physical changes or result in plant operation in a configuration outside the plant safety analyses or design basis.

   Therefore, the proposed change does not involve a significant increase in the probability or consequences of any accidents previously evaluated.

2. Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

   Response: No

   The proposed LAR changes the tornado classification of the Turbine Building to indicate that the Turbine Building is a tornado resistant structure, evaluated under a new methodology and acceptance criteria. The new methodology and acceptance criteria include consideration of the maximum tornado wind speed of 250 mph for evaluation of the Turbine Building, and the use of nonlinear static finite element analysis methodology and acceptance criteria.

The proposed LAR does not alter the ability of the Turbine Building to perform its intended design function. Under the loads from the proposed maximum tornado wind speed, the TBSS will not jeopardize safe shutdown and non-isolable water source components located in the basement of the Turbine Building to perform their design function and will not adversely impact the adjacent Tornado Criterion "T" structure (i.e., Service Building Control House). As a result of the proposed LAR, no new effects on existing equipment are created nor are any new malfunctions introduced. Furthermore, the proposed change does not implement plant physical changes or result in plant operation in a configuration outside the plant safety analyses or design basis.

Therefore, based on the above evaluation, the proposed change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. <u>Does the proposed change involve a significant reduction in a margin of safety?</u>

   Response: No

   The proposed LAR changes the tornado classification of the Turbine Building to indicate that the Turbine Building is a tornado resistant structure, evaluated under a new methodology and acceptance criteria. The new methodology and acceptance criteria include consideration of the maximum tornado wind speed of 250 mph for evaluation of the Turbine Building, and the use of nonlinear static finite element analysis methodology and acceptance criteria.

   The proposed reduction in the maximum tornado wind speed from 360 mph to 250 mph does not correspond to an increase in the probability of occurrence of the design basis tornado and the original annual exceedance probability of 10^{-7} is still met. The nonlinear analysis methodology that was used for evaluation of the TBSS provides actual representation of material and member behavior and is checked against acceptance criteria from applicable industry requirements to assure building stability. Therefore, no significant safety margin will be lost because of the combined effects from the reduction in the design basis tornado wind speed and the use of nonlinear analysis methodology for evaluation of the TBSS.

   Therefore, the proposed change does not involve a significant reduction in a margin of safety.

Based upon the above, Dominion Energy Virginia concludes that the proposed amendment presents no significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and, accordingly, a finding of "no significant hazards consideration" is justified.

5 ENVIRONMENTAL CONSIDERATION

The proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9) as follows:

(i) The proposed change involves no significant hazards consideration.

As described in Section 4.2 above, the proposed change involves no significant hazards consideration.

(ii) There are no significant changes in the types or significant increase in the amounts of any effluents that may be released off-site.

The proposed LAR does not alter the design function or operation of any plant structure, system, or component. The Turbine Building will continue to meet its specific structural performance criteria such that it poses no threat to the safe shutdown and non-isolable water source components located in the basement of the Turbine Building due to the tornado wind load and will not adversely affect adjacent Tornado Criterion "T" structure (i.e., Service Building Control House). As such, the proposed change does not involve the installation or modification of any new equipment that may affect the types or amounts of effluents that may be released off-site. The proposed change will have no impact on normal plant releases and will not increase the predicted radiological consequences of accidents postulated in the UFSAR. Therefore, there are no significant changes in the types or significant increase in the amounts of any effluents that may be released off-site.

(iii) There is no significant increase in individual or cumulative occupational radiation exposure.

The proposed change does not implement plant physical changes or result in plant operation in a configuration outside the plant safety analyses or design basis. Furthermore, the Turbine Building will continue to meet its specific structural performance criteria such that it poses no threat to the safe shutdown and non-isolable water source components located in the basement of the Turbine Building due to the tornado wind load and will not adversely impact the adjacent Tornado Criterion "T" structure (i.e., Service Building Control House).

Based on the above, Dominion Energy Virginia concludes that, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

6 CONCLUSION

The proposed LAR replaces the existing Tornado Criterion "N/A" classification for the Turbine Building, in SPS UFSAR, Table 15.2-1, with a new Tornado Criterion "T+" classification, which indicates that the Turbine Building is a tornado-resistant structure, evaluated under a different methodology and acceptance criteria than those stated for the other Tornado Criterion "T" structures, for providing protection to the safe shutdown and non-isolable water source components, located in the basement of the Turbine Building, without adversely impacting the adjacent tornado Criterion "T" Service Building Control House. The new methodology and acceptance criteria, employed for evaluation of the TBSS, include the use of 250 mph tornado wind speed and nonlinear static finite element analysis methodology.

The reduction in the maximum tornado wind speed for evaluation of the TBSS from 360 mph to 250 mph is based on the more recent data used in the development of NUREG/CR-4461, Rev. 2 [2], RG 1.76, Rev. 1 [3], and the latest research by NIST [4], and provides margin for potential changes and conservatism. The proposed change will not result in plant operation in a configuration outside the current design basis and does not affect the safety analyses. The structural integrity of the Turbine Building under the loads due to the maximum tornado wind speed will be met under the proposed change and no damage will occur due to the tornado wind load to safe shutdown and non-isolable water source components located in the basement of the Turbine Building nor to the adjacent Tornado Criterion "T" structure (i.e., Service Building Control House) and safe shutdown components housed therein.

Therefore, Dominion Energy Virginia concludes, based on the considerations discussed herein, that (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

7 REFERENCES

[1] Surry Power Station UFSAR, Revision 53.01, Chapter 15: Structures and Construction.

[2] U.S. NRC, NUREG/CR-4461, Revision 2, "Tornado Climatology of the Contiguous United States," February 2007 (ML070810400).

[3] U.S. NRC, Regulatory Guide 1.76, Revision 1, "Design Basis Tornado for Nuclear Power Plants," March 2007 (ML070360253).

[4] National Institute of Standards and Technology (NIST), "New Tornado Risk Maps for Engineering Design," by Marc Levitan, Presented in 33rd Regulatory Information Conference (RIC), Technical Session – T11, Evolution of External Hazard Risks for U.S. Plants, Tuesday March 9, 2021.

[5] U.S. NRC, Regulatory Guide 1.76, Revision 0, "Design Basis Tornado for Nuclear Power Plants," April 1974 (ML003740273).

[6] U.S. NRC, Memorandum to Brian E. Thomas (NRR) from Scott C. Flanders (Office of New Reactors) dated August 15, 2016, "Results of Periodic Review of Regulatory Guide 1.76" (ML16208A347).

[7] WASH-1300, Technical Basis for Interim Regional Tornado Criteria, U.S. Atomic Energy Commission, May 1974, U.S. Atomic Energy Commission (ML13073A158).

[8] AISC, "Manual of Steel Construction," 6th Edition.

[9] AISC, "Manual of Steel Construction," 7th Edition.

[10] AISC "Manual of Steel Construction," 15th Edition.

[11] ASME Boiler and Pressure Vessel Code, Section VIII, Division 2, 2010 Edition.

[12] ASTM A36, "Standard Specification for Carbon Structural Steel," 2004.

[13] ASCE Paper No. 3269, "Wind Forces on Structures," in ASCE Transactions Vol. 126, Part 2, 1961.

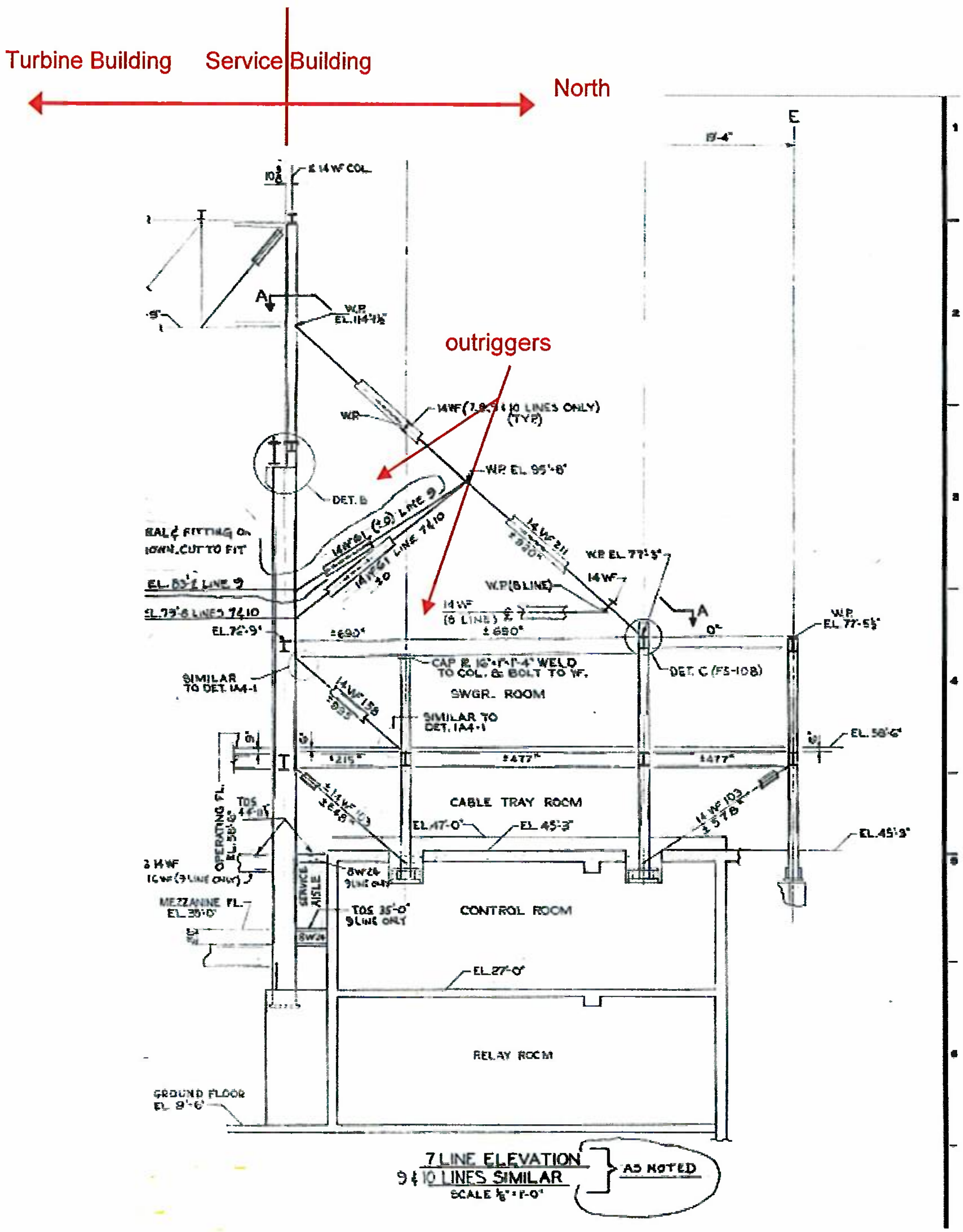
[14] NRC letter, "SECY-92-223 – Resolution of Deviations Identified During Systematic Evaluation Program," September 18, 1992 (ML12256B290).

Attachment 2

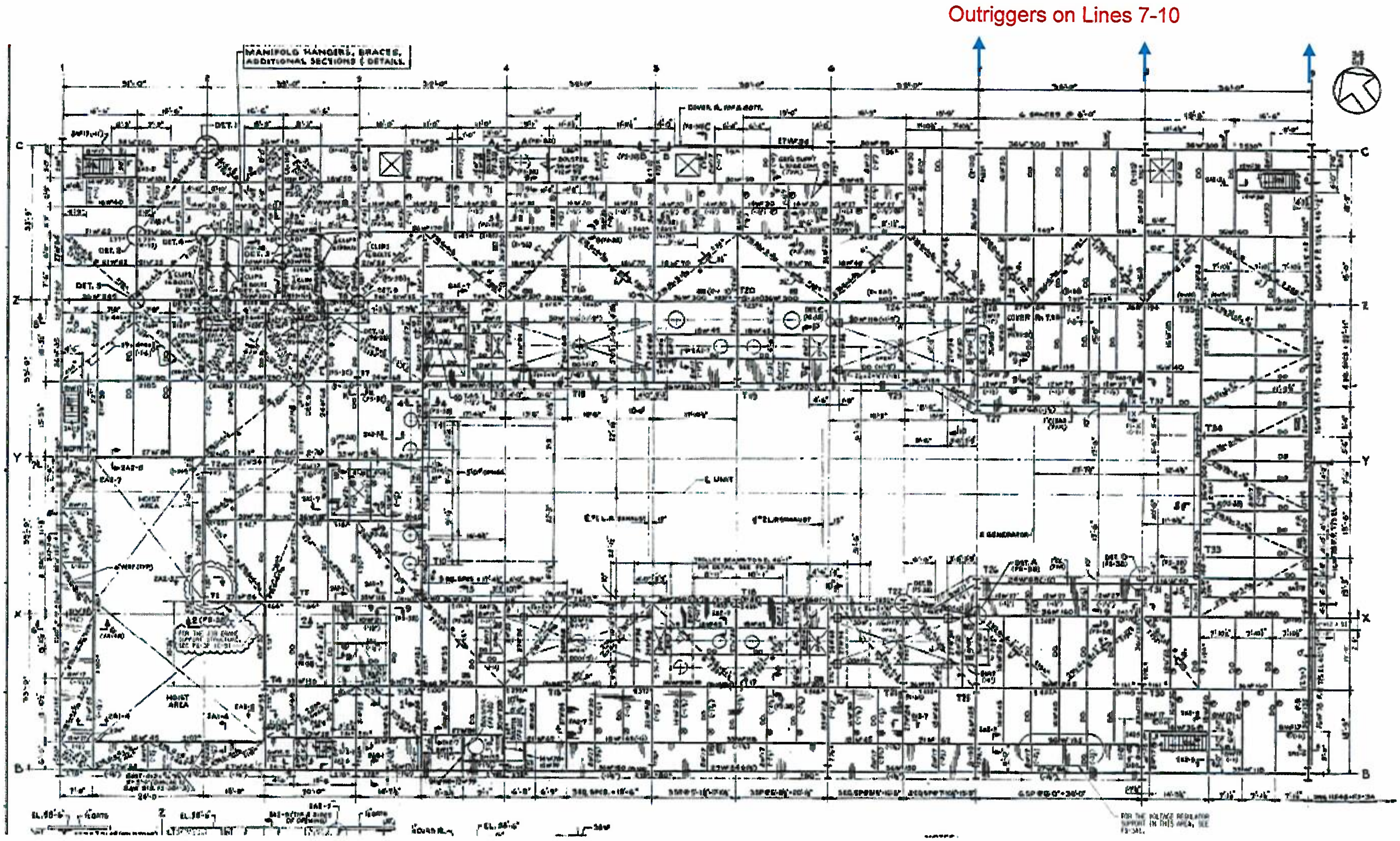
CONFIGURATION OF THE OUTRIGGERS TO THE SERVICE BUILDING

**Virginia Electric and Power Company
(Dominion Energy Virginia)
Surry Power Station Units 1 and 2**

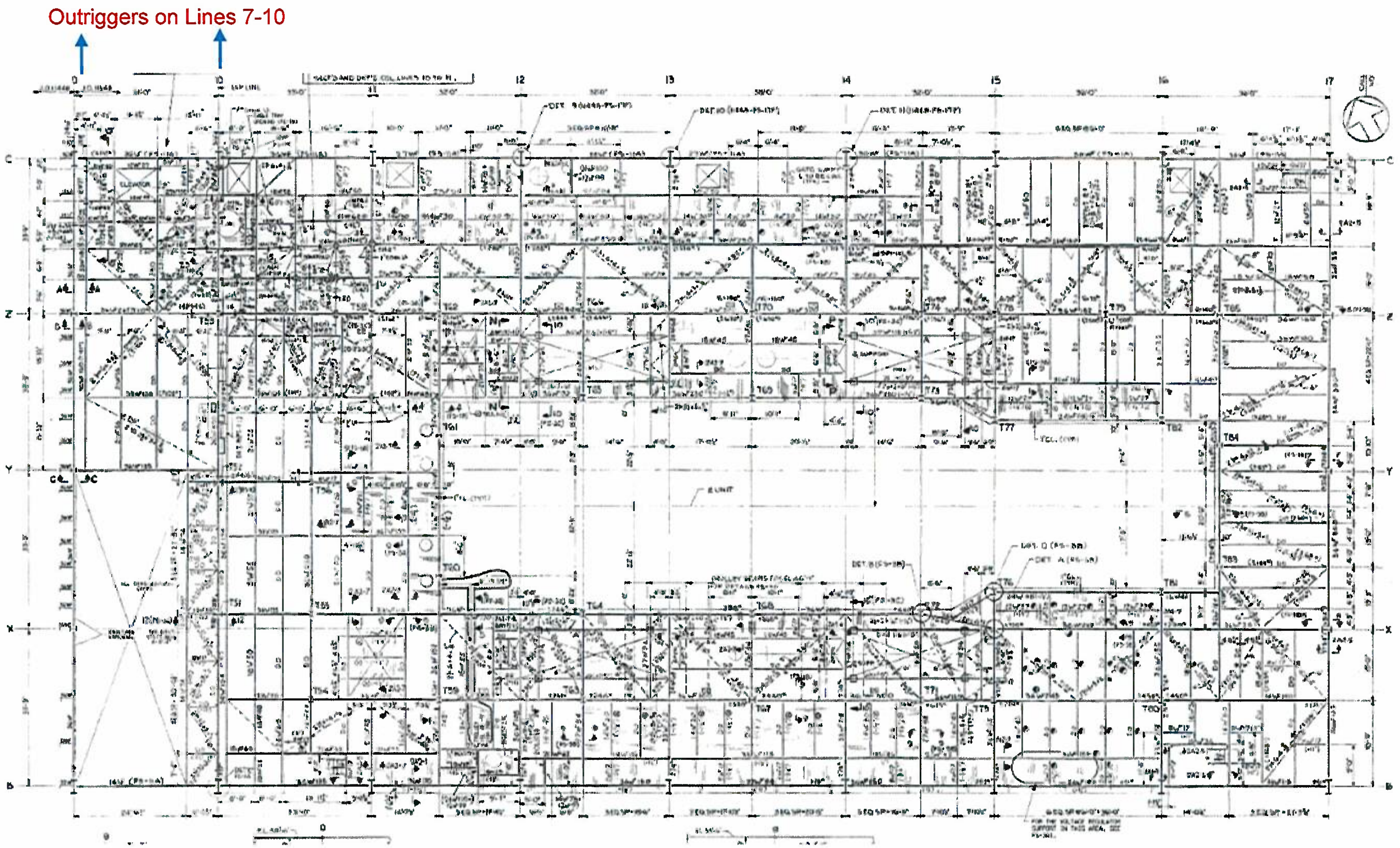
Configuration of the Outriggers to the Service Building



Elevation View of the Outriggers from the Turbine Building
to the Service Building Roof



Location of the Outriggers from the Turbine Building to the Service Building



Location of the Outriggers from the Turbine Building to the Service Building

Attachment 3

MARK-UP OF SPS UNITS 1 AND 2 UFSAR PLANNED CHANGES

Virginia Electric and Power Company
(Dominion Energy Virginia)
Surry Power Station Units 1 and 2

It is assumed that a tornado could generate either of the following potential missiles:

1. Missile equivalent to a wooden utility pole 40 feet long, 12-inch diameter, weighing 50 lb/ft^3 and traveling in a vertical or horizontal direction at 150 mph.
2. Missile equivalent to a 1-ton automobile traveling at 150 mph.

The design assumes maximum wind forces and partial vacuum to occur simultaneously with the impact of either of the missiles singly. Allowable stresses do not exceed 90% of the certified minimum yield strength of the steel, the capacity reduction factor given in Section 15.5.1.2 times the certified minimum yield strength of the reinforcing steel, and 75% of the ultimate strength of the concrete. The allowable stress limits of 0.9 Fy (steel superstructures) and 0.9 fy and 0.75 f'c (reinforced concrete structures) apply to stresses from the overall structural response due to tornado load effects. These stresses are located away from the tornado missile impact zone and outside any yield-line patterns that may develop during the tornado missile impact.

It is noted that the physical configuration of certain plant components does not provide complete physical protection against tornado-generated missiles. The vulnerable surface area for each component was assessed probabilistically using the Tornado Missile Risk Evaluator Methodology (Reference 12) and it was determined that the risk to the plant is acceptably low, such that the additional missile protection need not be provided. Refer to Table 15.2-1 for identification of these components.

15.2.4 Seismic Design

Class I structures, systems, and components designed to resist seismic forces are listed in Table 15.2-1. The design is based on two separate seismic criteria: the operating-basis earthquake (OBE) and the design-basis earthquake (DBE), as described in Section 2.5.

The seismic analysis of Class I structures, such as the containment structure, auxiliary building, fuel building, service building (including the control room), and safeguard areas, was based on the modal analysis response spectra technique. Major equipment-supporting structures, such as steam generator supports, reactor coolant pump supports, and pressurizer supports, were treated in an identical manner. Acceleration response spectra for the OBE and DBE are given on Figures 2.5-5 and 2.5-6.

Seismic loading includes the horizontal or vertical responses acceleration or combinations of both where the effects, as measured by the separate acceleration components, of horizontal and vertical accelerations are combined to produce maximum stress intensities, taking into account any potential adverse effect due to phase of the separate accelerations.

Damping factors for the structures, systems, and components are given in Table 15.2-2.

The design of the containment structures is based on ultimate strength design and loading factors as described in Section 15.5.1.2. Maximum allowable stress levels for both the

See INSERT on following page.

INSERT - SPS UFSAR Page 15.2-4

The US NRC approved license amendment request [References 14 and 15] which validates an evaluation that demonstrates the Surry Power Station (SPS) Turbine Building (TB) structure is a tornado-resistant structure, evaluated under a different methodology and acceptance criteria than other Tornado Criterion "T" structures at SPS. The following bullet items help to distinguish the tornado evaluation of the SPS TB structure from other Tornado Criterion "T" structures at SPS.

- A nonlinear, static, finite element analysis methodology and associated acceptance criteria demonstrates that the TB is a tornado-resistant structure, which provides protection for safe shutdown and non-isolable components located in the basement of the TB during a tornado. Nonlinear material acceptance criteria are based on the applicable requirements of ASME Boiler and Pressure Vessel Code, Section VIII, Division 2, 2010 Edition and column stability is based on a 1% maximum drift ratio from ASCE 7-10. The evaluation demonstrates that during a tornado, partial building collapse of the TB structure is expected above the operating deck elevation, but the operating and mezzanine decks will remain stable. The stable operating and mezzanine decks of the TB provides tornado protection for safe shutdown and non-isolable water source components located below in the basement of the TB. Additionally, partial building collapse of the TB structure during a tornado will not damage any adjacent Tornado Criterion "T" structures or the protected components housed within.

- The maximum tornado wind speed for the TB is established as 250-mph, which is the sum of a 208-mph rotational component and a 42-mph translational component.

- Only local effects of tornado missiles (i.e., penetration) need to be considered for the design of the TB and the 2-foot thick, reinforced concrete slabs at the mezzanine deck elevation, which provide physical tornado missile protection for safe shutdown components located directly below.

- For other safe shutdown and non-isolable water source components located in the basement of the TB, where physical tornado missile protection cannot be provided, adequate tornado missile protection is demonstrated via the Tornado Missile Risk Evaluator (TMRE) methodology and designated by the Tornado Criterion "*P**" protection classification in SPS UFSAR, Table 15.2-1 (Ref. Revised TMRE & Notebook Analyses, Calculation No. TBD).

- Partial differential pressures will not develop during a tornado in a vented structure such as the TB.

15.2 REFERENCES

1. V. C. Gilberton and E. E. Mageanu, *Tornadoes, AIA Technical Reference Guide*, TRG 13-2, U. S. Weather Bureau.

2. T. W. Singell, *Wind Forces on Structures: Forces on Enclosed Structures, Journal of the Structural Division of the ASCE,* July 1958.

3. Deleted.

4. Letter, NRC to Vepco, Serial #85-885, dated December 4, 1985

5. ASME Boiler and Pressure Vessel Code, Section III, Division I, Code Case N-411, *Alternative Damping Values for Seismic Analysis of Piping Sections,* American Society of Mechanical Engineers, 345 E. 47th Street, New York, NY 10017, dated September 17, 1984.

6. NRC Bulletin No. 88-11: *Pressurizer Surge Line Thermal Stratification,* USNRC, December 20, 1988.

7. Virginia Power Letters Serial Nos. 89-006A dated May 3, 1989 and 89-006B dated November 13, 1989 to United States Nuclear Regulatory Commission.

8. *Revised report on the Reanalysis of Safety-Related Piping Systems - Surry Power Station, Unit 1*, August 1979, by Stone & Webster Engineering Corporation.

9. *Report on the I.E. Bulletin 79-14, Analysis for As-Built Safety-Related Piping Systems - Surry Power Station - Unit 2,* July 1981, by Ebasco Services, Inc.

10. *Report on the Reanalysis of Safety-Related Piping Systems - Surry Power Station - Unit 2,* Rev. 1, April 1980, by Ebasco Services, Inc.

11. Mitsubishi Heavy Industries, LTD., Design Report DG KCS-03-0008, *Dominion Generation, Surry Power Station Unit 2, Control Rod Drive Mechanism Design Report,* Rev. 3.

12. NEI 17-02, Rev. 1B, *Tornado Missile Risk Evaluator (TMRE),* September 2018, as implemented and approved at Shearon Harris Nuclear Power Plant (ML18347A385).

13. SWECO 7703, Missile-Barrier Interaction - A Topical Report, Stone & Webster Engineering Corporation, Boston, MA, September 1977

14. Letter from Virginia Electric and Power Company to USNRC dated 01/XX/22 (Serial No. 21-330), "Virginia Electric and Power Company, Surry Power Station Units 1 and 2, Request for NRC Approval of Methodology Change and Reclassification of the Turbine Building as a Tornado Resistant Structure."

15. Letter from the USNRC to Virginia Electric and Power Company dated XX/XX/XX, "Subject: Surry Power Station, Units 1 and 2 - Issuance of Amendment Nos. 3XX and 3XX RE: Methodology Change and Reclassification of the Turbine Building as a Tornado Resistant Structure."

Table 15.2-1 (CONTINUED)
STRUCTURES, SYSTEMS, AND COMPONENTS DESIGNED FOR SEISMIC AND TORNADO CRITERIA

(Refer to the equipment classification list (Q-list) for a more comprehensive list of components. See Note 1.)

Item	Earthquake Criterion	Tornado Criterion	Sponsor[a]	Note
Emergency diesel-generator rooms (continued)				
Walls, excluding louvers				
Roof slab	I	T		
Turbine building	NA	~~NA~~ T+	SW	By design, building collapse will not damage any Class I structures and components during earthquake, or tornado-resistant structures and components during tornado (See NOTE 3)
Mechanical Equipment Room-5	I	T		
Low-level intake structure	I	T	SW	T for emergency service water cubicle pump only
(Circulating water pump intake structure)				
High-level intake structures	I	T	SW	T, no missile protection required
Seal pits	I	T	SW	T, no missile protection required
High-level intake canal	I	NA	SW	
Fire-pump house	I	T	SW	Engine-driven pump only
Fuel-oil transfer pump vault	I	T	SW	
Boron recovery tank dikes	I	T	SW	
Waste gas & boron recovery pump house	I	T	SW	

a. HISTORICAL information, see Note 2.

Table 15.2-1 (CONTINUED)

STRUCTURES, SYSTEMS, AND COMPONENTS DESIGNED FOR SEISMIC AND TORNADO CRITERIA

(Refer to the equipment classification list (Q-list) for a more comprehensive list of components. See Note 1.)

Item	Earthquake Criterion	Tornado Criterion	Sponsor[a]	Note

Legend

W - Westinghouse Electric Corporation.

SW - Stone & Webster Engineering Corporation.

I - Refers to Seismic Class I criteria. All Class I components and structures are designed to resist the operating-basis earthquake within allowable working stresses. A check has been made to determine that failure to function will not occur with a design-basis earthquake.

T - Refers to structures that will not fail during the design tornado.

P - Refers to systems and components that will not fail during the design tornado since they are protected by tornado resistant structures or by being buried underground.

P* - Refers to systems and components that are not provided with complete physical protection from tornado-generated missiles, but have been evaluated using the Tornado Missile Risk Evaluator Methodology (Reference 12) and it has determined that the risk to the plant associated with the partially exposed SSC is sufficiently low such that complete physical protection from tornado-generated missiles need not be provided.

NA - Not applicable.

T+ - Refers to the main structural steel members of the operating and mezzanine decks of the Turbine Building structure, which will remain stable and not collapse during a tornado with a 250-mph maximum wind speed.

Table 15.2-1 (CONTINUED)
STRUCTURES, SYSTEMS, AND COMPONENTS DESIGNED FOR SEISMIC AND TORNADO CRITERIA

(Refer to the equipment classification list (Q-list) for a more comprehensive list of components. See Note 1.)

Item	Earthquake Criterion	Tornado Criterion	Sponsor[a]	Note

NOTES:

1. CAUTION, this table shall only be used for the classification of structures. Refer to the PAMS database for the classification of systems and components. A list of structures, systems, and components, like those in Table 15.2-1, was provided as part of the licensing application to permit a determination to be made as to the general suitability of the classification given and the design approach applied. Since the time of original plant licensing, an equipment classification listing (Q- List), was developed and subsequently replaced with a database (PAMS) to provide a more comprehensive and up-to-date list of individual components and their classifications than does this table, which only provides a general list of systems and components. According to the SPS current licensing basis, structures required to withstand the effects of a design basis tornado (Tornado Criterion "T") are also required to be designed to Seismic Category I requirements (Seismic Criterion "I"). Hence, all structures classified as "T" must also be classified as "I", but not necessarily vice versa. The Q-List and PAMS database only provide an input field for the more encompassing Seismic Category I classification for structures and do not provide a separate input field to identify those Seismic Criterion "I" structures that must also meet the Tornado Criterion "T" classification. Hence, SPS UFSAR, Table 15.2-1, was updated to be consistent with the SPS current licensing basis to reflect both the Seismic Criterion "I" and Tornado Criterion "T" classifications for structures at SPS in response to US NRC RIS 2015-06. For the classifications of systems and components at SPS, designed to be functional under Seismic Class I, Seismic Criterion "I", refer to the PAMS database.
2. The information in the sponsor column designates the division of responsibility between Westinghouse and Stone & Webster for the original design of listed structures, systems, and components. These designations are considered HISTORICAL and are not intended or expected to be updated for the life of the plant.
3. The extent of "building collapse" in the Turbine Building, under a 250-mph maximum tornado wind speed, consists of the failure of all roof trusses and their supporting steel columns down to the top of the operating deck elevation. The operating deck and mezzanine decks will remain stable to provide tornado protection to safe shutdown and non-isolable water source components located below. Additionally, no damage will occur to any adjacent Criterion "T" structures or the protected components housed within (e.g., Service Building - Control House).