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Dominion®

October 24, 2012

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Serial No. 12-519
NL&OS/ETS R3
Docket Nos. 50-338/339
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50-336/423
50-305
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NPF-49
DPR-43

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
DOMINION NUCLEAR CONNECTICUT, INC
DOMINION ENERGY KEWAUNEE, INC
NORTH ANNA POWER STATION UNITS 1 AND 2
SURRY POWER STATION UNITS 1 AND 2
MILLSTONE POWER STATION UNITS 2 AND 3
KEWAUNEE POWER STATION
RESPONSE TO NRC BULLETIN 2012-01 - DESIGN VULNERABILITY IN ELECTRIC POWER SYSTEM

On July 27, 2012, the NRC issued NRC Bulletin 2012-01, “Design Vulnerability in Electric Power System,” to 1) request information regarding the facilities’ electric power system design in light of the recent operating experience that involved the loss on one of the three phases of the offsite power circuits at Byron Station Unit 2 and 2) require a comprehensive verification of the facilities’ compliance with the regulatory requirements of GDC 17, “Electric Power Systems,” in Appendix A, General Design Criteria (GDC) for Nuclear Power Plants to 10 CFR Part 50 or the applicable principal design criteria in the updated final safety analysis report. The Bulletin requires a response to the Required Actions within 90 days of the date of this bulletin.

Consistent with the current licensing basis and GDC 17, existing protective circuitry will separate the engineered safety features (ESF) buses from a connected failed source due to a loss of voltage or a sustained, balanced degraded grid voltage concurrent with certain design basis accidents.

Dominion is following the industry efforts to identify a protective relay scheme that can automatically protect against an open phase condition in an offsite or preferred power

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source without degrading the reliability of the existing design and determine if design changes are applicable and needed at our nuclear stations.

The enclosures to this letter provide the requested information for North Anna, Surry Millstone and Kewaunee Power Stations.

If you have any questions or require additional information, please contact Mr. Thomas Shaub at (804) 273-2763.

Sincerely,

J. Alan Price
Vice President – Nuclear Engineering

VICKI L. HULL
Notary Public
Commonwealth of Virginia
140542
My Commission Expires May 31, 2014

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by J. Alan Price, who is the Vice President – Nuclear Engineering of Virginia Electric and Power Company, Dominion Nuclear Connecticut, Inc. and Dominion Energy Kewaunee, Inc. 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 24TH day of October, 2012.

My Commission Expires: May 31, 2014

Vicki L. Hull
Notary Public

Enclosures:

1. North Anna Response to NRC Bulletin 2012-01
2. Surry Response to NRC Bulletin 2012-01
3. Millstone Response to NRC Bulletin 2012-01
4. Kewaunee Response to NRC Bulletin 2012-01

Commitments made in this letter: None

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Enclosure 1

Response to NRC Bulletin 2012-01 Design Vulnerability in Electric Power System

North Anna Power Station Units 1 and 2

Virginia Electric and Power Company
(Dominion)

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System North Anna Power Station Units 1 and 2

Bulletin Response

The Bulletin response is arranged in the following way:

- System Description - Items 2, 1.d, 2.a, 2.c
- System Protection - 1, 1.a, 2.b, 2.d
- Consequences - 1.b, 1.c, 2.e
- Attachment 1 - Simplified One-Line Diagram
- Attachment 2 - Tables
  - Table 1 - ESF Buses Continuously Powered From Offsite Power Source(s)
  - Table 2 - ESF Buses Not Continuously Powered From Offsite Power Source(s)
  - Table 3A-3D - ESF Buses Major Loads
  - Table 4 - Offsite Power Transformers
  - Table 5 - Protective Devices

System Description

Items 2, 1.d, 2.a, 2.c request system information and are addressed in this section:

2. Briefly describe the operating configuration of the ESF buses (Class 1E for current operating plants or non-Class 1E for passive plants) at power (normal operating condition).

See Attachment 1, for a simplified one-line diagram of the station electrical distribution system.

As depicted in Attachment 1, there are four 4160VAC Engineered Safeguards Features (ESF) buses (two per unit) at North Anna Power Station (NAPS) (1H, 1J, 2H, and 2J). In the normal operating configuration (at power), the ESF buses are powered from their preferred power source, which are the three reserve station service transformers (RSSTs) (A, B, and C). Each RSST receives power at 34.5kV from three 34.5kV buses (Bus 3, 4, and 5), which are separated by normally open circuit breakers with open disconnect switches.

The 34.5kV buses receive power from three transformers (XFMR 1, 2 and 3), which have winding configurations as described in Table 4 (XFMR 1, XFMR 2, and XFMR 3) that are provided power from the point of interconnect on the 500kV and 230kV levels.

500-34.5kV XFMR 1 in the switchyard normally supplies 34.5kV Bus 3. Bus 3 normally supplies 34.5-4.16kV RSST-C which is the preferred source for ESF buses 1H and 2J.

500-34.5kV XFMR 2 in the switchyard normally supplies 34.5kV Bus 4. Bus 4 normally supplies 34.5-4.16kV RSST-B which is the preferred source for ESF bus 2H.

230-34.5kV XFMR 3 in the switchyard normally supplies 34.5kV Bus 5. Bus 5 normally supplies 34.5-4.16kV RSST-A which is the preferred source for ESF Bus 1J.

The above alignment is typical. Only 2 of the 3 34.5kV buses are required for operation. It is permissible to supply RSST-A and RSST-B from a single source. However, RSST-C is maintained separate from RSST-A and RSST-B in order to maintain separation of the associated ESF buses in accordance with Technical Specifications (TS). This response is based on the normal alignment.

The RSSTs are normally aligned to the ESF buses and the intake circulating water systems. The RSSTs also have the capacity to drive the station auxiliaries in the event of a loss of the normal ac power supply. The normally open feeder breakers from the RSSTs to the normal station service buses (1A, 1B, 1C, 2A, 2B, and 2C) are also depicted in Attachment 1.

Although the typical ESF bus alignment is as described above, the Unit 1 ESF buses have cross tie ability to the station service buses (1H to 1B & 1J to 2B). This cross tie alignment is considered a fully qualified offsite power source to the respective Unit 1 ESF buses. This cross tie alignment is noted as one situation where an ESF bus arrangement can be directly connected to the main generators.

The cross tie alignment is typically used only for maintenance evolutions where it would be required to switch RSST-A out online or to perform upstream 4160VAC breaker testing. Since the degraded voltage (DV) and under voltage (UV) protection for the ESF buses is instrumented from the respective ESF buses, offsite source alignment to a cross tie configuration results in the protection scheme being identical to the normal operating configuration protection schemes.

1.d. Describe the offsite power transformer (e.g., start-up, reserve, station auxiliary) winding and grounding configurations.

See Attachment 2, Table 4 for offsite power transformer winding and grounding configurations.

2.a. Are the ESF buses powered by offsite power sources? If so, explain what major loads are connected to the buses including their ratings.

As described above for item (2), during normal power operating configurations, the ESF buses are powered by their preferred offsite power sources. See Attachment 2, Tables 1 and 2 for the ESF bus power sources.

Under normal operation configurations, ESF bus loading is different than for accident conditions. The 4160VAC loads that are branch fed from the respective ESF buses are listed in Attachment 2, Table 3. However, the majority of the noted loads are only connected to the ESF buses during accident conditions.

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System North Anna Power Station Units 1 and 2

2.c. Confirm that the operating configuration of the ESF buses is consistent with the current licensing basis. Describe any changes in offsite power source alignment to the ESF buses from the original plant licensing.

The electrical distribution system lineup during normal plant operating conditions is the ESF buses powered from offsite power through the RSSTs and is consistent with the current licensing basis. Also, the cross tie alignment to the Unit 1 ESF buses as described in the System Description section is consistent with the current licensing basis. No changes to the offsite power source alignment were identified through this evaluation. Attachment 2, Table 1 identifies the normal arrangements from the RSSTs to the Unit 1 and Unit 2 ESF buses.

System Protection

Items 1, 1.a, 2.b, 2.d request information regarding electrical system protection and will be addressed in this section:

1. Given the requirements above, describe how the protection scheme for ESF buses (Class 1E for current operating plants or non-Class 1E for passive plants) is designed to detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on a credited offsite power circuit or another power sources.

Consistent with the current licensing basis and 10CFR50, Appendix A, GDC 17, the existing safety related protective circuitry will separate the ESF buses from a connected failed source due to a loss of voltage or a sustained, balanced degraded grid voltage.

Although the protection scheme at NAPS was not designed to detect and automatically respond to a single-phase open circuit condition on a credited offsite power circuit, preliminary analysis has shown that in some cases evaluated, the protection schemes will separate the ESF buses in an open phase condition and isolate the affected offsite power source, automatically transferring power to an onsite alternate supply (i.e., Emergency Diesel Generator).

An evaluation of the Byron event has been performed to determine the capability of existing NAPS safety related under voltage relays to detect and automatically respond to single-phase open circuit conditions of off-site power supplies to 4.16kV Class 1E vital buses. Regarding the ability of the NAPS ESF power distribution system UV relays to detect and respond to an open phase condition, the evaluation is based on analysis performed using EMPT based computer modeling software (PSCAD). Engineering has evaluated the results of the PSCAD analysis using published materials and the ETAP computer code, where possible, to ensure that the results are reasonable.

The NAPS under voltage relay scheme is similar to that described in IEEE Standard 741. The first level of under voltage protection is provided by the loss of voltage relays whose function is to detect and disconnect the Class 1E buses from the preferred power source upon a total loss of voltage. The UV relay setting equals 50.8V-SEC x 35/1 equals 1778-VPRI (phase-to-neutral voltage). Two-of-three UV relays are required to sense the loss voltage condition to initiate tripping of the preferred offsite power supply after 2 seconds.

The second level of under voltage protection is provided by the degraded voltage (DV) relays, which are set to detect a low-voltage condition. The DV relay setting equals 61.8V-SEC x 35/1 equals 2163-VPRI (phase-to-neutral voltage). Two-of-three DV relays are required to sense the low voltage condition to initiate tripping of the preferred offsite power source after 56 seconds, or after 7.5 seconds coincident with a safety injection signal. The under voltage/degraded relays are connected phase-to-neutral on the secondary of wye-grounded/wye-grounded connected 4200-120V potential transformers.

To determine the ability to detect an open phase from the preferred offsite power source, the phase-to-neutral voltage for each phase was required to be modeled for that condition. Three scenarios were analyzed to determine the vulnerability at NAPS of an open primary transformer phase condition. A summary of the results is as follows:

1. An open phase on the primary of one of the 34.5-4.16kV RSSTs will actuate the applicable ESF bus 74% UV relay circuit and separate from offsite power in 2 seconds. The Station Service Transformers (SSTs) utilized for the cross ties (1H to 1B & 1J to 2B) are connected similarly to the normal supply RSSTs (delta-wye low resistance grounded). In a cross tie configuration, the loss of a phase will be similar for either alignment. The SST primaries are supplied via the 22kV main generator isolated phase buses and are not subject to a loss of phase. Due to the connection similarities, the effect of a loss of a primary phase of either an SST or RSST would be similar. The results are unchanged assuming that the open transformer terminal is solidly grounded.

2. An open phase on the primary of 230-34.5kV XFMR 3 will result in a voltage imbalance on the applicable ESF bus that will not be automatically isolated by the UV or DV relays. The loss of phase would immediately render the offsite power source and applicable ESF inoperable. Like Byron, the voltage imbalance would impact operation of loads on the affected bus and would ultimately be self revealing. Unlike the Byron event, only one of two ESF buses per unit would potentially be affected. 230-34.5kV XFMR 3 in the switchyard normally supplies 34.5kV Bus 5. Bus 5 normally supplies the local 34.5kV distribution circuit and 34.5-4.16kV RSST-A, which is the preferred source for ESF Bus 1J. XFMR 3 is connected delta/wye-grounded and RSST-A is connected delta/wye-low resistance-grounded. The loss of one phase supplying the 230-34.5kV XFMR 3 will result in imbalanced voltages at the 34.5kV bus which, will in-turn, impact the 1J 4160-Volt ESF Bus. XFMR 3 was originally installed as a backup to XFMR 1 or XFMR 2. As stated, it normally supplies RSST-A. However, it is permissible to supply RSST-A and RSST-B or RSST-C from XFMR 3 at any time. It is not permissible to supply both ESF buses for an operating unit from a common offsite source. The open phase condition applies to the leads from the 230kV bus to the transformer. The bus design ensures that an open phase on the bus or beyond the switchyard does not impact the transformer voltage.

   Considering the A-phase opens (other single phase open is similar), the summary provided below describes the UV/DV relay sensing abilities. It should be noted that due to phase winding configurations, an open 230kV A-Phase results in 4.16kV B-Phase dropout.

UV Relays [50.8 x 35/1 equals 1778V-PRIMARY LN]
The B-Phase UV relay will drop-out due to the loss of voltage on that phase. However, the A-Phase and C-Phase UV relays will not drop-out and the trip circuit will not actuate since only 1 of 3 relays will drop-out (2 of 3 required).

DV Relays [61.8 x 35/1 equals 2163V-PRIMARY LN]
The B-Phase DV relay will drop-out due to the loss of voltage on that phase. The A-Phase and C-Phase DV relays will also drop-out starting the 60 second (non-SI) timer before tripping the preferred source circuit breaker. Prior to completion of the 60 second timer the RSST automatic load tap changer (LTC) is expected to correct the overall low voltage and likely prevent the automatic circuit breaker trip; the A-Phase and C-Phase DV relays will pick-up and the circuit will not actuate since only 1 of 3 relays will remain dropped out (2 of 3 required).

Expected Control Room Annunciator alarms include both the 4kV Bus Blown Fuse Alarm and ESF Bus UV/DV Alarm (after 15 second time delay). The RSST automatic LTC is expected to attempt to correct the low voltage and will likely clear the ESF Bus UV Alarm. However due to the very low voltage on one phase, the 4kV Bus Blown Fuse Alarm is expected to remain in alarm.

The results are unchanged assuming that the open transformer terminal is solidly grounded.

3. An open phase on the primary of 500-34.5kV XFMR 1 (or 2) will result in a relatively small imbalanced voltage condition at the 34.5kV and 4.16kV levels that will not be detected by the UV or DV relays. In this case, the ESF bus(es) and offsite power source remain operable and capable of performing their design functions.

   Considering the A-Phase opens (other single phase open is similar), a voltage mismatch of 2.1% at the ESF bus(es) would occur. A voltage mismatch of this magnitude will not affect ESF bus operation nor prevent the respective ESF buses from performing as designed during normal or accident loading situations.

   The open phase condition applies to the leads from the 500kV bus to the transformer. The bus design ensures that an open phase on the bus or beyond the switchyard does not impact the transformer voltage.

   If the open phase on the primary of 500-34.5kV XFMR 1 (or 2) is solidly grounded, this will result in a voltage imbalance on the applicable ESF bus(es) that will initially be detected by the UV or DV relays. The RSST automatic LTC is expected to attempt to correct the low voltage and the DV circuit will reset prior to separation of the ESF bus. The loss of phase would immediately render the offsite source and applicable ESF bus inoperable. Like Byron, the voltage imbalance would impact operation of loads on the affected bus and would at some point be self-revealing. Unlike the Byron event described in the IER, only one of two ESF buses per unit would potentially be affected. Expected Control Room Annunciator alarms include 4kV Bus Blown Fuse Alarm and Emergency Bus UV Alarm (after 15 second time delay, but will reset). Due to the very low voltage on one phase, the 4kV Bus Blown Fuse Alarm could remain.

As described above, the analysis included solidly grounding the transformer high side terminal in conjunction with an open phase. A high impedance ground was not evaluated for the open-phase condition. For a high impedance ground with the three phases intact, protective circuit actuation is expected. At NAPS, the 500kV, 230kV, and 34.5kV buses are effectively grounded. The 4.16kV buses are low resistance grounded. With the low impedance grounding configuration at NAPS, line to neutral short circuit current is sufficiently high when a high impedance ground fault is introduced. This ensures that protective relays isolate grounded energized phases. Ground over current relay settings typically have a minimum bolted-fault to trip-setting ratio of 2:1 to account for impedance of the fault. This is consistent with Industry practice. No further evaluation of this condition is warranted.

1.a. The sensitivity of protective devices to detect abnormal operating conditions and the basis for the protective device setpoint(s).

Consistent with the current licensing basis and GDC 17, existing electrical protective devices are sufficiently sensitive to detect design basis conditions, such as a loss of voltage or a degraded voltage, but were not designed to detect a single open phase condition in all offsite source configurations analyzed.

See Attachment 2, Table 5 for protective devices and the basis for the device setpoint(s).

2.b. If the ESF buses are not powered by offsite power sources, explain how the surveillance tests are performed to verify that a single-phase open circuit condition or high impedance ground fault condition on an off-site power circuit is detected.

The ESF buses at NAPS are powered by offsite power sources.

2.d. Do the plant operating procedures, including off-normal operating procedures, specifically call for verification of the voltages on all three phases of the ESF buses?

Daily Station Operations rounds procedures verify the presence of each of the three phases of voltage on the ESF buses. Station Operations annunciator response procedures are being modified to include instruction for phase verification when control room annunciator alarms “4kV Bus Blown Fuse Alarm” and “Emergency Bus UV” actuate. The control room annunciators are expected to alarm when there is an open phase in the switchyard. The additional instruction is intended to assist Operations personnel with diagnosing the open phase condition and further instructs Operations personnel to manually separate from the affected offsite source. Furthermore, as a result of the Byron event, the weekly walk down procedure for switchyard inspections is being revised with specific instruction for inspecting the high-side connections to the offsite sources in the switchyard.

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System North Anna Power Station Units 1 and 2

Consequences

Items 1.b, 1.c, 2.e request information regarding the consequences of an event and are addressed in this section:

1.b. The differences (if any) of the consequences of a loaded (i.e., ESF bus normally aligned to offsite power transformer) or unloaded (e.g., ESF buses normally aligned to unit auxiliary transformer) power source.

As described in the System Description portion of this response, the normal at power operating configuration is such that the ESF buses are powered from their preferred power sources which are the three RSSTs. In this configuration, the RSSTs are considered loaded. There is no configuration at NAPS where an unloaded source is awaiting command to transfer to an ESF bus.

The System Protection portion of this response identified three scenarios that were analyzed to determine the vulnerability of NAPS to an open primary transformer phase condition. The following discussion describes the loading characteristics of the subject transformers during the three scenarios:

1. An open phase (ungrounded or solidly grounded) on the primary of one of the 34.5-4.16kV RSSTs (or primary of 1B or 2B SSTs during cross tie configurations) will result in actuation of the applicable ESF bus 74% UV relay circuit and will result in separation from offsite power in 2 seconds. This scenario remains valid for both normal and accident loading conditions.

2. An open phase (ungrounded or solidly grounded) on the primary of 230-34.5kV XFMR 3 will result in a voltage imbalance on the applicable ESF bus that will not be automatically isolated by the UV or DV relays. In this case the ESF bus(es) and offsite power source are rendered inoperable. This scenario remains valid for both normal and accident loading situations. Furthermore, the noted Control Room Annunciator alarms (4kV Bus Blown Fuse Alarm and Emergency Bus UV Alarm) are expected for both normal and accident loading conditions.

3. An open phase (ungrounded) on the primary of 500-34.5kV XFMR 1 (or 2) will result in a relatively small imbalanced condition at the 34.5kV and 4.16kV levels that will not be detected by the UV or DV relays. In this case, the ESF bus(es) and offsite power source remain operable and capable of performing their design functions for both normal and accident loading conditions.

   An open phase (solidly grounded) on the primary of 500-34.5kV XFMR 1 (or 2) results in a voltage imbalance on the applicable ESF bus that will not be automatically isolated by the UV or DV relays. In this case the ESF bus(es) and offsite power source are rendered inoperable. This scenario remains valid for both normal and accident loading situations. Furthermore, the noted Control Room Annunciator alarms (4kV Bus Blown Fuse Alarm and Emergency Bus UV Alarm) are expected for both normal and accident loading conditions.

1.c. If the design does not detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on a credited offsite power circuit or another power source, describe the consequences of such an event and the plant response.

NAPS is vulnerable to such an event. There are, however, key differences from the Byron event regarding physical construction, electric plant line-ups, and design that minimize the impact if a similar event were to occur at NAPS.

1. An open phase (ungrounded or solidly grounded) on the primary of one of the 34.5-4.16kV RSSTs (or primary of 1B or 2B SSTs during cross tie configurations) will result in actuation of the applicable ESF bus 74% UV relay circuit and will result in separation from offsite power in 2 seconds. The impacted ESF bus will align to the EDG and the other redundant train will remain on offsite power.

2. An open phase on the primary of XFMR 3 (ungrounded or solidly grounded) will result in an inoperable ESF bus that would not auto separate from the preferred source; the 1J ESF Bus being source fed from RSST-A, Bus 5, and XFMR 3. In this case, however, as identified previously, main control room annunciators 4kV Bus Blown Fuse Alarm and Emergency Bus UV Alarm are expected to actuate if an open phase were to occur on the high-side of XFMR 3. Corrective action is being taken to ensure that the Operations annunciator response procedures are revised to provide clarified guidance for the noted condition. If the condition were to occur to XFMR 3, only one ESF bus for Unit 1 would be affected (1J) since the redundant ESF bus (1H) is source fed from an isolated offsite source (RSST-C, Bus 3, and XFMR 1). If this type of fault were to occur, the main effect on the plant would be increased thermal heating of the 1J ESF Bus loads due to the voltage imbalance. A timely response to the expected annunicators by Operations personnel trained to diagnose the failure would minimize the effect on running equipment. Therefore, the Byron event necessitated the need for additional guidance in the form of annunciator response procedures and training for NAPS Operations personnel. Preparations for training are being facilitated from corrective actions that were initiated in response to the Byron event.

3. An open phase (ungrounded) to XFMR 1 or XFMR 2 is undetectable, however, will not limit the ability of the offsite source to supply power to the affected ESF buses in both normal and accident loading conditions. Only a small voltage imbalance resulted, which would not render the affected ESF bus inoperable. Ultimately, if the event occurred to XFMR 1, only ESF Buses 1H and 2J would be affected, which leaves the other two unit specific redundant buses (1J and 2H) unaffected. If the subject fault occurred to XFMR 2, only the 2H ESF Bus would be affected leaving the other Unit 2 ESF bus (2J) unaffected. The robust maintenance program and walk downs, which are performed by subject matter experts, will ensure the condition would not be undetected for a prolonged period. Prior to the Byron event, the Dominion Transmission and Distribution weekly walk down procedure did not specifically mandate high-side phase connection inspections. However, corrective action has been instituted to ensure phase connections to the offsite circuits are inspected on a weekly frequency.

An open phase (solidly grounded) on the primary of XFMR 1 (or 2) will result in an inoperable emergency bus with the inability to auto separate from the preferred source; the 1H and 2J (or 2H) ESF buses being source fed from RSST-C (or RSST-B), Bus 3 (or 4), and XFMR 1 (or 2). In this case, however, as identified previously, main control room annunciators 4kV Bus Blown Fuse Alarm and Emergency Bus UV Alarm are expected to actuate. Corrective action is being taken to ensure that the Operations annunciator response procedures are revised to provide clarified guidance for the noted condition. If the condition were to occur to XFMR 1 (or 2), only one ESF bus for a unit would be affected. If this type of fault were to occur, the main effect on the plant would be increased thermal heating of the ESF bus loads due to the voltage imbalance. A timely response to the expected annunicators by Operations personnel trained to diagnose the failure would minimize the effect on running equipment. Therefore, the Byron event necessitated the need for additional guidance in the form of annunciator response procedures and training for NAPS Operations personnel. Preparations for training are being facilitated from corrective actions that were initiated in response to the Byron event.

2.e. If a common or single offsite circuit is used to supply redundant ESF buses, explain why a failure, such as a single-phase open circuit or high impedance ground fault condition, would not adversely affect redundant ESF buses.

Item 2.e is not applicable since NAPS does not use a common or single offsite source to supply redundant ESF buses.

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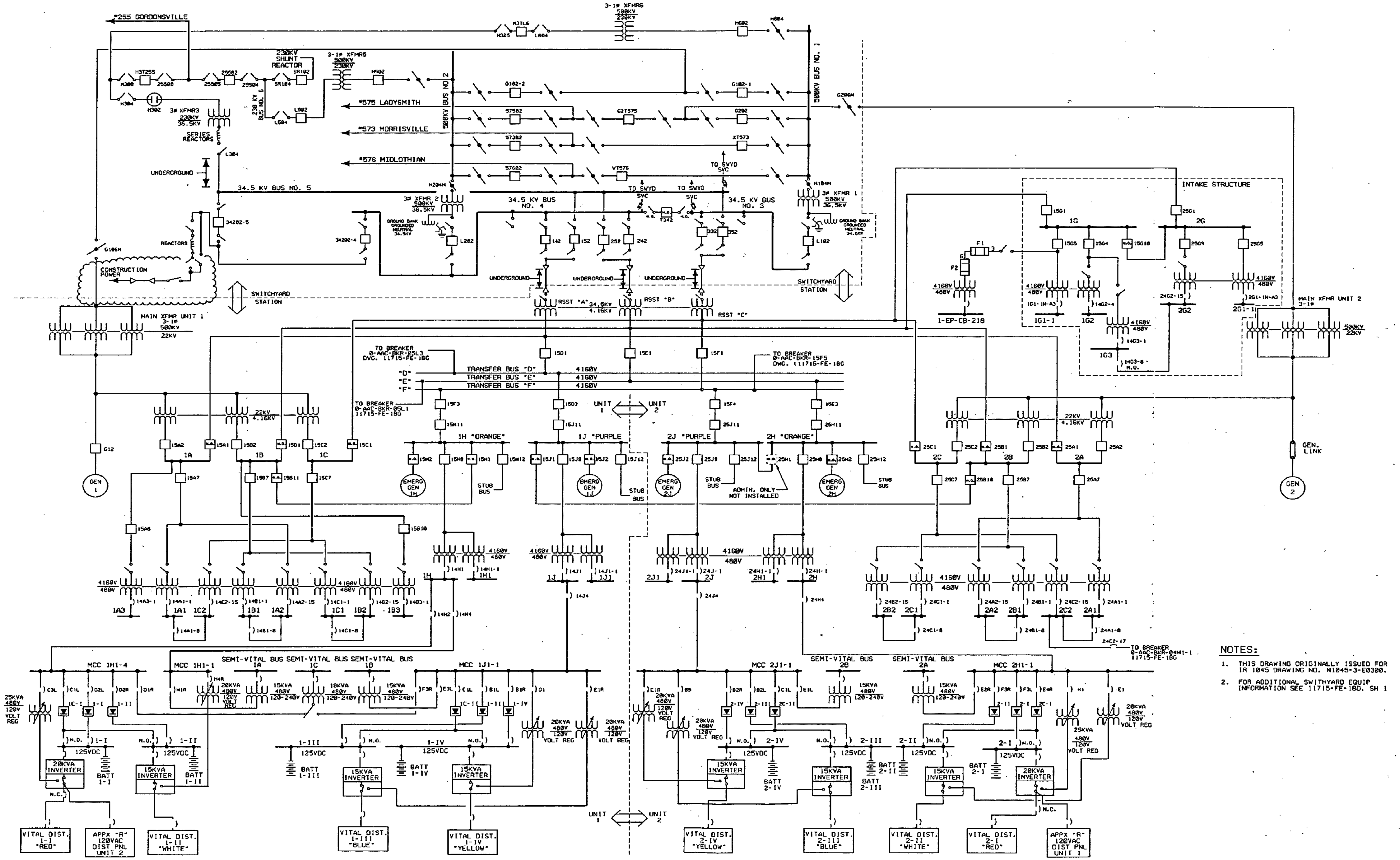
North Anna Power Station Units 1 and 2

Attachment 1 - Electrical Distribution System



NOTES:

1. THIS DRAWING ORIGINALLY ISSUED FOR IR 1045 DRAWING NO. N1045-3-E0300.
2. FOR ADDITIONAL SWITHYARD EQUIP INFORMATION SEE 11715-FE-1BD. SH 1

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System North Anna Power Station Units 1 and 2

Attachment 2 - Tables

Table 1 - ESF Buses Continuously Powered From Offsite Power Source(s)

Description of Offsite Power Source Configuration	ESF buses connected to offsite power (normal operating condition)	Original licensing basis configuration (Y/N)
RSST "C"	1H ESF Bus	Y
RSST "A"	1J ESF Bus	Y
RSST "B"	2H ESF Bus	Y
RSST "C"	2J ESF Bus	Y

Table 2 - ESF Buses Not Continuously Powered From Offsite Power Source(s)

Description of Offsite Power Source Configuration	ESF buses connected to offsite power (normal operating condition)	Original licensing basis configuration (Y/N)
Cross tie to 1B Station Service Bus	1H	Y
Cross tie to 2B Station Service Bus	1J	Y

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System
North Anna Power Station Units 1 and 2

Table 3A - ESF Bus 1H Major Loads

Bus	Load Mark #	Load Description	Normal Running Load = X	Rating (HP) unless otherwise noted
1H	01-FW-P-3A	Motor Driven Aux Feed Pump	--	450
1H	01-SW-P-4	Aux Service Water Pump	--	500
1H	01-SW-P-1A	Service Water Pump	**X** [There are 4 Service Water Pumps. 1 on 1J Train, 1 on 1H Train, 1 on 2J Train, 1 on 2H Train. Two pumps run (common system).]	500
1H	01-CH-P-1A	Charging Pump	**X** (There are 3 Charging Pumps. 1 on 1J Train, 1 on 1H Train, and 1 swing pump that can be aligned to either 1H or 1J. Typically only 1 of 3 run)	900
1H	01-CH-P-1C	Swing Charging Pump	**X** (There are 3 Charging Pumps. 1 on 1J Train, 1 on 1H Train, and 1 swing pump that can be aligned to either 1H or 1J. Typically only 1 of 3 run)	900
1H	01-EE-ST-1H & 01-EE-ST-1H1	TO 4160/480VAC DISTRIBUTION	**X**	1.333 (MVA) & 1.333 (MVA)
1H	01-SI-P-1A	Low Head SI Pump	--	250
1H	01-RS-P-2A	Outside Recirc Spray Pump	--	400
1H	01-CC-P-1A	Component Cooling Pump	**X** (There are 2 Component Cooling Pumps. 1 on 1J Train and 1 on 1H Train. Typically only 1 of 2 run)	600
1H	01-RH-P-1A	Residual Heat Removal Pump	--	300

Table 3B - ESF Bus 1J Major Loads

Bus	Load Mark #	Load Description	Normal Running Load = X	Rating (HP) unless otherwise noted
1J	01-FW-P-3B	Motor Driven Aux Feed Pump	--	450
1J	01-SW-P-1B	Service Water Pump	**X** [There are 4 Service Water Pumps. 1 on 1J Train, 1 on 1H Train, 1 on 2J Train, 1 on 2H Train. Two pumps run (common system).]	500
1J	01-CH-P-1B	Charging Pump	**X** (There are 3 Charging Pumps. 1 on 1J Train, 1 on 1H Train, and 1 swing pump that can be aligned to either 1H or 1J. Typically only 1 of 3 run)	900
1J	01-CH-P-1C	Swing Charging Pump	**X** (There are 3 Charging Pumps. 1 on 1J Train, 1 on 1H Train, and 1 swing pump that can be aligned to either 1H or 1J. Typically only 1 of 3 run)	900
1J	01-EE-ST-1J & 01-EE-ST-1J1	TO 4160/480VAC DISTRIBUTION	**X**	1.333 (MVA) & 0.75(MVA)
1J	01-SI-P-1B	Low Head SI Pump	--	250
1J	01-RS-P-2B	Outside Recirc Spray Pump	--	400
1J	01-CC-P-1B	Component Cooling Pump	**X** (There are 2 Component Cooling Pumps. 1 on J Train and 1 on H Train. Typically only 1 of 2 run)	600
1J	01-RH-P-1B	Residual Heat Removal Pump	--	300

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Table 3C - ESF Bus 2H Major Loads

Bus	Load Mark #	Load Description	Normal Running Load = X	Rating (HP) unless otherwise noted
2H	02-FW-P-3A	Motor Driven Aux Feed Pump	--	450
2H	02-SW-P-4	Aux Service Water Pump	--	500
2H	02-SW-P-1A	Service Water Pump	**X** [There are 4 Service Water Pumps. 1 on 1J Train, 1 on 1H Train, 1 on 2J Train, 1 on 2H Train. Two pumps run (common system).]	500
2H	02-CH-P-1A	Charging Pump	**X** (There are 3 Charging Pumps. 1 on 2J Train, 1 on 2H Train, and 1 swing pump that can be aligned to either 2H or 2J. Typically only 1 of 3 run)	900
2H	02-CH-P-1C	Swing Charging Pump	**X** (There are 3 Charging Pumps. 1 on 2J Train, 1 on 2H Train, and 1 swing pump that can be aligned to either 2H or 2J. Typically only 1 of 3 run)	900
2H	02-EE-ST-2H & 02-EE-ST-2H1	TO 4160/480VAC DISTRIBUTION	**X**	1.333 (MVA) & 1.333 (MVA)
2H	02-SI-P-1A	Low Head SI Pump	--	250
2H	02-RS-P-2A	Outside Recirc Spray Pump	--	400
2H	02-CC-P-1A	Component Cooling Pump	**X** (There are 2 Component Cooling Pumps. 1 on 2J Train and 1 on 2H Train. Typically only 1 of 2 run)	600
2H	02-RH-P-1A	Residual Heat Removal Pump	--	300

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Table 3D - ESF Bus 2J Major Loads

Bus	Load Mark #	Load Description	Normal Running Load = X	Rating (HP) unless otherwise noted
2J	02-FW-P-3B	Motor Driven Aux Feed Pump		450
2J	02-SW-P-1B	Service Water Pump	**X** [There are 4 Service Water Pumps. 1 on 1J Train, 1 on 1H Train, 1 on 2J Train, 1 on 2H Train. Two pumps run (common system).]	500
2J	02-CH-P-1B	Charging Pump	**X** (There are 3 Charging Pumps. 1 on 2J Train, 1 on 2H Train, and 1 swing pump that can be aligned to either 2H or 2J. Typically only 1 of 3 run)	900
2J	02-CH-P-1C	Swing Charging Pump	X (There are 3 Charging Pumps. 1 on 2J Train, 1 on 2H Train, and 1 swing pump that can be aligned to either 2H or 2J. Typically only 1 of 3 run)	900
2J	02-EE-ST-2J & 02-EE-ST-2J1	TO 4160/480VAC DISTRIBUTION	**X**	1.333 (MVA) & 0.75 (MVA)
2J	02-SI-P-1B	Low Head SI Pump	--	250
2J	02-RS-P-2B	Outside Recirc Spray Pump	--	400
2J	02-CC-P-1B	Component Cooling Pump	**X** (There are 2 Component Cooling Pumps. 1 on 2J Train and 1 on 2H Train. Typically only 1 of 2 run)	600
2J	02-RH-P-1B	Residual Heat Removal Pump	--	300

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Table 4 - Offsite Power Transformers

Transformer	Winding Configuration (High Side:Low Side)	MVA Size (OA/FA/FA)	Voltage Rating (Primary/Secondary)	Grounding Configuration
RSST "A"	Delta:Wye Low Resistance Grounded	20.16/26.88/33.6 (OA/FA/FOA)	34.5kV/4.16kV	34.5kV Bus is Effectively Grounded. RSST "A" is Wye Low Resistance Grounded (on secondary).
RSST "B"	Delta:Wye Low Resistance Grounded	20.16/26.88/33.6 (OA/FA/FOA)	34.5kV/4.16kV	34.5kV Bus is Effectively Grounded. RSST "B" is Wye Low Resistance Grounded (on secondary).
RSST "C"	Delta:Wye Low Resistance Grounded	20.16/26.88/33.6 (OA/FA/FOA)	34.5kV/4.16kV	34.5kV Bus is Effectively Grounded. RSST "C" is Wye Low Resistance Grounded (on secondary).
SST "1B"	Delta:Wye Low Resistance Grounded	16.8/22.4 (ONAN/ONAF)	22kV/4.4kV	SST "1B" is Wye Low Resistance Grounded (on secondary).
SST "2B"	Delta:Wye Low Resistance Grounded	16.8/22.4 (ONAN/ONAF)	22kV/4.4kV	SST "2B" is Wye Low Resistance Grounded (on secondary).
XFMR 1	Wye Grounded:Delta	67.2/89.6/112 (ONAN/ONAF/ONAF)	512.5kV/36.5kV	500kV bus is Effectively Grounded. XFMR 1 is Wye Solid Grounded (on primary). XFMR 1 is grounded via zig-zag ground bank (on secondary).
XFMR 2	Wye Grounded:Delta	67.2/89.6/112 (ONAN/ONAF/ONAF)	512.5kV/36.5kV	500kV bus is Effectively Grounded. XFMR 2 is Wye Solid Grounded (on primary). XFMR 2 is grounded via zig-zag ground bank (on secondary).
XFMR 3	Delta:Wye Grounded	67.2/89.6/112 (ONAN/ONAF/ONAF	230kV/36.5kV	230kV Bus is Effectively Grounded. XFMR 3 is Wye Grounded (on secondary).

Table 5 - Protective Devices

Protection Zone	Protective Device	Logic	Setpoint Nominal (VAC)	Sensitivity of Device (VAC)	Basis For Setpoint
1H ESF Bus Degraded Voltage	Degraded Voltage Relays	2 of 3	61.8 $V_{\text{LN-Secondary}}$	(+/-) 0.6077	Drop out to actuate upon a sustained ESF bus Degraded voltage of 90% nominal. Setpoint provides a minimum voltage the ESF buses can be operated at indefinitely.
1H ESF Bus Under Voltage	Loss of Voltage Relays	2 of 3	50.8 $V_{\text{LN-Secondary}}$	(+/-) 2.5423	The upper bound is set to ensure that the preferred power source shall not be disconnected for any transient experienced during the worst case voltage profile.
1J ESF Bus Degraded Voltage	Degraded Voltage Relays	2 of 3	61.8 $V_{\text{LN-Secondary}}$	(+/-) 0.6077	Drop out to actuate upon a sustained ESF bus Degraded voltage of 90% nominal. Setpoint provides a minimum voltage the ESF buses can be operated at indefinitely.
1J ESF Bus Under Voltage	Loss of Voltage Relays	2 of 3	50.8 $V_{\text{LN-Secondary}}$	(+/-) 2.5423	The upper bound is set to ensure that the preferred power source shall not be disconnected for any transient experienced during the worst case voltage profile.

Table 5 - Protective Devices (Continued)

Protection Zone	Protective Device	Logic	Setpoint Nominal (VAC)	Sensitivity of Device (VAC)	Basis For Setpoint
2H ESF Bus Degraded Voltage	Degraded Voltage Relays	2 of 3	61.8 $V_{LN\text{-}Secondary}$	(+/-) 0.6077	Drop out to actuate upon a sustained ESF bus Degraded voltage of 90% nominal. Setpoint provides a minimum voltage the ESF buses can be operated at indefinitely
2H ESF Bus Under Voltage	Loss of Voltage Relays	2 of 3	50.8 $V_{LN\text{-}Secondary}$	(+/-) 2.5423	The upper bound is set to ensure that the preferred power source shall not be disconnected for any transient experienced during the worst case voltage profile.
2J ESF Bus Degraded Voltage	Degraded Voltage Relays	2 of 3	61.8 $V_{LN\text{-}Secondary}$	(+/-) 0.6077	Drop out to actuate upon a sustained ESF bus Degraded voltage of 90% nominal. Setpoint provides a minimum voltage the ESF buses can be operated at indefinitely
2J ESF Bus Under Voltage	Loss of Voltage Relays	2 of 3	50.8 $V_{LN\text{-}Secondary}$	(+/-) 2.5423	The upper bound is set to ensure that the preferred power source shall not be disconnected for any transient experienced during the worst case voltage profile.

ENCLOSURE 2

Response to NRC Bulletin 2012-01
Design Vulnerability in Electric Power System

Surry Power Station Units 1 and 2

Virginia Electric and Power Company
(Dominion)

Response to NRC Bulletin 2012-01 Design Vulnerability in Electric Power System Surry Power Station Units 1 and 2

Bulletin Response

The Bulletin response is arranged in the following way:

- System Description - Items 2, 1.d, 2.a, 2.c
- System Protection - 1, 1.a, 2.b, 2.d
- Consequences - 1.b, 1.c, 2.e
- Attachment 1 - Simplified One-Line Diagram
- Attachment 2 - Tables
    - Table 1 - ESF Buses Continuously Powered From Offsite Power Source(s)
    - Table 2 - ESF Buses Not Continuously Powered From Offsite Power Source(s)
    - Table 3 - ESF Buses Major Loads
    - Table 4 - Offsite Power Transformers
    - Table 5 - Protective Devices

System Description

Items 2, 1.d, 2.a, 2.c request system information and are addressed in this section:

2. Briefly describe the operating configuration of the ESF buses (Class 1E for current operating plants or non-Class 1E for passive plants) at power (normal operating condition).

See Attachment 1, for a simplified one-line diagram of the station electrical distribution system. It should be noted that "Electric Power Distribution" (figure 8.3-2 from Surry Power Station (SPS) UFSAR Rev. 43.07) is being revised with respect to the completed 34.5kV Switchyard Modifications and will be updated during the next routine UFSAR revision to reflect the changes (Station Drawing 11448-FE-1A2 has already been appropriately updated within the drawing control database).

As depicted in Attachment 1, there are four 4160VAC Engineered Safeguards Features (ESF) buses (two per unit) at SPS (1H, 1J, 2H, and 2J). The circuits that supply power to the ESF buses through Switchyard Transformers (SRT) Nos. 1, 2, and 4 are known as "primary sources." Each primary source is capable of providing power to an ESF bus on each Unit. Surry Technical Specifications (TS) require a primary source for each ESF bus, during power operations and startup. As described in the Basis for Surry TS, the primary sources are defined as the System Reserve Transformers (SRT); 500-36.5kV Transformer No. 1 and 230-36.5kV Transformer No. 2. Transformer No. 4 (230-36.5kV) serves as a backup for loads supplied by either System Reserve Transformer No. 1 or No. 2.

The System Reserve Transformers supply the Reserve Station Service Transformers (RSST); SRT 1 supplies RSST A and RSST B, SRT 2 supplies RSST C. The RSSTs then feed the 4160V Transfer Buses, D, E, and F, and finally, the Transfer Buses supply the ESF Buses and, alternately, the Station Service Buses.

The 34.5kV buses receive power from three transformers which have winding configurations described in Table 4 (SRT 1, SRT 2, and SRT 4) which are provided power from the point of interconnect on the 500kV and 230kV levels.

500-34.5kV SRT 1 in the switchyard normally supplies 34.5kV Bus 5. Bus 5 normally supplies 34.5-4.16kV RSST-A and 34.5-4.16kV RSST-B which are the preferred sources for ESF buses 1J and 2H respectively.

230-34.5kV SRT 2 in the switchyard normally supplies 34.5kV Bus 6. Bus 6 normally supplies 34.5-4.16kV RSST-C which is the preferred source for ESF buses 1H and 2J.

230-34.5kV SRT 4 in the switchyard normally supplies 34.5kV Bus 7. Bus 7 is normally energized and has the capability to supply the loads serviced by SRT 1 or SRT 2.

The RSSTs are normally aligned to the ESF buses and also have the necessary control logic and capacity to power certain station auxiliaries in the event of a loss of the normal ac power supply. The normally open feeder breakers from the RSSTs to the normal station service buses (1A, 1B, 1C, 2A, 2B, and 2C) are also depicted in Attachment 1.

1.d. Describe the off-site power transformer (e.g., start-up, reserve, station auxiliary) winding and grounding configurations.

See Attachment 2, Table 4 for offsite power transformer winding and grounding configurations.

2.a. Are the ESF buses powered by off-site power sources? If so, explain what major loads are connected to the buses including their ratings.

As described above for item (2), during normal power operating configurations, the ESF buses are powered by their preferred-site power sources. See Attachment 2, Tables 1 and 2 for the ESF bus power sources.

Under normal operation configurations, ESF bus loading is different than for accident conditions. The 4160VAC loads that are branch fed from the respective ESF buses are listed in Attachment 2, Table 3. However, the majority of the noted loads are only connected to the ESF buses during accident conditions.

2.c. Confirm that the operating configuration of the ESF buses is consistent with the current licensing basis. Describe any changes in off-site power source alignment to the ESF buses from the original plant licensing.

The electrical distribution system lineup during normal plant operating conditions is the ESF buses powered from offsite power through the RSSTs and is consistent with the current licensing basis. No changes to the offsite power source alignment were identified through this evaluation. Attachment 2, Table 1 identifies the normal arrangements from the RSSTs to the Unit 1 and Unit 2 ESF buses.

System Protection

Items 1, 1.a, 2.b, 2.d request information regarding electrical system protection and will be addressed in this section:

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1. Given the requirements above, describe how the protection scheme for ESF buses (Class 1E for current operating plants or non-Class 1E for passive plants) is designed to detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on a credited offsite power circuit or another power sources.

Consistent with the current licensing basis and 10CFR50, Appendix A, GDC 17, the existing safety related protective circuitry will separate the ESF buses from a connected failed source due to a loss of voltage or a sustained, balanced degraded grid voltage.

Although the protection scheme at SPS was not designed to detect and automatically respond to a single-phase open circuit condition on a credited offsite power circuit, preliminary analysis has shown that, in some cases evaluated, the protection schemes will separate the ESF buses in an open phase condition and isolate the affected offsite power source/automatically transferring power to an onsite alternate supply (i.e., Emergency Diesel Generator).

An evaluation of the Byron event has been performed to determine the capability of existing SPS safety related under voltage relays to detect and automatically respond to single-phase open circuit conditions of offsite power supplies to 4.16kV Class 1E vital buses. Regarding the ability of the SPS ESF power distribution system under voltage (UV) relays to detect and respond to an open phase condition, the evaluation is based on analysis performed using EMPT based computer modeling software (PSCAD). Engineering has evaluated the results of the PSCAD analysis using published materials and the ETAP computer code, where possible, to ensure that the results are reasonable.

The SPS ESF under voltage relay scheme is similar to that described in IEEE Std 741. The first level of under voltage protection is provided by the loss of voltage relays whose function is to detect and disconnect the Class 1E buses from the preferred power supply upon a total loss of voltage (75% of 4160V). The UV relay setting equals 51.47V-SEC x 35/1 equals 1801VPRI (phase-to-neutral voltage). Two-of-three UV relays are required to sense the loss of voltage condition to initiate tripping of the preferred offsite power supply after 2 seconds.

The second level of under voltage protection is provided by the degraded voltage (DV) relays, which are set to detect a low-voltage condition (92.7% of 4160V). The DV relay setting equals 63.6V-SEC x 35/1 equals 2226V-PRI (phase-to-neutral voltage). Two-of-three DV relays are required to sense the low voltage condition to initiate tripping of the preferred offsite power source after 60 seconds or after 7 second coincident with a safety injection signal. The UV and DV relays are connected phase-to-neutral on the secondary of wye-grounded/wye-grounded connected 4200-120V potential transformers.

To determine the ability to detect an open phase from the preferred offsite power supply, the phase-to-neutral voltage for each phase was determined for that condition. Three scenarios were analyzed to assess the vulnerability of an open primary transformer phase condition at SPS. A summary of the results is as follows:

1. An open phase on the primary of one of the 34.5-4.16kV RSSTs will actuate the 75% UV relay circuit of the applicable ESF bus and separate from offsite power in 2 seconds. The results are unchanged assuming that the open transformer terminal is solidly grounded.

2. An open phase on the primary of the 230-34.5kV Transformer No. 2 (or No. 4) will result in a voltage imbalance on the applicable ESF bus(es) that will not be automatically isolated by the UV or DV relays. After 10 seconds, the Emergency Bus DV Control Room Annunciator will actuate but then will reset as the RSST automatic load tap changer (LTC) is expected to attempt to correct the low voltage. The loss of phase would immediately render the offsite power source and applicable ESF bus inoperable. Like Byron, the voltage imbalance would impact operation of loads on the affected bus and would ultimately be self revealing. Contrary to the Byron event, only one of two ESF buses per unit would potentially be affected.

   The open phase condition applies to the leads from the 230kV bus to the transformer. The ring bus design ensures that an open phase on the bus or beyond the switchyard does not impact the transformer voltage.

   Considering the A phase opens (any other single phase open is similar), the following summary describes the UV/DV relay sensing abilities. It should be noted that, due to phase winding configurations, an open 230kV A-Phase results in 4.16kV B-Phase dropout.

   UV Relays [51.47 x 35/1 equals 1801V-PRIMARY LN]
   The B-Phase UV relay will drop-out due to the loss of voltage on that phase. However, the A-Phase and C-Phase UV relays will not drop-out and this circuit will not actuate since only 1 of 3 relays will drop-out (2 of 3 required).

   DV Relays [63.6 x 35/1 equals 2226V-PRIMARY LN]
   The B-Phase DV relay will drop-out due to the loss of voltage on that phase. The A-Phase and C-Phase DV relays will also drop-out starting the 60 second (non-SI) timer before tripping the preferred source circuit breaker. Prior to completion of the 60 second timer the RSST automatic LTC is expected to attempt to correct the low voltage and likely will prevent the automatic circuit breaker trip; the A-Phase and C-Phase DV relays will pick-up and this circuit will not actuate since only 1 of 3 relays will remain dropped out (2 of 3 required). The Control Room Annunciator for Emergency Bus DV will alarm at 10 seconds. The RSST automatic LTC is expected to attempt to correct the low voltage and will likely clear the ESF Bus DV Alarm.

   The 60 second DV timer described is based on non-accident conditions. It has not been assumed that the open phase condition occurs coincident with an accident.

   The results are unchanged assuming that the open transformer terminal is solidly grounded.

3. An open phase on the primary of 500-34.5kV Transformer No. 1 will result in a relatively small imbalanced condition at the 34.5kV and 4.16kV levels that will not be detected by the UV or DV relays. In this case, the ESF bus(es) and offsite power supply remain operable and capable of performing their design functions.

   Considering the A-Phase opens (other single phase open is similar), a voltage mismatch of 1.8% at the ESF bus(es) would occur. A voltage mismatch of this magnitude will not affect ESF bus operation nor prevent the respective ESF buses from performing as designed during normal or accident loading situations. The open phase condition applies to the leads from the 500kV bus to the transformer. The ring bus design ensures that an open phase on the bus or beyond the switchyard does not impact the transformer voltage.

If the open phase on the primary of 500-34.5kV Transformer #1 is solidly grounded, this will result in a voltage imbalance on the applicable ESF bus(es) that will initially be detected by the DV relays. After 10 seconds, the Emergency Bus DV Control Room Annunciator will actuate but then the DV circuit will reset prior to separation of the ESF bus(es) as the RSST automatic LTC is expected to attempt to correct the low voltage. The loss of phase would immediately render the offsite source and applicable ESF bus inoperable. Like Byron, the voltage imbalance would impact operation of loads on the affected bus and would at some point be self-revealing. Unlike the Byron event, only one of two ESF buses per unit would potentially be affected.

As described above, the analysis included solidly grounding the transformer high side terminal in conjunction with an open phase. A high impedance ground was not evaluated for the open-phase condition. For a high impedance ground with the three phases intact, protective circuit actuation is expected. At SPS, the 500kV, 230kV, and 34.5kV buses are effectively grounded. The 4.16kV buses are low resistance grounded. With the low impedance grounding configuration at SPS, line-to-neutral short circuit currents are sufficiently high when a high impedance ground fault is introduced. This ensures that protective relays isolate grounded energized phases. Ground over current relay settings typically have a minimum bolted-fault to trip-setting ratio of 2:1 to account for impedance of the fault. This is consistent with industry practice. No further evaluation of this condition is warranted.

1.a. The sensitivity of protective devices to detect abnormal operating conditions and the basis for the protective device setpoint(s).

Consistent with the current licensing basis and GDC 17, existing electrical protective devices are sufficiently sensitive to detect design basis conditions, such as a loss of voltage or a degraded voltage, but were not designed to detect a single open phase condition in all offsite source configurations analyzed.

See Attachment 2, Table 5 for protective devices and the basis for the device setpoint(s).

2.b. If the ESF buses are not powered by offsite power sources, explain how the surveillance tests are performed to verify that a single-phase open circuit condition or high impedance ground fault condition on an off-site power circuit is detected.

The ESF buses at SPS are powered by offsite power sources.

2.d. Do the plant operating procedures, including off-normal operating procedures, specifically call for verification of the voltages on all three phases of the ESF buses?

Plant operating procedures are being changed to include instruction for phase verification when control room annunciator "Bus 1H (Typical) Degraded Voltage" actuates. This control room annunciator is expected in the case where there is an open phase in the switchyard. The additional instruction is intended to assist Operations personnel with diagnosing the open phase condition and further instructs Operations personnel to manually separate from the affected offsite source. Furthermore, as a result of the Byron event, daily Operations and weekly Electric Transmission walkdown procedures for switchyard inspections have been revised with specific instruction for inspecting the hi-side connections to the offsite sources in the switchyard.

Consequences

Items 1.b, 1.c, 2.e request information regarding the consequences of an event and are addressed in this section:

1.b. The differences (if any) of the consequences of a loaded (i.e., ESF bus normally aligned to offsite power transformer) or unloaded (e.g., ESF buses normally aligned to unit auxiliary transformer) power source.

As described in the System Description portion of this response, the normal at power operating configuration is such that the ESF buses are powered from their preferred power source via three RSSTs. In this configuration, the RSSTs are considered loaded. There is no configuration at SPS where an unloaded source is awaiting command to transfer to an ESF bus.

The System Protection portion of this response identified three scenarios that were analyzed to determine the vulnerability at SPS to an open primary transformer phase condition. The following discussion describes the loading characteristics of the subject transformers during the three scenarios:

1. An open phase (ungrounded or solidly grounded) on the primary of one of the 34.5-4.16kV RSSTs will result in actuation of the applicable ESF Bus 75% UV relay circuit and will result in separation from offsite power in 2 seconds. This scenario remains valid for both normal and accident loading conditions.

2. An open phase (ungrounded or solidly grounded) on the primary of 230-34.5kV Transformer No. 2 or No. 4 will result in a voltage imbalance on the applicable ESF bus that will not be automatically isolated by the UV or DV relays. In this case the ESF bus(es) and offsite power source are rendered inoperable. This scenario remains valid for both normal and accident loading situations. Furthermore, the noted Control Room Annunciator alarm (Bus 1H (Typical) Degraded Voltage) is expected for both normal and accident loading conditions.

3. An open phase (ungrounded) on the primary of 500-34.5kV Transformer No. 1 will result in a relatively small imbalanced condition at the 34.5kV and 4.16kV levels that will not be detected by the UV or DV relays. In this case, the ESF bus(es) and offsite power supply

remain operable and capable of performing their design functions for both normal and accident loading conditions.

An open phase (solidly grounded) on the primary of 500-34.5kV Transformer No. 1 will result in a voltage imbalance on the applicable ESF bus that will not be automatically isolated by the UV or DV relays. In this case the ESF bus(es) and offsite power source are rendered inoperable. This scenario remains valid for both normal and accident loading situations. Furthermore, the noted Control Room Annunciator alarm (Bus 1H (Typical) Degraded Voltage) is expected for both normal and accident loading conditions.

1.c. If the design does not detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on a credited offsite power circuit or another power sources, describe the consequences of such an event and the plant response.

SPS is vulnerable to such an event. There are, however, key differences from the Byron event regarding physical construction, electric plant line-ups, and design that minimize the impact if a similar event were to occur at SPS.

1. An open phase (ungrounded or solidly grounded) on the primary of one of the 34.5-4.16kV RSSTs will result in actuation of the applicable ESF bus 75% UV relay circuit and will result in separation from offsite power in 2 seconds. The impacted ESF bus will align to the EDG and the other redundant train will remain on offsite power.

2. An open phase (ungrounded or solidly grounded) on the primary of Switchyard Transformers No. 2 or No. 4 or an open phase (solidly grounded) of Transformer No. 1 will result in inoperable ESF buses that would not auto separate from the preferred source. In this case, however, as identified previously, main control room annunciator "Bus 1H (Typical) Degraded Voltage" Alarm is expected to actuate. Corrective action is being taken to ensure that the Operations annunciator response procedure is revised to provide clarified guidance for the noted condition. If these conditions were to occur at SPS, only one ESF bus per unit would be affected since the unit redundant ESF buses are source fed from an independent offsite source. If this type of fault were to occur, the main effect on the plant would be increased thermal heating of the affected ESF bus loads due to the voltage imbalance. A timely response to the expected annunicators by Operations personnel trained to diagnose the failure would minimize the effect on running equipment. Therefore, the Byron event necessitated the need for additional guidance in the form of annunciator response procedures and training for SPS Operations personnel.

3. An open phase (ungrounded) on the primary of Transformer No. 1 is undetectable; however, Transformer No. 1 loss does not limit the ability of the offsite source to supply power to the affected ESF buses in both normal and accident loading conditions. Only a small voltage imbalance will result, which would not render the affected ESF bus inoperable. Ultimately, if the event occurred on Transformer No. 1, only one ESF bus per unit would be affected, which leaves the other unit specific redundant buses unaffected. The robust maintenance program and walk downs, which are performed by subject matter experts, will ensure the condition would not be undetected for a prolonged period. Prior to the Byron event, the

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Dominion Transmission and Distribution weekly walk down procedure did not specifically mandate high side phase connection inspections. However, corrective action has been instituted to ensure phase connections to the offsite circuits are inspected on a daily frequency by Operations Staff and a weekly frequency by Electric Transmission Staff.

2.e. If a common or single offsite circuit is used to supply redundant ESF buses, explain why a failure, such as a single-phase open circuit or high impedance ground fault condition, would not adversely affect redundant ESF buses.

Item 2e is not applicable since SPS does not use a common or single offsite circuit to supply redundant ESF buses.

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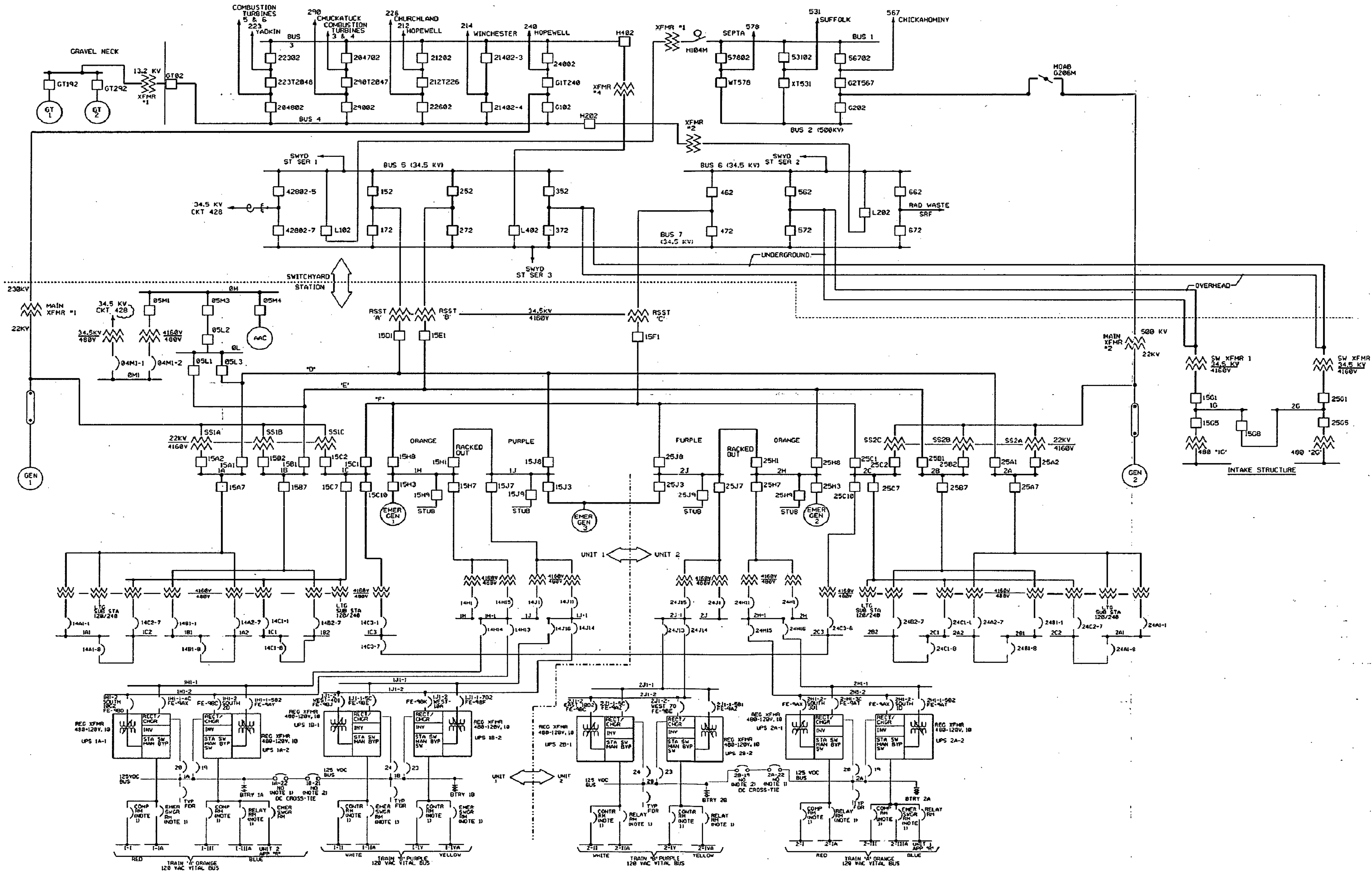
Surry Power Station Units 1 and 2

Attachment 1 - Electrical Distribution System



Response to NRC Bulletin 2012-01 Design Vulnerability in Electric Power System Surry Power Station Units 1 and 2

Attachment 2 - Tables

Table 1 - ESF Buses Continuously Powered From Offsite Power Source(s)

Description of Offsite Power Source Configuration	ESF buses connected to offsite power (normal operating condition)	Original licensing basis configuration (Y/N)
RSST "C"	1H ESF Bus	Y
RSST "A"	1J ESF Bus	Y
RSST "B"	2H ESF Bus	Y
RSST "C"	2J ESF Bus	Y

Table 2 - ESF Buses Not Continuously Powered From Offsite Power Source(s)

Description of Offsite Power Source Configuration	ESF buses connected to offsite power (normal operating condition)	Original licensing basis configuration (Y/N)
N/A	N/A	N/A

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Surry Power Station Units 1 and 2

Table 3 - ESF Buses Major Loads

Bus	Load Mark #	Load Description	Normal Running Load = X	Rating (HP) unless otherwise noted
1H	01-FW-P-3A	Motor Driven Aux Feed Pump		400
1H	01-CH-P-1A	Charging Pump	X (There are 3 Charging Pumps. 1 on 1J Train, 1 on 1H Train, and 1 swing pump that can be aligned to either 1H or 1J. Typically only 1 of 3 run)	600
1H or 1J	01-CH-P-1C	Swing Charging Pump	(There are 3 Charging Pumps. 1 on 1J Train, 1 on 1H Train, and 1 swing pump that can be aligned to either 1H or 1J. Typically only 1 of 3 run)	600
1H	01-EP-LCC-1H & 01-EP-LCC-1H1	TO 4160/480VAC Distribution	X	1.000 (MVA) & 1.333 (MVA)
1H	01-CC-P-1A	Component Cooling Pump	X (There are 2 Component Cooling Pumps. 1 on 1J Train and 1 on 1H Train. Typically only 1 of 2 run)	600
1H	01-RH-P-1A	Residual Heat Removal Pump		300
1J	01-FW-P-3B	Motor Driven Aux Feed Pump		400
1J	01-CH-P-1B	Charging Pump	(There are 3 Charging Pumps. 1 on 1J Train, 1 on 1H Train, and 1 swing pump that can be aligned to either 1H or 1J. Typically only 1 of 3 run)	600
1J	01-EP-LCC-1J & 01-EP-LCC-1J1	TO 4160/480VAC Distribution	X	1.000 (MVA) & 1.333 (MVA)
1J	01-CC-P-1B	Component Cooling Pump	(There are 2 Component Cooling Pumps. 1 on 1J Train and 1 on 1H Train. Typically only 1 of 2 run)	600
1J	01-RH-P-1B	Residual Heat Removal Pump		300

Response to NRC Bulletin 2012-01 Design Vulnerability in Electric Power System
Surry Power Station Units 1 and 2

Table 3 - ESF Buses Major Loads (Continued)

Bus	Load Mark #	Load Description	Normal Running Load = X	Rating (HP) unless otherwise noted
2H	02-FW-P-3A	Motor Driven Aux Feed Pump		400
2H	02-CH-P-1A	Charging Pump	**X** (There are 3 Charging Pumps. 1 on 2J Train, 1 on 2H Train, and 1 swing pump that can be aligned to either 2H or 2J. Typically only 1 of 3 run)	600
2H or 2J	02-CH-P-1C	Swing Charging Pump	(There are 3 Charging Pumps. 1 on 2J Train, 1 on 2H Train, and 1 swing pump that can be aligned to either 2H or 2J. Typically only 1 of 3 run)	600
2H	02-EP-LCC-2H & 02-EP-LCC-2H1	TO 4160/480VAC Distribution	**X**	1.000 (MVA) & 1.333 (MVA)
2H	01-CC-P-1C	Component Cooling Pump	**X** (There are 2 Component Cooling Pumps. 1 on 2J Train and 1 on 2H Train. Typically only 1 of 2 run)	600
2H	02-RH-P-1A	Residual Heat Removal Pump		300
2J	02-FW-P-3B	Motor Driven Aux Feed Pump		400
2J	02-CH-P-1B	Charging Pump	(There are 3 Charging Pumps. 1 on 2J Train, 1 on 2H Train, and 1 swing pump that can be aligned to either 2H or 2J. Typically only 1 of 3 run)	600
2J	02-EP-LCC-2J & 02-EP-LCC-2J1	TO 4160/480VAC Distribution	**X**	1.000 (MVA) & 1.000 (MVA)
2J	01-CC-P-1D	Component Cooling Pump	(There are 2 Component Cooling Pumps. 1 on 2J Train and 1 on 2H Train. Typically only 1 of 2 run)	600
2J	02-RH-P-1B	Residual Heat Removal Pump		300

Table 4 - Offsite Power Transformers

Transformer	Winding Configuration (High Side:Low Side)	MVA Size (OA/FA/FA)	Voltage Rating (Primary/Secondary)	Grounding Configuration
RSST "A"	Delta:Wye Low Resistance Grounded	18/24/30 (OA/FA/FA)	34.4kV/4.16kV	34.5kV Bus is Effectively Grounded. RSST "A" is Wye Low Resistance Grounded (on secondary)
RSST "B"	Delta:Wye Low Resistance Grounded	18/24/30 (OA/FA/FA)	34.4kV/4.16kV	34.5kV Bus is Effectively Grounded. RSST "B" is Wye Low Resistance Grounded (on secondary)
RSST "C"	Delta:Wye Low Resistance Grounded	18/24/30 (OA/FA/FA)	34.4kV/4.16kV	34.5kV Bus is Effectively Grounded. RSST "C" is Wye Low Resistance Grounded (on secondary)
SRT 1	Wye Grounded:Delta	67.5/90/112.5 (OA/FA/FOA)	512.5kV/36.5kV	500kV Bus is Effectively Grounded. SRT 1 Wye Solid Grounded (on primary), Grounded via zig-zag Ground Bank (on secondary)
SRT 2	Delta:Wye Grounded	67.2/89.6/112 (OA/FA/FOA)	230kV/36.51kV	230kV Bus is Effectively Grounded. SRT 2 Wye Grounded (on secondary)
SRT 4	Delta:Wye Grounded	67.2/89.6/112 (OA/FA/FOA)	230kV/36.5kV	230kV Bus is Effectively Grounded. SRT 4 Wye Grounded (on secondary)

Table 5 - Protective Devices

Protection Zone	Protective Device	Logic	Setpoint Nominal (VAC)	Sensitivity of Device (VAC)	Basis For Setpoint
1H ESF Bus Degraded Voltage	Degraded Voltage Relays	2 of 3	63.6 V $_{\text{LN-Secondary}}$	(+/-) 0.6077	Drop out to actuate upon a sustained ESF bus Degraded voltage of 92.7% nominal. Setpoint provides a minimum voltage the ESF buses can be operated at indefinitely.
1H ESF Bus Under Voltage	Loss of Voltage Relays	2 of 3	51.47 V$_{\text{LN-Secondary}}$	(+/-) 2.5423	The upper bound is set to ensure that the preferred power source shall not be disconnected for any transient experienced during the worst case voltage profile.
1J ESF Bus Degraded Voltage	Degraded Voltage Relays	2 of 3	63.6 V $_{\text{LN-Secondary}}$	(+/-) 0.6077	Drop out to actuate upon a sustained ESF bus Degraded voltage of 92.7% nominal. Setpoint provides a minimum voltage the ESF buses can be operated at indefinitely.
1J ESF Bus Under Voltage	Loss of Voltage Relays	2 of 3	51.47 V$_{\text{LN-Secondary}}$	(+/-) 2.5423	The upper bound is set to ensure that the preferred power source shall not be disconnected for any transient experienced during the worst case voltage profile.

Response to NRC Bulletin 2012-01 Design Vulnerability in Electric Power System
Surry Power Station Units 1 and 2

Table 5 - Protective Devices (Continued)

Protection Zone	Protective Device	Logic	Setpoint Nominal (VAC)	Sensitivity of Device (VAC)	Basis For Setpoint
2H ESF Bus Degraded Voltage	Degraded Voltage Relays	2 of 3	63.6 $V_{\text{LN-Secondary}}$	(+/-) 0.6077	Drop out to actuate upon a sustained ESF bus Degraded voltage of 92.7% nominal. Setpoint provides a minimum voltage the ESF buses can be operated at indefinitely.
2H ESF Bus Under Voltage	Loss of Voltage Relays	2 of 3	51.47 $V_{\text{LN-Secondary}}$	(+/-) 2.5423	The upper bound is set to ensure that the preferred power source shall not be disconnected for any transient experienced during the worst case voltage profile.
2J ESF Bus Degraded Voltage	Degraded Voltage Relays	2 of 3	63.6 $V_{\text{LN-Secondary}}$	(+/-) 0.6077	Drop out to actuate upon a sustained ESF bus Degraded voltage of 92.7% nominal. Setpoint provides a minimum voltage the ESF buses can be operated at indefinitely.
2J ESF Bus Under Voltage	Loss of Voltage Relays	2 of 3	51.47 $V_{\text{LN-Secondary}}$	(+/-) 2.5423	The upper bound is set to ensure that the preferred power source shall not be disconnected for any transient experienced during the worst case voltage profile.

ENCLOSURE 3

Response to NRC Bulletin 2012-01 Design Vulnerability in Electric Power System

Millstone Power Station Units 2 and 3

Dominion Nuclear Connecticut, Inc.
(DNC, Inc.)

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System Millstone Power Station Units 2 and 3

Bulletin Response

The Bulletin response is arranged in the following way:

- System Description - Items 2, 1.d, 2.a, 2.c
- System Protection - 1, 1.a, 2.b, 2.d
- Consequences - 1.b, 1.c, 2.e
- Attachment 1 - Simplified One-Line Diagram
- Attachment 2 - Tables
  - Table 1 - ESF Buses Continuously Powered From Offsite Power Source(s)
  - Table 2 - ESF Buses Not Continuously Powered From Offsite Power Source(s)
  - Table 3 - ESF Buses Major Loads
  - Table 4 - Offsite Power Transformers
  - Table 5 - Protective Devices

System Description

Items 2, 1.d, 2.a, and 2.c request system information and will be addressed in this section:

2. Briefly describe the operating configuration of the ESF buses (Class 1E for current operating plants or non-Class 1E for passive plants) at power (normal operating condition).

See Attachment 1, for a simplified one-line diagram.

The Millstone Power Station Unit 2 (MPS2) Engineering Safeguards Features (ESF) buses consist of facility 1 4160V bus 24C, facility 2 4160V bus 24D and a swing 4160V bus 24E that is aligned to either 24C or 24D. During normal operation, these buses are powered from the main generator via the Normal Station Service Transformer (NSST). The NSST is connected to non-safety buses 24A and 24B. Bus 24C is fed by bus 24A and bus 24D fed by bus 24B. The MPS2 Reserve Station Service Transformer (RSST) is available to power buses 24C and 24D directly if needed. A 4 KV cross tie is also available to provide power from Millstone Power Station Unit 3 (MPS3) to MPS2 if needed. This cross tie connects either bus 34A or 34B to bus 24E.

The MPS3 ESF buses consist of train A 4160V bus 34C and train B 4160V bus 34D. During normal operation, both of these buses are powered by the main generator via the NSST. The NSST is connected to non-safety buses 34A and 34B. Bus 34C fed by bus 34A and bus 34D powered by bus 34B. The MPS3 RSST is available to power buses 34C and 34D directly if needed.

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System Millstone Power Station Units 2 and 3

1. d Describe the offsite power transformer (e.g., start-up, reserve, station auxiliary) winding and grounding configurations.

See Attachment 2, Table 4 for offsite power transformer winding and grounding configurations.

The MPS2 RSST transformer is scheduled to be replaced in October 2012. The existing models are based on the old transformer. It is expected that modeling of the replacement transformer will result in similar results. Both the existing and replacement transformer data have been included in Attachment 2, Table 4.

2. a. Are the ESF buses powered by offsite power sources? If so, explain what major loads are connected to the buses including their ratings.

For at power (normal operating condition) configurations, the ESF buses are not powered by offsite sources. For both MPS2 and MPS3, the ESF buses are powered by the unit's main generator via the unit's NSST.

See Attachment 2, Tables 1 and 2 for ESF bus power sources

2. c. Confirm that the operating configuration of the ESF buses is consistent with the current licensing basis. Describe any changes in offsite power source alignment to the ESF buses from the original plant licensing.

The following at power (normal operating condition) configurations have been confirmed to be consistent with the current licensing basis:

Each Millstone Unit is required to have two paths to the offsite power system. The credited paths are:

1. MPS2 circuit 1: power to bus 24C and 24D via the MPS2 RSST
2. MPS2 circuit 2: power to bus 24C or 24D from bus 24E via the cross tie from MPS3. Either the MPS3 NSST(via buses 34A or 34B) or MPS3 RSST (via buses 34C/34A or 34D/34B) paths can be credited for this supply.
3. MPS3 circuit 1: power to bus 34C and 34D via the MPS3 NSST (via buses 34A and 34B, respectively).
4. MPS3 circuit 2: power to bus 34C and 34D via the MPS3 RSST.

The only change from original plant licensing concerns the second path for MPS2. Originally, the second path was a cross tie to Millstone Unit 1. When Millstone Unit 1 was decommissioned, this cross tie was realigned to MPS3.

System Protection

Items 1, 1.a, 2.b, and 2.d request information regarding electrical system protection and will be addressed in this section:

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System Millstone Power Station Units 2 and 3

1. Given the requirements above, describe how the protection scheme for ESF buses (Class 1E for current operating plants or non-Class 1E for passive plants) is designed to detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on a credited off-site power circuit or another power sources. Also, include the following information:

Consistent with the current licensing basis and GDC 17, existing protective circuitry will separate the ESF buses from a connected failed source due to a loss of voltage or a sustained, balanced degraded grid voltage.

Millstone has modeled various single phase open circuit scenarios to determine how the plant would respond. The ETAP electrical distribution system modeling program used at Millstone does not have the capability to accurately model an open phase on the high side of a station service transformer. Due to this limitation, corporate engineering worked with Dominion Electric Transmission to combine the Millstone ETAP model with the Electric Transmission PSCAD modeling software to evaluate the Millstone response to these scenarios. This is the best available modeling at this time. The ETAP software is currently being upgraded to provide a better modeling program. The results of the current modeling are documented in a Millstone Engineering Technical Evaluation. A summary of the at-power (or with Loss of Coolant Accident (LOCA) load), open circuit, with no ground scenarios evaluated and the results are provided below.

Scenario 1 - MPS2 NSST: Mode 1 or LOCA load
MPS2 does not have a main generator output breaker. If a single phase open circuit occurs on the NSST side, the main generator negative sequence relay would detect the condition, trip the generator and force a fast transfer to the RSST. This action automatically isolates the single phase open circuit.

Scenario 2 - MPS2 RSST: open circuit, no load
This scenario is the normal operating scenario where the RSST is in standby with no load. It is not connected to the 4.16 KV bus so degraded voltage and under voltage relays do not monitor the RSST voltage. If a single phase open circuit occurs on the high side of the RSST, the delta winding on the low side of the transformer will create the missing third phase of voltage. Since there are no motor loads connected, there is no damage to plant equipment. The concern for this scenario is that the RSST would appear to be available for service but would trip when load is added to it. This condition is not detectable by voltage indications.

Scenario 3 - MPS2 RSST: open circuit, Mode 1 or LOCA load
This scenario models the load on the RSST after a reactor trip from full power. The RSST is connected to the 4.16 KV bus. If a single phase open circuit occurs on the high side of the RSST, the 4.16 KV bus voltage drops below the degraded voltage relay setting. This will result in the tripping of the RSST feeder breaker after 8 seconds followed by the Emergency Diesel Generator (EDG) starting and repowering the bus.

Scenario 4 - MPS3 RSST: open circuit, no load
This scenario is the normal operating scenario where the RSST is in standby with no load. It is not connected to the 4.16 KV bus so degraded voltage and under voltage relays do not monitor the RSST voltage. If a single phase open circuit occurs on the high side of the RSST, the delta

monitor the RSST voltage. If a single phase open circuit occurs on the high side of the RSST, the delta winding on the low side of the transformer will create the missing third phase of voltage. Since there are no motor loads connected, there is no damage to plant equipment. The concern for this scenario is that the RSST would appear to be available for service but would provide unacceptable voltages when load is added to it. This condition is not detectable by voltage indications.

Scenario 5 - MPS3 RSST: open circuit, Mode 1 or LOCA load
This scenario models the load on the RSST after a reactor trip from full power combined with a loss of the NSST supply. The RSST is connected to the 4.16 KV bus. If a single phase open circuit occurs on the high side of the RSST, the 4.16 KV bus voltage drops but not low enough to be detected by the degraded voltage relays. This scenario is similar to the Byron event in that there will be voltage imbalances that will create high motor currents. The voltage relays will not detect the problem so the RSST breaker will remain closed and the EDG will not start. Operations will notice many loads tripping on overcurrent and will not be able to start new loads.

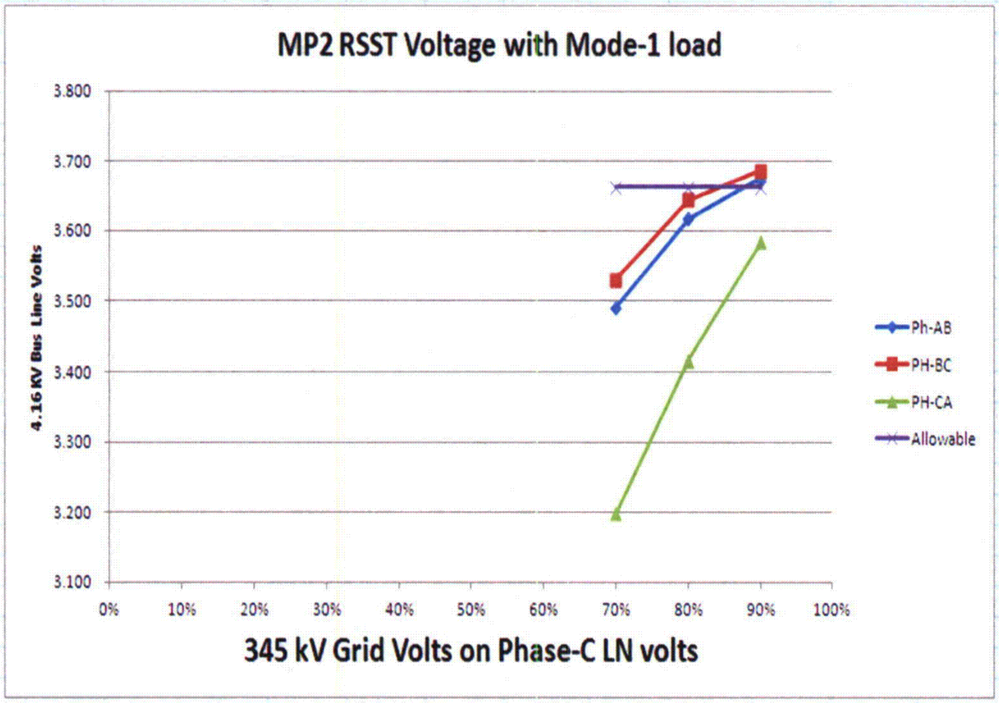
Scenario 6 - MPS3 NSST open circuit, Mode 1 or LOCA load
This scenario would be the normal configuration after a reactor trip. If an open circuit occurs on the high side of the main transformer during plant operation, the main generator negative sequence relay would operate and trip the generator. This would result in opening the main generator output breaker. The NSST would still be connected to the 4.16 KV bus and would be powered via the Main Transformer operating in a backfeed mode. The 4.16 KV bus voltage would remain above the degraded voltage relay setting and would have a very little voltage imbalance. Loads on the 4.16 KV bus will continue to operate normally in this condition.

For a high impedance ground with two phases intact and the third phase at reduced voltage simulating a high impedance fault (with or without that phase being open circuited), the bus voltages will vary depending on the amount of impedance to ground. Millstone modeled the effect on the 4 KV buses due to a decreasing phase to neutral voltage (associated with a high impedance ground) on a single 345KV phase. The graphs show the decreasing 4KV voltages and where they cross the degraded voltage allowable values. The MPS2 graph shows the RSST results after a fast bus transfer (FBT). The MPS3 graph shows the NSST results. As the ground impedance drops, protective relaying on the 345KV system will detect the ground and trip the associated breakers, but this action has not been included in the graph.

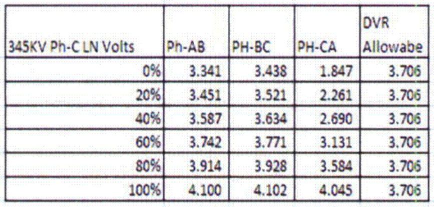
MP2 RSST 4.16 kV Bus voltages as a result of reduction on one of the phase voltage on 345 kV Grid

	24C/D			
345KV Ph-C LN Volts	Ph-AB	PH-BC	PH-CA	Allowable
70%	3.492	3.531	3.199	3.663
80%	3.618	3.644	3.417	3.663
90%	3.676	3.687	3.585	3.663

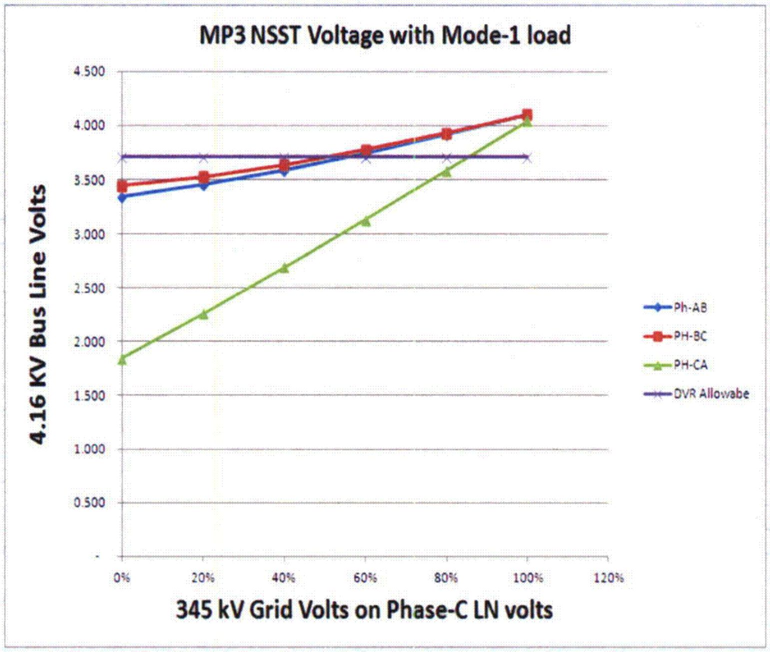
Line Volts	No Load at 70% volts
Ph-AB	4.078
PH-BC	4.097
PH-CA	3.411



MP3 NSST 4.16 kV Bus voltages as a result of reduction on one of the phase voltage on 345 kV Grid



345KV Ph-C LN Volts	Ph-AB	PH-BC	PH-CA	DVR Allowabe
0%	3.341	3.438	1.847	3.706
20%	3.451	3.521	2.261	3.706
40%	3.587	3.634	2.690	3.706
60%	3.742	3.771	3.131	3.706
80%	3.914	3.928	3.584	3.706
100%	4.100	4.102	4.045	3.706



1.a. The sensitivity of protective devices to detect abnormal operating conditions and the basis for the protective device setpoint(s).

Consistent with the current licensing basis and GDC 17, existing electrical protective devices are sufficiently sensitive to detect design basis conditions such as a loss of voltage or a degraded voltage, but were not designed to detect a single open phase condition. See Attachment 2, Table 5 for protective devices and the basis for the device setpoint(s). The MPS2 and MPS3 4KV systems are grounded systems. The individual loads have ground overcurrent relays but the buses do not have ground protection/alarms.

2.b. If the ESF buses are not powered by offsite power sources, explain how the surveillance tests are performed to verify that a single-phase open circuit condition or high impedance ground fault condition on an off-site power circuit is detected.

MPS2 Technical Specification (TS) surveillance requirement 4.8.1.1.1 requires a check of breaker alignment and indicated power availability. Power availability is checked by monitoring voltages. With a single phase open circuit, the voltages appear normal. This TS surveillance will not detect a single phase open circuit. Although this surveillance test would not detect a single phase open circuit, MPS2 would detect this condition due to normal plant operation. MPS2 does not have a main generator output circuit breaker. When MPS2 shuts down, the station service loads are transferred to the RSST. As such, a single phase open circuit would be detected on at least a refueling frequency.

MPS3 TS surveillance requirement 4.8.1.1.1.a is similar to MPS2 and will not detect a single phase open circuit. MPS3 has an additional TS surveillance requirement 4.8.1.1.1.b that requires transferring the power supply from the NSST to the RSST every 18 months. Depending on the bus loading at the time of the surveillance, a single phase open circuit may be detected if motors begin to trip. Additionally, MPS3 station service loads are transferred to the MPS3 RSST periodically in support of breaker PMs of the NSST feeder and 4KV bus tie breakers.

Several of the single phase open circuit scenarios result in unacceptable conditions that require additional action:

Scenarios 2 and 4 result in a condition that is not detectable by protective relays. Periodic walkdowns of the transformers and switchyard are performed by Operations, Generation Test Services (GTS), Northeast Utilities, and system engineering to identify these conditions. Due to the delta winding on the low side of the transformers, the voltage on the open circuited line may appear normal. Neither voltage relays nor operator monitoring of voltmeters would detect the single open phase. Since the RSSTs are normally in standby, individual phase currents are approximately zero. Neither negative sequence relays nor operator monitoring of bus/phase currents would detect a single phase open circuit. Caution needs to be taken to ensure that efforts to identify and isolate the single open phase condition do not result in a decreased reliability of the electrical system that could occur if an offsite power source was isolated unnecessarily. Based on current industry activities, there is no known protective relay scheme that can detect this unloaded single open phase condition.

Scenario 5 identifies a condition that would challenge the operators with overcurrent trips across many systems. This requires the operators to realize the supply voltage is compromised and trip the associated feeder breaker. Operator training is being developed to increase awareness of this scenario.

Although Millstone has not fully modeled the effect of high impedance grounds, preliminary models indicate that there will be voltage imbalances at the 4 KV level. With the affected source carrying load, depending on the magnitude of the ground, this may or may not be detected.

2.d. Do the plant operating procedures, including off-normal operating procedures, specifically call for verification of the voltages on all three phases of the ESF buses?

Based on the plant responses predicted by modeling single phase open circuits, Millstone procedures have been evaluated. Although an ungrounded single phase open circuit on the line feeding a standby RSST will result in almost normal phase voltages, a grounded phase could reduce that phase's voltage. As such, both MPS2 and MPS3 have added a check of each phase of the 4 KV voltage provided by their RSST to their weekly rounds.

Only one phase of ESF bus voltage is checked during operator rounds. This is acceptable since these buses are fed from the main generator. A single phase open circuit on the MPS2 generator would result in a negative sequence relay trip of the main generator and a fast transfer of the 4 KV buses to the RSST automatically isolating the open circuit.

A single phase open circuit on the MPS3 generator would result in a negative sequence relay trip of the main generator. Since MPS3 has a generator output breaker, a transfer to the RSST will not occur. The Millstone model predicts the voltages at the 4 KV buses in this scenario will be acceptable.

The MPS2 scenario for a loaded RSST with an open circuit shows bus voltage dropping below the degraded grid voltage relay setpoint. In this scenario, the RSST feeder breakers will automatically trip open in 8 seconds which will isolate the open circuit. Operator action is not needed in this case so no change to the operating procedure has been made.

The MPS3 scenario for a loaded RSST with an open circuit shows the bus voltage dropping, but not low enough to actuate the degraded grid voltage relays. Since the degraded voltage relays will not actuate, the associated alarm will not be received and the operators will not be looking at that annunciator response procedure. As such, changes to the degraded grid voltage annunciator response procedure to check each of the three phases would not improve the operators' response and no changes are planned for this procedure.

In response to the Byron event, Millstone is developing operator training. Additional changes to operator procedures may result from these training efforts.

Consequences

Items 1.b, 1.c, and 2.e request information regarding the electrical consequences of an event and will be addressed in this section:

1.b. The differences (if any) of the consequences of a loaded (i.e., ESF bus normally aligned to offsite power transformer) or unloaded (e.g., ESF buses normally aligned to unit auxiliary transformer) power source.

The installed relays were not designed to detect single open phase conditions. Existing loss of voltage and degraded voltage relays may respond depending on load and possible grounds. In general, there will be no automatic plant response or operator action for an unloaded RSST power source in the event of a single-phase open circuit because there is insufficient current to detect a single-phase open circuit in this configuration.

The plant response for the loaded and unloaded scenarios modeled at Millstone is provided in the answer to question 1 above.

1.c. If the design does not detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on a credited offsite power circuit or another power source, describe the consequences of such an event and the plant response.

The Class 1E ESF buses at Millstone 2 and 3 do not include a protection scheme that are designed to detect and automatically respond to a single-phase open circuit condition on the credited offsite power source..

The Millstone Electrical Design Basis is described in the Millstone TS and UFSAR as follows:

> MPS2 TS 3.8.1.1 - As a minimum, the following A.C. electrical power sources shall be OPERABLE: Two physically independent circuits between the offsite transmission network and the onsite Class 1E distribution system.
>
> During normal operation, these two paths are the MPS2 RSST and either the MPS3 NSST or MPS3 RSST via a 4 KV cross tie. The MPS2 NSST can be credited if the disconnecting links to the main generator are removed.
>
> MPS2 TS 3.3.2.1 - Describes the logic and settings of the 4 KV bus under voltage and degraded voltage relays.
>
> MPS3 TS 3.8.1.1 - As a minimum, the following A.C. electrical power sources shall be OPERABLE: Two physically independent circuits between the offsite transmission network and the onsite Class 1E Distribution System.
>
> The two paths are the MPS3 NSST and the MPS3 RSST.
>
> MPS3 TS 3.3.2 - Describes the logic and settings of the 4 KV bus under voltage and degraded voltage relays.
>
> Section 8 of each unit's FSAR describes the electrical distribution systems. An overview of the portion of the systems associated with the issues raised by NRC Bulletin 2012-01 is provided below:

The offsite power supply to the safety related 4.16 KV bus design is similar for MPS2 and MPS3. Each plant has two safety related 4.16 KV buses. Each plant has a main transformer and a NSST that taps off the 24KV bus between the generator and the main transformer. Additionally, each plant has a RSST that steps the 345 KV directly down to 4.16 KV. During normal plant operation, the 4.16 KV buses are supplied from the NSST. The NSST connects to two non-safety related 4.16 KV buses which are then connected to two safety-related 4.16 KV buses by cross tie breakers. MPS3 has a main generator output circuit breaker. If a plant trip occurs, the 4.16 KV buses remain powered by the NSST. If the generator output circuit breaker does not trip or there is a failure on the NSST side, a fast transfer of the 4.16 KV buses to the RSST will occur. MPS2 does not have a main generator output breaker. Every time the plant trips, the 4.16 KV buses fast transfer to the RSST.

The degraded grid voltage and under voltage design is the same for MPS2 and MPS3. Each train of the 4.16 KV safety related buses has 4 degraded grid relays/sensors and 4 under voltage relays/sensors. MPS3 uses relays for this function. MPS2 uses bistables within its sequencer for this function. The term "relay" will be used throughout this response for both units. Each unit has two degraded grid relays and two under voltage relays monitoring the phase A-B voltage and two degraded grid relays and two under voltage relays monitoring the phase B-C voltage. These relays are arranged in a 2 of 4 logic such that a single relay failing to operate when desired or spuriously operating (for example in response to a blown fuse) when not desired will not prevent a protective action nor cause a spurious actuation. The 4.16 KV bus phase A-C voltage is not monitored by protective relays.

At MPS2, if the degraded grid voltage setpoint is reached and maintained for 8 seconds, the RSST feeder breaker will trip. If the under voltage setpoint is reached and maintained for 2 seconds, the RSST and bus tie breakers will trip and the EDGs will start and repower the safety related 4.16 KV buses.

At MPS3, if the degraded grid voltage setpoint is reached and maintained for 7 seconds with an accident signal (SIS/CDA) or for 270 seconds without an accident signal present, the RSST and 4.16 KV bus tie breakers will open, the EDGs will start and repower the safety related 4.16 KV buses. If the under voltage setpoint is reached and maintained for 2 seconds, the plant will attempt an automatic slow transfer of the ESF buses to the RSST. If the slow transfer fails, the EDGs will repower the safety related 4.16 KV buses.

1. Since Millstone did not credit the detection and automatic response to a loss of a single phase event in the ESF design, an open phase fault was not included in the design criteria for either the loss of voltage or the degraded voltage relay schemes. Additionally, since open phase detection was not credited in the Millstone design basis, no calculations or design documents exist that previously considered this condition.

2. Using the best available modeling programs, Millstone evaluated several single phase open circuit scenarios. The results are described in the answer to question 1 above.

3. Millstone has open corrective actions to monitor industry efforts to improve modeling and protective relay designs and to take additional actions as appropriate.

4. The consequences of a high impedance ground fault are described in the answer to question 1 above.

2.e. If a common or single offsite circuit is used to supply redundant ESF buses, explain why a failure, such as a single-phase open circuit or high impedance ground fault condition, would not adversely affect redundant ESF buses.

Consistent with the Current Licensing Basis and GDC 17, protective circuitry will separate the ESF buses from a failed source due to a loss of voltage or a sustained balanced degraded grid voltage.

Although an ungrounded open phase condition would not be detected by voltage indications, an open phase that shorts to ground would be detectable. MPS2 and MPS3 have revised their weekly operator rounds to include the three phases of voltage indication in their voltage checks of the RSST.

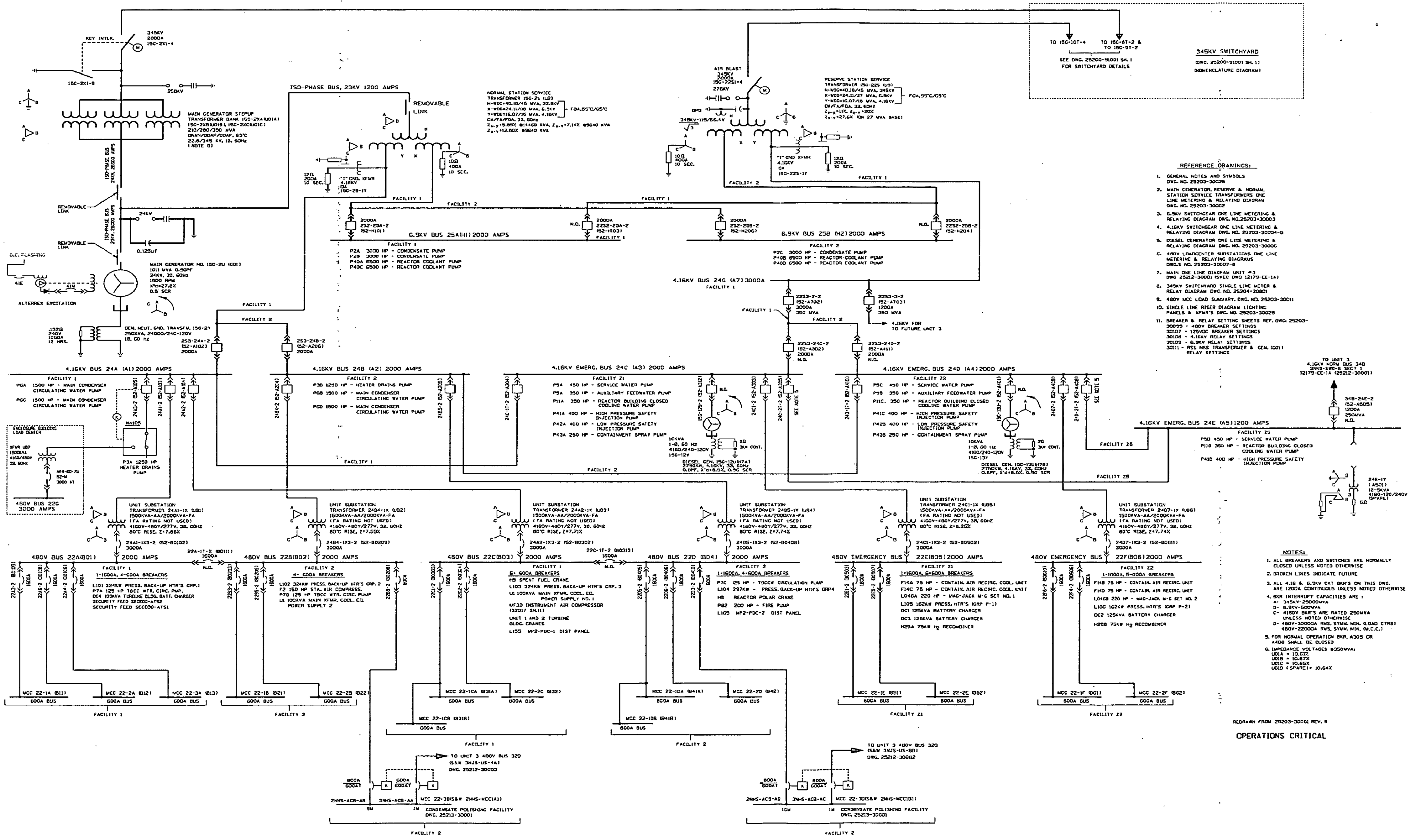
For MPS2, if a single phase open circuit failure occurs on the RSST supply line while it is feeding the ESF buses, the existing models show the 4 KV bus voltages dropping below the degraded voltage relay setpoint. This will isolate the ESF buses from the degraded source in eight seconds and transfer the ESF buses to the emergency diesel generators.

For MPS3, the NSST will normally continue to supply the ESF buses after a reactor trip. With a single phase open circuit, the existing models show the 4 KV bus voltages will remain above the degraded voltage settings and will remain balanced. The ESF buses will continue to operate normally in this condition. Although the MPS3 RSST models show an unacceptable response, it would take a failure of the NSST and an open circuit failure on the RSST supply to reach this condition. This scenario requires two separate failures.

For MPS2 and MPS3, depending on the magnitude of the high impedance ground fault, redundant ESF buses may or may not be affected. Millstone has open corrective actions to monitor industry efforts to improve modeling and protective relay designs and to take additional actions as appropriate.

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System Millstone Power Station Units 2 and 3

Attachment 1 - Electrical Distribution System Millstone Unit 2



REFERENCE DRAWINGS:

1. GENERAL NOTES AND SYMBOLS DWG. NO. 25203-30028
2. MAIN GENERATOR, RESERVE & NORMAL STATION SERVICE TRANSFORMERS ONE LINE METERING & RELAYING DIAGRAM DWG. NO. 25203-30002
3. 6.9KV SWITCHGEAR ONE LINE METERING & RELAYING DIAGRAM DWG. NO.25203-30003
4. 4.16KV SWITCHGEAR ONE LINE METERING & RELAYING DIAGRAM DWG. NO. 25203-30004-5
5. DIESEL GENERATOR ONE LINE METERING & RELAYING DIAGRAM DWG. NO. 25203-30006
6. 480V LOADCENTER SUBSTATIONS ONE LINE METERING & RELAYING DIAGRAMS DWG.S NO. 25203-30007-8
7. MAIN ONE LINE DIAGRAM UNIT #3 DWG 25212-30001 (SWEC DWG 12179-EE-1A)
8. 345KV SWITCHYARD SINGLE LINE METER & RELAY DIAGRAM DWG. NO. 25204-30801
9. 480V MCC LOAD SUMMARY, DWG. NO. 25203-30011
10. SINGLE LINE RISER DIAGRAM LIGHTING PANELS & XFMR'S DWG. NO. 25203-30025
11. BREAKER & RELAY SETTING SHEETS REF. DWG: 25203-
    30099 - 480V BREAKER SETTINGS
    30107 - 125VDC BREAKER SETTINGS
    30108 - 4.16KV RELAY SETTINGS
    30109 - 6.9KV RELAY SETTINGS
    30111 - RSS NSS TRANSFORMER & GEN. (G01) RELAY SETTINGS

NOTES:

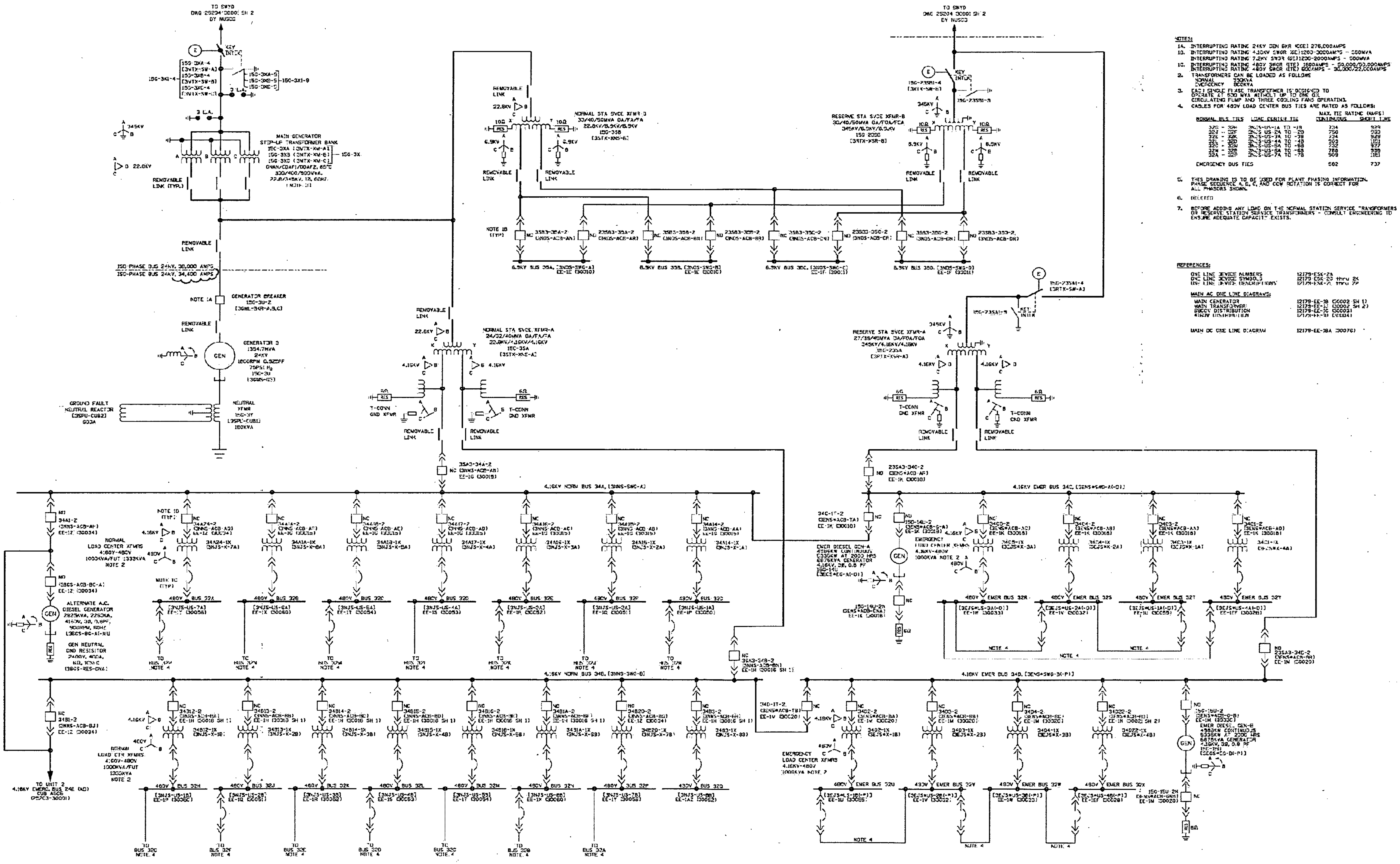
1. ALL BREAKERS AND SWITCHES ARE NORMALLY CLOSED UNLESS NOTED OTHERWISE
2. BROKEN LINES INDICATE FUTURE
3. ALL 4.16 & 6.9KV CKT BKR'S ON THIS DWG. ARE 1200A CONTINUOUS UNLESS NOTED OTHERWISE
4. BKR INTERRUPT CAPACITIES ARE :
    A- 345KV-25000MVA
    B- 6.9KV-500MVA
    C- 4160V BKR'S ARE RATED 250MVA UNLESS NOTED OTHERWISE
    D- 480V-30000A RMS. SYMM. MIN. (LOAD CTRS)
    480V-22000A RMS. SYMM. MIN. (M.C.C.)
5. FOR NORMAL OPERATION BKR. A305 OR A408 SHALL BE CLOSED
6. IMPEDANCE VOLTAGES @350MVA:
    U01A = 10.61%
    U01B = 10.67%
    U01C = 10.65%
    U01D (SPARE) = 10.64%

REDRAWN FROM 25203-30001 REV. 9

OPERATIONS CRITICAL

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System
Millstone Power Station Units 2 and 3

Attachment 1 - Electrical Distribution System Millstone Unit 3



NOTES:

1A. INTERRUPTING RATING 24KV GEN BKR (GE) 276,000AMPS
1B. INTERRUPTING RATING 4.16KV SWGR (GE) 1200-3000AMPS - 350MVA
INTERRUPTING RATING 7.2KV SWGR (GE) 1200-2000AMPS - 500MVA
1C. INTERRUPTING RATING 480V SWGR (ITE) 1600AMPS - 50,000/30,000AMPS
INTERRUPTING RATING 480V SWGR (ITE) 600AMPS - 30,000/22,000AMPS
2. TRANSFORMERS CAN BE LOADED AS FOLLOWS
NORMAL 930KVA
EMERGENCY 800KVA
3. EACH SINGLE PHASE TRANSFORMER IS DESIGNED TO OPERATE AT 500 MVA WITHOUT UP TO ONE OIL CIRCULATING PUMP AND THREE COOLING FANS OPERATING.
4. CABLES FOR 480V LOAD CENTER BUS TIES ARE RATED AS FOLLOWS:

NORMAL BUS TIES	LOAD CENTER TIE	MAX. TIE RATING (AMPS) CONTINUOUS	MAX. TIE RATING (AMPS) SHORT TIME
32G - 32H	3NJS-US-1A TO -1B	734	929
32J - 32F	3NJS-US-2A TO -2B	750	930
32E - 32K	3NJS-US-3A TO -3B	734	929
32L - 32D	3NJS-US-4A TO -4B	909	1101
32C - 32M	3NJS-US-5A TO -5B	732	927
32N - 32B	3NJS-US-6A TO -6B	788	930
32A - 32P	3NJS-US-7A TO -7B	909	1101
EMERGENCY BUS TIES		602	737

5. THIS DRAWING IS TO BE USED FOR PLANT PHASING INFORMATION. PHASE SEQUENCE A, B, C, AND CCW ROTATION IS CORRECT FOR ALL PHASORS SHOWN.
6. DELETED
7. BEFORE ADDING ANY LOAD ON THE NORMAL STATION SERVICE TRANSFORMERS OR RESERVE STATION SERVICE TRANSFORMERS - CONSULT ENGINEERING TO ENSURE ADEQUATE CAPACITY EXISTS.

REFERENCES:

ONE LINE DEVICE NUMBERS	12179-ESK-2A
ONE LINE DEVICE SYMBOLS	12179-ESK-2G thru 2K
ONE LINE DEVICE DESCRIPTIONS	12179-ESK-2L thru 2P
MAIN AC ONE LINE DIAGRAMS:	
MAIN GENERATOR	12179-EE-1B (30002 SH 1)
MAIN TRANSFORMER	12179-EE-1J (30002 SH 2)
6900V DISTRIBUTION	12179-EE-1C (30003)
4160V DISTRIBUTION	12179-EE-1D (30004)
MAIN DC ONE LINE DIAGRAM	12179-EE-1BA (30076)

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System Millstone Power Station Units 2 and 3

Attachment 2 - Tables

Table 1 - ESF Buses Continuously Powered From Offsite Power Source(s)

Description of Offsite Power Source Configuration	ESF buses connected to offsite power (normal operating condition)	Original licensing basis configuration (Y/N)
N/A	N/A	N/A

Table 2 - ESF Buses Not Continuously Powered From Offsite Power Source(s)

Description of Offsite Power Source Configuration	ESF buses connected to offsite power (normal operating condition)	Original licensing basis configuration (Y/N)
MPS2 NSST	24C, 24D, 24E	Y
MPS3 NSST	34C, 34D	Y

Table 3 - ESF Buses Normally Energized Major Loads

(Note: Table 3 is N/A for MPS since the ESF buses are not normally powered by offsite power. Ref. Bulletin question 2.a.)

Bus	Load Mark #	Load Description	Rating (HP) unless otherwise noted
N/A	N/A	N/A	N/A

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System
Millstone Power Station Units 2 and 3

Table 4 - Offsite Power Transformers

Transformer	Winding Configuration (High Side - Low Side)	MVA Size (OA/FA/FA)	Voltage Rating (KV) (Primary/Secondary)	Grounding Configuration
MPS2 Main Transformer	Wye:Delta	630/840/1050 ONAN/ODAF/ODAF	345/22.8	345 KV Wye solid grounded
MPS2 NSST	Delta:Delta:Wye	27/36/45 OA/FA/FOA	22.8/4.16/6.9	6.9 KV Wye resistance grounded
MPS2 RSST (Old transformer)	Wye:Delta:Wye	27/36/45 OA/FA/FOA	345/4.16/6.9	345 KV Wye solid grounded, 6.9 KV Wye resistance grounded
MPS2 RSST (New transformer)	Wye:Delta:Wye	36/48/60 ONAN/ONAF/ONAF	345/4.16/6.9	345 KV Wye solid grounded, 6.9 KV Wye resistance grounded
MPS3 Main Transformer	Wye:Delta	900/1200/1500 ONAN/ODAF1/ODAF2	345/22.8	345 KV Wye solid grounded
MPS3 NSST A	Delta:Delta:Delta	24/32/40 OA/FA/FA	22.8/4.16/4.16	None
MPS3 NSST B	Delta:Wye:Wye	30/40/50 OA/FA/FA	22.8/6.9/6.9	Both 6.9 KV windings are resistance grounded
MPS3 RSST A	Wye:Delta:Delta	27/36/45 OA/FOA/FOA	345/4.16/4.16	345 KV Wye solid grounded
MPS3 RSST B	Wye:Wye:Wye	30/40/50 OA/FOA/FOA	345/6.9/6.9	345 KV Wye solid grounded and both 6.9 KV windings are resistance grounded

Table 5 - Protective Devices

Protection Zone	Protective Device	Logic	Setpoint Nominal (VAC)	Basis For Setpoint
Bus 24C	Degraded Voltage Relays	2 of 4	3710V (89% of 4160)	To actuate upon a balanced grid degraded voltage condition
Bus 24C	Loss of Voltage Relays	2 of 4	2975V (72% of 4160)	To actuate upon a complete loss of ESF bus voltage
Bus 24D	Degraded Voltage Relays	2 of 4	3710V (89% of 4160)	To actuate upon a balanced grid degraded voltage condition
Bus 24D	Loss of Voltage Relays	2 of 4	2975V (72% of 4160)	To actuate upon a complete loss of ESF bus voltage
Bus 34C	Degraded Voltage Relays	2 of 4	3730V (90% of 4160)	To actuate upon a balanced grid degraded voltage condition
Bus 34C	Loss of Voltage Relays	2 of 4	2835 (68% of 4160)	To actuate upon a complete loss of ESF bus voltage
Bus 34D	Degraded Voltage Relays	2 of 4	3730V (90% of 4160)	To actuate upon a balanced grid degraded voltage condition
Bus 34D	Loss of Voltage Relays	2 of 4	2835 (68% of 4160)	To actuate upon a complete loss of ESF bus voltage

ENCLOSURE 4

Response to NRC Bulletin 2012-01 Design Vulnerability in Electric Power System

Kewaunee Power Station

Dominion Energy Kewaunee, Inc.
(DEK, Inc.)

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System Kewaunee Power Station

Bulletin Response

The Bulletin response is arranged in the following way:

- System Description - Items 2, 1.d, 2.a, 2.c
- System Protection - 1, 1.a, 2.b, 2.d
- Consequences - 1.b, 1.c, 2.e
- Attachment 1 - Simplified One-Line Diagram
- Attachment 2 - Tables
  - Table 1 - ESF Buses Continuously Powered From Offsite Power Source(s)
  - Table 2 - ESF Buses Not Continuously Powered From Offsite Power Source(s)
  - Table 3A-3D - ESF Buses Major Loads
  - Table 4 - Offsite Power Transformers
  - Table 5 - Protective Devices

System Description

Items 2, 1.d, 2.a, 2.c request system information and are addressed in this section:

2. Briefly describe the operating configuration of the ESF buses (Class 1E for current operating plants or non-Class 1E for passive plants) at power (normal operating condition).

See Attachment 1 for simplified one-line diagrams of the Kewaunee Power Station (KPS) electrical distribution system.

There are two 4.16-kV Engineered Safety Features (ESF) buses at KPS (1-5 and 1-6). In the normal operating configuration (at power), the 4.16-kV ESF buses are provided power from their preferred offsite power source via two independent transformers (Tertiary Auxiliary Transformer (TAT) to Bus 1-5 and Reserve Auxiliary Transformer (RAT) to Bus 1-6).

Both of the offsite power supply circuits (TAT and RAT) will normally be energized and will be connected to one or the other of the 4.16-kV ESF buses. Thus, a trip of the reactor, turbine generator, and main station auxiliary source of power (Main Auxiliary Transformer) does not require a transfer for the 4.16-kV ESF buses.

The KPS switchyard consists of 345-kV and 138-kV sections. Both the 345-kV and 138-kV sections have been configured to a double-breaker, double-bus orientation. The double-bus orientation within the 345-kV section of the switchyard includes the L1 bus and L2 bus. The double-bus orientation within the 138-kV section of the switchyard includes the west bus and east bus.

The TAT receives power from the Tertiary Supply Transformer (TST) via an underground insulated power cable and the RAT receives power from the Reserve Supply Transformer (RST) via an overhead transmission line. A load tap changer (LTC) is used on both the TST and RST to adjust the voltage to the RAT and TAT as necessary. The TST and RST receive power from the 138-kV section of the switchyard from independent points. The TST receives power via an underground insulated power cable that connects to the 138-kV section of the switchyard through two normally closed breakers. The RST receives power via an overhead transmission line that connects to the 138-kV section of the switchyard through two normally closed breakers (different from those used for the TST) that are each directly connected to the applicable 138-kV west bus and 138-kV east bus.

The 138-kV section of the switchyard is connected to the offsite grid via two overhead lines (F-84 and Y-51). Both lines can feed the 138-kV west bus and 138-kV east bus through its applicable normally closed breakers.

Additionally, the 138-kV section of the switchyard is connected to the 345-kV section of the switchyard through two independent transformers (T10 and T20). Transformer T10, which is connected to the 345-kV L1 bus, can feed the 138-kV west bus through the applicable normally closed breaker or the TST through the applicable normally closed breaker. Transformer T20, which is connected to the 345-kV L2 bus, can feed the 138-kV east bus through the applicable normally closed breaker or the TST through the applicable normally closed breaker.

The RAT also has the capacity to provide power to the 4.16-kV non-ESF buses in the event of a loss of the normal ac power supply from the generator (via the Main Auxiliary Transformer). The normally open feeder breakers from the RAT to the 4.16-kV non-ESF buses (Bus 1-1, Bus 1-2, Bus 1-3, and Bus 1-4) are also depicted in one of the single line diagrams within Attachment 1.

1. d. Describe the offsite power transformer (e.g., start-up, reserve, station auxiliary) winding and grounding configurations.

See Attachment 2, Table 4, for offsite power transformer winding and grounding configurations.

2. a. Are the ESF buses powered by offsite power sources? If so, explain what major loads are connected to the buses including their ratings.

For at-power normal operating configurations, the 4.16-kV ESF buses are powered by the described offsite sources.

See Attachment 2, Tables 1 and 2, for 4.16-kV ESF bus power sources.

The 4.16-kV ESF bus loading during at-power normal operating configurations will be much different than for accident conditions. In Attachment 2, Table 3, loads that are branch fed from the respective 4.16-kV ESF buses are listed. However, a majority of the noted loads are normally only connected during accident conditions (except surveillance testing during at-power normal operating configurations).

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System
Kewaunee Power Station

2. c. Confirm that the operating configuration of the ESF buses is consistent with the current licensing basis. Describe any changes in offsite power source alignment to the ESF buses from the original plant licensing.

Attachment 2, Table 1, identifies the normal arrangements to the 4.16-kV ESF buses.

The current licensing basis configuration (which is the same as the original licensing basis configuration) is the TAT aligned to 4.16-kV ESF Bus 1-5 and the RAT to 4.16-KV ESF Bus 1-6, which requires no transfer upon a trip of the reactor, turbine generator, and main station auxiliary source of power.

The original licensing basis configuration did not include the TST and RST, which have load tap changers (LTCs) installed. Additionally, the original licensing basis configuration did not include a switchyard with a complete double breaker, double bus orientation. However, these changes do no not impact the original licensing basis configuration as previously described.

System Protection

Items 1, 1.a, 2.b, 2.d request information regarding electrical system protection and will be addressed in this section:

1. Given the requirements above, describe how the protection scheme for ESF buses (Class 1E for current operating plants or non-Class 1E for passive plants) is designed to detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on a credited offsite power circuit or another power sources.

Consistent with the current licensing basis and the KPS USAR GDC 17 discussion, the existing protective circuitry will separate the ESF buses from a connected failed source due to a loss of voltage or a sustained, balanced degraded grid voltage concurrent with certain design basis accidents.

Although the protection scheme at KPS was not designed to detect and automatically respond to a single-phase open circuit condition (with or without a high impedance ground fault) on a credited offsite power circuit, preliminary analysis (on the portions of the circuit that were evaluated to date) has shown that the degraded voltage (DV) relay protection schemes will separate the ESF buses in an open phase condition (ungrounded or solidly grounded) and isolate the affected power source (automatically transferring power to an alternate supply). Evaluations of the remaining portion of the circuit are ongoing.

The preliminary analysis was performed to determine the capability of existing KPS under voltage relays to detect and automatically respond to single-phase open circuit conditions (ungrounded and solidly grounded) of offsite power supplies to 4.16-kV ESF buses. The modeling for the preliminary analysis was performed using EMPT based computer modeling software (PSCAD). Engineering has evaluated the results of the PSCAD modeling using published materials and the ETAP computer code, where possible, to ensure that the results are reasonable.

The first level of under voltage protection is provided by the loss of voltage (LOV) relays, which function to detect and disconnect the 4.16-kV ESF bus from the preferred offsite power supply upon a total loss of voltage condition. The LOV relay setting equals 101.69V-SECONDARY x 20/1 equals 2033.8V-PRIMARY (phase-to-neutral voltage). Two-of-two LOV relays are required to sense the loss of voltage condition to initiate the tripping of the preferred offsite power supply. The LOV relays have two pairs of relays for each 4.16-kV ESF bus.

The second level of under voltage protection is provided by the degraded voltage (DV) relays, which function to detect and disconnect the ESF bus from the preferred offsite power supply upon a low-voltage condition. The DV relay setting equals 112.93V-SECONDARY x 20/1 equals 2258.6V-PRIMARY (phase-to-neutral voltage). Two-of-two DV relays are required to sense the degraded voltage condition to initiate the tripping of the preferred offsite power supply. The DV relays have one pair of relays for each 4.16-kV ESF bus.

The under voltage relays (LOV and DV) are connected phase-to-neutral on single phase to ground (A & C Phase) 4200-120V potential transformers.

To determine the ability to detect an open phase (ungrounded and solidly grounded) from the preferred offsite power supply, the phase-to-neutral voltage for each phase was required to be modeled for that condition. Two scenarios have been evaluated during the preliminary analysis (evaluation of two other scenarios during the preliminary analysis remain ongoing) to determine the vulnerability of an open primary transformer phase condition at KPS. A summary of the results is as follows:

1. An open phase (ungrounded and solidly grounded) on the primary of the 138/13.8-kV TST

   LOV Relays

   The following discussion assumes the LOV relays drop-out above their Technical Specification (TS) minimum.

   For the TST feed cases with A or C phase open (ungrounded or solidly grounded), either A Phase or C Phase LOV relays will drop-out and this circuit will not actuate since 1 of 2 relays will drop-out (2 of 2 required). It will cause alarm 47092G, "Bus 5 Volt Restoring Blown Fuse" to actuate in 2.5 seconds or less.

   For the TST feed case with B phase open (ungrounded or solidly grounded), A Phase and C Phase LOV relays will not drop-out and this circuit will not actuate or alarm since 0 of 2 relays will drop-out (2 of 2 required to actuate, 1 of 2 to alarm).

   DV Relays

   The following discussion assumes the DV relays drop-out above their TS minimum.

For the TST feed cases, A Phase and C Phase DV relays will drop-out and this circuit will actuate since 2 of 2 relays will drop-out (2 of 2 required) in 7.4 seconds or less.

2. An open phase (ungrounded and solidly grounded) on the primary of the 138/21-kV RST

LOV Relays

The following discussion assumes the LOV relays drop-out above their TS minimum.

For the RST feed cases with A or C phase open (ungrounded or solidly grounded), either A Phase or C Phase LOV relays will drop-out and this circuit will not actuate since 1 of 2 relays will drop-out (2 of 2 needed). It will cause alarm 47092J, "Bus 6 Volt Restoring Blown Fuse" to actuate in 2.5 seconds or less.

For the RST feed case with B phase open (ungrounded or solidly grounded), A Phase and C Phase LOV relays will not drop-out and this circuit will not actuate or alarm since 0 of 2 relays will drop-out (2 of 2 required to actuate, 1 of 2 to alarm).

DV Relays

The following discussion assumes the DV relays drop-out above their TS minimum.

For the RST feed cases, A Phase and C Phase DV relays will drop-out and this circuit will actuate since 2 of 2 relays will drop-out (2 of 2 required) in 7.4 seconds or less.

As previously mentioned, the evaluations of two other scenarios during the preliminary analysis remain ongoing. These two other scenarios include an open phase (ungrounded and solidly grounded) on the primary of the 13.2/4.16-kV TAT (secondary of the 138/13.8-kV TST) and an open phase (ungrounded and solidly grounded) on the primary of the 20/4.16-kV RAT (secondary of the 138/21-kV RST).

Scenarios have also been evaluated during this preliminary analysis with open phase (ungrounded) locations at points in the 138-kV substation and beyond that would affect both the RST and TST. The results of this preliminary analysis indicated less than a 2% voltage imbalance at both 4.16-kV ESF buses in each scenario evaluated. This indicates that for KPS there should be no single open phase event that would adversely affect both 4.16-kV ESF buses.

A high impedance ground was not evaluated for any of the open phase conditions during this preliminary analysis.

For a high impedance ground with the three phases intact, protective circuit actuation is expected. At KPS, the 345-kV section of switchyard, the 138-kV section of switchyard, the 13.8-kV feed to the TAT, and the 21-kV feed to the RAT are effectively grounded. The 4.16-kV ESF buses are low resistance grounded. With the low impedance grounding configuration at KPS, line to neutral short circuit currents are sufficiently high when a high impedance ground fault is introduced. This ensures that protective relays isolated grounded energized phases.

Ground overcurrent relay settings typically have a minimum bolted-fault to trip-setting ratio of 2:1 to account for impedance of the fault. This is consistent with Industry practice. No further evaluation of this condition is warranted.

1.a. The sensitivity of protective devices to detect abnormal operating conditions and the basis for the protective device setpoint(s).

Consistent with the current licensing basis and the KPS USAR GDC 17 discussion, existing electrical protective devices are sufficiently sensitive to detect design basis conditions such as a loss of voltage or a degraded voltage, but were not designed to detect a single open phase condition (with or without a high impedance ground fault) in the offsite source configuration analyzed.

See Attachment 2, Table 5, for protective devices and the basis for the device setpoint(s).

2.b. If the ESF buses are not powered by offsite power sources, explain how the surveillance tests are performed to verify that a single-phase open circuit condition or high impedance ground fault condition on an offsite power circuit is detected.

This question is not applicable, because the 4.16-kV ESF buses at KPS are powered by offsite power sources.

2.d. Do the plant operating procedures, including off-normal operating procedures, specifically call for verification of the voltages on all three phases of the ESF buses?

Plant operating procedures are being revised to include instruction for phase verification when control room annunciator alarms 47092G ("Bus 5 Volt Restoring Blown Fuse"), 47092J ("Bus 6 Volt Restoring Blown Fuse"), 47091I ("Bus 5 Voltage Degraded"), 47091L ("Bus 6 Voltage Degraded"), 47091H ("Bus 5 Voltage Low"), and 47091K ("Bus 6 Voltage Low") actuate. The additional instruction is intended to assist operators with diagnosing the open phase condition and further instructs operators to manually separate from the affected offsite source if the automatic actuation has failed to do so.

Consequences

Items 1.b, 1.c, 2.e request information regarding the consequences of an event and are addressed in this section:

1.b. The differences (if any) of the consequences of a loaded (i.e., ESF bus normally aligned to offsite power transformer) or unloaded (e.g., ESF buses normally aligned to unit auxiliary transformer) power source.

The installed relays were not designed to detect single open phase conditions (with or without a high impedance ground fault). Existing LOV and DV relays may respond depending on load and possible grounds. In general, there will be no plant response for an unloaded power source in the event of a loss of a single-phase open circuit on a credited offsite power circuit because there is insufficient current to detect a single-phase open circuit for this configuration. The plant response for a loaded power source cannot be calculated without specifying the amount of loading and the specific loads involved.

The KPS 4.16-kV ESF buses would not be expected to have an unloaded offsite power source. As stated within USAR Chapter 8 Electrical Systems:

> "Both of the offsite power supply circuits will normally be energized at all times and will be connected to one or the other of the engineered safeguards buses at all times. Thus, loss of the reactor, turbine generator, and main station auxiliary source of power does not even require a transfer for the safeguards buses."

1.c. If the design does not detect and automatically respond to a single-phase open circuit condition or high impedance ground fault condition on a credited offsite power circuit or another power sources, describe the consequences of such an event and the plant response.

KPS was not designed (as documented in the Current Licensing Basis (CLB)) for the Class 1E protection scheme (for the 4.16-kV ESF buses) to detect and automatically respond to a single-phase open circuit condition (with or without a high impedance ground fault) on the credited offsite power source.

The offsite power circuits at KPS consist of two independent circuits. As stated within USAR Chapter 8 Electrical Systems:

> "The reserve supply transformer is used to furnish power to the 20.0 kV reserve (startup) auxiliary transformer via a 20 kV overhead transmission line from the substation. The tertiary supply transformer is used to furnish power to the 13.2 kV tertiary auxiliary transformer via an underground insulated power cable. This cable becomes the second of the two physically independent circuits to provide off-site power to the on-site distribution systems."
>
> "The reserve supply transformer and the tertiary supply transformer are bifurcated at the substation to connect to either the east or west 138 kV buses. Each leg of the bifurcation is separated from the respective bus with a 138 kV circuit breaker."

Since KPS was not designed and licensed for the detection and automatic response to a loss of a single phase event, an open phase fault was not included in the design criteria for the LOV relay scheme, the DV relay scheme or secondary level under voltage protection system (SLUPS) design criteria. Since open phase detection was not within the KPS design or licensing basis, no design basis calculations or design documents exist that previously considered this condition.

Without formalized engineering calculations or engineering evaluations, the electrical consequences of such an open phase event (including plant response), can only be evaluated to the extent of what has already been published by EPRI and Basler; a generic overview, at best. The difficulty in applying these documents to the KPS specific response is that these are generic assessments and cannot be formally credited as a basis for an accurate response. The primary reason is that detailed plant specific models need to be developed (e.g., transformer magnetic circuit models, electric distribution models, motor models; including positive, negative, and zero sequence impedances (voltage and currents) would need to be compiled and analyzed for the KPS specific Class 1E electric distribution system (EDS)).

Preliminary analysis was performed to determine the capability of existing KPS under voltage relays to detect and automatically respond to single-phase open circuit conditions (ungrounded and solidly grounded) of offsite power supplies to 4.16-kV ESF buses.

Based on this preliminary analysis, an open phase (ungrounded or solidly grounded) on the primary of the RST (LTC) would result in a voltage imbalance on the applicable 4.16-kV ESF bus that would cause an automatic transfer to the applicable Emergency Diesel Generator (EDG) by the applicable DV relays. The event should not cause a plant trip. The loss of phase (ungrounded or solidly grounded) would immediately render the offsite source and applicable 4.16-kV ESF bus inoperable. Like the event that occurred at the Byron unit, the voltage imbalance would impact operation of loads on the affected 4.16-kV ESF bus until the automatic transfer occurs. Unlike the event that occurred at the Byron unit, only one of two 4.16-kV ESF buses would potentially be affected.

Based on this preliminary analysis, an open phase (ungrounded or solidly grounded) on the primary of the TST (LTC) would result in a voltage imbalance on the applicable 4.16-kV ESF bus that would cause automatic transfer to the applicable EDG by the applicable DV relays. The event should not cause a plant trip. The loss of phase (ungrounded or solidly grounded) would immediately render the offsite source and applicable 4.16-kV ESF bus inoperable. Like the event that occurred at the Byron unit, the voltage imbalance would impact operation of loads on the affected 4.16-kV ESF bus until the automatic transfer occurs. Unlike the event that occurred at the Byron unit, only one of two 4.16-kV ESF buses would potentially be affected.

As previously mentioned, the evaluations of two other scenarios during the preliminary analysis are ongoing. These two other scenarios include an open phase (ungrounded or solidly grounded) on the primary of the 13.2/4.16-kV TAT (secondary of the 138/13.8-kV TST) and an open phase (ungrounded or solidly grounded) on the primary of the 20/4.16-kV RAT (secondary of the 138/21-kV RST). While it is unknown whether the impacted 4.16-kV ESF bus would automatically transfer to its associated EDG for these two other scenarios, only one of the two 4.16-kV ESF buses could be affected by each scenario (unlike the event that occurred at the Byron unit).

Scenarios have also been evaluated during this preliminary analysis with open phase (ungrounded) locations at points in the 138-kV substation and beyond that would affect both the RST and TST. The results of this preliminary analysis indicated less than a 2% voltage imbalance at both 4.16-kV ESF buses in each scenario evaluated. This indicates that for KPS there should be no single open phase event that would adversely affect both 4.16-kV ESF buses (unlike the event that occurred at the Byron unit).

A high impedance ground was not evaluated for any of the open phase conditions during this preliminary analysis.

2.e. If a common or single offsite circuit is used to supply redundant ESF buses, explain why a failure, such as a single-phase open circuit or high impedance ground fault condition, would not adversely affect redundant ESF buses.

This question is not applicable because KPS does not use a common or single offsite circuit to supply redundant 4.16-kV ESF buses.

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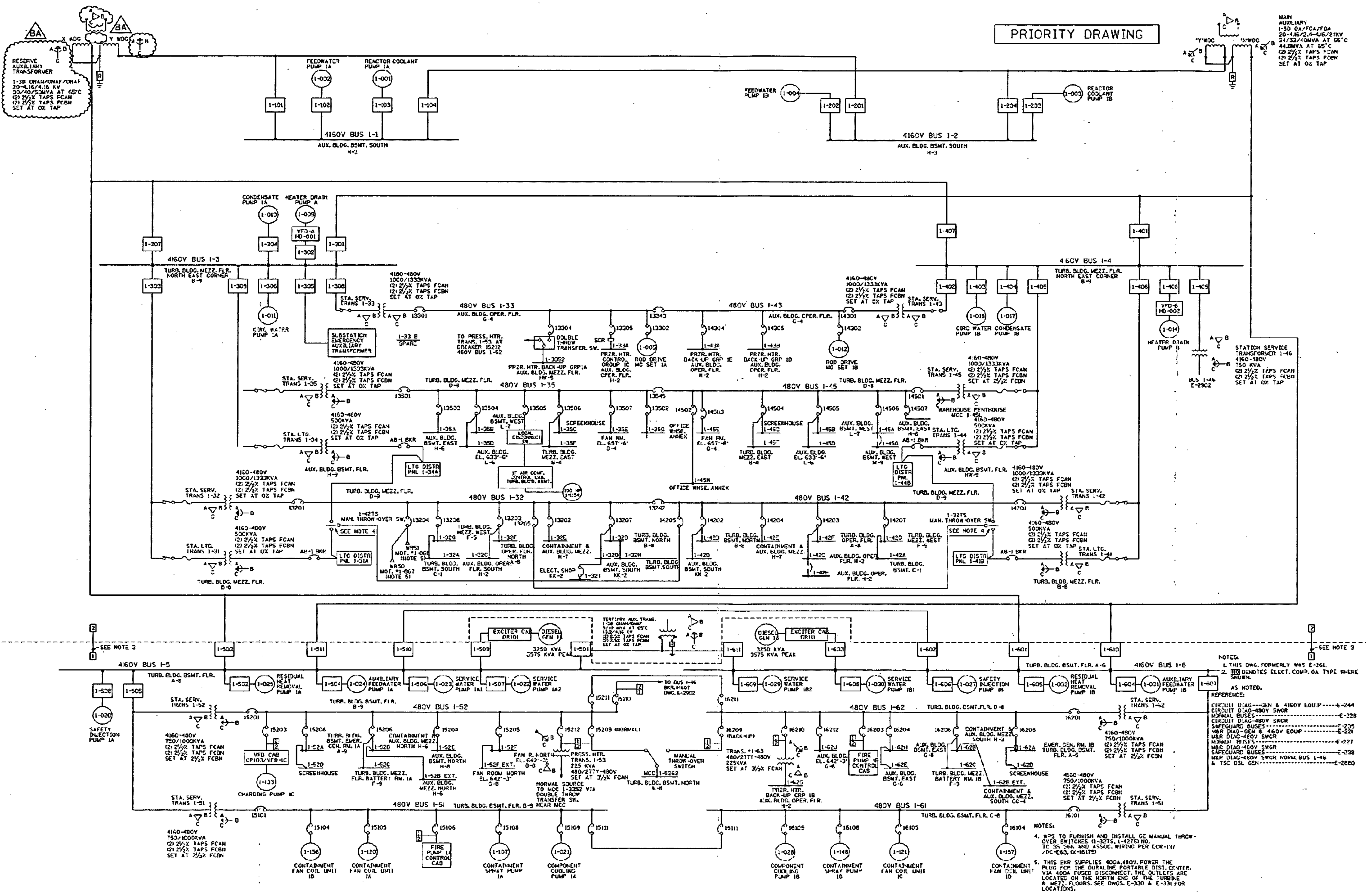
Attachment 1 - Electrical Distribution System



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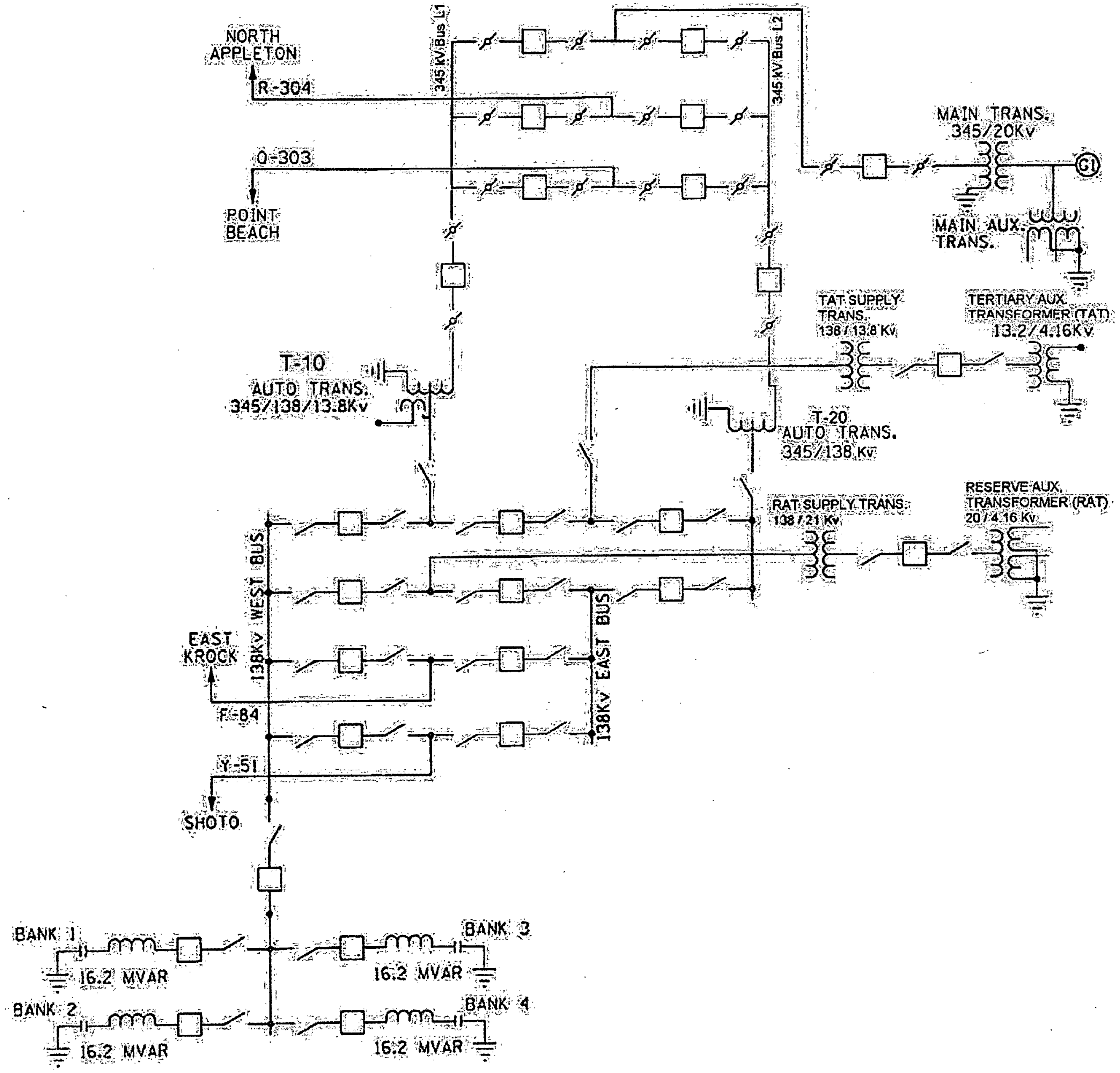

Response to NRC Bulletin 2012-01 Design Vulnerability In Electric Power System Kewaunee Power Station

Attachment 2 - Tables

Table 1 - ESF Buses Continuously Powered From Offsite Power Source(s)

Description of Offsite Power Source Configuration	ESF Buses Powered by Offsite Power (Normal Operating Condition)	Original Licensing Basis Configuration (Y/N)
138-kV Section of Switchyard to TST (LTC) to TAT	4.16-kV Bus 1-5	Yes *
138-kV Section of Switchyard to RST (LTC) to RAT	4.16-kV Bus 1-6	Yes *

* The original licensing basis configuration is the TAT aligned to 4.16-kV ESF Bus 1-5 and the RAT to 4.16-KV ESF Bus 1-6, which requires no transfer upon a trip of the reactor, turbine generator, and main station auxiliary source of power.

Table 2 - ESF Buses Not Continuously Powered From Offsite Power Source(s)

Description of Offsite Power Source Configuration	ESF Buses Powered by Offsite Power (Normal Operating Condition)	Original Licensing Basis Configuration (Y/N)
NA	NA	NA

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Table 3A – 4.16-kV ESF Bus 1-5 Major Loads

ESF Bus	Load Mark #	Load Description	Normal Running Load = X	Rating (HP - Unless Otherwise Noted)
1-5	1-020	Safety Injection Pump 'A' (4160V)		800
1-5	1-022	Service Water Pump 'A2' (4160V)	**X** (Typically 3 or 4 of 4 Train 'A' and Train 'B' Running)	400
1-5	1-023	Service Water Pump 'A1' (4160V)	**X** (Typically 3 or 4 of 4 Train 'A' and Train 'B' Running)	400
1-5	1-024	Auxiliary Feedwater Pump 'A' (4160V)		300
1-5	1-025	Residual Heat Removal Pump 'A' (4160V)		200
1-51	1-013	Fire Pump 'A' (480V)		200
1-51	1-021	Component Cooling Pump 'A' (480V)	**X** (Typically Only Train 'A' or Train 'B' Running)	250
1-51	1-107	Containment Spray Pump 'A' (480V)		250
1-51	1-120	Containment Fan Coil Unit 'A (480V)	**X**	125
1-51	1-156	Containment Fan Coil Unit 'B' (480V)	**X**	125
1-52	1-133	Charging Pump 'C' (480V)	**X**	125
1-52	MCC52A	Motor Control Center 1-52A (480V)	**X**	32 kVA *
1-52	MCC52B	Motor Control Center 1-52B (480V)	**X**	102 kVA *
1-52	MCC52BEXT	Motor Control Center 1-52B Extension (480V)		0 kVA *
1-52	MCC52C	Motor Control Center 1-52C (480V)	**X**	88 kVA *
1-52	MCC52D	Motor Control Center 1-52D (480V)	**X**	27 kVA *
1-52	MCC52E	Motor Control Center 1-52E (480V)	**X**	118 kVA *
1-52	MCC52F	Motor Control Center 1-52F (480V)	**X**	52 kVA *
1-52	MCC52FEXT	Motor Control Center 1-52F Extension (480V)		0 kVA *
1-52	MCC5262	Motor Control Center 1-5262 (480V)	**X**	61 kVA *

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Table 3B – 4.16-kV ESF Bus 1-6 Major Loads

ESF Bus	Load Mark #	Load Description	Normal Running Load = X	Rating (HP - Unless Otherwise Noted)
1-6	1-027	Safety Injection Pump 'B' (4160V)		800
1-6	1-029	Service Water Pump 'B2' (4160V)	X (Typically 3 or 4 of 4 Train 'A' and Train 'B' Running)	400
1-6	1-030	Service Water Pump 'B1' (4160V)	X (Typically 3 or 4 of 4 Train 'A' and Train 'B' Running)	400
1-6	1-031	Auxiliary Feedwater Pump 'B' (4160V)		300
1-6	1-032	Residual Heat Removal Pump 'B' (4160V)		200
1-61	1-028	Component Cooling Pump 'B' (480V)	X (Typically Only Train 'A' or Train 'B' Running)	250
1-61	1-121	Containment Fan Coil Unit 'C' (480V)	X	125
1-61	1-148	Containment Spray Pump 'B' (480V)		250
1-61	1-157	Containment Fan Coil Unit 'D' (480V)	X	125
1-62	1-234	Fire Pump 'B' (480V)		200
1-62	MCC62A	Motor Control Center 1-62A (480V)	X	17 kVA *
1-62	MCC62B	Motor Control Center 1-62B (480V)		0 kVA *
1-62	MCC62BEXT	Motor Control Center 1-62B Extension (480V)		0 kVA *
1-62	MCC62C	Motor Control Center 1-62C (480V)	X	86 kVA *
1-62	MCC62D	Motor Control Center 1-62D (480V)	X	24 kVA *
1-62	MCC62E	Motor Control Center 1-62E (480V)	**X**	144 kVA *
1-62	MCC62G	Motor Control Center 1-62G (480V)	**X**	192 kVA *
1-62	MCC62H	Motor Control Center 1-62H (480V)	**X**	5 kVA *
1-62	MCC62J	Motor Control Center 1-62J (480V)	**X**	20 kVA *

* MCC kVA rating represents normal operation load

Table 4 - Offsite Power Transformers

Transformer	Winding Configuration (High Side - Low Side)	MVA Size (OA/FA/FA)	Voltage Rating (Primary/Secondary)	Grounding Configuration
TST (Tertiary Supply Transformer)	Delta - Wye (Wye Lags)	12 / 16 / 20 (ONAN/ONAF/ONAF)	138 kV - 13.8 kV	Wye (Neutral) Solid Grounded
TAT (Tertiary Auxiliary Transformer)	Delta - Wye (Wye Leads)	8 / 10 / 12.5 (Future) (ONAN/ONAF/ONAF)	13.2 kV - 4.16 kV	Wye (Neutral) Resistance Grounded
RST (Reserve Supply Transformer)	Delta - Wye (Wye Lags)	30 / 40 / 50 (ONAN/ONAF/ONAF)	138 kV - 21 kV	Wye (Neutral) Solid Grounded
RAT (Reserve Auxiliary Transformer)	Delta - Wye / Wye (Wye / Wye Leads)	30 / 40 / 50 (HV & XV) 15 / 20 / 25 (YV) (ONAN/ONAF/ONAF)	20 kV - 4.16 kV / 4.16 kV	Wye / Wye (Neutral) Resistance Grounded

Table 5 - Protective Devices

Protection Zone	Protective Device	Logic	Setpoint Nominal (VAC)	Sensitivity of Device (VAC) - SP Criteria	Basis For Setpoint
ESF Bus 1-5	Degraded Voltage Relays (27AY/B5 & 27CY/B5)	2 of 2	3902.26 (93.8% of 4160), 112.93 at Relay [time delay of 6.72 seconds]	112.73 to 113.13	The analytical limit of 3856.32V (92.7% of 4160) is used to determine the Nominal Dropout Setpoint including the 0.05% safety margin.
ESF Bus 1-5	Loss of Voltage Relays (27A/B5 & 27CZ/B5)	2 of 2	3513.76 (84.47% of 4160), 101.69 at Relay [time delay of 1.75 seconds for 27A/B5 and time delay of 0.1 seconds for 27CZ/B5]	101.49 to 101.89	A starting point of 3473.6V (83.5 % of 4160) results in the Nominal Dropout Setpoint being conservatively above the minimum analytical limits (including 3452.8V, 83% of 4160). The higher starting point adds a safety margin and insures increased protection for plant motors.

Table 5 - Protective Devices (continued)

Protection Zone	Protective Device	Logic	Setpoint Nominal (VAC)	Sensitivity of Device (VAC) - SP Criteria	Basis For Setpoint
ESF Bus 1-5	Loss of Voltage Relays (27C/B5 & 27AZ/B5)	2 of 2	3513.76 (84.47% of 4160), 101.69 at Relay [time delay of 1.75 seconds for 27C/B5 and time delay of 0.1 seconds for 27AZ/B5]	101.49 to 101.89	A starting point of 3473.6V (83.5 % of 4160) will result in the Nominal Dropout Setpoint being conservatively above the minimum analytical limits (including 3452.8V, 83% of 4160). The higher starting point adds a safety margin and insures increased protection for plant motors.
ESF Bus 1-6	Degraded Voltage Relays (27AY/B6 & 27CY/B6)	2 of 2	3902.26 (93.8% of 4160), 112.93 at Relay [time delay of 6.72 seconds]	112.73 to 113.13	The analytical limit of 3856.32V (92.7% of 4160) is used to determine the Nominal Dropout Setpoint including the 0.05% safety margin.

Table 5 - Protective Devices (continued)

Protection Zone	Protective Device	Logic	Setpoint Nominal (VAC)	Sensitivity of Device (VAC) - SP Criteria	Basis For Setpoint
ESF Bus 1-6	Loss of Voltage Relays (27A/B6 & 27CZ/B6)	2 of 2	3513.76 (84.47% of 4160), 101.69 at Relay [time delay of 1.75 seconds for 27A/B6 and time delay of 0.1 seconds for 27CZ/B6]	101.49 to 101.89	A starting point of 3473.6V (83.5 % of 4160) will result in the Nominal Dropout Setpoint being conservatively above the minimum analytical limits (including 3452.8V, 83% of 4160). The higher starting point adds a safety margin and insures increased protection for plant motors.
ESF Bus 1-6	Loss of Voltage Relays (27C/B6 & 27AZ/B6)	2 of 2	3513.76 (84.47% of 4160), 101.69 at Relay [time delay of 1.75 seconds for 27C/B6 and time delay of 0.1 seconds for 27AZ/B6]	101.49 to 101.89	A starting point of 3473.6V (83.5 % of 4160) will result in the Nominal Dropout Setpoint being conservatively above the minimum analytical limits (including 3452.8V, 83% of 4160). The higher starting point adds a safety margin and insures increased protection for plant motors.