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BVY 12-074

October 25, 2012

U.S. Nuclear Regulatory Commission
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SUBJECT: 90-Day Response to Bulletin 2012-01, *Design Vulnerability in Electric Power System*
Vermont Yankee Nuclear Power Station
Docket No. 50-271
License No. DPR-28

REFERENCE: 1. NRC letter to Entergy, Bulletin 2012-01 *Design Vulnerability in Electric Power System*, dated July 27, 2012

Dear Sir or Madam:

On July 27, 2012, the NRC issued Bulletin 2012-01 (Reference 1), requesting that each licensee submit a written response in accordance with 10 CFR 50.54(f) within 90 days of the bulletin to provide requested information. This letter provides the Entergy Nuclear Operations, Inc. 90-day response to Reference 1 for Vermont Yankee.

There are no new regulatory commitments contained in this submittal.

Should you have any questions or require additional information concerning this submittal, please contact Mr. Robert J. Wanczyk at (802)451-3166.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on October 25, 2012.

Sincerely,

CJW/JTM

IE76
NRR

Attachments: 1. VY 90-Day Response to NRC Bulletin 2012-01
2. Simplified One-Line Diagram
3. Tables

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Attachment 1

VY 90-Day Response to NRC Bulletin 2012-01

VY 90-Day Response to NRC Bulletin 2012-01

Overview:

- 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 2 - Simplified One-Line Diagram
- Attachment 3 - 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 2, for a simplified one-line diagram.

Vermont Yankee has two 4.16 kV Class 1E buses which are tied to two Non Safety Related (NSR) 4.16 kV buses. The 4.16 kV buses are normally supplied from the main generator through a three winding unit auxiliary transformer (each low voltage winding supplies one NSR and one Class 1E 4.16 kV bus). Upon generator trip, the 4.16 kV buses are transferred to two startup transformers. Each startup transformer supplies one NSR and one Class 1E 4.16 kV bus. The startup transformers are normally unloaded during station operation except startup transformer T-3B supplies the mechanical draft cooling tower loads during summer months.

The immediate source of offsite power to Vermont Yankee is the Vermont Yankee 115 kV switchyard which supplies power to the two 115 kV/4.16 kV startup transformers. A delayed source of offsite power is established by backfeeding the station 4.16 kV buses from the VY 345 kV transmission system through the generator step up transformer and unit auxiliary transformer. This source is established by opening the generator no load disconnect switch.

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

See Attachment 3, 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 condition) configurations, ESF buses are not powered by offsite sources. For at power (normal operating condition) configurations, the non-safety buses are not powered by offsite power sources except for cooling tower loads which are normally supplied by offsite power during the summer months.

See Attachment 3, Tables 1 and 2 for ESF bus power sources.

See Attachment 3, Table 3 for ESF bus major loads energized during normal power operations, including their ratings.

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:

ESF buses (4160 V Buses 3 and 4) are normally supplied from the main generator through the unit auxiliary transformer. Upon unit trip the buses are transferred to the two startup transformers (two winding) which are supplied from the 115 kV switchyard (immediate access power source). A delayed access power source is established by backfeed from the 345 kV switchyard through the generator step up transformer by opening the generator no load disconnect switch. A Station Blackout Alternate AC Power Source is available to either 4160 V Bus 3 or4 from the 69kV switchyard from the adjacent Vernon Hydro Electric Station.

The following changes in offsite power source alignment to the ESF buses have been made since the original plant licensing:

1. The original startup transformer (T-3) was a 4 winding transformer (one primary winding at 115 kV and three low voltage windings). One low voltage winding supplied 4160 V NSR Bus 1 and 4160 V ESF Bus 2; the second winding supplied 4160 V NSR Bus 2 and 4160 V ESF Bus 4 and the third low voltage winding supplied 4160 V NSR Bus 5 which supplies the mechanical draft cooling tower loads. This transformer was replaced after it failed with two – two winding transformers. Startup transformer T-3-1A supplies 4160 V NSR Bus 1 and 4160 V ESF Bus 2. Startup transformer T-3-1B supplies 4160 V NSR Bus 2 4160 V ESF Bus 4 and NSR 4160 V Bus 5.

2. The station was originally licensed with two delayed access offsite power sources. One delayed access source was the backfeed from the 345 kV switchyard to the 4160 V buses through the generator step up transformer and unit auxiliary transformer by removing generator links. This source could be established within 6 hours as described in the original Technical Specification Bases. The second delayed access source was a connection to the adjacent Vernon Hydroelectric Station. It could be connected to a single ESF bus.

The tie to Vernon Hydroelectric Station was credited to meet 10CFR50.63, the Station Blackout Regulation and therefore it is no longer credited as a delayed access source of offsite power. The backfeed through the generator step up transformer and unit auxiliary transformer has been upgraded by the addition of a generator no-load disconnect switch. This backfeed can be manually established within one hour by opening the switch.

System Protection

Items 1, 1.a, 2.b, and 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 off-site power circuit or another power sources. Also, include the following information:***

Consistent with the current licensing basis, existing protective circuitry will separate the ESF buses from a connected failed offsite source due to a loss of voltage or a sustained, balanced degraded grid voltage concurrent with certain design basis accidents. The relay systems were not specifically designed to detect an open single phase of a three phase system. Detection of a single-open phase condition is beyond the approved design and licensing basis of the plant.

The electrical analyses for off-site circuits have been reviewed with regard to high impedance grounds. The effect of a high impedance ground has been analyzed to have no impact on the electrical distribution system if the ground occurs on the secondary side of the offsite power transformers because the 4160 V distribution system is a high impedance grounded power system designed to operate in the presence of a single ground fault.

Preliminary analysis of a single phase high impedance ground occurring on the primary of the offsite power system transformers with all three phases intact indicate that if the fault impedance is as low as 8 ohms, the fault would not be detectable by the existing ground fault relaying associated with the offsite power transformers. In this case, based on unbalanced fault analysis using ETAP, the fault would not impact the ability of the offsite power system to power the Class 1E buses. [Note: a single ground fault with all three phases intact should be detected by the existing bus differential relay schemes and would result in isolation of the fault.] Analysis of the impact of open phase fault in combination with a high impedance ground fault cannot be completed until the open phase fault analysis is completed.

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, existing electrical protective devices are sufficiently sensitive to detect design basis conditions like a loss of voltage or a degraded voltage, but were not designed to detect a single phase open circuit condition. See Attachment 3, Table 5 for undervoltage protective devices and the basis for the device setpoint(s).

Existing electrical protective devices are also sufficiently sensitive to detect a ground faults which impact the ability of the power system to transfer power to the Class 1E buses. Ground detection is provided on the non safety related 4160 V buses which normally supply the 4160 V Class 1E buses. Attachment 3, Table 5 lists ground alarms for the ESF buses 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 Vermont Yankee are not normally powered by offsite power sources. Vermont Yankee has implemented the following as interim measures:

- Heightened surveillances have been initiated to detect an open phase fault. These include a once per shift visual check of the overhead conductors associated with the offsite power source and enhanced once per shift control room meter readings to check for balanced voltage and currents on lines and buses associated with the offsite power circuits.
- Night orders have been issued to make operators aware of symptoms associated with open phase conditions.
- The heightened surveillances and night orders are being converted to permanent changes to operator rounds and permanent changes to existing station Operating Procedure OPON-3150-01, "Loss of Start Up Transformer(s)"
- Revision to operator training programs for initial training and requalification training have been initiated to include the Byron event, its consequences and the interim operator response required.
- Vermont Yankee has reviewed the configuration of the overhead lines associated with the offsite power circuits. Vermont Yankee has concluded, based on the configuration of its lines and insulators (predominantly Lapp suspension insulators) that it is less susceptible to the same failures which occurred at Byron Station.
- Vermont Yankee has initiated an inspection program of the insulators associated with the offsite power circuits as a commitment under license renewal.
- Vermont Yankee shall initiate studies to determine actual currents and voltages which would exist on the primary and secondaries of offsite power transformers under single open circuit conditions at various load levels. Results of these studies are necessary to determine how the open phase fault may be reliably 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?

The heightened surveillances implemented as interim compensatory measures described above, specifically call for verification of the voltages on all three phases of the startup transformers which supply the ESF buses. Incorporation of the heightened surveillances into current plant operating procedures (formal operator rounds) is in progress.

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.

Installed relays were not designed to detect single phase open circuit conditions. Existing loss of voltage and degraded voltage relays may respond depending on load and possible grounds. In general, based on preliminary studies performed by the industry, there will be no plant response for an unloaded (e.g., ESF buses normally aligned to an auxiliary transformer) power source in the event of a single-phase open circuit on a credited off-site 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.

As stated above, a single high impedance ground would have no impact on the electrical distribution system if the ground occurs on the secondary side of the offsite power transformers because the 4160 V distribution system is a high impedance grounded power system designed to operate in the presence of a single ground fault. This is true whether the buses or transformers are loaded or unloaded. A high resistance ground occurring on the primary of the unloaded startup transformers would not actuate the ground fault relays associated with transformer protection but may result in transformer or bus differential relay operation. This would not have an immediate impact of ESF buses which are not normally aligned to off-site power.

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.

A high impedance ground will have no immediate effect on plant operation. A high impedance ground occurring on the secondary of the unit auxiliary or startup transformers will have no impact because the 4.16 kV system is a high impedance grounded system designed for operation with a ground fault. No protective relaying action will occur regardless of ground fault resistance. If the ground fault on the primary of the VY startup transformers is sufficiently large to affect plant operation, protective relaying will isolate the ground automatically.

1. Vermont Yankee did not credit in the Current Licensing Basis (CLB) that the Class 1E protection scheme (for the emergency safeguard feature (ESF) buses) was designed to detect and automatically respond to a single-phase open circuit condition on the credited off-site power source as described in the UFSAR and Technical Specifications.

   The offsite power circuits at Vermont Yankee consist of two circuits. An immediate access offsite power circuit from the transmission system to the Vermont Yankee 115 kV switchyard to the Class 1E Buses through the startup transformers and a delayed access offsite power source from the transmission system to the Vermont Yankee 345 kV switchyard to the Class 1E buses by backfeed through the Generator Step Up Transformer and Unit Auxiliary Transformer with the generator no load disconnect switch open.

2. Since Vermont Yankee did not credit the ESF bus protection scheme as being capable of detecting and automatically responding to a single phase open circuit condition, an open phase fault was not included in the design criteria for either the loss of voltage or the degraded voltage relay (DVR) scheme. Since open phase detection was not credited in the Vermont Yankee design or licensing basis, no design basis calculations or design documents exist that previously considered this condition.

3. 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; which is a generic overview. The difficulty in applying these documents to the Vermont Yankee 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 would 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), and the models would need to be compiled and analyzed for the Vermont Yankee specific Class 1E electric distribution system).

4. As stated previously, Vermont Yankee has implemented interim measures to identify and respond to open phase faults. These measures consist of periodic visual inspection of the overhead lines connecting to the startup transformers, heightened surveillances and revised operating procedures intended to detect and respond to a degraded offsite source due to single open phase condition. Long term corrective actions consist of completing the plant specific models and completing plant specific open circuit analyses. Results of the analysis can be used to design a protection system to reliably detect and protect the Class 1E buses from effects of open phase faults.

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.

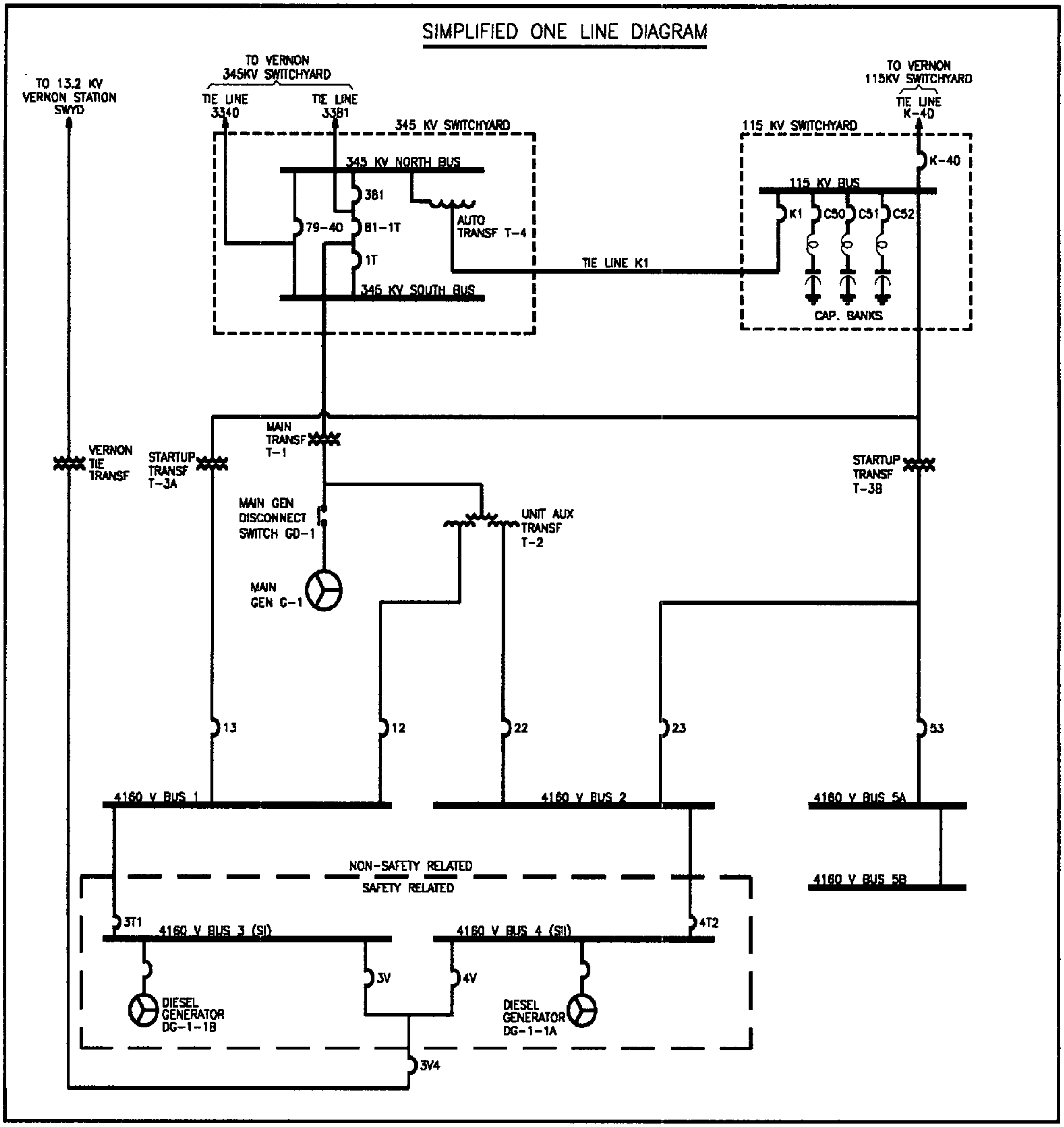
Consistent with the Current Licensing Basis protective circuitry will separate the ESF buses from a failed offsite source due to a loss of voltage or a sustained balanced degraded grid voltage concurrent with certain design basis accidents. The relay systems were not specifically designed to detect an open single phase of a three phase system. Detection of a single-open phase circuit is beyond the approved design and licensing basis of the plant. No calculations for this scenario have been done.

Consistent with the current station design, protective circuitry will protect from a ground fault condition with all three phases intact.

Attachment 2

VY 90-Day Response to NRC Bulletin 2012-01

Simplified One-Line Diagram


SIMPLIFIED ONE LINE DIAGRAM
TO 13.2 KV VERNON STATION SWYD
TO VERNON 345KV SWITCHYARD
TIE LINE 3340
TIE LINE 3381
345 KV SWITCHYARD
345 KV NORTH BUS
381
79-40
81-1T
1T
AUTO TRANSF T-4
345 KV SOUTH BUS
TIE LINE K1
TO VERNON 115KV SWITCHYARD
TIE LINE K-40
115 KV SWITCHYARD
K-40
115 KV BUS
K1
C50
C51
C52
CAP. BANKS
VERNON TIE TRANSF
STARTUP TRANSF T-3A
MAIN TRANSF T-1
STARTUP TRANSF T-3B
MAIN GEN DISCONNECT SWITCH GD-1
UNIT AUX TRANSF T-2
MAIN GEN G-1
13
12
22
23
53
4160 V BUS 1
4160 V BUS 2
4160 V BUS 5A
4160 V BUS 5B
NON-SAFETY RELATED
SAFETY RELATED
3T1
4160 V BUS 3 (SI)
4160 V BUS 4 (SII)
4T2
3V
4V
DIESEL GENERATOR DG-1-1B
DIESEL GENERATOR DG-1-1A
3V4

Attachment 3

VY 90-day Response to NRC Bulletin 2012-01

Tables

Attachment 3 – Tables

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

Description of ESF Bus Power Source	ESF Bus Name (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 ESF Bus Power Source	ESF Bus Name (normal operating condition).	Original licensing basis configuration (Y/N)
UAT T-2-1A X winding	4kv Bus 3	Y
UAT T-2-1A Y winding	4kV Bus 4	Y

Table 3 - ESF Buses Normally Energized Major Loads

ESF Bus	Load	Voltage Level	Rating (HP)
4kv Bus 3	Service Water Pump P-7-1B	4000 V	250 HP
4kv Bus 3	Service Water Pump P-7-1D	4000 V	250 HP
4kv Bus 3	4160/ 480 V Transformer T-8	4160 V	1000 kVA
4kV Bus 4	Service Water Pump P-7-1A	4000 V	250 HP
4kV Bus 4	Service Water Pump P-7-1C	4000 V	250 HP
4kV Bus 4	4160/ 480 V Transformer T-9	4160 V	1000 kVA

Table 4 - Offsite Power Transformers

Transformer	Winding Configuration	MVA Size (OA/FA/FOA)	Voltage Rating (Primary/Secondary)	Grounding Configuration
Startup Transformer T-3-1A	WYE- Delta	15/20/25 28 at 65° C FOA	115 kV / 4.16 kV	Neutral Grounded (primary)
Startup Transformer T-3-1B	WYE- Delta	15/20/25 28 at 65° C FOA	115 kV / 4.16 kV	Neutral Grounded (primary)

Table 5 - Protective Devices

Protection Zone	Protective Device	Logic	Setpoint (Nominal)	Basis for Setpoint
4 KV ESF Bus	Loss of Voltage Relay	2 of 2	1925V (46% of 4160V)	To actuate upon complete loss of ESF Bus voltage condition
4 KV ESF Bus	Degraded Grid	2 of 2	3700V (89% of 4160)	To automatically actuate on degraded voltage at ESF Bus coincident with an accident signal
4 KV ESF Bus	Degraded Grid	1 of 2	3700V (89% of 4160)	To provide degraded grid voltage alarm for ESF Bus – not coincident with an accident signal
4 KV ESF Bus	Ground Protection Alarm	1 of 1	560V across grounding resistor (13% of 4160)	Provide ground fault alarm for 4kV system indicating presence of single ground on high resistance grounded 4 kV system.
115 kV system	Ground Protection	1 of 1	Ground fault > 480 Amps	Detect significant ground fault on 115 kV system