RESPONSE TO PUBLIC COMMENTS ON DOCKET ID NRC-2014-0131

Draft Branch Technical Position (BTP) 8-9, "Open Phase Conditions in Electric Power System" and Draft Revision 5 to Standard Review Plan, Section 8.1, "Electric Power Introduction," of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (Federal Register Notice 79 FR 32580)

On June 5, 2014, the NRC staff published a Notice of Opportunity for Public Comment in the *Federal Register* to provide the public an opportunity to comment on draft BTP 8-9. BTP 8-9 establishes guidance to the staff for reviewing various licensing actions insofar as they may involve an electric power system design vulnerability due to open phase conditions (OPCs) in an offsite electric power system. The staff performs these reviews in accordance with (1) Appendix A, **"**General Design Criteria for Nuclear Power Plants,**"** to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," General Design Criteria (GDC) 17, "Electric Power Systems," or principal design criteria specified in the updated final safety analysis report, and (2) 10 CFR 50.36(c)(2) and 10 CFR 50.36(c)(3), and (3) 10 CFR 50.55a(h)(2) or 10 CFR 50.55a(h)(3). Comments were received from 11 organizations/individuals.

1. (1) Robert Meyer (ADAMS Accession No ML14205A446)	2. (2-4) Madan Goel (ADAMS Accession No. ML14205A447)	3. (5-8) STARS Alliance LLC (ADAMS Accession No. ML14206A744)	4. (9-11) DTE Energy Company (DTE) (ADAMS Accession No. ML14205A007)
5. (12) Technical Specifications Task Force (ADAMS Accession No. ML14198A269).	6. (13-24) Florida Power and Light Company and NextEra (ADAMS Accession No. ML14206A745)	7. (25-43) Dominion (ADAMS Accession No. ML14205A448)	8. (44-48) Westinghouse Electric Company (ADAMS Accession No. ML14205A445)
9. (49-90) Duke Energy (ADAMS Accession No. ML14223A771)	10. (91- 113) AP1000 Utilities - Integrated Comments provided by Duke Energy for Southern Company; South Carolina Electric & Gas; Florida Power and Light; and Duke Energy (ADAMS Accession No. ML14205A008)	11. (114-235) Nuclear Energy Institute (NEI) (ADAMS Accession No.ML14205A006)	

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1.	General	Robert Meyer	I endorse the Standard Review Plan. Open Phase conditions challenge operators and may delay recovery actions during events.	Agree. Comment noted.
2.	Section B. 1.V(2)b	Madan Goel	The detection and protection for faults in the transmission system is commonly maintained with a single channel due to protection of the equipment and personal. This is in contrast of what commission is proposing single failure criteria requirements for open phase faults. The event at Byron would have been detected if the relays were designed to operate with "1 out of 1" logic instead of "2 out of 2" logic.	Disagree. Not all OPCs can be detected with undervoltage protection schemes. See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) for functional requirements to resolve OPCs.
3.	BTP Section B. 1.III	Madan Goel	The transmission system of the plants is a non-safety related and a Class 1E detection and actuation circuits as proposed by the commission is far reaching in the non-safety area. Not only this will be overly burdensome to implement, it dilutes the distinction between safety and non-safety related system.	Disagree. The staff did not characterize the offsite power systems as safety-related, and the protection scheme need not be Class 1E. The staff position is that power quality issues caused by any event or condition such as open phase, loss of voltage, and degraded voltage that could affect redundant engineered safety features (ESF) buses and loads should have features such as physical separation, electrical isolation, independence, and redundancy. These features should be included in the design to aid in preventing a mechanism by which a single design basis event could cause redundant equipment within the station's Class 1E power system to be inoperable.
4.	General	Madan Goel	Everyone knows the danger of dropped transmission/distribution lines, since the transmission industry does not have a viable method to detect such faults. Three phase power in the industry is commonly applied intentionally with open-delta configuration using 2 single phase transformers to save additional cost of transformer. That	Comment noted. Any proposed solution to the open phase condition vulnerability should satisfy the requirements of GDC 17. That is, it should be sufficiently robust to ensure the ESF buses are able to operate as designed and perform the safety functions described in the safety analysis.

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			means some configuration can successfully operate with open phase on high side of the transformer. In that case, an open phase could be considered a planned configuration instead of a fault or anomaly. It is important to detect the open phase but since it is rare event and no practical method exists at this time, the regulator and industry should move cautiously to enforce and implement any solutions. Due to differences in design, physical and operating configurations, vulnerability of the plants to open phase is different and different approach should be used. All factors such as switchyard and plant topology and single unit versus multiple units' plant should be considered. For example, the exposure of open phase is much higher if the plant powers the redundant trains from a single grid versus the plant that powers redundant trains from two different grids. Similarly response of "2 out of 2" logic versus" 2 out of 3 logic" will be different to open phase. There are fail safe solution such as EPRI neutral injection which provide active supervisory instrumentation to minimize spurious actuation which are capable of providing adequate protection from mal-operation, without use of redundant sensors or coincidence logics.	See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203).

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5.	Section A, Background (last paragraph) Section B(1), Nuclear Power Plants with Active Safety Features Section 8(1)(V)(3), first page 5, unnumbered paragraph	STARS Alliance LLC	The BTP is inappropriately referred to as criteria document. Additionally, the Interim NRC OPC Enforcement Policy implies applicability to current plant licensing bases. The treatment of open phase condition is beyond current plant design and licensing basis. As such, it would not be appropriate to impose new requirements without performing a backfit analysis in accordance with 10 CFR 50.109. Res: Explicitly state that the BTP does not establish any new criteria for existing plants.	Disagree. The BTP does not establish any new criteria for existing plants. However, staff will use BTP as a review criteria for any licensing actions regarding open phase issue consistent with § 50.34(h). GDC 17 requires that an onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety. The safety function for each system (assuming the other system is not functioning) shall be to provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents. The open phase event at Byron prevented both the offsite and onsite power systems from performing their intended safety functions. The staff issued Bulletin 2012-01 based on this operating experience, in which the staff requested licensees to reevaluate the design of their plant electric power system and address the non-compliance. Should the NRC impose the positions stated in the BTP on an existing licensee, the NRC will document in any order imposing these positions an analysis performed in accordance with the applicable backfit or finality regulations in 10 CFR Part 50 or 52. The criteria specified in this BTP are one way for staff to verify whether the proposed resolution addresses the design vulnerability and meets applicable regulatory requirements.
6.	Section A,	STARS	The single failure consideration of	Disagree

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	Background (2nd from last paragraph)	Alliance LLC	passive components within non-Class 1E systems is beyond current requirements. Res. Consider postulated open phase conditions as an event by itself.	Non-Class 1E power system components can be assumed to fail. Only Class 1E components (both active and passive) of the onsite power system need to meet the single failure criteria.
7.	Section A, Background; Section B(1)(lll), Circuit Classification; Section B(1)(V)(2), Protective Actions (w/ Accident Signal)	STARS Alliance LLC	The implication that a design basis accident must be assumed concurrent with an open phase condition is incorrect. Res: Safe shutdown capability, not accident mitigation, must be assured for an open phase event.	Disagree. GDC 17 requires that an onsite electric power system and an offsite electric power system shall be provided to permit functioning of structures, systems, and components important to safety. The safety function for each system (assuming the other system is not functioning) shall be to provide sufficient capacity and capability to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents. The staff position is that power quality issues caused by any event or condition such as open phase, loss of voltage, and degraded voltage that could affect redundant ESF buses and loads should have features such as physical separation, electrical isolation, independence, and redundancy. These features should be included in the design to aid in preventing a mechanism by which a single design basis event could cause redundant equipment within the stations Class 1E power system to be inoperable.
8.	Section B 1(VI) Surveillances and Limiting	STARS Alliance LLC	A separate LCO and condition is not necessary.	Disagree. Although LCO and associated

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	Conditions for Operation		Res: Consider modifying the section to reflect this.	action statements are provided for offsite power systems, the design features for open phase protection and their surveillance requirements need to be provided in plant Technical Specifications in accordance with 10 CFR 50.36 or sufficient justification should be documented for not doing so.
9.	BTP Section A, Paragraph 6, Sentence 2 and BTP Section B.1.V.	DTE Energy Company	*The draft BTP is predicated on the assumption that all plants are similarly vulnerable to an Open Phase Condition (OPC), with resulting failures of both offsite power systems and onsite emergency generation systems; specifically, that an OPC on one of the two offsite power systems could result in the loss of capability of the alternate offsite power circuit and the onsite power system to restore power to safety related loads. This is not the case; e.g., see the Fermi 2 response to Bulletin 2012-01 (ML12299A246). Fermi 2 has two independent, separate offsite Extra High Voltage (EHV) sources directly powering divisional Engineered Safety Features (ESF) buses (the Station Auxiliary Transformers are always loaded), Emergency Diesel Generators (EDGs) start on Design Basis Accident (DBA) signal, and transfer of loads between the offsite and onsite sources is direct and not dependent on intermediate Unit Auxiliary Transformer (UAT) and System Service Transformer (SST) bus transfer. An OPC on one offsite power source will not impact the availability of the other offsite power source or onsite emergency power.* *Res: The staff should not assume automatic OPC*	Disagree The staff reviewed responses to Bulletin 2012-01 and determined that the design vulnerability applies to all operating plants except one. As stated in staff's summary report (ADAMS Accession No. ML13052A711), operating nuclear plants with redundant trains such as Fermi 2 supplied from different transformers and connections to separate transmission systems are unlikely to have simultaneous open circuit or fault conditions on redundant ESF buses. In such configurations, one train of ESF buses can be affected by an open-phase conditions with or without a high impedance ground fault condition between the offsite switchyard and one of the power transformers for the following power configurations: (a) Both trains of ESF buses normally fed from two redundant SATs with a separate connection to switchyard (single-phase open circuit condition to one of the SATs). (b) Both trains of ESF buses normally fed from UAT with fast transfer to two SATs (single phase open circuit condition to one of the two SATs). For the above configuration, if a single failure is postulated on an ESF bus, the safety function of the electric power system would be lost. Therefore, without addressing the open phase design vulnerability, the

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			protection is required for GDC 17 compliance. The BTP should identify that other design configurations (i.e., other than the BTP specified designs for automated detection and actuation circuits) are acceptable, based on GDC 17 requirements.	existing electric power system design may not meet the provisions required by GDC 17 or equivalent principal design criteria specified in the FSAR.
10.	BTP Section B.1.III	DTE Energy Company	*Class 1E detection and actuation circuits are not appropriate considering; (1) an OPC solution 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.* *Res: Eliminate discussion of Class 1E solution.*	Any proposed solution should be able to detect a loss of phase(s) on the high voltage side of the credited offsite power circuit. The staff does not have any position regarding the physical location of the open phase isolation system (OPIS). The electric power system OPC design vulnerability may be resolved through non-Class 1E OPIS circuitry (independent of Class 1E protection systems). However, this approach does not relieve an applicant from complying with the provisions of GDC 17 applicable to the ESF systems. If a non-Class 1E OPIS protection scheme on the offsite power system is proposed, sufficient justification and analysis to demonstrate that GDC 17 is satisfied should be provided.
11.	BTP Section B.1.V(2) b	DTE Energy Company	Single failure criterion is not applicable to the OPC analysis. Res: Eliminate “including single failure criterion.”	Disagree insofar as the onsite electric power system is concerned. The OPC analysis should ensure that one train of the onsite power system is available to support safety functions, given a single failure in the onsite power system, even if the offsite power system is degraded (open phase, degraded voltage, loss of voltage, etc.).
12	Section VI - General Comment	Technical Specifications Task Force	Section VI, "Surveillances and Limiting Conditions for Operation," states, "The technical specifications should include requirements in accordance with 10 CFR 50.36(c)(2) and (c)(3) for limiting conditions for operations (LCO), surveillance requirements, trip setpoints, alarm set points, and maximum and minimum allowable	The staff has revised the BTP to refer to TS LCO and surveillance requirements more generally. Section VI is specifying the regulatory requirements for LCO and surveillance requirements. The staff notes that this is consistent with staff positions established for loss of voltage and degraded

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			values for the open phase conditions relays and associated time delay devices." This section is overly specific and is not the preferred method by which the NRC identifies Technical Specifications requirements. The section is overly specific in many ways. 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's 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. Technical Specifications requirements are not typically established in Branch Technical Positions. Since 1993, the industry Technical Specifications Task Force (TSTF) and the NRC have cooperated in developing generic Technical Specifications to address a wide range of regulatory requirements. The TSTF will work with the NRC to develop a Technical Specifications Traveler applicable to all operating plant types to incorporate any new or revised requirements needed to satisfy the requirements of 10 CFR 50.36, "Technical Specifications." This Traveler will be incorporated into the Standard Technical Specifications, and its availability will be noticed in the *Federal Register* for use by licensees. We recommend that issues related to Technical Specifications needed to address the Open Phase Condition be addressed in that well-proven	voltage protection instrumentation in BTP 8-6. The staff welcomes the opportunity to develop model or standard generic TS provisions to govern open phase protection schemes.

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			process. To resolve these problems, we recommend that Section VI of the document be revised to state, "The technical specifications should include necessary requirements to meet 10 CFR 50.36 in a manner consistent with the Standard Technical Specifications (NUREG-1430 through NUREG-1434)."	
13	All	Florida Power and Light Company and NextEra	Applicability of 10 CFR 50.55a(h)(2)(3) – All references to 10 CFR 50.55a(h)(2) and 10 CFR 50.55a(h)(3) should be deleted. Requirements and design bases for open phase monitoring and trip schemes should be consistent with the requirements and design bases for the offsite power system. Res: All references to 10 CFR 50.55a(h)(2) and 10 CFR 50.55a(h)(3) should be deleted. Requirements and design bases for open phase monitoring and trip schemes should be consistent with the requirements and design bases for the offsite power system.	Disagree. See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) regarding requirements applicable to OPC. In 10 CFR 50.55a(h)(2), the NRC requires nuclear power plants with construction permits issued after January 1, 1971, but before May 13, 1999, to have protection systems that meet the requirements stated in either Institute of Electrical and Electronics Engineers (IEEE) Standard 279, “Criteria for Protection Systems for Nuclear Power Generating Stations,” or IEEE Standard 603-1991, “Criteria for Safety Systems for Nuclear Power Generating Stations,” and the correction sheet dated January 30, 1995. For nuclear power plants with construction permits issued before January 1, 1971, protection systems must be consistent with their licensing basis or meet the requirements of IEEE Standard 603-1991 and the correction sheet dated January 30, 1995. In 10 CFR 50.55a(h)(3), the NRC requires that applications filed on or after May 13, 1999, for combined licenses under 10 CFR Part 52, must meet the requirements for safety systems in IEEE Standard 603–1991 and the correction sheet dated January 30, 1995.

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				These IEEE standards state that the protection systems must automatically initiate appropriate protective actions whenever a condition the system monitors reaches a preset level. Once initiated, protective actions should be completed without manual intervention to satisfy the applicable requirements of the IEEE standards. In the absence of an adequate protection scheme, an OPC can degrade power quality to an extent that these IEEE standards are not met.
14	Page BTP 8-9-3, Section 1.I. (2nd Paragraph)	Florida Power and Light Company and NextEra	Administrative controls and/or compensatory measures should be allowed for temporary operating alignments for maintenance instead of requiring automatic protection. Res: Revise design requirements to allow administrative and/ or compensatory measures to be utilized for short duration alignments for maintenance outages.	Disagree. The administrative controls and/or compensatory measures are allowed for temporary operating alignments in accordance with licensee programs and procedures consistent with NRC Administrative letter 98-10 and TS LCO requirements. No changes are warranted.
15	Page BTP 8-9-3, Section 1.II. (1st Paragraph) and Page BTP 8-9-5, Section V.(ii & iii "Non-Class 1E")	Florida Power and Light Company and NextEra	Actuation circuits (independent dual sensors and coincidence logics). Page 8-9-3, Section 1.11 "The design of actuation circuit should minimize misoperation, maloperation, and spurious actuation of an operable off-site power source (delete remainder of sentence)." Page 8-9-5, Section V.ii and V.iii Replace ii and iii with following: "The design of actuation circuit should minimize misoperation, maloperation, and spurious actuation of an operable off-site power source (delete remainder of sentence)." Res: Page 8-9-3, Section 1.11 "The design of actuation circuit should minimize misoperation, maloperation, and spurious	Disagree. See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) regarding protective scheme design in regard to OPCs.

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			actuation of an operable off-site power source (delete remainder of sentence)." Page 8-9-5 Section V.ii and V.iii Replace ii and iii with following "The design of actuation circuit should minimize misoperation, maloperation, and spurious actuation of an operable off-site power source (delete remainder of sentence)."	
16	Page BTP 8-9-3, Section 1.II. (2nd Paragraph)	Florida Power and Light Company and NextEra	FMEA: The addition of a new protection system will have a minor decrease in plant reliability but the BTP states it "does not" impact plant reliability and should be reworded. Res: Recommend rewording: "... demonstrate that the additional actuation circuit does not result in a more than minimal increase in overall plant reliability."	Agree with the recommendation. See the revised version of the BTP. This section was deleted.
17	Page BTP 8-9-3, Section 1.III. (1st Paragraph) and page BTP 8-9-4, Section V(2).b	Florida Power and Light Company and NextEra	Draft BTP assumes a GDC-17 plant. Need to account for non-GDC-17 plants. Res: Recommend rewording: GDC-17 (or similar principal design criteria specified in the UFSAR)."	See the revised version of the BTP. This section was deleted.
18	Page BTP 8-9-5, Section V. (I -vi "Class 1E")	Florida Power and Light Company and NextEra	Class 1E solution on the secondary side of the transformer is not a realistic solution for unloaded transformers (particularly with breakers open and certain load transformers (delta secondary windings)). Res: The goal is to protect from a loss on the high side of the transformer. For unloaded transformers, detection on the secondary side of the transformer is not realistic and should be recognized. Caveat should be inserted: “This solution may not be available for certain types of unloaded transformers, and only Section V	For clarification, see NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) regarding protective scheme design in regard to OPC. Please note that the staff revised the final BTP, and it does not prescribe any particular protective scheme; rather, it specifies the functions that should be accomplished.

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			"Non-Class 1E" applies."	
18.A.	Page BTP 8-9-5, Section V. (iii "Non-Class 1E")	Florida Power and Light Company and NextEra	Not clear with statement of "... per train/per phase basis". Res: Proposed rewording to "... per train or per phase basis."	See the revised version of the BTP. This section was deleted.
19	Page BTP 8-9-5, Section V. (iv "Non- Class 1E")	Florida Power and Light Company and NextEra	This requirement discusses protective devices should automatically disconnect the offsite power sources... " Res: Recommend adding provision for alarm in cases of isolated/unloaded GDC-17 transformers in non-accident cases	See the revised version of the BTP. This section was deleted.
20	Page BTP 8-9-5, Section V. (iv "Non- Class 1E")	Florida Power and Light Company and NextEra	Need for capability for calibration is not clear. At power calibration of risk to the plant and should be left to off-line activity, similar to other switchyard/transformer protection. Res: Recommend removing "calibration" from this requirement.	See the revised version of the BTP. This section was deleted.
21	Page BTP 8-9-6, Section VI	Florida Power and Light Company and NextEra	The condition of "Operability" should be per Technical Specification 3/4.8.1 (offsite power). Res: Technical Specification Basis updated to reflect design of open phase detection system.	See response to Comment No. 12.
22	Page BTP 8-9-7, Section 3	Florida Power and Light Company and NextEra	Consideration Guidelines should not be overly prescriptive. Res: Recommend citing first sentence only of 3.a, 3.b, 3c, and 3.d.	Disagree. The level of details is consistent with rest of the BTPs in Section 8 of the SRP. See the revised version of the BTP. This section was deleted.
23	Page BTP 8-9-6, Section VI	Florida Power and Light Company	10 CFR 50.36 is not applicable to Open Phase Protection and GDC 17.	Disagree. See response to Comment No. 12. Nonetheless, the staff removed detail from BTP on this subject.

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		and NextEra	Res: Proposed re-wording to "Periodic tests, calibrations, setpoint verifications or inspections (as applicable) should be established for any new detection and alarm circuits to ensure their reliability to perform its intended design/support functions."	
24	Overall	Florida Power and Light Company and NextEra	Need to address the requirements of the BTP for non-standard review plants (NUREG 0800) since not all plants are SRP plants. In addition, how are non-GDC 17 plants going to implement this regulation? For example, at least one plant Specific GDC does not contain any requirements for offsite power that are contained within 10 CFR Part 50, Appendix A, GDC's. Res: Need to determine appropriate avenue for non-SRP plants and non-GDC plants.	The SRP generally describes an acceptable means of meeting the regulations, but not necessarily the only means. The requirements for pre-GDC plants are the principal design criteria specified in the updated final safety analysis report, and 10 CFR 50.36(c)(2) and (c)(3).
25	General Section A, Paragraph 5	Dominion	Reference is made to February 26, 2013, summary report. Res: 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."	Disagree. Adequate information is provided in the Background Section with all applicable references. The focus of this BTP is to provide guidance to the staff in reviewing various licensing actions that relate to the electric power system design vulnerability due to open phase conditions in offsite electric power system.
26	Editorial Section B. (ii)	Dominion	Extra word "either" appears between "the" and "offsite" Res: Remove the word "either"	Agree Staff revised this section.
27	Editorial Section B. (ii)	Dominion	First word of section not capitalized.	Agree.

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			Res: Capitalize first word of section	Staff revised this section.
28	Editorial Section B.1.	Dominion	First sentence, change "For performing licensing reviews" to "For performing licensee reviews" .	Disagree. The guidance is written for staff reviews of future proposed licensing actions.
29	General Section (ii)	Dominion	Clarification: loss of two of the three phases...configurations and loading conditions. Res: Loss of two of the three phases (without ground) of the ~~either~~ offsite power circuit on the high voltage side of a transformer connecting an offsite power circuit to the transmission system under all operating electrical system configurations and loading conditions.	Agree. Staff revised this section as follows: " Loss of two of the three phases of the independent circuits (without ground) on the high voltage side of a transformer connecting an offsite power circuit to the transmission system under all operating electrical system configurations and loading conditions.
30	General I B.1.II	Dominion	Two separate and distinct requirements are embedded in the second paragraph of this section. The coordination requirement is uniquely different from the FMEA requirement. Res: For clarity, separate the second paragraph into two paragraphs.	Agree Staff revised this section.
31	General I B.1.II	Dominion	OPC protection system architecture should allow a primary/back-up configuration as an alternative to independent dual sensors. Res: Change the first paragraph to read: The design of the actuation circuit should minimize misoperation, maloperation, and spurious actuation of the protection system against an operable off-site power source by providing independent dual sensors "or primary and backup sensors" and coincident logics.	Agree. Staff revised this section.
32	Technical B.1.V.(1}	Dominion	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	Agree. Staff revised this section.

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			absence of an accident condition. Res: 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.	
33	Technical B.1.V.(2}	Dominion	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. Res: Change the heading for Section {2) to "If the requirements of Section (1) above cannot be met, then: "Delete subsection b and incorporate it into Section (1) above as Subsection 1.1V(1)e or into the section heading preceding the list a-d.	Agree. Staff revised this section.
34	Editorial B.1.V.(1)b.	Dominion	Insert "and" between sections b. and c.	Agree. Staff revised this section.
35	General B.1.V.(2) b	Dominion	Testing may not be feasible: Alternatively, a licensee/applicant may demonstrate by analytical analyses and actual testing that all design. Res: Change wording: Alternatively, a licensee/applicant may demonstrate by analyses or actual testing that all design	Staff revised this section.
36	General B.1.V.(3)	Dominion	NOTE: It is not clear that 10 CFR 50.55a(h)(2) or 10 CFR 50.55a(h)(3) apply to compliance for an open phase condition; however this feedback is provided should they be determined to be applicable. This section has duplicate sets of lower case	Comment noted. See the revised version of the BTP. This section was deleted.

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			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 1 E and non-Class 1 E). 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. Res: 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.1.1V (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	
37	Technical B.1.V.(3) v.	Dominion	NOTE: It is not clear that 10 CFR 50.55a (h}(2) or	Agree.

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	[both such sections]		10 CFR 50.55a(h)(3) apply to compliance for an open phase condition, however this feedback is provided should they be determined to be applicable. "Capability to test and calibrate..." Res: Eliminate calibrate. Change test to functionally test.	See the revised version of the BTP. This section was deleted.
38	General B.1.V.(3}ii. [second such section]	Dominion	NOTE: It is not clear that 10 CFR 50.55a (h)(2) or 10 CFR 50.55a(h)(3) apply to compliance for an open phase condition, however this feedback is provided should they be determined to be applicable. Res: Change to read an independent dual detection scheme "or single primary and backup detection scheme" should be provided at the non-Class 1E level for each circuit that feeds the division of the Class 1E power system	Agree. See the revised version of the BTP. This section was deleted. .
39	General B.1.V.(3)iv. [both sections]	Dominion	NOTE: It is not clear that 10 CFR 50.55a (h)(2) or 10 CFR 50.55a(h)(3) apply to compliance for an open phase condition, however this feedback is provided should they be determined to be applicable. 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.1.1V(2)a. Res: Delete both Subsections "iv." and blend with Section B.1.1V(2)a. The remaining subsections will now exclusively address the architecture of the protection system vs. its	Agree. See the revised version of the BTP. This section was deleted.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			actuation logic.	
40	General B.1.V.(3)iv. [second such section]	Dominion	NOTE: It is not clear that 10 CFR 50.55a (h)(2) or 10 CFR 50.55a(h)(3) apply to compliance for an open phase condition, however this feedback is provided should they be determined to be applicable. Res: Add to the existing section. "With the detection of the open phase condition take manual action to disconnect the offsite power sources."	Disagree. To the extent that an OPC may affect the quality of power supplied to the protection system, automatic protective action in response to the OPC is required. See response to comment no. 13.
41	General B.1.VI.	Dominion	Maximum/minimum limits for surveillance may not be applicable. The technical specifications should include requirements in accordance with 10 CFR 50.36(c)(2) and (c)(3) for limiting conditions for operations, surveillance requirements, trip setpoints, alarm set points, and maximum and minimum allowable values for the open phase conditions relays and associated time delay devices. Res: The technical specifications should include number of operable devices such as 2/3 or 2/4 etc. for detection of the condition.	Partially, Agree. Yes, In addition, the TS should include the number of operable devices.
42	General B.3.a.	Dominion	Unavailability of the Data: ... 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 shall be included. Res: Add a sentence: "For the Transformers, where zero sequence impedance value is not available, sensitivity analysis may be performed using range of the zero sequence impedance values."	Disagree. The required data for analysis should be obtained from the transformer manufacturer. However, this sentence was deleted from the BTP.
43	General B.3....	Dominion	Add a new item to considerations to recognize that protective device may not be readily available. Also, no provision is included for a	Disagree. The level of details such as these should be addressed as part of

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			monitoring period prior to implementing a new scheme. Res: 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."	implementation of procedures and is not included in the SRP.
44	2.1, page 6, line 15, 19, & 22	Westinghouse Electric Company	"important-to-safety" There are no systems that are "important-to-safety" that are associated with the AP1000 plant. Systems are either safety related or non- safety related.	Disagree Staff's use of important to safety is consistent with the terminology used in 10 CFR Part 50, Appendix A, General Design Criteria.
45	3.b, page 7, line 19	Westinghouse Electric Company	"important-to-safety" There are no systems that are "important-to- safety" that are associated with the AP1000 plant. Systems are either safety related or non- safety related.	Disagree Staff's use of important to safety is consistent with the terminology used in 10 CFR Part 50, Appendix A, General Design Criteria.
46	1.111, page 3	Westinghouse Electric Company	The section titled circuit classification is not clear in that it allows the function to be performed on Class IE equipment or non-Class IE equipment, but is prescriptive when using non-Class IE equipment. Instead of prescribing requirements for functional performance on non-Class IE equipment, categorize the function that is to be performed. The function to be performed is similar to Anticipated Transient Without Scram (ATWS) Mitigating System Actuation Circuitry (AMSAC) with the possible exception of a Class IE interface. The open phase actuation circuit will separate the offsite power	Disagree. The function to be performed is not similar to ATWS or AMSAC. The ATWS or AMSAC is a backup protection for existing primary protection schemes. Rather, the BTP describes an acceptable "primary" OPC protection scheme, not a backup. Therefore, the staff does not agree with the comparison of OPC to ATWS or AMSAC.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			system allowing the Class IE portion of the onsite power system to perform its safety function.	
47	1.III, page3	Westinghouse Electric Company	NRC regulations 10 CFR 50.55a(h)(2) and 10 CFR 50.55a(h)(3) do not apply to power system protective relaying. Res: Remove specific requirements for classification and applicability of regulation to systems, structures and components (SSC) and discuss the category of the function to be performed. Existing regulations and industry standards provide adequate direction for determining the class and quality requirements of SSC performing functions that are appropriately categorized.	Disagree. NRC regulations in 10 CFR 50.55a(h)(2) and 10 CFR 50.55a(h)(3) apply to power system protective relaying for active plant designs. See existing undervoltage and degraded voltage protection schemes that start emergency power system. Also, see responses to Comments No.13 and 40.
48	I.V(3), pages 4 and5	Westinghouse Electric Company	This section prescribes specific requirements that are intended to satisfy the function described in I.V(I) and I.V(2); however, these specific requirements are not needed in all systems designs to satisfy the functions described. Res: Rather than prescribing the solution, identify the required functions and categorize the function per Regulatory Guide 1.201.	Disagree. For active plant design, safety function is to start emergency power system if offsite power system is degraded by OPC. For passive plant design, see Section 3.
49	General	Duke Energy	The term open phase condition is too vague for a technical document like the BTP. As well, condition is used by itself in B1.V.(1)a, b, and c, but is preceded by with “accident condition” and is not clear what condition is being referred to. Res: Globally replace the term “open phase condition: with “open phase fault” in the BTP.	Disagree. Open phase condition (OPC) is defined in BTP. Since OPC does not always result in a fault condition the staff did not change the term.
50	General	Duke Energy	Three terms are used in Section B to identify what is being protected: important-to-safety, Class 1E, and	Disagree. For electric power systems, ESF

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			ESF. The use of all these terms when referring to a design for electrically separating specific equipment makes the BTP unnecessarily confusing. Res: Throughout Section B, replace the term "important- to-safety" and "ESF" with Class 1E.	circuits are Class 1E. But not all important-to-safety circuits are Class 1E.
51	General	Duke Energy	The term "important-to-safety" is used repeatedly throughout the document. Need to define what this term applies to. Res: Define "important- to-safety"	Comment is not incorporated. The term is used in 10 CFR Part 50, Appendix A, General Design Criteria and the staff defined it in previous correspondence with licensees. Therefore, there is no need to define it in the BTP. See Generic Letter 84-01, "NRC Use of the Terms "Important to Safety" and "Safety Related" (January 5, 1984); Letter dated December 19, 1983, from H.R. Denton, Director, Office of Nuclear Reactor Regulation, NRC, to T.S Ellis, III, Esq., Hunton & Williams (Both available at ADAMS Accession No. ML031150515).
52	Section B	Duke Energy	Main transformers are not typically part of normal plant alignment to feed Class 1E buses from offsite power (backfeed). This is mainly done in Mode 5 and 6 while the unit is in an outage. Res: Add provision in Section B to allow exclusion of main transformer protection where backfeed is not part of normal plant alignment. Additional surveillances may be needed when in backfeed to ensure an open phase condition does not affect Class 1E buses.	Comment is not incorporated. At least three new reactor designs and seven operating reactors use the main transformer as an immediate qualified offsite power source. The staff position is that all credited offsite power sources and any intervening transformers that could affect the quality of offsite power system should have OPC protection.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
53	Section B	Duke Energy	Need to structure the BTP to clearly define the requirements for a safety-related solution versus non-safety related solution. Res: Safety-Related Solution: - Protection at the Class 1E buses alone is adequate in response to expected transients from an OPC -There is no requirement for open phase detection, only Class 1E bus protection against an OPC Non-Safety Related Solution - It is acceptable to use a single reliable technology to provide detection and protection on the high side of the transformer. Diversity is not required to address common cause software failures since failure of the device will not directly place the unit in an unanalyzed condition – multiple failures would be required. It is at the discretion of the licensee to provide redundant solutions with coincident logic to minimize spurious trips of the offsite power source.	Comment is not incorporated. BTP was revised to provide only the functions of the protective design features and not the classification of those features. It is an applicant's responsibility to ensure that the electric power system design is consistent with all applicable regulatory requirements. See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203).
54	Section B	Duke Energy	Long-term requirements are not included. Res: It is acceptable for the licensee to implement compensatory measures at any time that the protection system is not functional. The compensatory measures would be in place during circumstances such as troubleshooting, repair, or transformer replacement where a monitoring period is needed prior to placing the trip circuitry into service.	Comment is not incorporated. The BTP is directed to future licensing actions for current and future new reactors. BTP is not a requirement. (For inoperable equipment, a licensee should follow applicable TS requirements.)
55	B(i)	Duke Energy	The first sentence assumes a GDC 17 plant. Res: Eliminate the discussion of two physically independent circuits.	Comment is not incorporated. No. The statement is incorrect. BTP discusses both GDC and pre-GDC plants.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
56	B.1.I	Duke Energy	Need to reword the sentence for clarity on what is required to be detected for sites planning to install safety-related relays on Class 1E switchgear. Res: "Under all operating electrical system configurations and loading conditions detection circuits should be able to identify the effects of an open phase fault which would prevent the functioning of Class 1E equipment."	Comment is not incorporated. See response to Comment No. 53.
57	B.1.I	Duke Energy	The paragraph states that open phase detection is required "unless it can be shown that the open phase condition does not prevent functioning of important-to-safety SSCs." Res: Add a specific clarification to exempt further action if function can be maintained.	See the revised BTP. This sentence was deleted.
58	B. Introduction	Duke Energy	Recommend that the Introductory paragraph of the BTP be reworded as follows: Res: Electric power from the transmission network to the onsite electric distribution system is supplied by two physically independent circuits. The design of the electrical system should address open circuit faults on the high voltage side of the transformer(s) the transmission system to the plant onsite electric distribution system. The design should address the following types of open circuits under both loaded and unloaded operating conditions of the transformer(s): ▪ Any phase opened; ▪ Any phase opened and solidly grounded; ▪ Any phase opened and impedance grounded; ▪ Any two phases opened;	Additional clarifications are provided in the revised BTP.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			▪ Any two phases opened , one of which is solidly grounded; and ▪ Any two phases opened, one of which is impedance grounded. If it can be shown that the OPC does not prevent functioning of Class 1E SSCs, no further is action is required. Otherwise, the following criteria should be satisfied.	
59	B.1I	Duke Energy	Recommend rewording as follows: See comments 57 and 58. Res: An OPC should be automatically detected and alarmed in the control room. Detection circuits for the OPC should be sensitive enough to identify an OPC under all operating electrical system configurations and loading conditions for which they are required to be operable. See resolutions for Comments 57 and 58	See responses to Comments 57 and 58.
60	B.1.II	Duke Energy	The section applies to both non-safety related and Class 1E, yet the text provides details specific only to a non-safety related design. Res: Reword the paragraph to read: "The design of the actuation circuit should minimize misoperation, maloperation, and spurious actuation."	See the revised version of the BTP. This section was deleted.
61	B.1.II	Duke Energy	A design with relays installed on the Class 1E switchgear would not need to coordinate with transmission system protection relays. Reword the sentence to read: "these devices must be coordinated with other power system protective relays (short circuit fault protection, overcurrent relays, etc.)	See the revised version of the BTP. This section was deleted. Also, see NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203).

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
62	B.1.II	Duke Energy	Paragraph B.1.II (Actuation Circuits) is for all intents and purposes, the same subject matter as existing Paragraph B.1.V (Protective Actions). Res: Recommend combining the subject material into one section and deleting the other section.	See the revised version of the BTP. This section was deleted. Also, see NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203).
63	B.1.III	Duke Energy	The first sentence assumes a GDC-17 plant. Need to account for non-GDC 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. Res: 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 meet the applicable requirements of GDC 17 (or similar principal design criteria specified in the UFSAR."	See the revised version of the BTP. This section was deleted. Also, see NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203).
64	B.1.III	Duke Energy	The stated purpose of the draft BTP is to "address loss of one of the three phases of the independent circuits on the high voltage side of a transformer connecting an offsite power circuit to the transmission system under all operating electric system configurations and loading conditions." This is acknowledged to be a newly recognized design vulnerability and gap in licensee design bases across the operating fleet. The identified failure location is explicitly in the non-safety portion of the plant auxiliary power distribution system. The safety related plant Class 1E buses are downstream of this location. Res: The BTP should explicitly acknowledge the infeasibility of	See the revised version of the BTP. This section was deleted. Also, see NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203).

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			downstream, safety related circuits for open phase detection and protection as defined in the BTP.	
65	B.1.III	Duke Energy	In lieu of open phase detection, this newly recognized design vulnerability and gap in license design basis might be alternatively defined and addressed by enhanced protection on the safety related Class 1E buses similar to the sustained, degraded voltage protection systems. Res: The BTP should decouple the enhanced protection alternative from the explicit open phase detection /protection criteria.	See the revised version of the BTP. This section was deleted. Also, see NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203).
66	B.1.III	Duke Energy	Paragraph pertains to all Detection, Alarm and Actuation (protection) circuits. Res: Recommend promoting this subject to the position of the first paragraph and renumbering the succeeding paragraphs.	See the revised version of the BTP. This section was deleted.
67	B.1.IV	Duke Energy	Paragraph pertains to documentation and not system requirements. Res: we recommend that Paragraph B.1.IV, UFSAR, be moved down the text until after the discussion of all technical criteria re completed.	See the revised version of the BTP. This section was deleted.
68	B.1. V	Duke Energy	This section references protection for ITS equipment. A Class 1E solution will not protect ITS equipment. Res: Clearly define equipment to be protected by a Non-Class 1E vs. A Class 1E solution. This should also be applied to Section B.3, Considerations for Protective Devices for Alarm and trip Functions.	See the revised version of the BTP. This section was deleted. Also, see NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203).
69	B.1.V	Duke Energy	Automatic protection needs to be defined.	See NRC response letter dated November 25, 2014 (ADAMS

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			Res: Automatic protection is required for safety-related SSCs. For non-safety related SSCs, periodic surveillances, alarms or other means may be used.	Accession No. ML14120A203).
70	B.1.V(1)	Duke Energy	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. Res: If these groupings are on purpose, the Purpose should be explained in the section.	See the revised version of the BTP. This section was deleted.
71	B.1.V(1)	Duke Energy	Depending on the electrical system configuration and loading, the criteria of existing Paragraph B.1.V(1) (a. and b.) may not be met. Res: Recommend revising this paragraph to acknowledge the expected protective actions.	See the revised version of the BTP. This section was deleted.
72	B.1.V(1) a,b,c	Duke Energy	ITS equipment function will be affected by the actuation of non-Class 1E protective devices. These loads are not generator backed. These protective features should protect ITS equipment from damage. Res: Revise section to remove implication that additional power sources (generators) would be required should actuation of protective features occur.	See the revised version of the BTP. This section was deleted.
73	B.1.V(1)/ (2)	Duke Energy	This is confusing to have different criteria and actions for whether or not an accident signal is present. Res: Eliminate the mention of whether an accident condition signal is present or not. Replace the section with the following: The licensee/applicant should demonstrate that the following design requirements are met following an open phase fault. The analysis should include all design	See the revised version of the BTP. This section was deleted.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			and licensing basis assumptions including single failure criterion. a. The function of the Class 1E equipment is not adversely affected, b. An abnormal operating occurrence, transient, event, or accidents (e.g., RCP seal failure) is not created as a result, c. Class 1E equipment is not damaged or prevented from operating due to actuation 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 equivalent criterion) are met. If any of these cannot be met, a scheme to detect the phase fault shall be implemented into the plant design. The design of the scheme shall include automatic detection of the fault and actuation of the appropriate circuit breakers to separate the Class 1E equipment from the fault. Either the scheme or existing design features should be used to then ensure safe transfer of the Class lE loads to alternate power sources to ensure that safety functions are preserved, as required by the current licensing basis.	
74	B.1.V(2)(b)	Duke Energy	Paragraph essentially duplicates the discussion in Comment No. 57. Res: Add a specific clarification to exempt further action if function can be maintained.	See response to Comment No. 57.
75	B.1.V(3)	Duke Energy	It is confusing to discuss voltage and current sensors when talking about medium voltage or high voltage power circuits. Res: reword the sentence to read:	See the revised version of the BTP. This section was deleted.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			"The voltage or current sensors transformers used for open phase fault detection should be designed for …."	
76	B.1.V.(3)	Duke Energy	There is no section differentiation between the Class 1E subsection and the non-Class 1E section. Res: Add subsection numbers, and possibly even headings, to separate the Class 1E subsection and non-Class 1E subsection.	See the revised version of the BTP. This section was deleted.
77	B.1.V(3)	Duke Energy	Paragraph B.1.V(3) is not clearly structured. The first unnumbered introductory paragraph implies its applicability to the first set of Criteria (i) through (vi) apparently for the Class 1E circuits. The second two unnumbered paragraphs appear similarly related to the second set of criteria (i) through (v1.) for the non-Class 1E circuits. Res: This paragraph should be clarified.	See the revised version of the BTP. This section was deleted.
78	B.1.V(3)	Duke Energy	We do not agree with the application of or reference to 10 CFR 50.55a(h)(2) or 10 CFR 50.55a(h)(3), "Protection Systems" as stated in the second , unnumbered paragraph of Paragraph B.1.V. Res: Remove all references to 10 CFR 50.55a(h)(2) or 10 CFR 50.55a(h)(3), "Protection Systems.	The reference to 10 CFR 50.55a(h)(2) or 10 CFR 50.55a(h)(3) is for the onsite power system. See responses to comments no. 13 and 40.
79	B.1.V(3)	Duke Energy	The small Roman numeral bullets in this paragraph appear to be explicit criteria for meeting the10 CFR 50.55a(h)(2) or 10 CFR 50.55a(h)(3) criteria. Res: While we do not agree with the application of or reference to 10 CFR 50.55a(h)(2) or 10 CFR 50.55a(h)(3), if it was the	The reference to 10 CFR 50.55a(h)(2) or 10 CFR 50.55a(h)(3) is for the onsite power system. See responses to comments no. 13 and 40.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			intent of the BTP to define these as acceptable methods of compliance, the BTP should so explicitly state.	
80	B.1.V(3)	Duke Energy	The draft wording could imply that independent sensors are required to provide input to each coincident relay (logic) device, For a protective device, such as the ABB60Q that requires 3 phase voltages to determine unbalance, this could require 9 medium voltage PTs. Res: While we do not agree with the application of or reference to 10 CFR 50.55a(h)(2) or 10 CFR 50.55a(h)(3, recommend clarifying this paragraph to permit the use of common sensors to independent relay (logic) device.	See the revised version of the BTP. This section was deleted.
81	B.1.V(3)	Duke Energy	The second set of Criteria (i) through (vi) (implicitly the non-safety circuits), Criteria (ii) and (iii) may not be consistent. *Res: While we do not agree with the application of or reference to 10 CFR 50.55a(h)(2) or 10 CFR 50.55a(h)(3), recommend clarification as to the acceptable criterion.*	See the revised version of the BTP. This section was deleted.
82	B.1.V(3) Class 1E iv	Duke Energy	It is not clearly stated that 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 include the time delay limits. Res: 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. *Res: The open phase protective devices should automatically isolate the safety bus.*	See the revised version of the BTP. This section was deleted. Also, see NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203).

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
83	B.1.V(3) iv.	Duke Energy	Is the intent of the statement to disconnect all Class 1E equipment from the open phase or disconnect all safety and non-safety loads from the open phase.?	The purpose of the BTP statement is to disconnect the Class 1E equipment and avoid the consequences of an OPC. See response to comment 40. In addition, the staff revised the BTP to focus on functions and deleted the statement.
84	B.1.V(3)v	Duke Energy	Why does testing and calibration need to occur at power? Res: Capability for test and calibration should be provided.	Appendix A to 10 CFR Part 50, GDC 18 or equivalent criterion in the FSAR requires capability to test design functions at power.
85	B.2.II	Duke Energy	This section states "If OPC actuation circuits are required…." This section needs to define when these circuits would be required. Res: define criteria to determine when actuation circuits would be required.	It is clarified in the revised version of the BTP. See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203).
86	B.3	Duke Energy	Heading and lead-in sentence for this section does not really describe what is in it. Res: Replace the heading and lead-in sentence with: "Considerations for Supporting Analysis:" "This section provides considerations related to the analyses that may be needed to support verification of the design of an open phase protection system:"	See the revised version of the BTP. This section was deleted.
87	B.3	Duke Energy	If a solution was presented that has the protection at the Class 1E bus level that looks at the loads and is based upon their voltage unbalance capabilities and not specifically the OPC, what would be the analysis requirements? Res: Add additional section(s) for analysis requirements for Class 1E solution that is focused on equipment voltage unbalance capabilities. This section would	See the revised version of the BTP. This section was deleted.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			detail if full analysis (what is already called out for OPC- Section 5.3) needed or analysis for settings for relays at the Class 1E level.	
88	B.3.a.	Duke Energy	In the last sentence using "shall" is out of place when discussing items to consider and it may also unnecessarily restrict future analysis requirements. Res: 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."	See the revised version of the BTP. This section was deleted.
89	B.3.b.	Duke Energy	Use of adjective "major" is selecting only part of the population to protect and does not explain why partial protection is sufficient. Res: Replace sentence with: "Establish the capability of the Class 1E equipment to withstand unbalanced voltage/current conditions expected during various operating and loading conditions."	See the revised version of the BTP. This section was deleted.
90	B.3.c.	Duke Energy	Establish the limitations of existing protective devices may not be necessary for open phase protective devices. Res: Replace sentence with: "Coordinate with existing protective devices for various operating and loading conditions with an open phase fault on each phase."	See the revised version of the BTP. This section was deleted.
91	General	AP1000 utilities	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. Res: The staff should demonstrate	Disagree. See NRC letter dated November 5, 2014 (ADAMS Accession No. ML14246A167) to AP1000 licensees concerning actions the NRC staff would

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			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.	consider adequate to address the regulatory issues identified in the Bulletin.
92	General	AP1000 utilities	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. Res: The staff should reexamine its application of the GDC requirements in the case of defense-in-depth, nonsafety-related SSCs, which are not credited with operating to mitigate design basis accidents.	Disagree. See NRC letter dated November 25, 2014 (ADAMS Accession No. ML14246A167) to AP1000 licensees concerning actions the NRC staff would consider adequate to address the regulatory issues identified in the Bulletin. In addition, the comment appears to confuse the term "important to safety" with the term "safety-related," as defined in 10 CFR 50.2.
93	General	AP1000 utilities	The staff's application of the requirements for SSCs identified as important to safety for the AP1000 plant is inconsistent with precedent staff positions. Res: The staff should reexamine its 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.	Disagree. See NRC letter dated November 5, 2014 (ADAMS Accession No. ML14246A167) to AP1000 licensees concerning actions the NRC staff would consider adequate to address the regulatory issues identified in the Bulletin. In addition, the comment appears to confuse the term "important to safety" with the term "safety-related," as defined in 10 CFR 50.2.
94	Section A, Paragraph 2, last sentence	AP1000 utilities	Note: The LOCA event due to RCP seal degradation identified as a potential consequence of the loss of phase condition encountered at Byron may not be a concern for passive plant designs. Res: It should be noted that the accident sequence approached at the Byron plant may not be applicable to all plant designs, especially passive plants.	Agree. Comment noted. The staff revised the BTP to obviate this concern.
95	Section A, Paragraph 2, last sentence	AP1000 utilities	Passive plant designs that do not require ac power sources to mitigate design- basis events may provide adequate time for operators	See NRC letter dated November 5, 2014 (ADAMS Accession No. ML14246A167) to AP1000 licensees concerning actions the

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			to diagnose and correct an open phase condition without the potential for the condition to propagate into a more serious event. Res: The potential for accidents of greater consequence may not limit the time available to the operators to diagnose a loss of phase condition for a passive plant design. Passive plant designs that do not require ac power sources to mitigate design-basis events should inherently provide adequate time for operators to diagnose and correct an open phase condition without the potential for the condition to propagate into a more serious event.	NRC staff would consider adequate to address the regulatory issues identified in the Bulletin.
96	Section A, Paragraph 4, last sentence	AP1000 utilities	Passive plants do not employ emergency diesel generators. Res: Passive plant designs do not require ac power sources to mitigate design-basis events. Automatic alignment of the diesel generators is not needed to achieve or maintain safe shutdown conditions in passive plant designs.	Disagree. The licensing basis for AP1000 plants calls for automatic alignment of non-Class 1E diesel generators to feed the auxiliary ac buses upon loss of offsite power. Specifically, AP1000 Design Control Document Chapter 8.3.1.1.1," Onsite AC Power System," states "The onsite standby power system powered by the two onsite standby diesel generators supplies power to selected loads in the event of loss of normal and preferred ac power supplies followed by a fast bus transfer to the reserve auxiliary transformers. Loads that are priority loads for defense-in-depth functions based on their specific functions (permanent nonsafety loads) are assigned to buses ES1 and ES2. These plant permanent nonsafety loads are divided into two functionally redundant load groups (degree of redundancy for each load is described in the sections for the respective systems). Each load group is connected to either bus ES1 or ES2. Each bus is backed by a non-Class 1E onsite standby diesel generator. In the event of a loss of voltage on these buses, the diesel generators are automatically started and connected to the

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
				respective buses. In the event where a fast bus transfer initiates but fails to complete, the diesel generator will start on an undervoltage signal; however, if a successful residual voltage transfer occurs, the diesel generator will not be connected to the bus because the successful residual voltage transfer will provide power to the bus before the diesel connection time of 2 minutes." The AP1000 in particular and passive plants in general employ diesel generators for defense-in-depth.
97	Section A, Paragraph 6, First sentence	AP1000 utilities	The safety significance of an open phase condition is not the same for a passive plant. Res: The staff should differentiate between the safety significance of an open phase condition for passive plants as compared to active plants.	Agree. Comment noted. The staff revised the BTP to obviate this concern. See response to Comment No. 91.
98	Section A, Paragraph 6, First sentence	AP1000 utilities	The accident sequence precursor analyses conducted by the staff have not been shared with passive plant designers or COL holders or applicants. Therefore, it's applicability to the passive designs cannot be verified. Res: 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).	Accident sequence precursor analysis is based only on Byron open phase operating event. This information is available publicly for all stakeholders to review (ADAMS Accession No. ML13232A062). The NRC has not performed accident sequence precursor analysis specific to passive plants.
99	Section A,8-9-2, Line No. 43-44	AP1000 utilities	"...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? Res: Since this is shown in Section 1.VI. Surveillances and Limiting Conditions for Operation, specifically, should this be removed from opening paragraph	The staff revised the BTP to obviate this concern.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			in Section A.? It is not shown in Section 2.1V. Surveillances.	
100	Sections 8.1 and 8.2	AP1000 utilities	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. Res: 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.	Disagree. The staff position is consistent with accident analysis assumptions for active plants. Because the accident analysis for a passive plant differs from that for an active plant, the staff position likewise differs for a passive plant, as compared to an active plant. See response to Comment No. 91. See NRC letter dated November 5, 2014 (ADAMS Accession No. ML14246A167) to AP1000 licensees concerning actions the NRC staff would consider adequate to address the regulatory issues identified in the Bulletin.
101	8-9-2&3/B.(i)	AP1000 utilities	The use of the term "all" as used here in this application creates an impossible requirement for both the utility and regulator. Res: Provide a better definition of requirements that can be met by both regulator and utility.	Disagree. "All" is referring to the loading and operating configurations described in the licensing and design basis for AP1000 plants.
102	General 8-9-3/8.1.111	AP1000 utilities	10 CFR 50.55a(h)(2) and 10 CFR 50.55a(h)(3) provide guidance on which IEEE standard to use and do not otherwise provide equivalent system requirements or other guidance. The IEEE standards referenced, 279 and 603, do not apply to the subject circuits. Also, to say that a non-class 1E circuit is acceptable as long as it meets the requirements of a Class 1E circuit gains nothing. Res: 1. Remove the references to 10 CFR 50.55a(h)(2) and 10 CFR 50.55a(h) (3). 2. Provide requirements for a non-Class 1E circuit that provides availability with high- side equipment.	See the revised version of the BTP. This section was deleted. Also, see NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203).

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
103	8-9-418.1.V.(3)	AP1000 utilities	The best/preferable design solutions available at the present time are not implementable at the Class 1E bus level. By forcing this requirement the regulator is forcing the implementation of a less adequate design. Res: Develop a strategy that allows for the best overall design solution to the issue.	See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) concerning staff positions to address the OPC issue.
104	Section B (i), Page 8-9-2, Lines 1, 2, 3 & 4	AP1000 utilities	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. Res: 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.....	Agree. A note was added to clarify that AP1000 plants have only one GDC 17 circuit.
105	Section B.1.V(1)b	AP1000 utilities	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. Res: 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."	See the revised version of the BTP. This section was deleted.
106	Section B.2, Page 8-9-6, Line No. 8	AP1000 utilities	The AP1000 preferred GDC 17 source is neither designed nor required to be single-failure proof, and as such may experience	See NRC letter dated November 5, 2014 (ADAMS Accession No. ML14246A167) to AP1000 licensees concerning actions the

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			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.	NRC staff would consider adequate to address the regulatory issues identified in the Bulletin.
107	Section 8.2.1, Page 8.9.6, Line 1	AP1000 utilities	"Important-To-Safety" classification is not defined. Res: At all places used in this BTP, delete the term ….important-to-safety..." and replace with nuclear industry defined and generally accepted terminology/classifications.	See response to Comment No. 44.
108	Section B.2.I, Page 8-9-6, Line 15, 19 & 22	AP1000 utilities	"Important-To-Safety" Res: APOG's position is that there are no systems that are "Important-to-safety" that are associated with the AP1000. Systems are either safety related or non-safety related.	See response to Comment No. 45.
109	Section B.2.II, Page 8-9-6	AP1000 utilities	<u>Actuation Circuits</u> This appears to be a design requirement for non-safety power sources (i.e., by providing independent sensors and actuation logics that could cause separation from an operable off-site power...." The entire paragraph appears to be adding new design requirements.	See the revised version of the BTP. This section was deleted.
110	Section B.2.II, Page 8-9-6	AP1000 utilities	In addition, need to clarify what is the plan referred to here "does not result in lower overall plan operation reliability." Res: Change plan to plant.	See the revised version of the BTP. This section was deleted
111	Section B.2.III, Page 8-9-6	AP1000 utilities	Restoration of preferred or Onsite AC Power: This new requirement to specify to "ensure the standby diesel generators are connected to	See the revised version of the BTP. This section was deleted.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			the auxiliary alternating current buses." seems overly proscriptive given the plant specific nature of the offsite power systems. It appears to be making assumptions on what failure mechanism occurred. Res: Replace with a more generic action and give the standby diesel generators as an example.	
112	Section B.3.a thru d, Page8.9,7, All Lines	AP1000 utilities	Analyses of plant electrical systems are not necessary to detect an OPC on a HV offsite power circuit. Res: Since the first line of Section 8.3 contains the words "should be performed", then the guidance provided in sub-sections a, b, c & d are not requirements.	See the revised version of the BTP. This section was deleted.
113	Section B.3.b, Page 8-9-7, Line 19	AP1000 utilities	"important-to-safety" Res: APOG's position is that there are no systems that are "important-to-safety" that are associated with theAP1000 Systems are either safety related or non-safety related.	See NRC letter dated November 5, 2014 (ADAMS Accession No. ML14246A167) to AP1000 licensees concerning actions the NRC staff would consider adequate to address the regulatory issues identified in the Bulletin.
114	All	NEI	Applicability of 10 CFR 50.55a(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 10 CFR 50.55a(h)(2) and 10 CFR 50.55a(h)((3) is not applicable to the design of the offsite power supply since it is not	See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) concerning staff positions to address the OPC issue.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			part of the plant protection system as defined in 10 CFR 50.55a(h)(2), 10 CFR 50.55a(h)(3), and GDC 20 of Appendix A of 10 CFR Part 50. Res: All references to 10 CFR 50.55a(h)(2) and 10 CFR 50.55a(h)(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.	
115	All	NEI	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 10 CFR 50.55a(h)2, 10 CFR 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 10 CFR 50.55a(h)2, 10 CFR 50.55a(h)(3) to the open phase condition, and provide the basis in a letter to NEI at the earliest convenience.	See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) concerning staff positions to address the OPC issue.
116	All	NEI	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	See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) concerning staff positions to address the OPC issue.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			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. Res: Maintain the 1E boundary at the safety buses and EDGs.	
117	All	NEI	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? Res: Review the BTP and NRC position to ensure maintenance of nuclear safety	Staff has not reviewed the risk on a plant-specific basis. However, the operating event at Byron Unit 2 was reviewed as part of the accident sequence precursor (ASP) program. The staff identified the Conditional Core Damage Probability from an open phase condition as 1×10^{-4}. The staff is concerned that since loss of a single phase on the offsite power source can potentially damage both trains of the emergency core cooling system, the protection scheme for OPCs should automatically initiate isolation of the degraded offsite power source and transfer the safety buses to the emergency power source within the time period assumed in the accident analysis. In regard to spurious actuation, the revised BTP states that the design for resolving the OPC should "minimize misoperation, maloperation, and spurious actuation of an operable off-site power source. Additionally, the protective scheme should not separate the operable off-site power source in the range of voltage perturbations such as switching surges, load or generation variations etc., normally expected in the transmission system."
118	All	NEI	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	Disagree. See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) concerning staff positions to address the OPC issue. See response to Comment No. 9.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			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. Res: 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.	
119	All	NEI	It is not clear how the NRC intends to backfit compliance with the BTP into the current licensing basis. Res: NRC should perform a backfit analysis under 10 CFR 50.109.	The purpose of this BTP is to provide guidance to the staff in reviewing various licensing actions related to electric power system design vulnerability due to open phase conditions in offsite electric power system in accordance with Appendix A to 10 CFR Part 50, GDC 17 or principal design criteria specified in the updated final safety analysis report, and 10 CFR 50.36(c)(2) and (c)(3). The BTP is not a requirement. However, it is acceptable to the staff if a licensee voluntarily chooses to use this staff guidance to meet the current regulations. Should the NRC impose the positions stated in the BTP on an existing licensee, the NRC will document in any order imposing these positions an analysis performed in accordance with the applicable backfit or finality regulations in 10 CFR Part 50 or 52.
120	All	NEI	Reference to non-applicable IEEE Standards. IEEE Stds 279 and 603 are not applicable to the AC electrical power system. Res: Reference IEEE Std. 308 for electric power system design guidance, if applicable. Otherwise, provide criteria more appropriate	Disagree. See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) concerning staff positions to address the OPC issue.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			for the AC electrical power system.	
121	All	NEI	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. Res: Class 1E equipment should be protected; therefore, all instances where “important-to-safety SSCs or ESF” are referenced, change to Class 1E equipment.	Disagree. Since some important to safety equipment may not be Class 1E, staff did not incorporate this comment.
122	All	NEI	Single failure considerations, if utilizing non-Class 1E fault protection. Res: 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 Part 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	Single failure considerations apply to onsite power systems. The design consideration should address the consequence of OPC affecting both the onsite and offsite power systems. See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) concerning staff positions to address the OPC issue.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			active component failure and vice versa.	
123	All	NEI	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). Res: 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 or the principle design criteria specified in FSAR set the standards that apply to OPCs. See also NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) concerning staff positions to address the OPC issue. Also, an OPC can result in damage to onsite power systems due to power quality issues and without adequate power (voltage) from the transmission network.
124	All	NEI	Clarification that the intended protection requirements are for Class 1E functionality / independence from a source with an open phase fault. Res: Class 1E functionality and source independence are evaluated utilizing a risk informed approach.	See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) concerning staff positions to address the OPC issue.
125	All	NEI	General term used to describe the "open phase condition" is too vague and not consistently used throughout the document.	See response to Comment No. 49.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			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. Res: 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."	
126	All	NEI	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 (TS), which satisfies the requirements of 10 CFR 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. Res: Additional Technical Specification requirements are not required. Remove reference in BTP. Engage Industry Technical Specifications Task Force for resolution.	Disagree. Section 50.36(c)(3) requires that TS include Surveillance Requirements, which "are requirements relating to test, calibration, or inspection to assure that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the limiting conditions for operation will be met." Although offsite and onsite power systems are currently covered in TS, the components for OPC protection features address operability of both electric power systems in accordance with 10 CFR 50.36. In general, however, current surveillance requirements do not demonstrate electric power system operability in regard to OPCs. See also NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) concerning staff positions to address the OPC issue. .
127	All	NEI	The term "open phase condition" is	See response to Comment No. 49.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			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. Res: 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.”	
128	All	NEI	If a solution is determined to solve the problems of an open phase fault, potential coverage for other unknown failures could be provided. Res: 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.	See NRC response letter dated November 25, 2014 (ADAMS Accession No. ML14120A203) concerning staff positions to address the OPC issue.
129	All	NEI	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. Res: Provide definition in Section B.	Section B of the BTP provides the staff guidance for open phase condition design vulnerability in the electrical system. See response to Comment No. 49.
130	All	NEI	This BTP includes information and specifications of a specific design, rather than only the design objectives. Res: Provide design objectives only and do not specify a particular design.	BTP has been revised to address this comment.
131	All	NEI	The staff’s application of the	See NRC letter dated November 5,

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			requirements for SSCs identified as important to safety for the active plants as compared to the application to the passive plants has been inconsistent. Res: 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.	2014 (ADAMS Accession No. ML14246A167) to AP1000 licensees concerning actions the NRC staff would consider adequate to address the regulatory issues identified in the Bulletin. Since some important to safety equipment may not be Class 1E, staff did not incorporate this comment. See responses to Comments Nos. 91 and 100.
132	All	NEI	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. Res: 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.	See response to Comment No. 92.
133	All	NEI	The staff's application of the requirements for SSCs identified as important to safety for the AP1000 plant is inconsistent with precedent staff positions. Res: 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 response to Comment No. 93.
134	Section A, Paragraph 1, Sentence 3	NEI	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	Disagree. The ground condition at Byron was a high impedance ground. Staff defines the high impedance ground faults as ground faults that produce fault currents below the ground fault relay setting. Therefore, the comment is not

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			ground fault". Res: 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."	incorporated.
135	Section A, Paragraph 1, Sentence 5	NEI	Need to clarify and correct details in the background. The sentence states that "ESF loads remained energized momentarily…" which implies all tripped quickly. Res: Remove the word "momentarily."	Agree. Comment has been incorporated in the BTP.
136	Section A, Paragraph 1, Sentence: last	NEI	Need to clarify and correct details in the background. Replace "overload condition" with "overcurrent condition". Res: Replace sentence with: "The overcurrent condition caused several ESF loads to trip."	Agree. Comment has been incorporated in the BTP.
137	Section A, Paragraph 2, Sentence: last	NEI	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." Res: 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."	Agree. Comment has been incorporated in the BTP.
138	Section A, Paragraph 3, Sentence 2	NEI	Need to clarify and correct details in the background. "This event was also initiated … of the circuit"	Staff reviewed the proposed clarification and determined that the information is not consistent with the terminology used elsewhere in the

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			Res: 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."	BTP.
140	Section A, Paragraph 3, Sentence 4	NEI	Need to clarify and correct details in the background. "The 4.16-kV ESF… From the 4.16-kV buses." Res: 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.	Agree. Comment has been incorporated in the BTP.
141	Section A, Paragraph 4, Sentence 1	NEI	Need to clarify and correct details in the description. "Past operating ...Fitzpatrick" Res: 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.	Agree. Modified BTP text reflects the comment.
142	Section A, Paragraph 4, Sentence 1	NEI	References to licensee reports for these events are not in the Draft BTP. Need to verify that references in the Draft BTP contain these. Res: Include event reports in reference section.	Agree. Modified BTP text reflects the comment.
143	Section A, Paragraph 4, Sentence 6	NEI	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,	Agree. Modified BTP text reflects the comment.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			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). Res: 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."	
144	Section A, Paragraph 5	NEI	Reference is made to February 26, 2013 summary report Res: 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."	Disagree. The reference merely provides the background regarding the status of compliance of current licensees; the summary report does not add to the guidance provided in the BTP.
145	Section A, Paragraph 6, Sentence: first	NEI	The safety significance of an open phase condition is not the same for a passive plant. Res: The staff should differentiate between the safety significance of an open phase condition for passive plants as compared to	Agree. The BTP provides different review guidance for passive designs.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			active plants.	
146	Section A, Paragraph 6, Sentence: last	NEI	The results of the accident sequence precursor (ASP) 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. Res: 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).	See response to Comment No. 98.
147	Section A, Paragraph 7, Sentence: last	NEI	"…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? Res: 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.	See response to Comment No. 126. .
148	Section B	NEI	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	The staff has modified the BTP to simplify it. However, the staff disagrees that the BTP is premature. See the staff position described in NRC letter dated November 25, 2014, to NEI (ADAMS Accession No. ML14120A203) Further clarification is provided in the revised version of the BTP.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			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	
149	Section B	NEI	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. Res: In addition to the undervoltage and degraded voltage schemes to protect 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.	The staff revised the BTP to focus on protective functions as suggested to protect the Class 1E equipment from OPCs. The revised BTP provides considerations for (1) loss of a single phase with and without a high impedance ground and (2) two open phases. The revised BTP also considered OPCs resulting from other locations in the plant based on comments/ recommendations from the Advisory Committee on Reactor Safeguard. See ADAMS Accession No. ML14352A059 for more information. Also, see the staff position described in NRC letter dated November 25, 2014, to NEI (ADAMS Accession No. ML14120A203).
150	Section B	NEI	"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.	Disagree. The staff clarified the term "high impedance." See response to Comment No. 134.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			Res: Remove reference to “High Impedance” fault and replace with “ground fault”	
151	Section B (i), Paragraph 1	NEI	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. Res: 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.”	Disagree. See responses to Comment Nos. 134 and 150.
152	Section: B.1 and B.2	NEI	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. Res: 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.	Disagree. See responses to Comment Nos. 91 and 100.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
153	Section B	NEI	Order of section B.1. Section is confusing. Res: Suggest: Circuit Classification, Detection and Alarms, Actuation, Protective Actions, UFSAR, Surveillance and Limiting Condition for Operation (LCO).	See response to Comment No. 149.
154	Section B (i),	NEI	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. Res: 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. . . ."	See response to Comment No. 104.
155	Section B (i), Paragraph 1	NEI	The first sentence assumes a GDC 17 plant. Res: Eliminate discussion of two physically independent circuits.	See response to Comment No. 104.
156	Section B(i), Paragraph 1, Sentence 2	NEI	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. Res: Revise the document to	See response to Comment No. 149. Also, see response to Comment No. 18.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			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.	
157	Section B(ii)	NEI	Clarification required “Loss of two of the three phases… configurations and loading conditions” Res: Reword to: “two of the three phases open without ground”	Disagree. The existing statement is correct, as written.
158	Section B.1	NEI	The draft guidance for “active safety features” plants ignore industry research and developing experience on how best to provide the desired protection. Res: 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.	See the staff position described in NRC letter dated November 25, 2014, to NEI (ADAMS Accession No. ML14120A203).
159	Section B.1	NEI	Res: First sentence, change: "For performing licensing reviews" to "For performing licensee reviews"…	Disagree. The existing statement is correct, as written.
160	Section B.1.I, Paragraph 2	NEI	Replace "the" with "an". Res: Replace sentence with: “Detection circuits for an open	See response to Comment No. 149.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			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."	
161	Section B.1.I.	NEI	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. Res: 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."	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
162	Section B.1.I, Paragraph 1	NEI	"Automatically" does not make sense Res: Delete automatically	Disagree. "Automatically" refers to the alarm feature.
163	Section B.1.I, Paragraph 2	NEI	Change "under all operating conditions" Res: To "under applicable operating conditions" or "under all applicable operating conditions	Disagree. An OPC can affect safety functions under all operating conditions, so the existing statement is correct, as written.
164	Section B.1.II	NEI	Two separate and distinct requirements are imbedded in the second paragraph of this section. The coordination requirement is uniquely different from the FMEA requirement. Res: For clarity, separate the second paragraph into two paragraphs.	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
165	Section B.1.II, Paragraph 1	NEI	Introduction needed for when to isolate	See response to Comment No. 149; also see response to Comment No. 18.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			Res: 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."	
166	Section B.1.II, Paragraph 1	NEI	Replace "The design of actuation…coincidence logics." Res: Replace with: "The design of actuation circuit should utilize reliable components to minimize misoperation, and spurious isolation of an operable off-site power source."	See response to Comment No.149.
167	Section B.1.II, Paragraph 1	NEI	The function of the protection is to protect the loads, not the parameters of the offsite power system. Res: Delete second sentence: "Additionally, the protective scheme should not … normally expected in the transmission system."	See response to Comment No.149.
168	Section B.1.II, Paragraph 1	NEI	This section applies to both non-safety-related and Class 1E, yet the text provides details specific only to a non-safety-related design. Res: Reword the paragraph to read: "The design of the actuation circuit should utilize reliable components to minimize misoperation, mal-operation, and spurious actuation."	See response to Comment No. 149.
169	Section B.1.II	NEI	The title implies criteria for "Actuation Circuits," the text addresses the reliability of the detection circuits. Res: Remove this section and, unless already included, include any additional requirements in	See response to Comment No. 149.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			Section B.1.V.(3).	
170	Section B.1.II, Paragraph 2	NEI	First sentence is not consistent wording with other BTP's Res: Delete first sentence: "Licensees/applicants should … plant operation reliability."	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
171	Section B.1.II, Paragraph: 2	NEI	A design with relays installed on the Class 1E switchgear would not need to coordinate with transmission system protective relays. Res: 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.)."	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
172	Section B.1.II, Paragraph 22	NEI	"must coordinate" may not be achievable by all designs Res: Change "must" to "should."	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
173	Section B.1.III	NEI	"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. Res: Eliminate discussion of Class 1E detection and actuation circuits.	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
174	Section B.1.III	NEI	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.	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			Res: Instead of prescribing requirements for functional performance on non-Class 1E equipment, categorize the function that is to be performed.	
175	Section B.1.III, Paragraph 1	NEI	The requirements of GDC 17 do not currently include provisions related to the detection of OPFs. Res: 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."	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
176	Section B.1.III, Paragraph 1	NEI	Replace first paragraph: "Class 1E detection … if the following is satisfied." Res: 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."	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
177	Section B.1.III, Paragraph 1	NEI	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. Res: 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	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			applicable requirements of GDC 17 (or similar principal design criteria specified in the UFSAR)."	
178	Section B.1.III, Paragraph 2	NEI	Demonstrating compliance with the listed requirements using an equivalent non-1E system is not possible. Res: 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.	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
179	Section B.1.III, Paragraph 2	NEI	Unnecessary complication of the intent. Res: ……(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.	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
180	Section B.1.IV, Paragraph 1	NEI	"The Updated Final Change wording: Safety … Res: 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."	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
181	Section B.1.V	NEI	Section does not seem to include considerations where a bus transfer schemes occur (e.g., unit trip).	See response to Comment No. 149.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			Res: Identify considerations for open phase faults in situations where a bus transfer is utilized.	
182	Section B.1.V	NEI	Significant clarification of how to comply with the use of a non-Class-1E solution. Guidance should explain how 10 CFR 50.36(c)(2) and 10 CFR 50.36(c)(3) expectations apply to a non-Class 1E solution. Res: Additional guidance for this type of alternative.	See response to Comment No.149.
183	Section B.1.V	NEI	The term “accident condition” is not clear in the context of the BTP. Res: Clarify the term by adding a definition, referencing a definition in another NRC document, or listing the ‘accident condition’ contemplated.	The staff revised the BTP to delete the term “accident condition.”
184	Section B.1.V. 1/2	NEI	This is confusing to have different criteria and actions for ‘if there is’ or ‘is not’ an accident signal present. Res: 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	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			compromised for all operating and anticipated operational occurrences, and e. All design basis accident acceptance criteria and GDC-17 (or principal design criteria specified In the UFSAR.	
185	Section B.1.V.1	NEI	Delete (a) and (c) since they are an expansion of the regulatory scope that is not necessary. Res: Keep (d) as the requirement	The staff deleted the text to which the comment refers.
186	Section B.1.V.1.a	NEI	Change wording: "the condition does not… system and components." Res: Replace with: "The open phase fault does not adversely affect the function of important-to-safety structures, systems and components; or"	The staff deleted the text to which the comment refers.
187	Section B.1.V.1.b	NEI	Change wording: "the condition does not… system and components." Res: Replace with: "No abnormal operating occurrences or UFSAR Chapter 15 events would be created as a result of the condition, and…"	See response to Comment No. 149.
188	Section B.1.V.1.b	NEI	It is unclear what "abnormal operating occurrence, transients, events, and accidents" refer to. Res: Provide clarification	See response to Comment No. 149.
189	Section B.1.V.1.b	NEI	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. Res: 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	The staff did not change BTP in response to this comment because it is important to prevent OPCs from causing abnormal operating occurrence and operational transients. See also response to Comment No. 18.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			"absence of an accident condition signal."	
190	Section B.1.V.1.c	NEI	Change wording: Res: Replace with: "Important to safety equipment is neither prevent from operating nor damaged by the condition, and…"	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
191	Section B.1.V.1.d	NEI	Change wording: Res: Replace with: "Safe Shutdown capability is maintained for all operating and anticipated operational occurrences."	See response to Comment No. 149.
192	Section B.1.V.1	NEI	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. Res: 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.	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
193	Section B.1.V.1	NEI	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 staff deleted the text to which the comment refers.
194	Section B.1.V.1	NEI	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. Res: If these groupings are intentional, the purpose should be explained in the section.	The staff deleted the text to which the comment refers.
195	Section B.1.V.2.a	NEI	Wording is overly restrictive Res: Replace with:	The staff deleted the text to which the comment refers.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			"Protection scheme will ensure safety functions are preserved, as required by the current licensing basis."	Also, see response to Comment No. 149.
196	Section B.1.V.2.b	NEI	Change wording: Res: 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."	See response to Comment No. 149.
197	Section B.1.V.2.b	NEI	Testing may not be feasible Res: Replace with: "Alternatively, a licensee/applicant may demonstrate by analytical analyses or actual testing…"	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
198	Section B.1.V.2.b	NEI	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. Res: Delete "including single failure criterion."	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
199	Section B.1.V.3	NEI	Remove reference to voltage/current sensors designed to satisfy 10 CFR 50.55 a(h)(2) requirements.	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
200	Section B.1.V.3	NEI	It is confusing to discuss voltage and current "sensors" when talking about medium voltage or high voltage power system circuits. Res: Reword the sentence to read: "The voltage or current transformers used for OPF detection should be designed for…"	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
201	Section B.1.V.3	NEI	There is no section differentiation between the Class 1E subsection and the non-Class 1E subsection. Res: Add subsection numbers and possibly even headings, to separate the Class 1E subsection and the non-Class 1E subsection.	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
202	Section B.1.V.3	NEI	Any protection scheme can be credited for protection (i.e. no requirement for the protection scheme to be labeled "open phase protection") Res: Reference to "Open Phase" should be removed from Items (iii) and (iv).	See response to Comment No.149.
203	Section B.1.V.3	NEI	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. Res: 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	The staff has revised and reorganized the BTP.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			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.	
204	Section B.1.V.3.i, non-Class 1E	NEI	Only the faulted power source will be disconnected. Res: The open phase protective devices should automatically disconnect the offsite faulted power source when the setpoints …	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
205	Section B.1.V.3, Class 1E.iv	NEI	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. Res: 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 staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
206	Section B.1.V.3.v, Class 1E and non-Class 1E	NEI	On-line testing may not be feasible and may risk plant operation. Reword Res: Replace sentence with: "Capability for test … should be provided, if possible." or add clarification: "On-line testing of the system is preferred if it does not risk plant operation."	The staff revised the BTP to delete the statement regarding on-line testing.
207	Section	NEI	Unclear of intent on the isolation	The staff revised the BTP to delete

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
	B.1.V.3.ii, iii, iv, non-Class 1E,		function having redundancy. Res: 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).	the statement regarding isolation function redundancy.
208	Section B.1.V.3.iv [second such section]	NEI	Res: Add to the existing section: "With the detection of the open phase condition take manual action to disconnect the offsite power sources."	Comment noted, but suggested text not added in view of reorganization of BTP.
209	Section B.1.V.3.v, non-Class 1E,	NEI	The disconnection cannot be tested during power operation. Res: … test and calibration of the dual detection system during power operation should be provided.	See response to Comment No. 206.
210	Section B.1.V.3 v, [both such sections]	NEI	"Capability to test and calibrate…" Res: Eliminate calibrate. Change test to functionally test.	Although the staff revised the BTP to delete the reference to calibration, instrument recalibration after surveillance should be governed by plant procedure to ensure that the as-left condition of a setpoint is within an acceptable range.
211	Section B.1.V.3 v, [both such sections]	NEI	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. Res: 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.	The staff has revised and reorganized the BTP. The staff has not attempted to define what might be a "tolerable" open phase condition.
212	Section B.1.V.3	NEI	This is a lengthy section with many types of requirements. There are	The staff has revised and reorganized the BTP.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			duplicated paragraph numbers used. Res: Split the section into Class 1E requirements and non-Class 1E requirements (if claiming an exemption from 1E requirements).	
213	Section B.1.V.3	NEI	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). Res: 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 …"	See response to Comment No. 149.
214	Section B.1.V.3	NEI	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. Res: Rather than prescribing the solution identify the required functions and categorize the function per Regulatory Guide 1.201.	See response to Comment No. 149.
215	Section B.1.V.3, non-Class 1E, Paragraph 1 and 2	NEI	Unnecessary complication of the intent Res: Consider the wording: "If the non-Class-1E open phase	The staff has revised and simplified the BTP.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			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.	
216	Section B.1.VI	NEI	Modify wording " … values for the open phase conditions relays and associated time delay devices" Res: Reword the sentence to read: "… values for the relays and associated time delay devices, as required."	The staff deleted the text to which the comment refers.
217	Section B.1.VI	NEI	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. Res: Provide more generic wording for requirements.	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
218	Section B.1.VI	NEI	This section is overly specific and is not the preferred method by which the NRC identifies Technical Specifications requirements. Res: 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)."	The staff deleted the text to which the comment refers. Also, see response to Comment No. 149.
218 A	Section B.1.VI	NEI	Surveillance activities only apply to Class 1E circuits. Res: For Class 1E application, the Technical Specifications …	Disagree. Nonetheless, the staff deleted the text to which the comment refers.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
219	Section B.2	NEI	AP1000 plant design does not require AC power to perform safety-related safe shutdown functions. Res: Revise to ensure features of the AP1000 design are properly represented.	While the comment is true, the comment does not contemplate the defense-in-depth functions served by the AP1000 offsite circuit. The BTP addresses that issue. See also NRC staff position described in NRC letter dated November 5, 2014 (ADAMS Accession No. ML14246A167) addressed to AP1000 licensees.
220	Section B.2.I	NEI	Important-To-Safety classification is not defined. Res: Define Important-To-Safety classification using nuclear industry defined and generally accepted terminology/classifications.	Disagree. See responses to Comment Nos. 51 and 100.
221	Section B.2.I	NEI	"important-to-safety" Res: There are no systems that are "important-to-safety" that are associated with the AP1000. Systems are either safety related or non-safety related.	Disagree. See response to Comment No. 44; NRC staff position described in NRC letter dated November 5, 2014 (ADAMS Accession No. ML14246A167) addressed to AP1000 licensees.
222	Section B.2.II	NEI	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. Res: Delete section	The staff deleted the text to which the comment refers.
223	Section B.2.II	NEI	In addition, need to clarify what is the plan referred to here "does not result in lower overall plan operation reliability. Res: Change plan to plant.	The staff deleted the text to which the comment refers.
224	Section B.2.III	NEI	Restoration of preferred or Onsite AC Power This new requirement to specify: "ensure the standby diesel	The staff deleted the text to which the comment refers.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			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. Res: Replace with a more generic action and give the standby diesel generators as an example.	
225	Section B.2.IV	NEI	Surveillance activities only apply to Class 1E circuits. Res: For Class 1E application, periodic tests, calibrations …	Disagree. See responses to Comment Nos. 99 and 218.
226	Section B.3	NEI	Heading and the lead-in sentence for this section does not really describe what is in it. Res: 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:"	The staff deleted the text to which the comment refers.
227	Section B.3	NEI	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. Res: Reword the sentence to clarify these are examples of analyses that may be needed rather than analysis that should be performed.	The staff deleted the text to which the comment refers.
228	Section B.3	NEI	Add a new item to considerations to recognize that a protective device may not be readily available. Also,	See the revised version of the BTP. This section was deleted. The applicant or licensee is responsible

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			no provision is included for a monitoring period prior to implementing a new scheme. Res: 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.”	for obtaining devices that are capable of performing the protective functions described in the application.
229	Section B.3.a	NEI	In the last sentence, using "shall" is out of place when discussing items to consider and it may also unnecessarily restrict future analysis advancements. Res: 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 staff deleted the text to which the comment refers.
230	Section B.3.a thru B.3.d	NEI	Analyses of plant electrical systems are not necessary to detect an OPC on a HV offsite power circuit. Res: 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.	The staff deleted the text to which the comment refers.
231	Section B.3.a	NEI	Required data may be unavailable. Res: Add the following: “If transformer data is not available, sensitivity analysis may be utilized for transformers where zero sequence impedance values are not available.”	The staff deleted the text to which the comment refers.
232	Section B.3.b	NEI	Use of the adjective "major" is selecting only part of the population	The staff deleted the text to which the comment refers.

No.	Section of BTP	Originator	*Industry Comment*/Proposed *Resolution*	NRC Resolution
			to protect and does not explain why partial protection is OK. Res: Replace sentence with: "Establish the capability of the Class 1E equipment to withstand unbalanced voltage/current conditions expected during various operating and loading conditions.	
233	Section B.3.b	NEI	….major important to safety components …. Res: major (Greater than 4 kv) class 1E components …	The staff deleted the text to which the comment refers.
234	Section B.3.c	NEI	Establish the limitations of existing protective devices may not be necessary for all open phase protective schemes. Res: Replace sentence with: "Coordinate with existing protective devices for various anticipated operating and loading conditions with an open phase fault."	The staff deleted the text to which the comment refers.
235	Section B.3.d	NEI	Uses “high impedance ground fault currents” Res: Change to “ground fault currents”	See response to Comment No. 134