GORDON A. CLEFTON
Senior Project Manager,
Engineering and Operations Support

1201 F Street, NW, Suite 1100
Washington, DC 20004
P: 202.739.8086
gac@nei.org
nei.org

NUCLEAR ENERGY INSTITUTE

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July 21, 2014

Ms. Cindy K. Bladey
Chief, Rules, Announcements, and Directives Branch (RADB)
Office of Administration
U.S. Nuclear Regulatory Commission
Washington, DC 20555–0001

Subject: Comments on new Draft Branch Technical Position (BTP) 8–9, "Open Phase Conditions in Electric Power System" and draft Revision 5 to Section 8.1, "Electric Power— Introduction," of NUREG–0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (Docket ID NRC–2014–0131) (*Federal Register* Notice 79FR32580)

Project Number: 689

Dear Ms. Bladey:

The U.S. Nuclear Regulatory Commission (NRC), through the *Federal Register* Notice (79FR32580) and Docket ID: NRC–2014–0131, issued for public comment Draft Branch Technical Position (BTP) 8–9, "Open Phase Conditions in Electric Power System" and draft Revision 5 to Section 8.1, "Electric Power—Introduction," of NUREG–0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants." This letter forwards for NRC consideration comments compiled by the Nuclear Energy Institute (NEI).[1]

The attached table contains consolidated industry comments that are supported by three additional attachments: Comments #7 RPS-Electric Power System Basis, Comment #20 APOG Comment Basis and Comment #44 Alternatives for Open Phase Condition Protection. These were included separately because the supplemental information would have unnecessarily lengthened the consolidated comment table.

Draft BTP 8-9 contains proposed guidance for the staff's safety review of licensing actions related to electric power system design capability for coping with open phase electrical conditions in the offsite power sources.

[1] The Nuclear Energy Institute (NEI) is the organization responsible for establishing unified industry policy on matters affecting the nuclear energy industry, including the regulatory aspects of generic operational and technical issues. NEI's members include all entities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect/engineering firms, fuel cycle facilities, nuclear materials licensees, and other organizations and entities involved in the nuclear energy industry.

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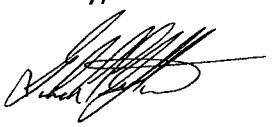
The industry understands that the NRC staff does not intend to impose or apply the positions described in the draft BTP 8–9 or SRP to existing licenses and regulatory approvals.

Our overreaching concern with the draft BTP 8-9 is it contains a number of requirements that we do not believe are consistent with existing licensing bases. The draft BTP 8-9 goes beyond the requirements of General Design Criteria (GDC) 17 of 10 CFR 50, Appendix A. Also, the BTP references 10 CFR 50.55a(h)(2) and 10 CFR 50.55a(h)(3) which address "Protection Systems." In our letter (ML14087A253) dated March 21, 2014, we provided a detailed discussion of why plant "Protection System" requirements are not applicable to open phase isolation systems. Based on the industry position, all references to 10 CFR 50.55a(h)(2) and 10 CFR 50.55a(h)(3) should be deleted from the BTP 8-9. NEI has not yet received a response from the NRC on the industry's evaluation of the applicability of 10 CFR 50.55a(h)(2) and 10 CFR 50.55a(h)(3) to the open phase condition.

The industry supports the idea of further interactions with the NRC in workshops, teleconferences and meetings to use all the resources available to facilitate completion of this document. If you have any questions or require additional information, please contact me.

Sincerely,



Gordon A. Clefton

Attachments

COMMENTS ON DRAFT BRANCH TECHNICAL POSITION 8-9 "OPEN PHASE CONDITIONS IN ELECTRIC POWER SYSTEM" (DOCKET ID NRC–2014–0131)

Consolidated Industry Comments

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
1	All	Applicability of 10CFR50.55a(h)2/3 The 2012 open phase event at Byron involved a failure in the offsite (or preferred) power supply which is a non-safety related system. NRC Bulletin 2012-01 requested licensees to confirm that licensees comply with Title 10 of the Code of Federal Regulations (10 CFR) 50.55a(h)(2), 10 CFR 50.55a(h)(3) and Appendix A to 10 CFR Part 50, General Design Criteria (GDC) 17, or principal design criteria specified in the updated final safety analysis report. Reference to 10CFR 50.55a(h)(2) and (3) is not applicable to the design of the offsite power supply since it is not part of the plant protection system as defined in 10CFR50.55a(h)2, 10CFR 50.55a(h)(3), and GDC 20 of Appendix A of 10CFR50.	All references to 10CFR50.55a(h)(2) and (3) should be deleted. Requirements and design bases for open phase fault (OPF) monitoring and trip schemes should be consistent with the requirements and design bases for the offsite power supply.	Open phase condition protection 'type and location' of the fault do not meet the definitions included in IEEE Stds. 279 or 603. Letter from G. Clefton (NEI) to J. Zimmerman (NRC), dated March 21, 2014, "Review of the Regulatory Requirements for Open Phase Condition Detection and Isolation," provides a detailed discussion of why plant "Protection System" requirements are not applicable to open phase isolation system. Primarily because these circuits do not: sense and command features of the reactor trip system, generate signals or actuate engineered safety features (ESF), or provide power to any of the engineered safety features actuation system (ESFAS) actuation devices. These circuits may be located on connections to the station switchyard, switchyard transmission lines, or the transmission network which, as discussed in IEEE Std. 308-1974, "IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations," are excluded from the Class 1E power systems design requirements.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
2		NEI Letter (G. Clefton) to NRC (J. Zimmerman) dated March 21, 2014, Review of the Regulatory Requirements for Open Phase Condition Detection and Isolation, provides a detailed discussion of why plant "Protection System" requirements are not applicable to open phase isolation system. Therefore, all references to 10CFR50.55a(h)2, 10CFR 50.55a(h)(3) should be deleted from the Branch Technical Position 8-9, Open Phase Conditions in Electric Power System. Please provide the results of the NRC's Office of General Council's evaluation of the applicability of 10CFR50.55a(h)2, 10CFR 50.55a(h)(3) to the open phase condition, and provide the basis in a letter to NEI at the earliest convenience.		

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
3	All	The industry is currently in compliance with their current licensing basis (CLB) with respect to GDC 17 (i.e., "minimize the probability of losing electric power from any remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, the loss of power from the onsite electric power source"). There are currently no gaps in compliance with GDC 17 as licensed. This comment also applies to the enforcement discretion draft. Additionally, this type of vulnerability may have been previously recognized in certain station designs.	Maintain the 1E boundary at the safety buses and EDGs.	The 1E boundary historically has been the safety busses and EDGs (i.e., deterministic analysis applies). This design category division was blurred with the imposition of 1E degraded voltage and under voltage relays. Now, with OPC it appears that the NRC staff is attempting to impose a new position that expands the Class 1E boundary outward to the non-safety-related offsite source transformers. The industry's OPC solutions are further minimizing the probability of losing electric power and are no different than grid protection. Probabilistic determination is applicable to our OPC solutions. This is considered a low probability event that is adequately addressed or mitigated with operator rounds and manual actions.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
4	All	How has the NRC reviewed the BTP 8-9 requirement for actuation circuits with respect to the probability of spurious separation versus the probability of an open phase condition concurrent with a LOCA?	Review the BTP and NRC position to ensure maintenance of nuclear safety	This should be completed and discussed by the regulator prior to issuing the requirement. Not by requiring licensees to show that they are not making the plant less safe by installing a required modification. A healthy safety bias requires proving that actions are safe prior to proceeding versus proving they are unsafe to stop. It may be that detection only, within a certain response time, is safer overall, because it limits spurious separation, and the probability of an OPC concurrent with a LOCA is exceedingly small.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
5	All	The draft BTP appears to be predicated on the assumption that all plants are similarly vulnerable to an OPC, with resulting failure of both offsite power systems and onsite emergency generation systems. Specifically: an open phase fault on one of the two power systems could result in the loss of capability of the alternate power circuit; thus, implying that the alternate power system would be unable to restore power to safety related loads. This is not the case.	The staff should not assume automatic open phase condition protection is required for GDC 17 compliance. The BTP should identify that other design configurations are acceptable, based on GDC 17 requirements.	BTP Section A, para 6, sentence 2 states "At Byron, both offsite and onsite electric power systems were not able to perform their intended safety functions due to (OPC) design vulnerability." BTP Section B.1.V, "Protective Actions," states: "For an open phase condition, the staff finds the following method for meeting the design requirements acceptable..." Many station responses provided as part of Bulletin 2012-01 revealed that most station designs are not similar to Byron and would have not had the same results. Additionally, operating experience which was documented in both the BTP and NRC bulletin show that the consequences at other stations as well as a second event at the Byron station, was not similar to the consequences the first Byron Station event.
6	All	It is not clear how the NRC intends to backfit compliance with the BTP into the current licensing basis.	NRC should perform a backfit analysis under 10 CFR 50.109.	
7	All	Reference to non-applicable IEEE Standards. IEEE Stds. 279 and 603 are not applicable to the AC electrical power system.	Reference IEEE Std. 308 for electric power system design guidance, if applicable. Otherwise, provide criteria more appropriate for the AC electrical power system.	Incorrect NRC and IEEE guidance is being used relative to GDC 17. See Attachment "Comments #7 RPS-Electric Power System Basis".

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
8	All	Terms which describe equipment to be protected are not consistently used throughout the BTP . (e.g., when discussing the design of systems to address an open phase fault (OPF) in Section B, the ultimate focus is ensuring the fault does not adversely affect the functioning of "important to safety SSCs"). The recommended design would do this by separating the fault from the Class 1E switchgear (e.g., similar to degraded grid relays that protect Class 1E buses) . This protection scheme would not protect the "important-to-safety", "ESF", or others outside of the Class 1E system.	Class 1E equipment should be protected; therefore, all instances where "important-to-safety SSCs or ESF" are referenced, change to Class 1E equipment.	According to NRC Standard Review Plan Section 8.1 "Electric Power - Introduction," Table 8-2, NRC Staff Interpretation of the Requirements of GDC 17, the safety function is the area of concern for independence between the offsite and onsite sources. Based on similar system protection to maintain independence or ability to transfer the safety system to an alternate source, the class of equipment required to be "protected' should be limited to Class 1E to maintain consistency with existing regulations and NRC guidance documents. While, individual "important to safety SSCs" is referenced in GDC 17, individual equipment protection is utilized to prevent damage to individual connected equipment (e.g. transformer protection, overcurrent protection for motors, neutral or grounding protection, etc.), because system protection cannot be provided outside the boundary of the safety system.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
9	All	Single failure considerations, if utilizing non-Class 1E fault protection.	Fault protection at the transformer should be considered an active component within the offsite power system, since it changes state upon detection of an open phase fault. Based on the requirements found in the Definitions and Explanations section of 10 CFR 50, Appendix A, the electric power system (i.e., offsite plus onsite electric power system) designs would not need to consider the failure of the protective relay coincident with the failure of a passive component like an open phase fault to meet the single failure criteria. This is due to the fact that the single failure requirements assume that passive components function properly in the presence of an active component failure and vice versa.	Multiple unrelated failures have been assumed by inspectors and NRC staff since it is more conservative; however, multiple layers of conservative analysis have led to reduced operating margins when reasonable assumptions are utilized.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
10	All	Clarification of what the intended protection requirements is required. • Class 1E functionality/independence from a common source (grid). • Station fault protection from an open phase fault. A design cannot protect "Important to Safety SSCs" with Class 1E protection due to the location requirements. Only Class 1E equipment can be protected with Class 1E protection (in the boundaries).	GDC 17 requires stations to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of power from the transmission network. For open phase faults, this can be accomplished in at least two ways: • Installation of fault protection at or around the transformer to remove the affected zone or • Installation of protection at the Class 1E bus to maintain source independence and allow individual equipment protection to operate outside of the Class 1E boundary.	GDC 17 does require important to safety SSC protection; however, this is in the non-Class 1E system and has non-Class 1E requirements and properties (i.e. differential protection, overcurrent, etc.). If the concern of the NRC is for the power quality of the incoming power system and asset protection, then conventional fault protection can be implemented on the non-Class 1E system without need for new regulatory requirements or guidance like the subject BTP. If the purpose is the protection of Class 1E functionality and maintenance of independence of power sources, then the BTP guidance should be similar in nature to the undervoltage protection scheme.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
11	All	Clarification that the intended protection requirements are for Class 1E functionality / independence from a source with an open phase fault.	Class 1E functionality and source independence are evaluated utilizing a risk informed approach.	Utilization of risk informed approach would allow solution determination based on reliability of the protection scheme and its ability to provide adequate protection for a given nuclear generating station. If non-Class 1E fault protection is provided, consideration of coincident unrelated failures is not required as discussed in 10 CFR 50 Appendix A, Definitions and Explanations. If a class 1E solution can be utilized, then documentation is reduced and the nuclear power generating station must consider the financial risk associated with the degradation of equipment which may be connected to an open phase fault.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
12	All	General term used to describe the "open phase condition" is too vague and not consistently used throughout the document. Recommend using "Open Phase Fault" to better describe the item to be corrected. The term 'open phase condition' better describes the event. IEEE Std 100 provides the basis for this recommendation.	Define "Open Phase Fault" in section B: Open Phase Fault - The loss of a single phase, or two phases, based on a single event which results in an open phase fault in one or two phases of the three phase power connection. For all instances referring to the item to be corrected in an open phase condition, use the term "Open Phase Fault".	Multiple references to the "event" of concern utilizing different non-defined or incorrect terminology allow interpretation of meaning, potentially in a non-conservative manner. Clarifying and streamlining the terminology to accurately detail the event will allow greater chance at compliance with the intent and greater understanding of those reading the BTP. The ongoing research into the analysis of OPFs has revealed that the fault analysis is similar to the analysis of short circuits. This was especially evident during the upgraded of ETAP software. Although the NEI Initiative refers to the phenomenon as an "Open Phase Condition", it refers to the event. The BTP guidance document provides the opportunity to employ the preferred terminology based on industry research and analysis. It is recommended to use IEEE 100 consensus standard language where possible to reduce confusion.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
13	All	The open phase fault is a fault on the offsite electric power systems that may impact the capability or capacity of the offsite power system to perform its designated safety function. As the preferred power source, the qualified offsite power circuits are already included in plant Technical Specifications, which satisfies the requirements of 10CFR 50.36(c)(2)(ii)(C) Criterion 3 as structures, systems, or components, that are part of the primary success path which function or actuate to mitigate a design basis accident or transient that assumes the failure of or presents a challenged to the integrity of a fission product barrier.	Additional Technical Specification requirements are not required. Remove reference in BTP. Engage Industry Technical Specifications Task Force for resolution.	The Technical Specifications currently include requirements for verifying the capacity and capability of the qualified offsite power circuits. Technical Specifications requirements may need to be updated, based on station design and licensing basis evaluations, to account for the evolving understanding of the impact of the OPF.
14	All	The term "open phase condition" is referred to as "condition" in section B (e.g., B.1.V.(1)a, b, and c), but is preceded with a reference to "accident condition" and it is not clear what "condition" is being referenced.	Globally replace "Open Phase Condition" with "Open Phase Fault", when addressing the failure and not the event. Additionally, replace any appropriate instances where the terminology is currently truncated to "condition" or "event" and replace with "Open Phase Fault".	Too many statements of "condition" will provide error traps and require interpretation or further clarification.
15	All	If a solution is determined to solve the problems of an open phase fault, potential coverage for other unknown failures could be provided.	Review BTP and current position to define the most effective goal(s) for protection, so that a currently unidentified fault would have appropriate guidance when discovered in the future.	Addressing unidentified faults now would eliminate future BTP revisions and/or new regulations.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
16	All	Term "open phase fault" is not defined. Recommend using "Open Phase Fault" to better describe the item to be corrected. The term 'open phase condition' better describes the event.	Provide definition in section B.	**Open Phase Fault** - an open phase fault occurs on the high voltage side of a transformer connecting a credited offsite power circuit to the transmission system and can be considered: • loss of a single phase with a ground fault, • loss of a single phase without a ground fault; and • loss of two of the three phases without a ground fault
17	All	This BTP includes information and specifications of a specific design, rather than only the design objectives.	Provide design objectives only and do not specify a particular design.	The BTP references 'dual sensors and coincidence logics' rather than just indicating the performance objective of minimizing misoperation, mal-operation, and spurious actuation. The open phase detection designs (e.g., EPRI design) or other approaches may be capable of initiating adequate protection from mal-operation, etc., without the use of redundant sensors or coincidence logics. NRC should state performance objectives, not design details. This is the 'trap' that the NRC fell into with the Millstone Generic Letter design issues for degraded voltage protection schemes. Providing design details is not utilized in other BTPs.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
18	All	The staff's application of the requirements for SSCs identified as important to safety for the active plants as compared to the application to the passive plants has been inconsistent.	The staff should provide guidance for a passive plant how an open phase condition can prevent electrical equipment important to safety (i.e., – equipment credited in the safety analyses) from performing their safety functions.	The staff has provided examples that, for active plants, an open phase condition can prevent electric equipment important to safety from performing their safety functions; however, the staff has not demonstrated so for passive plants.
19	All	The staff is incorrectly applying the GDC requirements to SSCs that are not important to safety and are not credited with safety functions in the accident analyses.	The staff should adjust its BTP application of the GDC requirements in the case of defense in depth, non-safety-related SSCs which are not credited with operating to mitigate design basis accidents.	Passive plant designs do not credit AC power systems or active components such as diesel generators, pumps, or fans for mitigation of design basis accidents. Thus, such components are not important to safety and are not required to meet the requirements of GDC 17 or the other GDCs. The application of GDC requirements to these defense in depth systems is inconsistent with regulatory precedent.
20	All	The staff's application of the requirements for SSCs identified as important to safety for the AP1000 plant is inconsistent with precedent staff positions.	The staff should adjust its BTP application of the requirements for SSCs defined as important to safety to the AP1000 defense in depth systems. The defense in depth systems are not credited with safety functions and their operation is not required to bring the plant to a safe shutdown condition.	See Attachment "Comment #20 APOG Comment Basis"

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
21	Sect: A, para: 1, sent: 3	Need to clarify and correct details in the background. Replace "high impedance fault" with "grounded condition" and "sustained open phase condition" with "sustained open phase with ground fault".	Replace sentence with: "The insulator failure resulted in a **grounded condition** through the fallen Phase C conductor and a sustained open phase **with ground fault** on the high voltage side of the SAT."	Description of the event is misleading. Rewording more accurately describes the event.
22	Sect: A, para: 1, sent: 5	Need to clarify and correct details in the background. The sentence states that "ESF loads remained energized momentarily..." which implies all tripped quickly.	Remove the word "momentarily".	Description of the event is misleading. Rewording accurately describes the event since some loads remained connected longer than the verbiage implies. The buses remained energized for eight minutes.
23	Sect: A, para: 1, sent: last	Need to clarify and correct details in the background. Replace "overload condition" with "overcurrent condition".	Replace sentence with: "The **overcurrent** condition caused several ESF loads to trip."	Description of the event is misleading. Rewording would provide an accurate depiction of the event.
24	Sect: A, para: 2, sent: last	Need to clarify and correct details in the background. "In the event that the operators failed to diagnose the condition in a timely ... few more minutes."	Replace sentence with: "Although the operators appropriately diagnosed the condition in a timely manner, if the condition was allowed to persist for an additional six minutes, damage to the RCP seals could have occurred due to loss of RCP seal cooling water. This in turn could have resulted in a loss-of-coolant from the RCP seals in the containment building."	Description of the event is misleading. Rewording accurately describes the event. The operators diagnosed the condition, but procedural guidance to address the OPF did not exist at the time the event occurred.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
25	Sect: A, para: 3, sent: 2	Need to clarify and correct details in the background. "This event was also initiated ... of the circuit"	Replace sentence with: "This event was also initiated by a failed inverted porcelain insulator which resulted in an open phase fault on the **transmission side** of the **open** phase."	Description of the event is misleading. Rewording more accurately describes the event.
26	Sect: A, para: 3, sent: 4	Need to clarify and correct details in the background. "The 4.16-kV ESF... From the 4.16-kV buses."	Replace sentence with: The 4.16-kV ESF buses experienced a **loss of voltage** condition due to the opening of 345 kV system breakers, which resulted in separation of SATs from the 4.16-kV buses.	Description of the event is misleading. Rewording more accurately describes the event. The loss of voltage relay actuated once power to the Class 1E bus was lost.
27	Sect: A, para: 4, sent: 1	Need to clarify and correct details in the description. "Past operating ...Fitzpatrick"	Replace sentence with: Past operating experience has identified single open phase faults at South Texas, Unit 2; Beaver Valley Power Station, Unit 1; **and a single event that affected** Nine Mile Point, Unit 1, and neighboring James A. Fitzpatrick.	Description of the event is misleading. Rewording provides a more accurate description of the event. This was a single event common to the two stations.
28	Sect: A, para: 4, sent: 1	References to licensee reports for these events are not in the Draft BTP. Need to verify that references in the Draft BTP contain these.	Include event reports in reference section.	Summarized description of the events doesn't give enough information to identify the gravity of the concern; however, adding too much detail in the BTP would be of little benefit. Directing readers to the event reports would allow further clarification.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
29	Sect: A, para: 4, sent: 6	Need to clarify and correct details in the description. "Second, the Forsmark, Unit 3 in Sweden reported that protective relaying scheme is vulnerable to open phase events based on an event that occurred on May 30, 2013 (circuit breaker to the 400 kV grid was disconnected in two phases, when power source to the safety buses were in the process of realigning to an alternate 70 KV source).	Replace sentence with: "Second, in Sweden, Forsmark Unit 3 reported that its protective relaying scheme is vulnerable to open phase events based on an event that occurred on May 30, 2013. Even though the Forsmark event was caused by human error, when the power source to the safety-related buses was in the process of realigning to an alternate 70kV source, a circuit breaker connected to the 400kV grid was opened but one of the phases in the breaker failed to open, creating a double open phase fault on the power circuit."	Rewording provides as accurate depiction of the event. Replacing the parenthetical description with a separate sentence provides needed details from the summary of the event.
30	Sect: A, Para: 5	Reference is made to February 26, 2013 summary report	Add conclusion from summary report: "In summary, all licensees stated that the relay systems were not specifically designed to detect a single-phase open circuit condition in a three-phase system because they considered this to be beyond the approved design and licensing bases of the plants. No formal calculations for this scenario have been performed by most of the licensees to address the design vulnerability identified in the Bulletin."	This explains why the vulnerability exists.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
31	Sec: A Para: 6, sent: first	The safety significance of an open phase condition is not the same for a passive plant.	The staff should differentiate between the safety significance of an open phase condition for passive plants as compared to active plants.	A passive plant design does not require AC power sources to mitigate design-basis events. The offsite power system does not serve a safety function. As such, a fault in the AC power system does not carry the same significance.
32	Sec: A Para: 6, sent: last	The results of the accident sequence precursor analyses conducted by the NRC have not been shared with passive plant designers or COL holders or applicants; therefore, its applicability to the passive designs cannot be verified.	Provide an accident sequence precursor analysis specific to passive plants that identifies the postulated event combined with the accident precursor of note (open phase condition).	The staff has not yet identified an accident sequence that when combined with an open phase condition would result in an increase in the core damage frequency for passive plant designs. Additionally, the staff has not identified an accident sequence that, combined with an open phase condition, would result in the failure of the protective system to actuate ESFs.
33	Sec: A Para: 7, sent: last	"...and 10 CFR 50.36(c)(2) and (c)(3)...." Is this a requirement in addition to the GDC 17 circuit(s), or the fulfillment of the GDC 17 requirement?	Since this is shown in section 1.VI. Surveillances and Limiting Conditions for Operation, specifically, this should be removed from the opening paragraph in section A. It is not shown in section 2.IV. Surveillances.	

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
34	Sect: B	The presentation guidance for complying with requirements does not allow the reader to readily follow. Layout and description is choppy and users would require prior experience/knowledge with the subject matter to interpret the requirements and apply any guidance.	Re-write BTP to: • Correct the identified comments • Define the equipment to be protected • Provide clarification to revisit consensus industry standards (like those referenced in most other BTP's) once they have been developed • Adjust the BTP to document the current aspects of the evolving nature of this issue • Not issue premature guidance prior to evaluation of technical strategies	BTP doesn't follow the existing formats and contains several factual errors, inconsistent terminology, and competing requirements for solutions which will cause confusion and result in inconsistencies. Writing the document to clearly present the requirements of the protection scheme and convey NRC's requirements will cause less confusion. Additionally it will create alleviate the need for clarification or interpretation in the future.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
35	Sect: B	Requirements are not clear. Consider rewording as in proposed resolution. Introduction should include what the protection scheme is supposed to accomplish and a definition of the event it is protecting against.	In addition to the undervoltage and degraded voltage schemes to protectect the Class 1E buses from undervoltage, guidance should be provided for protection of the Class 1E equipment from an open phase fault, if appropriate. The following open phase faults should be considered: • loss of a single phase with a ground fault, • loss of a single phase without a ground fault; and • loss of two of the three phases without a ground fault For each of these, the open phase fault occurs on the high voltage side of a transformer connecting a credited offsite power circuit to the transmission system. *Note: Faults at other locations are not considered as part of the open phase fault and should not be included for this BTP.*	Separation of items is not consistent with other BTP's.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
36	Sect: B	"High Impedance Ground Fault Condition" is not a definable term. In the context of this document, it is to represent variable resistance value that could affect the resistance of the connection to ground and cause a different result than that of a bolted ground fault or a truly open phase.	Remove reference to "High Impedance" fault and replace with "ground fault"	Inclusion of a "high impedance" fault is indeterminate and undefined. Requirements to analyze the boundaries should envelope the consequences. This was discussed during several public meetings and removed from all literature prior to the drafting of this document. Analysis has shown that there is a possible break point where results of acceptability and/or detectability between a grounded fault and an ungrounded fault might occur. This value is dependent on the design of the system, not the OPF. If this is the case for a particular station, these values should be determined by analysis and not globally defined in the BTP for all station types, configurations, etc.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
37	Sect: B (i) , para 1	Need to clarify and correct details in the description. "Electrical power from the transmission..." Reorganizing of the numbering system is recommended to provide clarification. Removal of "high impedance" reference.	Replace introduction with: "The following open phase fault conditions must be considered: a. loss of a single phase with a ground fault, b. loss of a single phase without a ground fault; and c. loss of two of the three phases without a ground fault. For each of these, the open phase occurs on the high voltage side of a transformer connecting a credited offsite power circuit to the transmission system. Applicable operating electrical system configurations and loading conditions should be considered."	The introduction does not detail the OPF location or clarify the considerations. Inclusion of a "high impedance" fault is indeterminate and undefined. Requirements to analyze the boundaries should envelope the consequences. This was discussed during several public meetings and removed from all literature prior to the drafting of the subject document.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
38	Sect: B.1 and B.2	The staff's position on detection and mitigation of the effects of the open phase conditions on systems "important-to-safety" for the active plants as compared to the same application to the passive plants is inconsistent.	The equipment classification and licensing basis treatment of protective circuits necessary to prevent an open phase condition from adversely affecting the capability of components important to safety to perform their safety functions should be consistently applied to plants with active and passive emergency safety features.	The staff position states that an "open phase condition should be automatically detected and alarmed in the control room unless it can be shown that the open phase condition does not prevent functioning of important-to-safety SSCs." The staff's treatment of the equipment classification and licensing basis treatment of the protective circuits (should they be shown to be necessary) for passive plants is inconsistent with the guidance for active plants. If indeed, an open phase condition is shown to adversely affect the capability of a safety-related or an important to safety SSC in a passive plant to perform its safety function, the protective circuits of such a detection system should be Class 1E or equivalent protection systems meeting the requirements of 10 CFR 50.55a(h)(3), and the surveillance requirements of 10 CFR 50.36 should be applied as required. Likewise, if it is shown an open phase condition could adversely affect the capability of an important to safety SSC to perform its safety function for a passive plant, the protective circuits of the requisite detection system would warrant discussion in the UFSAR.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
39	Sect: B	Order of section B.1. Section is confusing.	Suggest: Circuit Classification, Detection and Alarms, Actuation, Protective Actions, UFSAR, Surveillance and Limiting Condition for Operation (LCO).	Provides more logical flow
40	Sect: B (i),	Clarify that all plants do not have a license commitment to provide two GDC 17 circuits for each unit and clarify that this BTP applies only to GDC 17 circuits.	Delete the first sentence. Clarify the second sentence by changing the words ". . . three phases of the independent circuits on the high voltage side of a transformer connecting an offsite power circuit to the transmission . . ." to read " . . . three phases of the high voltage GDC 17 circuit connecting the high voltage transformer to the transmission. . . ."	The AP1000 plant is licensed to provide one GDC 17 circuit for each unit.
41	Sect: B. (i) para: 1	The first sentence assumes a GDC 17 plant.	Eliminate discussion of two physically independent circuits.	The mention here of the detail that GDC 17 requires two circuits is not necessary to the point of the paragraph, which is to identify the types of OPFs to be addressed.

42	Sect: B(i), para: 1 sent: 2	This sentence along with the description in the following Section 1 essentially requires a Class 1E detection system under all operating conditions whether a transformer is loaded or not. As evidenced by numerous industry studies and testing at TVA, there are certain transformer designs where the event cannot be detected by Class 1E equipment under any known scheme in all operating conditions.	Revise the document to clarify that automatic protective actions are only required under conditions when the Class 1E equipment is prevented from accomplishing its safety-function. Provide guidance as to whether or not automatic protective actions are required in time to prevent loss of required safety-functions or equipment damage.	Detection by Class 1E equipment cannot be accomplished in all operating conditions for all transformer designs. In many cases, correction without automatic action may be a preferable action to prevent an unnecessary challenge to plant systems, operations, and/or safety-functions.
43	Sect: B(ii)	Clarification required "Loss of two of the three phases... configurations and loading conditions"	Reword to: "two of the three phases open without ground"	Loss of two phases with a ground would produce less conservative results and is already bounded by loss of phase with a ground.
44	Sect: B.1	The draft guidance for "active safety features" plants ignore industry research and developing experience on how best to provide the desired protection.	Provide alternative guidance based on the physical and engineering limitations of the configurations. NRC should work with industry to develop reasonable guidance on how to provide an adequate level of protection based on the applicable IEEE standards that can be practically implemented.	The suggested guidance provides a more flexible framework for appropriate OPC relaying design while providing an acceptable level of nuclear safety. This is necessary in light of the inability of Class 1E relaying to detect an OPC in some situations. See the Attachment "Comment #44 Alternatives for Open Phase Condition Protection".
45	Sect: B.1		First sentence, change: "For performing licensing reviews" to "For performing licensee reviews"...	

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
46	Sect: B.1.I para: 2	Replace "the" with "an".	Replace sentence with: "Detection circuits for **an** open phase fault, which prevents the functioning of important-to-safety SSCs, should be sensitive enough to identify an open phase fault under all operating electrical system configurations and loading conditions for which they are required to be operable."	Grammatical correction
47	Sect: B.1.I.	Need to reword the sentence for clarity on what is required to be detected for sites planning to install safety-related relays on the Class 1E switchgear.	Reword the paragraph to read: "Detection circuits should be able to identify an open phase fault which would prevent the functioning of Class 1E equipment under all applicable operating electrical system configurations and loading conditions."	A design that installs phase voltage imbalance relays on the Class 1E switchgear and fully protects the Class 1E equipment from phase imbalances may not be able to detect all OPFs on the high voltage side of an offsite power circuit. In this case, the "effects of an open phase fault which could prevent functioning of Class 1E equipment" is what could be detected.
48	Sect: B.1.I. para: 1	"Automatically" does not make sense	Delete automatically	If the idea is to prevent only visual detection, the feature to "detect and alarm in the control room" cannot be complete by visual inspection. The word automatically is not needed.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
49	Sect: B.1.I. para: 2	Change "under all operating conditions"	To "under applicable operating conditions" or "under all applicable operating conditions"	"all" can be interpreted by individual inspectors as beyond what is required to meet safety analyses. It should be the responsibility of the licensee to determine the applicable operating conditions for their detection scheme.
50	Sect: B.1.II	Two separate and distinct requirements are imbedded in the second paragraph of this section. The coordination requirement is uniquely different from the FMEA requirement.	For clarity, separate the second paragraph into two paragraphs	
51	Sect: B.1.II para: 1	Introduction needed for when to isolate	Add sentence to the beginning: "An open phase condition should be automatically isolated, unless it can be shown that the open phase condition does not prevent functioning of important to safety SSCs."	Definition of actuate could be for control room detection or protection trip. Paragraph seems to describe trip. If analysis determines that the condition does not adversely impact the capability of the qualified circuits between the offsite transmission network and the onsite Class 1E AC electrical power distribution system to perform their designated safety functions, the need for isolation to address the fault is not necessary.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
52	Sect: B.1.II para: 1	Replace "The design of actuation...coincidence logics."	Replace with: "The design of actuation circuit should **utilize reliable components to** minimize misoperation, misoperation, and spurious **isolation** of an operable off-site power source."	Independent dual sensors and coincident logics should be removed from this section. How such a design is applied is not clear. Analysis demonstrates that the use of independent dual sensors and coincident logic may have an adverse impact on plant risk due to the human factors introduced by the performance of the additional maintenance required for multiple divisions or channels. These factors are not present in single channel designs. Reliability and availability may be maximized through the use of logic that can notify if the system self-diagnoses a loss of functionality and inclusion of the system in the licensees Maintenance Rule Program in accordance with 10 CFR 50.65(b)(2)(ii) (i.e., non-safety-related structures, systems, or components whose failure could prevent safety-related structures, systems, and components from fulfilling their safety-related function), and NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," Revision 4A

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
53	Sect: B.1.II para: 1	The function of the protection is to protect the loads, not the parameters of the offsite power system.	Delete second sentence: "Additionally, the protective scheme should not ... normally expected in the transmission system."	If it is shown that some parameters of what is considered an "operable" offsite power system prevents the functioning of components, then the source should be disconnected.
54	Sect B.1.II. para: 1	This section applies to both non-safety-related and Class 1E, yet the text provides details specific only to a non-safety-related design.	Reword the paragraph to read: "The design of the actuation circuit should utilize reliable components to minimize misoperation, mal-operation, and spurious actuation."	Dual sensors are not needed for a Class 1E design, which would be similar to the degraded voltage relay with two out of three logic built off individual phase potential transformers. Independent sensing for each relay in the 2/3 scheme is not required for Class 1E designs. As demonstrated through representative analysis, the implementation of a functioning single-channel open phase isolation system provides adequate protection based on core damage frequency. Additional system complexity would not have an appreciable benefit from a plant risk perspective. Since the details of sensors and logic are discussed in separate Class 1E and non-Class 1E subsections in B.1.V(3), no information is lost by truncating this sentence.
55	Sect B.1.II	The title implies criteria for "Actuation Circuits", the text addresses the reliability of the detection circuits.	Remove this section and, unless already included, include any additional requirements in Section B.1.V.(3).	Guidance on system requirements should only be included in one section.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
56	Sect: B.1.II para: 2	First sentence is not consistent wording with other BTP's	Delete first sentence: "Licensees/applicants should ... plant operation reliability."	
57	Sect: B.1.II. para: 2	A design with relays installed on the Class 1E switchgear would not need to coordinate with transmission system protective relays.	Reword the sentence to read: "These devices must be coordinated with other power system protective relays (e.g., short circuit fault protection, overcurrent relays, etc.)."	It appears this detail came out of the NEI Initiative, which does not address Class 1E installations. The sentence is adequate without inclusion of the specifics of the coordination with other protective relays.
58	Sect: B.1.II. para: 22	"must coordinate" may not be achievable by all designs	Change "must" to "should"	Coordination is the goal, but occasions of minor overlap exist and may be acceptable.
59	Sect: B.1.III	"Circuit Classification," states, "Class 1E detection and actuation circuits at the ESF bus level meet the applicable requirements of GDC 17..." This is not appropriate considering: 1) open phase fault detection should be implemented on the high side of the transformer, and 2) the definition of Class 1E equipment infers requirements for separation from non-Class 1E circuits.	Eliminate discussion of Class 1E detection and actuation circuits.	Reliable detection of open phase faults requires the desired protection element to be measured on the high side of the transformer. Relays at other locations typically do not have the capability to sense some open phase conditions. The draft BTP classification of 1E detection and actuation circuits would require measurement at ESF buses on the low side of the System Auxiliary Transformer (SAT) where typically there is no definitive indication of the open phase fault. The measured values at different locations are known to be influenced by many factors and may bear no direct correlation with an open phase fault.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
60	Sect: B.1.III	The section titled circuit classification is not clear in that it allows the function to be performed on Class 1E equipment or non-Class 1E equipment, but is prescriptive when using non-Class 1E equipment.	Instead of prescribing requirements for functional performance on non-Class 1E equipment, categorize the function that is to be performed.	The BTP suggests a solution for an OPC is to have a diverse system of augmented quality clear the fault allowing the emergency diesel generators to energize the vital bus and power the ESF functions. This approach would be similar to and consistent with NRC regulation 10 CFR 50.62 which provides requirements for reduction of risk from ATWS events. In an ATWS event, a safety system (e.g. reactor trip switchgear) fails to perform its safety function. The solution is a diverse system of augmented quality that starts safety related equipment (through qualified isolation) to mitigate the event.
61	Sect: B.1.III para: 1	The requirements of GDC 17 do not currently include provisions related to the detection of OPFs.	Change to: "The circuit design should minimize the probability of losing electric power from any of the remaining power supplies (i.e., onsite or offsite) as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies. Both Class 1E and non-Class 1E circuit designs that satisfy this requirement are acceptable."	Accurately reflects the portion of GDC 17 that will apply.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
62	Sect: B.1.III para: 1	Replace first paragraph: "Class 1E detection ... if the following is satisfied."	Replace with: "Either Class 1E circuits at the Class 1E bus level or non-Class 1E circuits are acceptable, if the licensee can demonstrate compliance with GDC 17 or equivalent design requirements."	This modification is to bring the utility back in compliance with GDC 17. Without making that requirement, then there is no basis for the change.
63	Sect: B.1.III. para: 1	The first sentence assumes a GDC 17 plant. Need to account for non-GDC 17 plants. Having "detection" and "actuation" together in the sentence is confusing. It would also be helpful to add clearly what is being actuated for the Class 1E design.	Reword the sentence to read: "Class 1E detection at the Class 1E switchgear with actuation circuits that separate the open phase fault at the Class 1E switchgear incoming circuit breakers meets the applicable requirements of GDC 17 (or similar principal design criteria specified in the UFSAR)."	Include the qualifier for non-GDC 17 plants used in other areas of the Branch Technical Position. Use the term "Class 1E switchgear" instead of "ESF bus" (see General comment). Split detection and actuation in the sentence for clarity.
64	Sect: B.1.III. para: 2	Demonstrating compliance with the listed requirements using an equivalent non-1E system is not possible.	If direction comes from OGC, revise BTP to state a scheme must provide the function in one of the following manners: 1. Comply with 10 CFR 50.55a(h)(2) or (3) 2. Propose an alternative non-1E function under an exemption to Item 1.	Either the requirement is "compliant" or an "equivalent function" (yet to be defined) but not both.
65	Sect: B.1.III, para: 2	Unnecessary complication of the intent.	.....(non-class-1E) is acceptable to the NRC if the licensee can demonstrate that success or failure of the scheme will not result in the Class-1E circuits being susceptible to an OPC, otherwise an exemption to this requirement in accordance with 10CFR 50.12, "Specific Exemptions," must be processed.	Clearly describes how the Class-1E systems will be protected. Removes the need to consider invoking 10CFR 50.55a(h)(2) & (3).

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
66	Sect: B.1.IV para: 1	Change wording: "The Updated Final Safety ...	Replace with: "The Updated Final Safety Analysis Report (UFSAR) should be updated to discuss the design features and analyses related to the effects of, and protection for, the OPF conditions **described at the beginning of this section**. This update would typically be **in** Chapter 8 of the UFSAR and completed in conjunction with 10 CFR 50.71(e) requirements."	Grammatical changes and clarification of OPC (not any OPF vulnerability that hasn't been identified at this time)
67	Sect: B.1.V	Section does not seem to include considerations where a bus transfer schemes occur (e.g. unit trip).	Identify considerations for open phase faults in situations where a bus transfer is utilized.	Bus transfer schemes require the loads to be shifted to an often times unloaded or standby transformer. If an open phase fault were to occur on this standby source, the detection of the open phase fault would not be achievable until the transformer was energized and/or loaded.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
68	Sect: B.1.V	Significant clarification of how to comply with the use of a non-Class-1E solution. Guidance should explain how 50.36(c)(2) and (3) expectations apply to a non-Class 1E solution.	Additional guidance for this type of alternative.	If a licensee determines that its design meets the criteria for items i thru vi under the non-class 1E protection scheme, the BTP guidance should clarify if this needs to be submitted and approved prior to implementation. It should also address how CFR 50.36 applies, since it would not be an initial condition or an accident mitigation system. The BTP should identify what would be a specific exemption that would require prior review and approval. Specific NRC staff approval or exception per 10 CFR 50.12 is a schedule impact for any plant attempting to implement the BTP guidance.
69	Sect: B.1.V	The term "accident condition" is not clear in the context of the BTP.	Clarify the term by adding a definition, referencing a definition in another NRC document, or listing the 'accident condition' contemplated.	The clarification will eliminate confusion over what conditions must be considered.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
70	Sect: B.1.V. 1/2	This is confusing to have different criteria and actions for 'if there is' or 'is not' an accident signal present.	Eliminate the mention of whether an accident condition signal is or is not present. (1)a, b, c, d, and (2)b (reworded) would apply to all designs at all times. Replace this section with the following: **"The licensee/applicant should demonstrate that the following design requirements are met following an open phase condition. The analyses should include all design and licensing basis assumptions including single failure criterion.** **a. The function of Class 1E equipment is not adversely affected,** **b. An abnormal operating occurrence, transient, event, or accident (e.g., RCP seal failure) is not created as a result,** **c. Class 1E equipment is not damaged or prevented from operating due to the activation of protective devices,** **d. Safe Shutdown capability is not compromised for all operating and anticipated operational occurrences, and** **e. All design basis accident acceptance criteria and GDC-17 (or principal design criteria specified**	Instead of this complex arrangement, a simpler setup is proposed that provides the basic criteria that should be met in all cases, no matter what. That is, when an OPC occurs, what functions need to be maintained and what situations do we make sure are not created by the OPC. It should be up to the plant to demonstrate what will happen when different OPCs occur and how they will maintain the critical functions listed in this section. Plant specific OPC protection schemes may or may not include logic integration with an accident signal. This greatly simplifies the layout of this section and will help users understand how to apply it to their designs and analyses.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
71	Sect: B.1.V.1	Delete (a) and (c) since they are an expansion of the regulatory scope that is not necessary	Keep (d) as the requirement	The purpose for having this signal/no-signal language in the NEI Initiative was to allow the tripping activation circuit to be bypassed or not required unless the plant is in the middle of an accident. Initially this was specifically made to allow standby transformers not to have to detect an open-phase condition if the transformer was unloaded. This was needed at the time because the first design at a plant could not detect an open phase condition on an energized but unloaded transformer. Now, a year or so later, technology has advanced and OPC protection schemes are available that make this detection possible. This logic was also built based on a specific plant design. The Bellefonte open phase test showed that it is possible for all equipment to be started and be fully functional given a specific type of OPC. If Bellefonte were an operating plant and they could demonstrate they still meet all the necessary criteria, it would be prudent to let them alarm only for these demonstrated faults, since no operations would be immediately at risk, and let operators provide an orderly path to restoration of the situation.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
72	Sect: B.1.V.1.a	Change wording: "the condition does not... system and components."	Replace with: "The open phase fault does not adversely affect the function of important-to-safety structures, systems and components; **or**"	To have "and" at the end of the sentence when nothing is adversely affected does not make sense. This wording allows this condition to be met or the next three together have to be met.
73	Sect: B.1.V.1.b	Change wording:	Replace with: "**No** abnormal operating occurrenc**es or UFSAR Chapter 15 events** would be created as a result of the condition, and..."	An open phase fault on the main transformer will always result in a unit trip at some plants. This is a required transient due to the open phase fault and inability to transfer the main generator to another output point in the system.
74	Sect: B.1.V.1.b	It is unclear what "abnormal operating occurrence, transients, events, and accidents" refer to.	Provide clarification	The wording implies inclusion of every transient or event which could include a reactor trip. Analysis and station design will have to determine if a reactor trip is required. It is not appropriate to provide a requirement without the basis. For example, if the open phase were to occur on the high side of the generator, due to power flows in the system and the ability of the generator to provide 3 phase power thru a 2 phase system would not be achievable. Unit trip would occur to protect the asset. Additionally, by definition an open phase fault would cause a transient and therefore this requirement could not be met as written.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
75	Sect: B.1.V.1.b	It may be unreasonable to require that, in the absence of an accident condition signal, an open phase condition would not result in an abnormal operating occurrence or operational transient.	Remove the requirement that an open phase condition would not result in an abnormal operating occurrence or operational transient, or clarify what is meant by an "absence of an accident condition signal."	An open phase condition is an abnormal operating occurrence that will result in main generator trip for many operating and new active and passive plants. With the current wording, it is unclear what is meant by this particular requirement. If the intent is that, if the open phase condition goes undetected, the licensee/applicant should demonstrate that AOO, transients, events and accidents would not be created as a result of the undetected condition, the statement in paragraph 1.V(1) could use clarification.
76	Sect: B.1.V.1.c	Change wording:	Replace with: "Important to safety equipment is neither prevent from operating nor damaged by the condition, and..."	Clarification
77	Sect: B.1.V.1.d	Change wording:	Replace with: "Safe Shutdown capability is **maintained** for all operating and anticipated operational occurrences."	Clarification
78	Sect: B.1.V.1	Section (1) and (2) do not logically complement each other and there is no need for conditional logic for the presence or absence of an accident condition. Remove the conditional logic for the presence or absence of an accident condition.	-Change the heading for section (1) to: "The licensee/applicant should demonstrate that:" -Incorporate the intent of (2).b. into this section as subsection "e" or into the section's heading itself.	Conditional logic for the presence of an accident signal is not required. It is not desired to disconnect from an offsite power supply experiencing an OPC shown by analysis or actual testing to have no adverse effect on important to safety SSC's. Thus, the response to an OPC is identical whether or not an accident signal is present.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
79	Sect: B.1.V.1	Add Notes section to better describe relationship with a, b, c, and d	Add text: "Note: Either (a) is determined or items (b), (c), and (d) must be met if function is adversely affected."	The requirements cannot all be met simultaneously. Either there is 'no adverse effect' or 'there is' and certain items apply. Clearly, 'no adverse effect' and 'adverse effect' cannot happen simultaneously to the same piece of equipment. Simply viewed, as a result of the open phase fault the station will have an abnormal operating occurrence.
80	Sect: B.1.V.1	The subsection a, b, c, & d seemed to be grouped with an "and" (a and b, c and d) yet they are all separated by semicolons.	If these groupings are intentional, the purpose should be explained in the section.	Cannot follow rationale for the grouping.
81	Sect: B.1.V.2.a	Wording is overly restrictive	Replace with: "Protection scheme will ensure safety functions are preserved, as required by the current licensing basis."	Automatic detection and actuation may not be required in all cases.
82	Sect: B.1.V.2.b	Change wording:	Replace with: "Alternatively, a licensee/applicant may demonstrate that all design basis accident acceptance criteria and GDC 17 or equivalent criterion is met with the OPF, given other plant design features. The analyses should include all design and licensing basis assumptions including single failure criteria."	
83	Sect: B.1.V.2.b	Testing may not be feasible	Replace with: "Alternatively, a licensee/applicant may demonstrate by analytical analyses **or** actual testing..."	Testing may not be feasible due to safety.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
84	Sect: B.1.V.2.b	BTP Section B.1.V(2)b states: "... The analyses should include all design and licensing basis assumptions including single failure criterion." Single failure criterion is not applicable to the OPC analysis.	Delete "including single failure criterion."	GDC 17 requires onsite power analyses assuming single failure, but does not require offsite power analysis assuming single failure, as provided below from GDC 17 (emphasis added): • "The onsite electric power supplies, including the batteries, and the onsite electric distribution system, shall have sufficient independence, redundancy, and testability to perform their safety functions **assuming a single failure**." • "Electric power from the transmission network to the onsite electric distribution system shall be supplied by two physically independent circuits (not necessarily on separate rights of way) designed and located **so as to minimize to the extent practical the likelihood of their simultaneous failure** under operating and postulated accident and environmental conditions."

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
85	Sect: B.1.V.3	Remove reference to voltage/current sensors designed to satisfy 10 CFR 50.55 a(h)(2) requirements		Not applicable for the requirements. Protection system definitions, with respect to GDC 17 circuits, need to be developed since they are not in line with current definitions for this "Protection Systems" as outlined in IEEE Std. 279 or IEEE Std. 603.
86	Sect: B.1.V.3	It is confusing to discuss voltage and current "sensors" when talking about medium voltage or high voltage power system circuits.	Reword the sentence to read: "The voltage or current transformers used for OPF detection should be designed for..."	When talking about medium voltage or high voltage power system circuits these "sensors" are known to power system engineers as potential transformers (PTs) and current transformers (CTs). These more descriptive and familiar terms should be used in the Branch Technical Position.
87	Sect: B.1.V.3	There is no section differentiation between the Class 1E subsection and the non-Class 1E subsection.	Add subsection numbers and possibly even headings, to separate the Class 1E subsection and the non-Class 1E subsection.	Section numbers and headings will make it easier to locate specific materials in the Branch Technical Position and to refer to them in station documents.
88	Sect: B.1.V.3	Any protection scheme can be credited for protection (i.e. no requirement for the protection scheme to be labeled "open phase protection")	Reference to "Open Phase" should be removed from items (iii) and (iv).	This fault condition can be successfully protected against by various protection schemes. (e.g. loss of voltage, overcurrent, neutral, grounding, etc.) A new scheme would only be required to protect a vulnerable area, not to include areas where protection can be provided by existing schemes.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
89	Sect: B.1.V.3	This section has duplicate sets of lower case Roman numeral subsections i. through vi. It appears the portion of the BTP was intended to address the two potential classifications of the solution (Class 1E and non-Class 1E). Note: It is not clear if this language would support a hybrid solution incorporating elements falling into both classifications that, together, form a complete solution.	Break the section into three subsections "a", "b", and "c" as indicated: "a. Portions of the protection system to be installed Class 1E (if any) shall meet the following requirements:" "b. Portions of the protection system to be installed non-Class-1E (if any) shall, as a minimum, meet the following equivalent protection system requirements specified in 10 CFR 50.55a (h)(2) or 10 CFR 50.55a(h)(3) or alternative in accordance with 10 CFR 50.12, "Specific exemptions,":" "c. Alternatives to the requirements sections of a. and b. may be submitted and authorized prior to implementation in accordance with... ... Specific exemptions," must be processed. Change the paragraph beginning "The voltage or current sensors..." into section B.1.IV(3)a.i., making it the first subsection under the proposed new subsection "a." Delete the first two paragraphs following the first existing subsection "vi" based on the proposed wording of the new section "b" heading	The overall OPC solution may be composed of several portions meeting: Class-1E requirements (where feasible) to protect the emergency buses, non-Class-1E requirements with characteristics of a Class-1E system for detecting all OPC conditions and exceptions to either category.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
90	Sect: B.1.V.3.i non-Class 1E,	Only the faulted power source will be disconnected.	The open phase protective devices should automatically disconnect the offsite **faulted power source** when the setpoints ...	
91	Sect: B.1.V.3. Class 1E.iv	It is not clearly stated what devices are being tripped. The sentence includes terms that are not the usual terms with discussing power system protection. The "setpoints" for protective relays includes the time delay limits.	Replace sentence with: "Whenever the open phase fault protective relay setpoints have been exceeded, automatic separation from the offsite power source should be initiated by opening the incoming Class 1E switchgear circuit breakers."	The circuit breakers to be opened upon actuation by the protective relays on the Class 1E buses should be stated for clarity. Since the action is protecting the Class 1E equipment, the incoming circuit breakers to the Class 1E switchgear would be opened to separate from the offsite power source. Terms normal to power system protection should be used to ensure clear understanding by the users of the Branch Technical Position.
92	Sect: B.1.V.3.v Class 1E and non-Class 1E	On-line testing may not be feasible and may risk plant operation. Reword	Replace sentence with: "Capability for test ... should be provided, **<u>if possible</u>**." or add clarification: "On-line testing of the system is preferred if it does not risk plant operation."	Depending on the design of the plant and selected solution for the open phase fault, it may not be safe or feasible to perform test and calibration during power operation. Although on-line testing and/or calibration are preferred methods, not all systems or components in a plant can be tested in this manner. Systems or components that cannot be tested or calibrated during operation should be tied to a plant outage period.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
93	Sect: B.1.V.3.ii, iii, iv non-Class 1E,	Unclear of intent on the isolation function having redundancy	Clearly state: Isolation of the faulted offsite power source may be accomplished by a single device (i.e., single high voltage circuit breaker via a single train trip scheme).	For example, for many plants' auxiliary power distribution systems, the Class 1E bus is fed through a single circuit breaker from an upstream non-1E bus.
94	Sect: B.1.V.3.iv [second such section]		Add to the existing section: "With the detection of the open phase condition take manual action to disconnect the offsite power sources."	
95	Sect: B.1.V.3.v non-Class 1E,	The disconnection cannot be tested during power operation.	... test and calibration **of the dual detection system** during power operation should be provided.	The word "major" should be deleted since it implies that only a portion of the population of equipment needs to be considered when determine withstand to phase imbalances. Also, here is a place where the subject should be Class 1E equipment rather than important-to-safety components, since a Class 1E scheme will only separate Class 1E equipment from the faulted offsite source.
96	Sect: B.1.V.3 v. [both such sections]	"Capability to test and calibrate..."	Eliminate calibrate. Change test to functionally test.	On-line calibration complicates the design and may not be necessary. Relay drift characteristics can be considered for longer test period such as refueling outage.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
97	Sect: B.1.V.3 v. [both such sections]	These list items do not differentiate between actionable open phase conditions and tolerable open phase conditions suggesting that any OPC should result in isolation of offsite power. It appears this section intends to describe the architecture of the protection system rather than its actuation logic, so these list items should be moved to section B.1.IV(2)a.	Deleted both subsections "iv." and blend with section B.1.IV(2)a. The remaining subsections will now exclusively address the architecture of the protection system vs. its actuation logic.	It is not desired to disconnect from an offsite power supply experiencing an OPC shown by analysis or actual testing to have no adverse effect on important to safety SSCs.
98	Sect: B.1.V.3.	This is a lengthy section with many types of requirements. There are duplicated paragraph numbers used.	Split the section into Class 1E requirements and non-Class 1E requirements (if claiming an exemption from 1E requirements).	Needs clarification, hard to follow with repeating section headings.
99	Sect: B.1.V.3.	Dividing the protective system requirements by their classification (1E or non 1E) makes the requirements confusing. Common requirement should be stated first, then specific requirement(s).	The generic requirements of iii, iv, and v, form the "Class 1E" sections should be stated first. The word protective device should generically be changed to open phase protective scheme for consistency. For a Class 1E scheme, the guidance should state ". . . equipment used should be physically located and electrically connected to the Class 1E switchgear" and independent schemes may be provided for each division. For non-Class 1E, ". . . separation requirements shall be satisfied for interface with class 1E ..."	Better organization, consistency, and accuracy of requirements.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
100	Sect: B.1.V.3	This section prescribes specific requirements that are intended to satisfy the function described in 1.V(1) and 1.V(2); however, these specific requirements are not needed in all systems designs to satisfy the functions described.	Rather than prescribing the solution identify the required functions and categorize the function per Regulatory Guide 1.201.	The variety of system configurations, types of equipment, and protection system designs does not lend itself to a prescriptive solution. The resulting designs may not be optimal for all plants.
101	Sect: B.1.V.3 non-Class 1E, para: 1 and 2	Unnecessary complication of the intent	Consider the wording: "If the non-Class-1E open phase circuit protection schemes are installed, the licensee must demonstrate that success or failure of the scheme will not result in the Class-1E circuits being susceptible to an OPC, otherwise an exemption to this requirement in accordance with 10CFR 50.12, "Specific Exemptions," must be processed."	Clearly describes how the Class-1E systems will be protected. Removes the need to consider invoking 10CFR 50.55a(h)(2) & (3
102	Sect: B.1.VI	Modify wording " ... values for the open phase conditions relays and associated time delay devices"	Reword the sentence to read: "... values for the relays and associated time delay devices**, as required**."	Clarification
103	Sect: B.1.VI	Maximum and minimum limit for surveillance may not be applicable. If there were a singular solution, typical requirements could be utilized; however, this will require individual plant design and licensing basis.	Provide more generic wording for requirements.	The proposed wording would not allow the use of a neutral injection system (i.e. EPRI solution) as the magnitude of the disturbance due to the open phase fault can vary based on the type of fault and the minimum/maximum level settings. This determines the variation from "nominal" and baseline values are determined continuously.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
104	Sect: B.1.VI	This section is overly specific and is not the preferred method by which the NRC identifies Technical Specifications requirements.	Revise to state: "The technical specifications should include necessary requirements to meet 10 CFR 50.36 in a manner consistent with the Standard Technical Specifications (i.e., NUREG 1430 through NUREG-1434)."	Technical Specifications requirements are not typically established in Branch Technical Positions. It has not been established whether addressing the Open Phase issue will fall under 10 CFR 50.36(c)(2) or (c)(3), or whether paragraph (c)(4) may be applicable. 10 CFR 50.36(c) does not describe Surveillances. It has not been established whether new limiting conditions for operation are needed. Further, alarm setpoints are not typically included in Technical Specifications. The current standard Technical Specifications (NUREGs 1430-1434) typically include either setpoints or allowable values, but not both.
105	Sect: B.1.VI	Surveillance activities only apply to Class 1E circuits.	For Class 1E application, the Technical Specifications ...	Requiring surveillance activities on non-Class 1E equipment is inconsistent.
106	Sect: B.2	AP1000 plant design does not require AC power to perform safety-related safe shutdown functions.	Revise to ensure features of the AP1000 design are properly represented.	The AP1000 preferred GDC 17 source is neither designed nor required to be single-failure proof and as such may experience credible faults such as an open phase condition with or without high impedance ground faults. Lack of detection for such a fault on the high side of the transformer does not prevent the AP1000 design from accomplishing safe shutdown, as the AP1000 design does not rely on power from the offsite system to accomplish safety-related functions.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
107	Sect: B.2.I	Important-To-Safety classification is not defined.	Define Important-To-Safety classification using nuclear industry defined and generally accepted terminology/classifications.	"Important-to-safety" is not defined nor used in the AP1000 Design Certification Document; hence, the AP1000 has no equipment or systems that are classified as "important-to-safety."
108	Sect: B.2.I	"important-to-safety"	There are no systems that are "important-to-safety" that are associated with the AP1000. Systems are either safety related or non-safety related.	AP1000 does not have any electrical systems that are classified as "important-to-safety".
109	Sect: B.2.II	Actuation circuits This appears to be a design requirement for non-safety power sources (i.e., by providing independent dual sensors and actuation logics that could cause separation from an operable off-site power...." The entire paragraph appears to be adding new design requirements.	Delete section.	The BTP does not clearly describe why actuation circuits are required for passive plants. The requirement of independent and dual sensors and actuation logic appears more in line with safety related SSCs. Defense-in-depth is achieved by multiple sources.
110	Sect: B.2.II	In addition, need to clarify what is the plan referred to here "does not result in lower overall plan operation reliability."	Change plan to plant.	Plan does not appear to be appropriate as used in this section.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
111	Sect: B.2.III	Restoration of preferred or Onsite AC Power This new requirement to specify: "ensure the standby diesel generators are connected to the auxiliary alternating current buses" seems overly prescriptive given the plant specific nature of the off-site power systems. It appears to be making assumptions on what failure mechanism occurred.	Replace with a more generic action and give the standby diesel generators as an example.	The action to specifically connect the "standby diesel generators ...to the auxiliary alternating current buses" maybe overly prescriptive, since the offsite power systems are plant specific.
112	Sect: B.2.IV	Surveillance activities only apply to Class 1E circuits	For Class 1E application, periodic tests, calibrations, ...	Requiring surveillance activities on non-Class 1E equipment is inconsistent.
113	Sect: B.3	Heading and the lead-in sentence for this section does not really describe what is in it.	Replace the heading and lead-in sentence with: "Considerations for Supporting Analyses" "This section provides considerations related to the analyses that may be needed to support verification of the design of an open phase protection scheme:"	A cleaner heading and lead-in help understanding by the user of the Branch Technical Position.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
114	Sect: B.3	The draft BTP states "The following guidelines provide an overview of the analyses that should be performed". This implies that the four types of analyses listed are required; however, some of the analyses may not be applicable depending on the design option selected.	Reword the sentence to clarify these are examples of analyses that may be needed rather than analysis that should be performed.	Circuit analyses mentioned in B.3.b and c – Not all design would require this level of analysis. Time delays – section B.3.d : There is no causal correlation between the open phase scenario and design basis accidents. As an independent event, there is no need to coordinate the time delay with an accident scenario. See general discussion below. This section is not very helpful for determining what analysis is required. This should simply state that the licensee should have analysis to show that safety functions are preserved, as required by the current licensing basis.
115	Sect: B.3	Add a new item to considerations to recognize that a protective device may not be readily available. Also, no provision is included for a monitoring period prior to implementing a new scheme.	Add text: "e. Different transformer configurations may require different solutions. Protective relays schemes may not be readily available for each configuration and schemes developed may have little or no operating experience to provide an indication of reliability. A monitoring period may be warranted prior to fully implementing the scheme."	It would be beneficial to obtain concurrence that a solution may not be available "off the shelf." A monitoring period is consistent with the Industry OPC Initiative.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
116	Sect: B.3.a	In the last sentence, using "shall" is out of place when discussing items to consider and it may also unnecessarily restrict future analysis advancements.	Replace sentence with: "For transformers, the effects of an embedded winding, no-load current and losses, transformer type (core and shell), and inter-phase A, B, C mutual coupling, including zero-sequence should be included, or bounding parameters **should** be established."	The whole purpose of this section appears to be to provide information to help the user perform any needed analyses, so the information should not include prescriptive requirements. Also, methods for determining bounding parameters for analysis purposes may be developed in the future.
117	Sect: B.3.a thru B.3.d	Analyses of plant electrical systems are not necessary to detect an OPC on a HV offsite power circuit.	Since the first line of Section B.3 contains the words "should be performed", then the guidance provided in sub-sections a, b, c, & d are not requirements.	Analyses as described in Section B.3 will not be performed for the AP1000 plant since such analyses are not required in order to detect and provide an alarm in the MCR when an OPC occurs on a GDC 17 offsite power circuit.
118	Sect: B.3.a	Required data may be unavailable.	Add the following: "If transformer data is not available, sensitivity analysis may be utilized for transformers where zero sequence impedance values are not available."	For older transformers the zero sequence impedance values may not be available and sensitivity analysis may be performed to ensure limiting model is created.
119	Sect: B.3.b	Use of the adjective "major" is selecting only part of the population to protect and does not explain why partial protection is OK.	Replace sentence with: "Establish the capability of the Class 1E equipment to withstand unbalanced voltage/current conditions expected during various operating and loading conditions."	The word "major" should be deleted since it implies that only a portion of the population of equipment needs to be considered when determine withstand to phase imbalances. Also, here is a place where the subject should be Class 1E equipment rather than important-to-safety components, since a Class 1E scheme will only separate Class 1E equipment from the faulted offsite source.

#	Section, Paragraph, Sentence	Comment	Proposed Resolution	Basis For Comment or Resolution
120	Sect: B.3.b	....major important to safety components	... major (Greater than 4 kv) class 1E components ...	Clarification.
121	Sect: B.3.c	Establish the limitations of existing protective devices may not be necessary for all open phase protective schemes.	Replace sentence with: "Coordinate with existing protective devices for various anticipated operating and loading conditions with an open phase fault."	Changing the language to "coordinate with" will be clearer for what is needed. The limitations of the existing devices may or may not need to be determined. Also need to replace "condition" with "fault".
122	Sect: B.3.d	Uses "high impedance ground fault currents"	Change to "ground fault currents"	"high impedance" is open for interpretation

The requirements for the AC electrical power system (EPS) design are contained in IEEE 308 and other related standards, not IEEE 279.

The EPS as described in GDC 17 is a distinctly different system from the reactor protection system (RPS) described in GDC 20-24. Similarly the EPS described in IEEE 308 is different from the RPS described in IEEE 279.

The AC EPS provides power for plant pumps, values, fans, etc., and the RPS. Separately from the RPS, the EPS senses no reactor system variables nor takes any reactor protective actions.

The assertion that IEEE 279-1971 is applicable to the elements of the EPS conflicts with its purpose as defined by IEEE in the Standard. In ascribing IEEE 279 RPS design elements to the EPS, the NRC has inappropriately credited it with nonexistent capabilities and applied inappropriate requirements to the EPS design. In claiming applicability of IEEE 279 to the EPS, it has selectively ignored other provisions of the standard which would necessarily apply and conflict with the EPS designs normally used.

By such assertions, the NRC has misrepresented the original provisions of GDC 17 and confused the industry. Furthermore, the NRC has ignored the guidance for the EPS design as prescribed in other IEEE Standards prepared for that purpose.

IEEE 279 Overview

There are two different interpretations of IEEE 279-1971 by the NRC.

1. It describes the design of the reactor protection system which senses reactor operating variables and determines and initiates any protective actions required.
2. It describes measures to conserve and protect ESF functions from disabling events such as a degraded grid or open phase condition.

The second item is not the intention of the Standard.

Key concepts of IEEE 279-1971 are:

A. Scope is protection for reactors, not the protection system sensing and actuation components.
B. It applies to devices and circuits that generate signals for reactor protection and that send the protective signal to the input of the device that should take the protective action.
C. A single failure shall not prevent the protective action of the "system". An individual channel may fail, but it can't prevent the protective action.
D. As to channel independence, Signals for the same protective function shall be independent and physically separated.

IEEE 279 was written with the safety-related Reactor Protection System (RPS) trip channels as its subject. This Standard has been exploited by the NRC and applied to all safety-related circuits whether they provide a direct RPS trip function or not. Degraded Grid Voltage (DGV) relaying is another system which does not provide a RPS trip function.

Note this quote from the Forward:

> "As interpretation of the term "protection system" seems to be evolving, this document should also include criteria for actuator systems. Work to expand the scope of the document to this end is underway and will be reflected in a future revision. At that time, the system presently described herein can more appropriately be called a "protection signal system," which by definition includes both instrument and logic channels. The protection system will then consist of the protective signal system and the actuator system. The user should recognize that neither the present nor the expanded scope includes all of the structures and equipment required for complete protection."

And this quote from the Scope:

> "For purposes of these criteria, the nuclear power generating station protection system encompasses all electric and mechanical devices and circuitry (from sensors to actuation device input terminals) involved in generating those signals associated with the protective function."

The phase "...to actuation device input terminals" refers to the input signals to the breakers or other devices which start pumps, close valves, etc., but the scope does not include them.

The limitations of this scope are reinforced in NRC Standard Review Plan (SRP) Appendix 7.1-B, "Guidance for Evaluation of Conformance to IEEE Std. 279," as follows:

> "The scope of IEEE Std. 279-1971 includes those systems that actuate a reactor trip, and that in the event of a serious reactor accident, actuate engineered safety features."

IEEE Std. 603-1991 defines the protection systems discussed in IEEE Std. 279-1971 and IEEE 603-1991 as the sense and command features for the reactor trip system and the engineered safety features. It further clarifies that power sources, by definition, are considered auxiliary supporting features or other auxiliary features and, therefore, are not part of the reactor trip system and engineered safety features.

Both the Degraded Voltage Relay (DVR) and Open Phase Indication System (OPIS) are used to detect unacceptable offsite power supply condition, but neither directly trips the reactor nor provides signals to actuate engineered safeguards. Therefore, these systems should fall outside the scope of the protection systems as defined in IEEE Std. 279-1971 and IEEE Std. 603-1991. The NRC has reinterpreted these Standards and used them for purposes for which they were not intended.

Numerous Regulatory Guides, including 1.22, 1.47, 1.62, 1.70, 1.75, 1.118, and 1.153, recognize that the RPS of IEEE 279 is different from the system actuated or controlled by it including the components of the EPS.

Regulatory Guide 1.53, Rev. 2 states:

> "The NRC recognizes that "protection systems" are a subset of "safety systems." Safety system is a broad-based and all-encompassing term, embracing the protection system in addition to other electrical systems. This regulatory guide is not intended to change the scope of the systems covered in the final safety analysis report for the currently operating nuclear power plants. Therefore, the regulatory guidance in this revision applies only to plant protection systems for currently operating nuclear power plants; and any application to a broader scope, namely safety system modifications, is voluntary. The staff continues to encourage, but not require, operating nuclear power plants to comply with IEEE Std. 603-1991 and IEEE Std. 379-2000 for future system-level modifications."

10 CFR 50, Appendix A

Both the EPS and the RPS are designed for two particular plant conditions:

1. Anticipated Operational Occurrences (AOO) – Those conditions of normal operation which are expected to occur one or more times during the life of the nuclear power unit. For such expected occurrences, the fuel and pressure boundary design limits should not be exceeded.
2. Postulated Accident – Those conditions which are unexpected but postulated because they are within a realm of possibility. For such unexpected occurrences, the core is cooled, containment integrity, and other vital functions are maintained.

The functions supplied by each system differ significantly as contained in various industry and NRC documents. See the following table for a comparison.

The protection system shall be designed:

1. For AOO, initiate automatically the operation of appropriate systems including the reactivity control systems, to assure that specified acceptable fuel design limits are not exceeded, and
2. For an accident, sense the (*unanticipated*) condition, and initiate the operation of systems and components important to safety.

Reactor Protection System (RPS)	**Electric Power System (EPS)**
10 CFR 50, Appx. A, Section III, GDC 20-24	10 CFR 50, Appx. A, Section II, GDC 17-18
R. G. 1.22, 1.53, 1.62, 1.75, 1.118	R. G. 1.6, 1.32, 1.75, 1.81, 1.93, 1.118
FSAR – Chapter 7 SAR content per R,G. 1.70 The reactor instrumentation senses the various reactor parameters and transmits appropriate signals to the regulating systems during normal operation, and to the reactor trip and engineered safety feature systems during abnormal and accident conditions. The information provided in this chapter should emphasize those instruments and associated equipment which constitute the protection system (as defined in IEEE Std 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations"). Note: GDC 17 & 18 are not mentioned in this section.	FSAR – Chapter 8 SAR content per R,G. 1.70 A system description and an analysis sufficient to demonstrate compliance with 10 CFR Part 50 and the Commission's General Design Criteria (GDC) in Appendix A to 10 CFR Part 50 should be provided. In addition, the SAR should indicate the extent to which the applicant has followed the recommendations of regulatory guides and other applicable standards and criteria (e.g., industry standards normally used by the applicant in the installation of safety systems and internal standards and criteria). In particular, the circuits that supply power for safety loads from the transmission network should be identified and shown to meet GDC 17 and 18. Describe the onsite a.c. power systems with emphasis placed on those portions of the systems that are safety related. Those portions that are not related to safety need only be described in sufficient detail to permit an understanding of their interactions with the safety-related portions. The description of the safety-related portions should include: 1. Power supply feeders (i.e., network configuration), 2. Busing arrangements, 3. Loads supplied from each bus, 4. Manual and automatic interconnections between buses, buses and loads, and buses and supplies, 5. Interconnections between safety-related and non-safety-related buses, 6. Redundant bus separation, 7. Equipment capacities, 8. Automatic loading and stripping of buses, 9. Safety-related equipment identification,

	10. Instrumentation and control systems for the applicable power systems with the assigned power supply identified, 11. Electric circuit protection system network (e.g., selective trip), including setting criteria, 12. The scheme for testing these systems during power operation, and 13. Any systems and equipment shared between units. Provide analyses to demonstrate compliance with the Commission's General Design Criteria and to indicate the extent to which the recommendations of regulatory guides and other applicable criteria are followed. Especially important are the analyses to demonstrate compliance with GDC 17 and 18 and the discussion to indicate the extent to which the recommendations of Regulatory Guides 1.6, 1.9, and 1.32 (Safety Guides 6, 9, and 32) are followed.
IEEE NPEC SC 6 Stds. 279, 603	IEEE NPEC SC 4 Stds. 308, 387, 741, 765, 1792
Scope Composed of (1) sensing components that monitor the capability of the RCS, and (2) logic and control components that initiate appropriate reactor protective actions.	Scope Composed of an Offsite (Non-Class 1E) and Onsite (Class 1E) EPS, each of which is capable of providing power for protective actions.
Purpose Sense an AOO or an accident condition and initiate automatic protective actions.	Purpose Provide power for functioning of the SSC providing protective actions in the case of an AOO or an accident condition.
Function The RPS is designed to initiate: (1) the operation of appropriate systems including the reactivity control systems, to assure that specified acceptable fuel design limits are not exceeded as a result of anticipated operational occurrences and (2) Sense accident conditions and to initiate the operation of systems and components important to safety.	Function Each of the two EPSs provides sufficient capacity and capability to assure: (1) Anticipated operational occurrences (AOO) – (Expected during normal operation) – For AOO, do not exceed fuel design limits and RCS pressure boundary design limits, and (2) For an accident (Unexpected but possible during normal operation), core is cooled, containment integrity, and other vital functions are maintained.

Redundancy and Failures Designed such that: (1) No single failure results in loss of the protection function (2) Removal from service of any component or channel does not result in loss of the required minimum redundancy unless the acceptable reliability of operation of the protection system can be otherwise demonstrated. System is designed to fail into a safe state or into a state demonstrated to be acceptable on some other defined basis	Redundancy and Failures Offsite Two independent circuits designed to minimize to the extent practical the likelihood of their simultaneous failure. Onsite Two independent circuits designed to perform the safety functions assuming a single failure. Note: Redundant functions can be lost upon a circuit's removal from service. The EPS is an active system that does not have a fail-safe state.
Coincidence The protection system shall be separated from control systems to the extent that failure of any single control system component or channel, or failure or removal from service of any single protection system component or channel which is common to the control and protection systems leaves intact a system satisfying all reliability, redundancy, and independence requirements of the protection system. Coincidence, such as 2 of 4 devices monitoring the same variable (e.g. pressure), is normally used to initiate a protective action.	Coincidence The EPS cannot normally maintain redundancy requirements upon a single failure. The EPS does not use coincidence when taking actions. Different variables (e.g. different phases of the of the 3-phase power system) are sometimes used to decide actions. This incorrectly considered coincidence.
Diversity Functional diversity or diversity in component design and principles of operation shall be used to the extent practical to prevent loss of the protection function.	Diversity Each of the two ESPs (Offsite or Onsite) is designed to be functional assuming the other is not.

Comment #20 APOG Comment Basis

The Commission's definition of electrical equipment "important-to-safety" is interpreted as defined in §50.49(b) of the Commission's regulations, which reads as follows:

> (b) Electric equipment important to safety covered by this section is:
> (1) Safety-related electric equipment.
> (i) This equipment is that relied upon to remain functional during and following design basis events to ensure—
> (A) The integrity of the reactor coolant pressure boundary;
> (B) The capability to shut down the reactor and maintain it in a safe shutdown condition; or
> (C) The capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures comparable to the guidelines in § 50.34(a)(1), § 50.67(b)(2), or § 100.11 of this chapter, as applicable.
> (2) Non-safety-related electric equipment whose failure under postulated environmental conditions could prevent satisfactory accomplishment of safety functions specified in subparagraphs (b)(1) (i) (A) through (C) of paragraph (b)(1) of this section by the safety-related equipment.
> (3) Certain post-accident monitoring equipment.

There are no components specifically classified as "important to safety" in the AP1000 design. In the AP1000 plant, components meeting the description applied in subparagraphs (b)(1) through (3) of §50.49 are all classified as safety-related components. Safety-related electric equipment meeting the definitions in §50.49(b) are powered by the Class 1E electrical distribution systems, which are electrically isolated from the non-Class 1E systems by the battery chargers and voltage regulating transformers. The main generation system (ZAS), offsite power system (ZBS), main ac power system (ECS), and onsite standby power system (ZOS) do not meet the definitions in §50.49(b) and are not Class 1E systems. A failure in these systems, including an open phase condition, would not prevent the functioning of safety-related SSCs (which encompasses SSCs important to safety for the AP1000 plant).

As stated in the staff's final safety evaluation report for the AP1000 design certification (NUREG-1793), the AP1000 plant does not rely on power from the offsite system to accomplish safety functions. In addition, as stated in the response to Bulletin 2012-01 submitted by Southern Nuclear Company for Vogtle Electric Generating Plant Units 3 and 4, an open phase condition in the AC electrical system would not prevent the safety-related electrical system from performing its safety function because the "IDS battery chargers will perform their normal [non-safety-related] charging function until equipment input or output monitored electrical parameters are sensed out-of-tolerance. When the equipment input or output monitored electrical parameters become unacceptable and the battery charger no longer provides sufficient DC bus voltage, the Class 1E electrical system DC bus receives power from the applicable IDS battery and the battery charger maintains isolation [its only safety-related function] between the Non-Class 1E AC and Class 1E DC power systems." Such operation is inherent of the battery charger and does not require implementation of open phase detection circuitry to ensure its isolation safety function is met. Therefore, the staff has not demonstrated that regulatory enforcement of an automatic open phase detection and alarm system for the AP1000 plant is necessary to provide adequate protection of the health or safety of the public.

Comment #44 Alternatives for Open Phase Condition Protection

In some cases, an Open Phase Condition (OPC) cannot be detected at the Class 1E bus as desired. In 10 CFR 50.55a, concerning applicable codes and standards, paragraph (a)(3) contains provisions for allowing approval of alternatives to the listed requirements if:

(i) The proposed alternatives would provide an acceptable level of quality and safety.

(ii) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Both of the listed provisions are applicable to the OPC and the industry has provided alternative requirements that meet paragraph (i).

The following suggest basic alternative considerations for meeting an acceptable level of OPC protection.

Design Problem

Since the Class 1E electrical distribution system (EDS) is normally dependent on the offsite power system for its power source, it is subject to outside influences such as problems in the offsite preferred power supply. Engineers have designed Class 1E protective relaying such as undervoltage relaying to protect the Class 1E system from such problems, and guard the safety functions from the undesired influences.

An OPC is a unique design challenge as it cannot always be detected by the Class 1E components and it does not always result in immediate loss of safety function. The detectability is partly a function of the transformer design. Accordingly, a new approach to protective relaying is necessary for this issue.

Relaying Purpose

The purpose is to disconnect from an OPC before Class 1E loads functions are affected (tripped or damaged) or when the source becomes incapable of providing power even though loads are not yet affected. This is similar to other source relaying which disconnects before the Class 1E EDS can detect the problem (e.g. transformer short circuit).

Relaying Reliability

A failure of the relaying employed to detect an OPC may have a greater probability than the event for which it is designed to detect. Accordingly, OPC relaying shall be design to minimize the possibility of inappropriate action which can disrupt the preferred offsite power supply to the Class 1E EDS. There are no specific redundancy or coincidence requirements as long as the probability of inappropriate action is minimized.

Offsite Circuit Configurations

Redundant Class 1E EDS are normally supplied in two basic operational configurations:

Case A - Redundant Class 1E systems are fed from a single offsite source with a provision for a transfer to an alternate standby source.

Case B - Redundant Class 1E systems are fed from separate offsite sources. Each system has a provision for a transfer to the other source or an alternate standby source.

OPC Relaying Design Criteria

Case A

For an OPC, relaying shall disconnect the connected redundant Class 1E buses to prevent loss of safe shutdown capability.

A single failure in the OPC detection or actuation circuit shall not result in loss of the minimum circuits (a train or division) required to achieve safe shutdown, assuming no other failures.

A single failure in the OPC detection or actuation circuit shall not cause an inappropriate trip (i.e. false actuation) of more than the minimum circuits (a train or division) required to achieve safe shutdown, assuming no other failures.

Case B

For an OPC, relaying shall disconnect the related Class 1E buses to prevent damage to the affected Class 1E equipment and loss of its functional capability.

Assuming no other failure, safe shutdown capability shall be available from the redundant Class 1E distribution system and its preferred offsite power circuit.

Credited Standby Offsite Circuits

For a credited alternate offsite power circuit energized in a standby mode, relaying shall detect an OPC and block connection to any related Class 1E distribution system.

A single failure in the OPC detection or actuation circuit shall not result in loss of the minimum circuits (a train or division) required to achieve safe shutdown, assuming no other failures.

A single failure in the OPC detection or actuation circuit shall not cause an inappropriate trip (i.e. false actuation) of more than the minimum circuits (a train or division) required to achieve safe shutdown, assuming no other failures.

1E or Non-1E Design

Either Class 1E or Non-1E OPC relaying is acceptable as long as the above criteria can be met.

Motor Protection

There are various methods and various conservatisms to determine unacceptable motor conditions. Note that bus conditions may not be reflective of motor conditions. One of the following methods shall be used to determine motor condition unacceptability:

- NEMA unbalanced bus voltage > 3%
- IEEE C37.96-2012, Section 7.2.6.2, Motor I2/I1 > 15%
- For motor [(I2/I1)^2*t] > 40 seconds, where t = time at a particular negative sequence condition (I2/I1)
- NEI Guidance, $I_{EQ} = \sqrt{I_1^2 + 175 * \left(\frac{I_2 * I_{FL}}{I_{LR}}\right)^2}$ Note all "I" values are in amperes.

IEQ/IFL can be used as a per unit value to evaluate the effect of the negative sequence current and to determine motor protective requirements based on a comparison to typically available motor per-unit overcurrent limits typically captured on protective relaying TCC curves.