UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, DC 20555 - 0001

September 8, 2017

MEMORANDUM TO: Edwin M. Hackett, Chairman
Committee to Review Generic Requirements

FROM: Brian E. Holian, Acting Director ***/RA/***
Office of Nuclear Reactor Regulation

SUBJECT: REQUEST FOR REVIEW AND ENDORSEMENT OF THE OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3 - RESPONSE TO TASK INTERFACE AGREEMENT 2014-05, DESIGN ANALYSIS FOR SINGLE FAILURE AND THE INTEGRATION OF CLASS 1E DIRECT CURRENT CONTROL CABLING IN RACEWAYS WITH HIGH ENERGY POWER CABLING (CAC NOS. MF4626, MF4627, AND MF4628)

The Office of Nuclear Reactor Regulation (NRR) requests that the Committee to Review Generic Requirements (CRGR) review and endorse the U.S. Nuclear Regulatory Commission (NRC) staff's position in the subject Response to Task Interface Agreement (TIA) 2014-05, which is provided as Enclosure 1 to this memorandum (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16302A483). Enclosure 2 (ADAMS Accession No. ML17237C034) provides the responses to Appendix C of the CRGR Charter.

On June 27, 2017, the CRGR issued a report on its assessment of the NRC's implementation of backfitting and issue finality requirements and guidance (ADAMS Accession No. ML17174B161). The CRGR report referred to the subject TIA response as a topic under NRC staff review, which industry stakeholders believe could constitute a facility-specific backfit. The Executive Director for Operations, by memo dated July 19, 2017 (ADAMS Accession No. ML17198C141), endorsed the staff to implement interim guidance, referenced in Sections 4.1 and 4.2 of the CRGR report, as the staff formally updates agency and office guidance and training. The staff's position is that the subject TIA response would not result in a facility-specific backfit if enforced and that there is no generic applicability of the site-specific conclusions. No change in a previously held staff position is either intended or approved by the issuance of this TIA response, and therefore, the NRC staff has not performed a backfit analysis.

The proposed TIA response is being issued in response to a request from Region II for NRR to provide answers to several questions related to the compliance of cable configuration in certain recently installed underground raceways at Oconee Nuclear Station, Units 1, 2, and 3 (ONS), with the ONS licensing basis, design basis, and NRC regulations and requirements. These questions were specifically related to trench 3 and Protected Service Water Modifications (ADAMS Accession No. ML14290A136)

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By letters dated May 11 and August 7, 2015 (ADAMS Accession Nos. ML15139A049 and ML15224A370, respectively), Duke Energy Carolinas, LLC (Duke Energy, the licensee), voluntarily submitted supplemental information to the NRC on the issues associated with TIA 2014-05. In addition, in accordance with the NRR TIA Office Instruction, COM-106, Revision 5, “Control of Task Interface Agreements” (ADAMS Accession No. ML15219A174), on August 2, 2016, the NRC provided the licensee with the draft TIA 2014-05 response (ADAMS Accession No. ML16214A003) for a fact check. The licensee’s letter dated August 15, 2016, provided its response (ADAMS Accession No. ML16231A451).

The NRC staff has completed its review of the licensee’s response dated August 15, 2016, and made a number of clarifying changes in response to the licensee’s fact check. However, the NRC’s overall conclusions in the draft TIA response remain relatively unchanged. The staff’s TIA response and resolution to these comments is provided in Enclosure 1.

The NRC staff concludes that the ONS design, as modified from the original design by the licensee, does not comply with the licensing bases as it pertains to placing safety-related cables in close proximity to high energy nonsafety-related energy sources in trench 3 and Protected Service Water Modifications. Furthermore, the staff is concerned that these modifications may have introduced potential failure modes that were not adequately analyzed. It is recognized by the NRC staff that the licensee has taken a number of actions to address the concerns raised in the TIA. The NRC staff has not yet assessed these actions. However, this TIA response is an important document as it clarifies but does not change the staff’s position related to several key aspects of the licensing bases for ONS.

The Office of the General Counsel has reviewed the TIA response and the licensee fact check resolution (Enclosure 1) and has no legal objection.

The TIA response is sponsored by Eric J. Benner, Deputy Director, Division of Operating Reactor Licensing, NRR.

Docket Nos. 50-269, 50-270, and 50-287

Enclosures:
1. Final TIA Response and NRC Staff Response to Licensee Fact Check (Table) (non-public until issued)
2. CRGR Charter Appendix C Responses (public)
3. Proposed NRC Staff Response to Licensee Fact Check

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JBartley, RII/DRS/EB1
MRiley, RII/DRS/EB1
TFanelli, RII/DRS/EB1
JEargle, RII/DCO/IB3

ADAMS Accession Nos. Package: ML17237C031; Memorandum: ML17237C032; Enclosure 2: ML17237C034 ***concurred via e-mail;**

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ENCLOSURE 1

FINAL TASK INTERFACE AGREEMENT RESPONSE

AND

U.S. NUCLEAR REGULATORY COMMISSION STAFF
RESPONSE TO LICENSEE FACT CHECK (TABLE)

(concurred on and reviewed by all parties)

ADAMS ACCESSION NO. ML16302A483

ENCLOSURE 2

RESPONSES FOR APPENDIX C TO THE
COMMITTEE TO REVIEW GENERIC REQUIREMENTS CHARTER
REGARDING PROPOSED NRR TASK INTERFACE AGREEMENT RESPONSE 2014-05,
"DESIGN ANALYSIS FOR SINGLE FAILURE AND
THE INTEGRATION OF CLASS 1E DIRECT CURRENT CONTROL CABLING IN RACEWAYS
WITH HIGH ENERGY POWER CABLING
AT THE OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3"

ADAMS ACCESSION NO. ML17237C034

ENCLOSURE 3

PROPOSED NRC STAFF RESPONSE TO LICENSEE FACT CHECK

NRC Staff Response to Duke Energy Carolinas, LLC August 15, 2016, "Fact Check" Letter

In accordance with the Office of Nuclear Reactor Regulation (NRR) Office Instruction, COM-106, Revision 5, "Control of Task Interface Agreements" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15219A174), on August 2, 2016, the U.S. Nuclear Regulatory Commission (NRC) provided Duke Energy Carolinas, LLC (Duke Energy, the licensee), with the draft Task Interface Agreement (TIA) 2014-05 response (ADAMS Accession No. ML16214A003) for a fact check related to an unresolved item at the Oconee Nuclear Station (ONS), Units 1, 2, and 3 involving cable configurations in certain underground cable raceways. The licensee's letter dated August 15, 2016, provided its response (ADAMS Accession No. ML16231A451). The NRC staff has reviewed the licensee's response and concluded that it did not identify any factual errors. However, the staff made several clarifications to the TIA Response in response to the licensee's comments and observations. The following NRC staff's response is provided to document the basis for staff's conclusions concerning the licensees views pertaining to TIA response provided for the NRC Region II questions.

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
1.0, "Introduction" Comment No. 1	Duke Energy did not identify any factual inaccuracies in this section of the draft TIA response.	No NRC response required.	N/A
2.0, "Background" Comment No. 2	The ONS Updated Final Safety Analysis Report (UFSAR) Section 8.3.1.4.6.2 (Ref. 1) provides the licensing basis cable separation requirements. It should also be pointed out that NRR staff identified the ONS licensing basis for cable separation requirements in Section 3, "Staff's Technical Evaluation," of the draft response.	The language identified by this comment was in the background section of the NRC's TIA response, and represents a paraphrase of the Component Design Basis Inspection (CDBI) report. The TIA response did not rely upon the paraphrased language, and instead verified the licensing basis from a review of ONS licensing basis documents as described in the Evaluation section of the TIA.	No
Comment No. 3	This NRR statement is incorrect because the three (3) ONS units were licensed well before the issuance of the initial revision for Standard Review Plan (SRP), Section 8.2 (Ref. 2) and the SRP has not subsequently been added to the ONS licensing basis. Additionally, [Institute of Electronics and Electrical Engineers (IEEE)] Standard 379 (Ref. 3) is not a part of the ONS licensing basis and therefore statements in this standard, that all failures must be assumed, are outside of the scope of the ONS licensing	The language identified by this comment was in the background section of the NRC's TIA response, and represents a paraphrase of the CDBI report. The TIA response did not rely upon the paraphrased language, and instead verified the licensing basis from a review of ONS licensing basis documents as discussed in the Evaluation section of the TIA.	No

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	basis. Specifically, in the absence of regulations and standards at the time of initial ONS licensing, Duke Energy, with awareness by the Atomic Energy Commission (AEC), developed its own single failure criterion, using correspondence from the AEC and available mechanical and electrical codes at the time. In addition, ONS has not adopted IEEE Standard 379 or the use of the NRC-referenced version of SRP 8.2 in any subsequent ONS-related licensing basis docketed correspondence. The NRC has been aware of the ONS approach to satisfying single failure criteria as a result of decades of specific NRC review of related documents and Duke Energy submittals to the NRC. As an example, ONS specification OSS-254.00-00-4013, "Design Basis Specification for the Oconee Single Failure Criterion (Ref. 4)," provides the overall site guidance on the application of the single failure criterion. The ONS licensing basis is stated in Section 3.2.1.4.1, "Credible Failures," which states, "Application of the single failure criterion does not require that all failures be assumed. Only those failures with a credible chance of occurring must be considered in evaluations of system design bases...." As discussed throughout this enclosure, ONS has consistently determined that certain failures, which the NRC relies on, are not credible. The staff's Technical Evaluation focused on standards and did not address the design features that preclude the failure mechanisms raised by the TIA. Furthermore, NRR undertook a formal review of the ONS Electrical Distribution System (EDS) in August 1995. [A request for additional information (RAI)] response (Ref. 5) stated, in part, that, "In general, only those systems or components with a credible chance of failure are assumed to fail. ONS is not aware of a requirement that all possible	Although not specifically discussed in the Evaluation section of the TIA, as pointed out in this comment, IEEE Std. 379 and the referenced version of the SRP Section 8.2 is not part of the ONS licensing basis. The TIA relied on the ONS AEC GDC; included in the UFSAR IEEE Std. 279-1968 and single failure criteria requirements in IEEE Std. 279-1971 as discussed in the Evaluation section. The NRC agrees that only credible failures need to be addressed. In this TIA, as discussed in the Evaluation section, the NRC believes that the failure modes in question are credible and must be considered. The NRC does not believe that the ONS design features (bronze shielding) precludes the failure mechanisms.	

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
	failures must be assumed. Also, components are assumed to fail only in a credible failure mode." The necessity that the failure mode be credible forms the basis for ONS' decisions regarding separation, which are at issue. In its final report (Ref. 6), NRR acknowledged that, "Because Oconee was not licensed to 10 CFR 50, Appendix A, the plant specific single failure definition for Oconee remains valid and in effect with no additional requirements on the electrical power systems [as a result of 10 CFR 50.46 or 10 CFR 50, Appendix K]." (p. 113) Therefore, the staff erred in its reliance on IEEE-379 in making its conclusion. This error appears in multiple locations within the document.		
Comment No. 4	The wording in the May 13, 1976 (Ref. 7), letter states that "the Oconee onsite emergency [alternating current (AC)] and [direct current (DC)] power systems conform to the single failure requirements of IEEE 279-1971." The single failure requirements are contained in Section 4.2 of that standard. ONS did not commit to the rest of IEEE 279-1971 (Ref. 8) nor did it imply to do so in any subsequent correspondence. For the TIA to now reference other sections of IEEE 279-1971 (Ref. 8) and portray them as being within the ONS licensing basis (i.e., applicable to ONS) incorrectly portrays the commitment Duke Energy made in its May 13, 1976 letter.	Duke is correct in asserting that the 1976 Parker letter stated, "The design of the Oconee onsite emergency AC and DC power systems conforms to the <u>single failure</u> requirements of IEEE 279-1971" (emphasis added). The NRC will correct the error in the TIA response; however, the staff notes that single failure requirements are included in Sections 4.2, 4.7, 4.11, and 4.17 of IEEE Std. 279-1971. As stated in the TIA response, the design basis of the Oconee onsite emergency AC and DC power systems requires conformance to the single failure requirements of IEEE Std. 279-1971. Single failure requirements are specifically addressed in response to questions 2a, 2b, 2c, 2d and 2f. The basic definition and requirement for single failure criterion in Section 4.2 of IEEE Std. 279-1971 is adequate to maintain staff's position for the responses in this TIA. However, Section 4.7 is part of the single failure criteria and helps to understand the intent of 'separation/isolation criterion' and how to ensure that single failure vulnerabilities do not have adverse impact on related or redundant system. Section 4.7.2 elaborates on examples of credible failures and	Yes

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
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		potential failures of isolation devices. Section 4.7.3 elaborates on the requirements of redundant train after postulated single failure. Section 4.11 elaborates on the requirements of single failure criteria still applies while performing channel bypass or removal from operation. Section 4.17 elaborates on the requirements of single failure criteria still applies during manual initiation of a protection system.	
Comment No. 5	The terms "close proximity," "adjacent" and "mixing" suggest that cables were not routed in consideration of cable separation requirements. All cables are routed in accordance with ONS cable separation design and licensing requirements per [Updated Final Safety Analysis Report (UFSAR)] Section 8.3.1.4.6.2 (Ref. 1) and other station cable separation requirements (e.g., Ref. 27 and Ref. 29).	The language identified by this comment was in the background section of the NRC's TIA response, and represents a paraphrase of the CDBI report. The TIA response did not rely upon the paraphrased language, and instead verified the licensing basis from a review of ONS licensing basis documents.	No
Comment No. 6	The neutral grounding transformer and resistor installed on the Keowee generators were installed to limit equipment damage for phase-ground faults. This is a standard power system practice and by design, will limit phase-ground fault current resulting in a decrease of energy release magnitude.	The language identified by this comment was in the background section of the NRC's TIA response, and represents a paraphrase of the CDBI report. The TIA response did not rely upon the paraphrased language, and instead verified the licensing basis from a review of ONS licensing basis documents.	No
3.0, "Staff's Technical Evaluation" Comment No. 7 (History of ONS licensing basis for electric power systems and associated interfacing systems)	The NRR reference to UFSAR Section 8.3.1.4.6.2 is incomplete in that the following pertinent information should be included. Specifically, UFSAR Section 8.3.1.4.6.2 continues to state that it is ONS' "intent wherever physically possible to utilize metallically armored and protected cables systems. By this we mean the use of rigid and thin wall metal conduit, metal sheathed cables (aluminum and other metals), bronze armored control cables, steel interlocked armor, or metallic taped power and control cables, and either interlocked armor, served wire or braided armored instrumentation cables." Cable armoring has been an important design feature for satisfying cable separation criteria at ONS. Additionally, UFSAR Section 8.3.1.4.6.2	The licensee's reference to the ONS licensing basis with respect to armoring is not relevant to the discussion in UFSAR 8.3.1.4.6.2 on cable separation. Armoring of cable is a separate matter from separation of cable. The UFSAR discussion quoted by the licensee appears to be an explanation of the meaning of cable armoring and protection at ONS, and does not address whether armoring may substitute for separation. Accordingly, the safety evaluation report (SER) statements approving ONS cable separation design and installation, which are quoted by the licensee, cannot reasonably be read as an NRC staff approval of criteria for substituting cable armoring in lieu of meeting applicable separation requirements.	No

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
	also states that "five inches of cable tray rail to rail separation" is provided on installation of a cable tray. In a January 26, 1972 letter (Ref. 10), the AEC endorsed Duke Energy's proposal to revise the [final safety analysis report (FSAR)] to show that "the original cable separation criteria will be met including no cable tray overloading and a minimum of five inches rail-to-rail space between all vertical trays." The AEC stated in the letter that "we conclude that your proposal as noted above is acceptable." The ONS SER dated Dec. 29, 1970 (Ref. 11), (page 54, Section 8.5, "Cable and Equipment Separation and Fire Prevention"), endorses the staff's acceptance of Oconee's cable separation design through the following statements: "We have reviewed the applicant's design and provisions and installation arrangement plans relating to (1) the preservation of the independence of redundant safety equipment by means of identification and separation, and (2) the prevention of fires spreading through derating of power cables and proper tray loading. We have found these design provision and installation arrangements acceptable."	The staff also notes that until 2010, in this FSAR section, the final sentence of this paragraph stated: "With this type construction fire stops as such are not required." This indicates the intent of using metallically armored and protected cable systems was as a fire protection feature to eliminate the use of fire stops, not for physical separation of trains. This sentence was deleted by an FSAR change 09-51. The licensee referenced the AEC's approval of "five inches rail-to-rail space between all vertical trays." The licensee did not identify any part of the TIA response that is inconsistent with the AEC's approval. The licensee referred to the NRC's approval of ONS SER dated December 29, 1970. The licensee did not identify how the portion of the NRC approval referenced by the licensee relates to the discussion of cable separation in Section 3.0, Staff's Technical Evaluation, on page 14 of the TIA response.	

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
Comment No. 8 (Staff discussion of history of ONS licensing basis for electric power systems and associated interfacing systems)	The staff's interpretation of the ONS licensing basis with respect to the applicability of IEEE 603 and IEEE 379 to systems beyond [reactor protection system/engineered safeguards protection system (RPS/ESPS)] is inconsistent with licensing commitments made by ONS to the NRC. The ONS commitment to these standards is limited to the "new digital" portion of the RPS/ESPS upgrade. The January 2008 [license amendment request (LAR)] (Ref. 14) stated that "IEEE Standard 603-1991 applies only to portions of the RPS/ESPS affected by the design change." Furthermore, the ONS [failure modes and effects analysis (FMEA)] calculation (Ref. 15) that was reviewed and referenced in the January 2010 SER (Ref. 16) for LAR 2007-09 (Ref. 14) clearly states that IEEE-Standard 603 is only applied to the digital components.	The NRC agrees that amendment Nos. 366, 368, and 367 for ONS Units 1, 2, and 3 for LAR 2007-09 (ADAMS Accession No. ML100220016) incorporated IEEE Std. 603-1998 and 379-1994 as the licensing basis criteria for the single-failure criterion, independence and separation requirements of the portion of the RPS/ESPS affected by the design change. However, the ONS FMEA for the digital RPS/ESPS includes consideration of impacts of cable faults on the digital RPS/ESPS circuits. These standards are part of the ONS licensing basis for the FMEA for the digital components. The TIA has been revised to clarify this position.	Yes
3.1, "Response to Requested Actions" Comment No. 9 (Ref: TIA Question 1)	As discussed in several Duke Energy Comments in this enclosure, it appears the draft TIA response incorrectly describes the ONS licensing basis in that the draft TIA response does not recognize elements of the licensing basis and/or it incorrectly expands aspects of the licensing basis to systems and components beyond that which was identified in licensee commitments.	The staff disagrees with the comment. The staff has performed an extensive examination of all the NRC correspondence with Duke Energy, all relevant safety evaluations for license amendments, the CDBI inspection report, all applicable sections of the ONS UFSAR, and the background information provided by the CDBI inspection team in the TIA, including Duke Energy letters dated May 11, 2015 (ADAMS Accession No. ML15139A049), and August 7, 2015 (ADAMS Accession No. ML15224A370), and the NRC independent review team's feedback. Based on the review of these documents, the staff has correctly assessed what the ONS licensing basis is and has documented that in Section 3.0 of the draft TIA response.	No
Comment No. 10 (Ref: TIA Question 2.a)	Because ONS was issued construction permits on November 6, 1967 (Ref. 17), "protection systems must be consistent with their licensing basis" in order to satisfy the requirements of 10 CFR 50.55a(h)(2). As noted in Duke Energy Comment #4, the only portion of IEEE Standard 279-1971 that is a part of the ONS licensing basis for the onsite AC and DC emergency power systems are	The staff agrees that the single failure criteria requirements of IEEE Std. 279-1971 is part of the ONS licensing basis. IEEE Std. 279 1971 Section 4.2, "Single Failure Criterion," states, "'Single failure' includes such events as the shorting or open-circuiting of <u>interconnecting signal or power cables</u>."	Yes

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
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	the single failure requirements in Section 4.2. The staff is incorrect in stating that Section 3, "Design Basis," of the standard applies to the ONS power cables. Furthermore, as noted in Duke Energy Comment #8, it is also incorrect to apply IEEE Standard 603-1991 requirements to the ONS power cables that are the subject of this TIA. In addition, IEEE Standard 279-1971 does not include the term "multiphase." The Note in IEEE 279-1971 Section 4.2 references "shorting or open-circuiting or interconnecting signal or power cables" and "credible malfunctions." A multiphase fault can occur at either end of the subject cables, since that is the location where all three phases come together at a common connection point. For faults at other locations, ONS' position on a "shorting" malfunction resulting in "multiphase" faults for the single-conductor medium voltage bronze tape power cables is as follows: Each phase conductor of the subject three-phase 13.8 [kiloVolt (kV)] and 4.16 kV power systems is a single discrete component. For the specific ONS cable design and installation, a single failure (i.e. shorting malfunction) begins as a cable insulation failure resulting in a single phase-ground fault. Engineering analysis has demonstrated that the cable bronze tape metallic shield is capable of carrying the phase-ground fault current for the required duration to allow the protective relaying and breaker to detect and clear the fault prior to propagation to a multiphase fault in other separate discrete cables. Cable fault testing of the ONS single conductor bronze tape cable was performed in 2015. The fault testing included purposely induced phase-ground cable faults using power	Where "shorting" between independent interconnecting power cables is an exact parallel condition to multi-phase shorts. The staff disagrees that only the single failure requirements in Section 4.2 of IEEE Std. 279-1971 is part of the ONS licensing basis. The staff notes that single failure requirements are included in Sections 4.2, 4.7, 4.11, and 4.17 of IEEE Std. 279-1971. The ONS adopted IEEE 279-1968 in its entirety as its licensing basis. Section 3 "Design Basis" items (g) for transient conditions of IEEE 279-1968 are equivalent to Section 3 "Design Basis" item 7 of IEEE 279-1971 for transient and steady-state conditions. The ONS adopted IEEE 279-1968 in its entirety as its licensing basis. Section 3 "Design Basis" items (h) for malfunctions, accidents, or other unusual events of IEEE 279-1968 are equivalent to Section 3 "Design Basis" item 8 of IEEE 279-1971. As stated above for response to Comment No. 8, the staff has determined that IEEE Std. 603 requirements are also applicable to the ONS Units 1, 2, and 3 based on licensee commitments documented in Amendment Nos. 366, 368, and 367 for ONS, Units 1, 2, and 3, respectively, for LAR 2007-09 (ADAMS Accession No. ML100220016). The ONS FMEA for the digital RPS/ESPS includes consideration of impacts of cable faults on the digital RPS/ESPS circuits. These standards are part of the ONS licensing basis for the FMEA for the digital components. References to IEEE Std. 603-1998 have been clarified or removed. In addition, the licensee has referenced IEEE Std. 279-1971 stating that it does not include the term "multiphase." This statement challenges the meaning of "multiphase" and it does not challenge factual information of the ONS licensing basis.	

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
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	sources that emulated the ONS and Fant power systems with respect to power source grounding type (solid and resistance), voltage, available phase-ground and multiphase fault currents and fault durations. The fault durations were based on relay response and breaker opening times. The results of the fault testing demonstrated that a single-phase to ground fault would not propagate to a multiphase fault. Therefore, based on analysis that has been validated by testing, ONS believes it has adequately addressed multi-phase faults on the single conductor bronze tape design in our analyses.	Therefore, the staff's conclusions of Section 3.1, "Response to Requested Actions," remain unchanged. Regarding cable fault testing, the NRC staff observed the referenced tests and reviewed the results. The staff determined that the testing as conducted by the licensee produced anecdotal results that did not demonstrate the capability of the bronze tape cable to meet separation requirements for the cable design and configurations in question. The testing failed to simulate the failure modes identified in the TIA, or the actual power levels to which these systems and the ESPS cabling are exposed. The staff noted that the specified test criteria appear contingent on the concepts specified in the ONS "internal memo to file," which then produced the observed anecdotal results: The tests discounted multi-phase faults because the licensee believes that they are not credible. This was the subject of Question 2.e; the licensee must consider failures at any time including credible failure modes for cable short circuits and multi-phase failures are in fact credible. The licensee used the single failure "on-demand" concept to reduce the fault current available to damage components. This was the subject of Question 2.c; the licensee must consider failures at any time including credible worst-case scenarios. The ONS report did not include the induced voltages observed on the test conductors. The observed induced voltages appeared large enough to be extremely damaging to the DC ESPS cables, which are a subject of the TIA. Question 2.f asked about induced voltages and impressed	

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
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		voltages. ONS must consider these voltages along with the consequential damage to adjacent Class 1E components. The staff considered all testing and arguments presented by ONS and concluded that multi-phase short circuits were a credible failure mode that Duke must consider in the ONS design. Also, per IEEE Std. 279-1971 Section 4.2, "Single Failure Criterion," "the shorting or open-circuiting of interconnecting signal or power cables" was identified as a credible single failure. 'Shorting' between independent interconnecting power cables is considered a single failure by the staff and is an exact parallel condition to multi-phase shorts. (page 25 of the final TIA response; it is a single failure when two cables short together.) Therefore, the staff concluded that the medium-voltage power cables that are intended to provide emergency power to the ONS Units 1, 2, and 3 are within the scope of IEEE Std. 279-1971 for compliance with the requirements specified in NRC regulations 10 CFR 50.55a(h)(2) and 10 CFR 50.54(jj). In addition, the staff has determined that Section 3, "Design Basis," of IEEE Std. 279-1971 is applicable to the ONS power cables based on the fact that these system descriptions are detailed in the scope of IEEE Std. 279-1971. Section 3 of IEEE Std. 279-1968 is equivalent to Section 3 of IEEE Std. 279-1971.	

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
Comment No. 11 (Ref: TIA Question 2.b)	The 3-phase medium voltage power cables are “interconnected” to RPS/ESPS equipment in the context that the Keowee generator is a power source and the interconnections are through a 13.8/4.16 kV transformer, then cabling to another 4.16 kV/600 [Volt (V)] transformer, then cabling to other transformers and/or battery chargers/inverters to reduce the voltage down to the requirements for RPS/ESPS signals. The cables associated with these voltage transformations have protective devices to detect and clear faults. As discussed in Duke Energy Comment #8, ONS has never committed to conform to the requirements of IEEE Standard 603-1991 for the medium voltage power and control cables that are the subject of this TIA question. The NRR Question 2.b statement also includes on page 24 (2nd paragraph) that “…this occurrence would be a single failure, not two failures as the licensee asserts.” It appears this statement is implying that ONS must consider multi-phase faults anywhere in the cable route. As previously stated in Duke Energy Comment #10, other than at the cable ends, a single failure is a phase-ground fault on one of the single conductor cables. Therefore the postulated “interconnection” via the initial phase-ground fault propagating to a three-phase fault that results in cable whip bringing the faulted cables in contact with [instrumentation and control (I&C)] cables is not credible and would require more than a single failure.	As stated above in Comment No. 10, the staff has determined that the medium-voltage power cables that are intended to provide emergency power to the ONS, Units 1, 2, and 3 are within the scope of the single failure criteria requirements of IEEE Std. 279-1971 for compliance with the requirements specified in NRC regulations 10 CFR 50.55a(h)(2) and 10 CFR 50.54(jj). IEEE Std. 279-1971 Section 4.2 states, that single failures included, “single credible malfunctions or events that cause a number of consequential component, module, or channel failures.” This statement in the standard is in direct conflict with the ONS comment. Therefore, the staff’s conclusions of Section 3.1 “Response to Requested Actions,” response to Question 2.b remain unchanged. Duke has stated that the interconnectivity of the three-phase medium voltage cables and the lower voltage RPS/ESPS signal cables exists through various transformers. The comment states further that there are multiple protective devices in the circuit to detect and clear faults implying that the fault consequences are minimal. The staff notes that protective devices function AFTER a fault has occurred.. Duke has not provided an adequate basis to conclude that multi-phase faults are non-credible in all sections of the cable runs, other than at the terminal connections.	No

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
Comment No. 12 (Ref: TIA Question 2.b)	As previously discussed in Duke Energy's May 11, 2015 (Ref. 18) letter to the NRC, ONS analysis supports a conclusion that cable shielding provides a level of protection sufficient to preclude inter-cable shorts or faults, thereby removing from credibility, short circuits between the single conductor shielded power cables as a credible single failure.	The NRC staff has determined that the licensee's testing and analyses do not demonstrate that the bronze tape shielding for the ONS cable design and configurations in question will prevent short circuits between single conductor cables. The staff has reviewed Duke Energy's May 11, 2015, letter and other supplemental information to the NRC and determined that it does not provide any new information that requires a change in the conclusions of the TIA response. The staff has determined that the licensee's testing described in this letter is inadequate and does not resolve any of the licensing basis questions posed by the Region II staff in the TIA. This is because the licensee's test did not prove that cable design with bronze shield can withstand <u>a worst-case credible three-phase fault or prevent consequential damages to the nearby cables as discussed in the TIA response</u>. In addition, the licensee's cable crush test did not prove that the cable can withstand or prevent a worst-case credible three-phase fault. It only proved the mechanical capability of the cable. The staff determined that the electromagnetic forces produced during short circuits would likely cause failure of the cable restraint system and could challenge the integrity of the cables along the raceway system to transformer CT4 and the manholes associated with the raceway system to the protected service water (PSW) system. Since the licensee has not fully evaluated the worst-case credible cable faults and single failures to determine the integrity of the emergency power system and other safety-related systems, the staff determined that the cited testing is insufficient to support the licensee's current position described in its response.	No

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
Comment No. 13 (Ref: TIA Question 2.c)	The NRR statement is inaccurate because the ONS licensing basis does not limit the timing of failure to minimize damage and all credible failures are assumed (e.g., failures are assumed at initiation or time of demand consistent with the ONS [current licensing basis (CLB)]). ONS does not limit its considerations based on whether or not the outcome would be acceptable. As communicated in Duke Energy's May 11, 2015 letter to the NRC, the ONS emergency power system switching logic was designed based on failures occurring on initial demand. The switching logic and the associated time delays in the Chapter 15 accident analyses are predicated on failures occurring on initial demand. This design basis has been maintained throughout ONS' history. Therefore, the staff's assessment that ONS' design basis is that single failures may occur at any time is inaccurate. As previously noted herein, the failure on-demand position was also communicated to the NRC in a March 8, 1995 letter (Ref. 19) clarifying meeting minutes issued by the NRC in association with the Keowee Underground Breaker Modification. It is reasonable for ONS to have concluded that the NRC's acceptance (Ref. 20) had indicated that the NRC's single failure concerns had satisfactorily been resolved.	The single failure criteria of IEEE Std. 279-1971 is part of the ONS licensing basis. A single failure may be the result of events and conditions discussed in Section 3 of IEEE Standard 279-1971. Section 3.7 requires consideration of "the range of transient and steady-state conditions of both the energy supply and the environment (for example, voltage, frequency, temperature, humidity, pressure, vibration, etc. during normal, abnormal and accident circumstances throughout which the system must perform." The maximum energy supply, resulting from a short circuit may not be available at the start time or demand time of a circuit. Single failures with maximum energy, as described in IEEE Std. 279-1971, may occur at any time and are applicable to the licensee's design basis for the cable configurations in question. No The staff position is based on understanding the requirements delineated in all sections of IEEE 279-1971 and further clarified by SECY-77-439 states, in part, that: 'application of the Single Failure Criterion to systems evaluation depends not only on the initiating event that invokes safety action of these systems, together with consequential failures, but also on active or passive electrical failures, which can occur independent of the event. Thus, evaluation proceeds on the proposition that single failures can occur at any time.	Yes
Comment No. 14 (Ref: TIA Question 2.c)	See Duke Energy Comment #3 regarding the application of IEEE Standard 379-2000 requirements.	Although not specifically discussed in the Evaluation section of the TIA, as pointed out in Comment 3, IEEE Std. 379 is not part of the ONS licensing basis. The TIA relied on the ONS AEC GDC; included in the UFSAR IEEE Std. 279-1968 and	Yes

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
		single failure criteria requirements in IEEE Std. 279-1971 as discussed in the Evaluation section.	
Comment No. 15 (Ref: TIA Question 2.c)	The worst case credible single failure and its associated maximum fault currents have been considered and evaluated in the design of ONS, which as demonstrated throughout this enclosure, has been accepted by the NRC. In addition, the aforementioned NRC statement references IEEE Standard 379, which is not a part of the ONS licensing basis for single failure criteria. The NRR statement references an NRC requirement for ONS to consider the failures of non-Class 1E cables concurrent with a single failure of Class 1E equipment. Doing so is also contrary to the ONS licensing basis. As mentioned in the May 2015 Duke Energy letter to NRC, and described in the ONS Single Failure Criterion Design Basis Document, the “licensing basis for Oconee contains single failure evaluations that make no distinction between a failure of a “qualified” component and a failure of a “non-qualified” component. (Here “non-qualified” is used to represent equipment variously called control grade, non-safety, non-QA-1, etc. in ONS documents).” The relevant distinction for application of single failure requirements is limited to whether and how the specific system in question is committed to be designed to handle single failures. The components of such a system may or may not be “qualified”, but that is not a factor for single failure design requirements. As presented in an April 12, 1995 letter to the NRC (Ref. 21), several components that are non-QA-1 but required for accident mitigation, were re-designated by ONS as QA-5. This approach was found acceptable in an August 3, 1995 NRC letter (Ref. 22).	Reference 21 (April 12, 1995, Duke letter) explains the ONS licensing history regarding the site quality assurance program (QAP) and the quality assurance measures applied to mechanical piping SSCs that perform some safety functions. This was in response to Generic Letter (GL) 83-28, “Required Actions Based on Generic Implications of Salem ATWS Events,” dated July 8, 1983 (ADAMS Accession No. ML031080266). Reference 22 (NRC letter and safety evaluation report dated August 3, 1995; ADAMS Legacy Accession No. 9608090111) approved Duke’s approach for a graded QA classification of SSCs. The staff at the time based the approval on the belief, as provided by ONS, that the lower grade SSCs were not safety-related. However, quality assurance measures are not the issue here and the April 12 submittal noted this with the statement on page 5, “it is clear that some seismically designed, single failure proof systems were not classified as QA-1.” The issue is how the plant design basis meets the single failure criteria requirements of IEEE Std. 279-1971, and the PDCs applicable to the ONS licensing basis. The April 12 letter did not justify why ONS tried to credit the failure of non-Class 1E SSCs (i.e., the Fant line or the PSW power cables) single failure when IEEE Std. 279-1971 and PDCs do not allow it. The 1995 NRC letter did not approve such a proposal. The implication that the NRC granted ONS the discretion to credit “non-Class 1E” SSCs as a single failure contrary to the ONS licensing basis is unsupportable. The ONS single failure analyses presented to the CDBI team misconstrued the idea of safety-related and the idea of 10 CFR 50 Appendix B quality assurance measures (which ONS identified as QA-1 in the April 12 1995 letter). The idea	No

Oceonee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
	This point is material because design criteria applied to plants licensed later than ONS may assume all "non-qualified" SSCs (structures, systems, and components) fail, in addition to taking a single failure in a "qualified" system. Such assumptions do not align to Oconee's licensing basis.	of safety-related has at least two recognized usages applicable to the ONS licensing basis. The first is comprehensive in nature (Safety-Related), as defined in American Nuclear Society (ANS) Standard 3.2-1972, and the second is specific to the SSCs that form the reactor protection systems (Safety-Related Class 1E), as defined in IEEE Std. 279-1971 and PDCs, which excludes such SSCs as the reactor coolant system pressure boundary piping. The functional performance requirements of the SSCs defined the usages not the quality measures applied to the SSCs. To clarify this, a discussion of the two usages follows below. First, "Safety-Related" is defined in the original ONS QA plan dated 1973 (ADAMS Accession No. ML16030A215). This included all safety-related SSCs including piping and protection systems SSCs. The QA plan committed to Safety Guide 33, and hence, to ANS 3.2-1972 (American National Standards Institute (ANSI) N18.7-1972). Standard ANS 3.2-1972, Section 2, "Definitions," Subsection 2.2.19, "Safety Related," defined, "[t]hose plant features necessary to assure the integrity of the reactor coolant pressure boundary, the capability to shut down the reactor and maintain it in a safely shut down condition, or the capability to prevent or mitigate the consequences of accidents which could result in off-site exposures comparable to the guideline exposures of AEC Regulations 10 CFR Part 100." No exceptions to the safety guide were noted in the QA plan. Amendment 2 of the QA plan dated July 21, 1975 (ADAMS Legacy Accession No. 7911250016), stated that the ONS QA plan conformed to ANSI N18.7-1972 with no exceptions. Second, "Class 1E," is specified by the IEEE Std. 100 definitions in the ONS licensing basis.	

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
		The IEEE standards specified that Class 1E included the electrical and mechanical SSCs pertinent to the functional performance of the reactor protection systems. Although, both IEEE standards required appropriate levels of quality assurance measures comparable to 10 CFR 50 Appendix B or ANSI NQA-1, they both separated the functional performance criteria from quality.	
Comment No. 16 (Ref: TIA Question 2.d)	ONS does not distinguish between active and passive electrical single failures for the emergency power system. The ONS licensing basis requires that a single failure, either passive or active, is addressed for the emergency electric power system as noted in Oconee UFSAR Section 8.3.1.2.	The staff agrees that the ONS licensing basis is as described in UFSAR Section 8.3.1.2 and not the ONS "internal memo to file" document. Specifically, the UFSAR Section 8.3.1.2 states "The basic design criterion for the electrical portion of the emergency electric power system of a nuclear unit, including the generating sources, distribution system, and controls is that a single failure of any component, passive or active, will not preclude the system from supplying emergency power when required." The staff also notes that the above criteria is consistent with UFSAR Section 3.1.21, "Criterion 21 - Single Failure Definition (Category B)," which states that "[m]ultiple failures resulting from a single event shall be treated as a single failure."	No
Comment No. 17 (Ref: TIA Question 2.e)	All faults and their effects were considered in the design of the subject cables. As stated in the Duke Energy Comment #10, other than at the cable ends, a credible single cable failure is a phase-ground fault on one of the single conductor cables. The draft TIA response references to IEEE Standards 141 and 242 (Refs. 24 and 25) on phase-ground fault current are not applicable to the 13.8 kV Keowee fed power system since it is resistance grounded and the phase-ground fault current will be limited to about 18 Amps.	Since the licensee's evaluations and cable tests only assessed a phase-ground fault on the end of a cable, the NRC staff disagrees with the licensee's statement. The licensee has not provided any documented evidence of how it has considered the following electrical single failures in the onsite power system: (1) phase-to-phase faults, (2) single phase-to-ground fault conditions (including high impedance faults), (3) double phase-to-ground (including high impedance faults), and (4) three phase-to-ground or three phase bolted faults (including high impedance faults). The staff position is provided in response to Question 2.e and the response to Comment No. 10.	Yes

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
		The references to IEEE Standards 141 and 242 were removed.	
Comment No. 18 (Ref: TIA Question 2.f)	As stated in Duke Energy Comment #4, ONS has not stated that it conforms to IEEE 279-1971 and therefore, this TIA statement (as Duke Energy has previously noted in this enclosure) is inaccurate. Furthermore, more discussion from IEEE 603-1991 also appears in this portion of NRR's draft response, which also has no applicability to the ONS design and licensing basis for the emergency power systems as stated in Duke Energy Comment #8.	See discussion of history of ONS licensing basis for electric power systems and associated interfacing systems provided in Section 3.0 of the TIA response. The ONS licensing basis includes conformance with single failure requirements of IEEE Std. 279-1971. References to IEEE Std. 603 have been clarified. Also, refer to NRC responses to Comment Nos. 4, 8, and 10. Duke is correct in asserting that the 1976 Parker letter stated, "The design of the Oconee onsite emergency AC and DC power systems conforms to the <u>single failure</u> requirements of IEEE 279-1971" (emphasis added). The NRC will correct the error in the TIA response; however, the staff notes that Sections 4.2, 4.7, 4.11, and 4.17 of IEEE Std. 279-1971 all address single failure, not only Section 4.2.	Yes
Comment No. 19 (Ref: TIA Question 2.f)	This statement disregards the cable crush and fault testing which were performed in 2015 for the ONS and therefore is inaccurate by omission. The results of the cable crush testing were provided to the NRC in the May 11, 2015 letter. The results of cable fault testing on the 4.16 kVac and 13.8 kVac cables were also presented in a meeting at NRR headquarters in December 2015. Specific answers to the staff's questions regarding the cable testing were provided in Attachment 2 to Duke Energy's February 15, 2016 request for alternative submittal (Ref. 26). ONS concludes that the cable testing validated that the ONS emergency power cable design provides an acceptable level of quality and safety.	See the staff's responses to Comment Nos. 10 and 12, and the staff's discussion provided in response to TIA Question 2.j. This statement was revised to reflect that the NRC did consider the testing and analyses described by Duke in its letters dated May 11 and August 7, 2015, as stated in Section 2.0 of the draft TIA response. The fault testing conducted by Duke in late 2015, as described in the letter dated February 15, 2016, was considered by the staff, as discussed in the response to Comment No. 10.	Yes
Comment No. 20	The NRR draft response to this question is inconsistent with the ONS licensing basis. The current day version of the	Refer to the NRC response to Comment No. 15.	No

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
(Ref: TIA Question 2.g)	definition of safety-related or Class 1E, as presented on Page 1 of the draft TIA response aligns with the definition of a basic component in 10 CFR 21.3. 10 CFR Part 21 was issued after ONS was licensed to operate. For ONS, the term safety-related refers to those structures, systems, and components (SSCs) which have been designated QA-1, as defined in the Duke Energy QA Topical. The general criteria for identifying an SSC as QA-1 is divided into two categories: 1) SSCs that were designated QA-1 as part of the original licensing basis and 2) SSCs that Duke Energy committed to treat as QA-1 in correspondence subsequent to initial licensing. The first category is comprised of those SSCs which were deemed essential to prevent and mitigate the effects of a Large Break LOCA (LBLOCA) coincident with a Loss of Offsite Power (LOOP). As such, there exists SSCs that are deemed non-safety (i.e., not QA-1) but that are credited to prevent and/or mitigate the effects of other UFSAR Chapter 15 design basis accident, non-LBLOCA/LOOP events. Further discussion on QA-1 designation at Oconee can be found in UFSAR Section 3.1.1.1 'Oconee QA-1 Program.' This licensing history has been previously reviewed and agreed upon within an August 3, 1995 safety evaluation titled "Safety Evaluation by the Office of Nuclear Reactor Regulation Supplemental Response to Subpart 1 of Section 2.2.1 of Generic Letter 83-28 General Criteria for Classifying QA-1 for Structures, Systems, and Components." The staff stated that "all commercial, non-safety related (i.e., non-Class 1E) electrical components are assumed to fail in the most limiting way. Only safety-related (Class 1E) components are credited to mitigate design basis events with a single failure (see IEEE 279-1971, ONS UFSAR,		

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
	Chapter 15 for SSCs credited in the accident analysis assumptions).” The previous statements contradict the original ONS licensing basis for both QA-1 (safety-related) components and mitigation of UFSAR Chapter 15 design basis accidents and, if they were true, then ONS would not be able to credit certain functions necessary to prevent or mitigate the effects of some design basis accidents beyond the LBLOCA/LOOP. In addition, UFSAR Section 15.1.9, ‘Credit for Control Systems and Non-Safety Components and Systems,’ contains a listing of non-safety components credited in the accident analyses for mitigating design basis events. Therefore, the staff’s application of current standards to the existing licensing basis constitutes a change in regulatory position. As for application of the single failure criterion, ONS performs single failure analysis for an SSC consistent with the licensing basis of the SSC in question. For the Emergency Power System, UFSAR Section 8.3.1.2, ‘Analysis,’ states, “the basic design criterion for the electrical portion of the emergency electric power system of a nuclear unit, including the generating sources, distribution system, and controls is that a single failure of any component, passive or active, will not preclude the system from supplying emergency power when required.” This same statement was present in FSAR Section 8.2.3.3 as part of Oconee’s initial licensing. The present day UFSAR and historic FSAR Chapter 8 discussion on this basic design criterion are included as part of the overall response in UFSAR Section 3.1.39 and FSAR Section 1A.39, ‘Criterion 39 – Emergency Power for Engineered Safety Features (Category A),’ for Oconee’s accepted (by initial licensing) alternate approach to meeting the intent of the proposed [General Design Criteria (GDC)] 39. Using this criterion, ONS performs single failure analysis based upon		

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
	the design of the system and does not distinguish between safety-related and non-safety-related equipment.		
Comment No. 21 (Ref: TIA Question 2.h)	Duke Energy did not identify any factual corrections for this section of the draft response. However, as summarized below, Duke Energy maintains that the analysis provided in the May 11, 2015 letter to the NRC remains valid and no collateral damage to DC systems would occur. For three-phase faults at the cable ends with postulated electromagnetically induced cable movement in Trench 3, the robust cable construction (as validated by crush and impact testing) and cable installation design will not result in failure of adjacent DC and protection system cables. For faults at other locations within Trench 3, as previously stated in the Duke Energy Comment #10, a credible single cable failure is a phase-ground fault on one of the single conductor cables. Under these fault conditions, only one conductor has the potential to carry fault current. Since at least two current carrying conductors are required to develop attractive and repulsive electromagnetic forces, this scenario will not result in unrestrained cable movement.	Refer to the NRC response to Comment Nos. 10, 12, and 19. Duke did not identify any factual corrections to the staff's statements in Response 2.h, but believes the May 11, 2015, letter provided analyses that demonstrated that cable whip in trench 3 would not result in failure of the DC control circuits. The staff evaluated all testing and arguments presented by ONS and concluded that multi-phase short circuits were a credible failure mode that Duke must consider in the ONS cable configurations in question. Also, Per IEEE Std. 279-1971 Section 4.2, "Single Failure Criterion," "the shorting or open-circuiting of interconnecting signal or power cables" was identified as a credible single failure. "Shorting" between independent interconnecting power cables is considered a single failure by the staff and is an exact parallel condition to multi-phase shorts.	No
Comment No. 22 (Ref: TIA Question 2.i)	It is Duke Energy's belief that there is no regulatory link between the results of a short circuit analysis and the required cable separation to meet regulatory requirements and the ONS licensing basis.	As described in the staff's response to Comment No. 21, there is a regulatory link between short circuit power and results pertaining to the required separation.	No
Comment No. 23 (Ref: TIA Question 2.j)	The draft TIA response incorrectly describes the function of cable insulation shielding with respect to the single conductor bronze tape cables and does not acknowledge the dual use of bronze tape as both a metallic insulation shield and armor for cable mechanical protection. Analysis previously provided in letters to the NRC as well as the results of extensive cable testing supports that the bronze tape shield/armor in our design provides a level of	See responses to Comment Nos. 10 and 12 above. The part of the staff's TIA response referred to in Comment No. 23 is a generic discussion on the functions of cable shielding and armor, and is factually correct. However, the licensee contends that the response fails to address the specific design and performance of the bronze tape shielded	Yes

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
	protection sufficient to preclude inter-cable shorts or faults. Also, it should be noted that the picture shown on Page 32 of the draft TIA response is incorrect since it illustrates a cable design consisting of three conductors, while the subject cables at ONS are single conductor cables.	cable used at ONS, which it contends will not experience, or can withstand, the types of failures assumed by the staff. The licensee has cited three sets of tests to support its position: the McGuire and Catawba medium-voltage cable test report (addressed in the TIA response to Question 2.j); the Oconee medium-voltage cable crush tests (conducted in early 2015, as discussed in the May 11, 2015 letter); and the Oconee fault testing (conducted in late 2015, as discussed in February 15, 2016 letter). The latter two sets of tests were not addressed in the draft TIA response. The fault testing conducted by Duke in late 2015, as described in the letter dated February 15, 2016, was considered by the staff, as discussed in the responses to Comment Nos. 10 and 19. Regarding cable fault testing, the NRC staff observed the referenced tests and reviewed the results. The staff determined that the testing as conducted by the licensee produced anecdotal results that did not demonstrate the capability of the bronze tape cable to meet separation requirements for the cable design and configurations in question, and did not address the other staff concerns. The testing failed to simulate the failure modes identified in the TIA, or the actual power levels to which the licensee exposes these systems and the ESPS cabling. The staff noted that the specified test criteria appear contingent on the concepts specified in the ONS "internal memo to file," which then produced the observed anecdotal results: The tests discounted multi-phase faults because the licensee believes that they are not credible. This was the subject of Question 2.e; the licensee must consider failures at any time	

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
		including credible failure modes for cable short circuits and multi-phase failures are in fact credible. The licensee used the single failure "on-demand" concept to reduce the fault current available to damage components. This was the subject of Question 2.c; the licensee must consider failures at any time including credible worst-case scenarios. The ONS report did not include the induced voltages observed on the test conductors. The observed induced voltages appeared large enough to be extremely damaging to the DC ESPS cables, which are a subject of the TIA. Question 2.f asked about Induced voltages and impressed voltages. ONS must consider these voltages along with the consequential damage to adjacent Class 1E components. For additional information, refer to the NRC response to Comment Nos. 12, 19, and 21. The staff will add a figure of the ONS cable design in its response to Question 2.j.	
Comment No. 24 (Ref: TIA Question 2.j)	The staff's draft TIA response incorrectly equates/combines the insulation shield with the bronze tape metallic shield which is not representative of the ONS cable configuration. The ONS single conductor bronze tape cables have three different shields - the strand (conductor) shield, insulation shield and metallic shield. The strand shield (or conductor screen) is a semi-conducting layer extruded over the conductor and its purpose is to present a smooth cylinder at the interface between the conductors and the insulation thereby reducing and equalizing the voltage stress in an outward radial direction.	The staff disagrees with the licensee's comment. See responses above. The staff response is supported by industry accepted quality standards as stated in the TIA response. The ONS specific definitions are not consistent with any industry standards, vendor published catalog, or vendor design data. The licensee did not identify nor provide any new information.	No

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
	The section “Functions of Shielding,” Items a-b, do not fully describe the insulation shield components as it applies to the ONS cable design. For the ONS cable design, the insulation shield is made of two separate components with different electrical functions; a nonmetallic semiconducting (or stress relief) shield and a metallic shield. The semiconducting shield is extruded over the insulation and its purpose is similar to the strand shield. Whenever the cable is energized, voltage is present on the insulation semiconducting shield. The metallic insulation shield is applied over the semiconducting insulation shield and is grounded. The electrical functions of the metallic shield are to protect personnel from voltage present on the semiconducting insulation shield, to provide a low resistance path to ground for cable charging current and to provide a path to ground for detection and clearing of phase-ground faults. For the ONS single-conductor power cables, the greater than standard bronze tape thickness serves an additional mechanical function as cable armor. In the section on Armor vs. Shielding, the statement that “Whether armor or shielding are both used in a cable depends on the application for which it is being designed” appears to imply that using bronze tape for both shielding and armor are mutually exclusive. As discussed above, the bronze tape performs the electrical requirements for metallic shielding and based on UL 1569 testing performed in 2015, passes the crush and impact performance requirements for Metal Clad cable. As stated in the Definition of Armor section of the draft TIA response, Metal Clad cable is armored cable. Therefore, the Duke Energy cable design with bronze tape is considered armored cable.		

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
Comment No. 25 (Ref: TIA Question 2.j)	As discussed in Duke Energy Comment #s 10 & 19, ONS has validated the current configuration using crush and fault testing, and that the robust design of the single-conductor bronze tape cables will preclude an initial phase-ground fault from "propagating from one cable to another." The staff has been made aware of the test results as provided in letters to the NRC (May 2015 and February 2016). At the 2015 fault testing at KEMA labs, Region II and NRR staff witnessed that cable faults did not propagate from one cable to another. During that testing, ONS demonstrated that electrical faults will not propagate from one cable to another.	Refer to the NRC response to Comment Nos. 10, 12, 19, and 23.	No
Comment No. 26 (Ref: TIA Question 2.j)	The overall MCM-1354.00-0029.001 document contains a series of test reports evaluating both overload and short circuit conditions in power and control cables. Duke Energy infers from the TIA statements quoted above that NRR is referencing, in particular, the August 1976 Westinghouse High Power Laboratory fault test report as it makes reference to fire propagation and utilized test voltages of 600 V, 4160 V, and 6900 V). Although reference to testing for fire propagation is made within that particular Westinghouse High Power Laboratory fault test report, the overall purpose of the testing program was to evaluate the ability of armored cable to act as a barrier and therefore, is relevant to Duke's positions on this matter. As stated in the "Introduction" section of MCM 1354.00-0029.001: "Section 8.3.1.2.7.5, Cable Application and Installation of the McGuire Nuclear Station Final Safety Analysis Report states that all wire and cables are of fire retardant construction and selected for the application. Armored cable which has been demonstrated to be an excellent barrier to	Duke's comments fail to justify why the different cable types tested are applicable to ONS, or how armored cable that may provide protection against fire propagation also protects against electrical faults (and more specifically, how is the 13.8-kV bronze tape cable at ONS equivalent to the lower voltage, steel-interlocked armored cable at Catawba Nuclear Station and McGuire Nuclear Station.) In addition, refer to the NRC response to Comment Nos. 10, 12, 19, and 23.	No

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
	externally and internally generated fires is used throughout the plant. Short circuit tests have been conducted on the interlocked armor cable by Duke Power Company (Duke Energy). These tests have demonstrated its acceptability as an adequate barrier by preventing damage to adjacent cables. This report provides the methods of approach, test data, and test results for those tests performed to demonstrate the acceptability of interlocked armor cable as an adequate barrier to internally generated faults." Further discussion on the use and application of the testing within McGuire Nuclear Station's licensing basis was included in the Duke Energy August 7, 2015 supplemental information submittal. As for the number and variance of tests performed, MCM 1354.00-0029.001 documents an approach of first performing exploratory tests followed by more rigorous testing. The July 24, 1975 Federal Pacific Test Lab report documents the eleven exploratory tests, all performed at a test voltage of 610 V and fault currents ranging from 23.4 [kiloamperes (kA)] to 100 kA. The rigorous testing regimen is documented in the previously discussed August 1976 Westinghouse High Power Laboratory fault test report. The rigorous testing consisted of three tests at 6900 V and 50 kA, four tests at 4160 V and 50 kA, and three tests at 600 V and 50 kA.		
Comment No. 27 (Ref: TIA Question 2.j)	Although the NRR statements on the armor of the faulted cable being blown back and the loading crate being set on fire are factual, it omits other "key" test results. The NRR referenced statements are found within the 1976	Duke's comments fail to justify why the different cable types tested are applicable to ONS, or how armored cable that may provide protection against fire propagation also protects against electrical faults (and more specifically, how is the	No

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
	Westinghouse High Power Laboratory fault test report for test number 2-51304-B. For the sake of completeness, it should be noted that the results of the test also concluded the following: • For the control cable tray directly above the faulted cable, "damage to control cables in this tray were limited to superficial PVC jacket damage." • For the other cables directly adjacent to the faulted cable in the specimen middle tray, "there was only superficial damage to the other cables in the specimen tray." • For the control cable tray directly below the faulted cable, "damage to control cables in this tray was limited to superficial [polyvinyl chloride (PVC)] jacket damage."	13.8-kV bronze tape cable at ONS equivalent to the lower voltage, steel-interlocked armored cable at Catawba Nuclear Station and McGuire Nuclear Station.) In addition, refer to the NRC response to Comment Nos. 10, 12, 19, and 23.	
Comment No. 28 (Ref: TIA Question 2.k)	NRR conclusions based on the use of "GDC" (General Design Criteria) terminology are inaccurate since the three (3) Oconee Units were licensed before the GDCs were in-effect. ONS complies with the 70 Principal Design Criteria (PDC) that were developed for Nuclear Power Plant Construction Permits proposed by the AEC in a proposed rule-making published for 10 CFR Part 50 in the Federal Register of July 11, 1967. There are no designed interconnections between the [Keowee Hydro Station (KHS)] and the ONS units such that a single failure due to "DC-to-DC short circuits" would credibly result in loss of both KHS units. Therefore, the NRR Statement and the basis on which it is made are inaccurate. At ONS, separation, independence and redundancy are ensured by system design and cable routing. Pertinent UFSAR sections and station implementation and guidance documents with respect to the Keowee and plant DC systems and cable separation are summarized below.	The NRC draft TIA response refers to the AEC GDCs, which formed the basis for the ONS PDCs described in the UFSAR, as discussed earlier in the TIA response (pages 9-13). Although the staff may have been imprecise in its reference here, there do not appear to be any substantive differences in the cited proposed AEC GDCs and the PDCs; thus, it is not clear what the licensee is disputing in its comment. The staff has clarified the TIA response. In the TIA response, the staff specified the areas where both trains of DC control power could be vulnerable to short circuits that could disable both trains (i.e., in the Keowee Hydro Unit (KHU) start panels at Keowee and ONS; at the terminal blocks) Duke's response states, in part, that: Cables of different safety channels or trains may be within less than five inches of each other when entering or accessing a common enclosure. However, mutually redundant safety cables, in any	Yes

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
	Keowee has two separate and redundant 125 Volt DC systems that are arranged such that a single fault within either unit's system does not preclude the other unit from performing its intended function of supplying emergency power (Ref. UFSAR Sections 8.3.2.1.3 (Ref. 1) and 8.3.2.2 (Ref. 1)). Each unit has two independent and physically separated 125 Volt DC systems. The 125 Volt DC Instrumentation and Control Power System is arranged such that a single fault within either system does not preclude the engineered safeguards equipment from performing their safety functions (Ref. UFSAR Sections 8.3.2.1.1 (Ref. 1) and 8.3.2.2.1 (Ref. 1)). Control, instrumentation, and power cables are applied and routed to minimize their vulnerability to damage from any source (Ref. UFSAR Sections 8.3.1.4.6.2). Cables of different safety channels or trains may be within less than five inches of each other when entering or accessing a common enclosure. However, mutually redundant safety cables, in any transition area, shall be precluded from making contact with each other. Barriers shall be installed any time the free air separation requirement cannot be met (Ref. OSS-0218.00-00-0019, Cable and Wiring Separation Criteria (Ref. 27)). Therefore, there are no designed interconnections between the KHS and ONS units such that a single failure due to "DC-to-DC short circuits" would result in loss of both KHS units. A single failure vulnerability does not exist for DC-to-DC short circuits in the KHU start panels.	transition area, shall be precluded from making contact with each other. Barriers shall be installed any time the free air separation requirement cannot be met (Ref. OSS-0218.00-00-0019, Cable and Wiring Separation Criteria (Ref. 27)). Section 8.3.1 of this internal Duke specification document (OSS-0218.00-00-0019, dated July 15, 1987) states, in part, that: Wiring and control devices are to be installed so as to maximize the physical separation distance between mutually redundant safety related wiring. In no case, shall mutually redundant safety related wiring or devices be in physical contact. When separation cannot be maintained a barrier must be installed. Duke did not provide sufficient detailed information describing the barriers in place in the specified areas where both trains of DC control power are in close proximity.	
4.0, "Conclusion" Comment No. 29	As discussed throughout this enclosure, this NRR statement is inaccurate by omission since it does not	The staff disagrees with the licensee's assertions. In response to various comments provided above, the staff has indicated that it reviewed all of the information provided by the	No

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
(Draft Response to TIA 2014-05: "Conclusion")	appear that NRR has considered information provided by Duke Energy.	licensee in developing its TIA responses. Since the licensee did not provide any new information, nor identify any factual errors, the staff determined that the TIA responses and conclusions remain the same. See the staff's responses to Comment Nos. 10 and 12, and the staff's discussion provided in response to TIA Question 2.j for additional information. As discussed in response to comment No. 19, the NRC staff did consider the testing and analyses described by Duke in its letters dated May 11 and August 7, 2015, as stated in Section 2.0 of the draft TIA response. The fault testing conducted by Duke in late 2015, as described in the letter dated February 15, 2016, was considered by the staff, as discussed in the response to Comment No. 10.	
Comment No. 30 (Draft Response to TIA 2014-05: "Conclusion")	The licensing basis single failure criterion that ONS conforms to for the onsite AC and DC power systems is delineated in IEEE Standard 279-1971, Section 4.2 as well as in UFSAR Section 8.3.1.2 (Ref. 1). ONS adheres to IEEE Standard 279-1971, Section 4.2, and UFSAR Section 8.3.1.2 and therefore is in conformance with its licensing basis with respect to the single failure criterion. It is inaccurate for the NRC to use standards that are not part of the ONS licensing basis (e.g., IEEE Standards 379 and 603) as the single failure criteria for the ONS onsite AC and DC power systems.	The licensing and design bases history of the ONS single failure criterion for analyzing electrical failure vulnerabilities between medium voltage AC power systems and low voltage DC circuits is discussed in Section 3.0. The TIA response has been revised as discussed in the individual comments above. Refer to the NRC responses to Comment Nos. 8 and 14.	Yes

Oconee Cable Separation – NRC Response to Duke Energy Comments on Draft Response to TIA 2014-05			
Draft TIA Response Section/Comment No.	**Duke Energy Comment**	**NRC Response**	**Change to TIA Response**
Comment No. 31	This statement and conclusion are inaccurate because NRR has omitted consideration of relevant ONS information. Cable fault testing performed by ONS in 2015 and provided to the NRC (but not evaluated in the TIA) involved inducing a fault on a single conductor medium voltage bronze armor power cable while monitoring for any effects on adjacent power and control cables. The fault testing validates the engineering analyses which have concluded that the single conductor power cables subject to a single phase-to-ground fault will not propagate to a multi-phase fault and will not adversely interact with the low voltage control cables leading to consequential functional failures of redundant trains. The cable crush testing demonstrated that the bronze armor power cables meet the UL 1569 impact and crush test performance requirements for metal clad cable (Ref. 18).	Refer to the NRC responses to Comment Nos. 10 and 12, and the staff's discussion in response to TIA Question 2.j.	No
Comment No. 32	As stated in Duke Energy Comment #s 3, 15, and 20, it does not appear that NRR reviewed all of the separation criteria in the ONS licensing basis.	Refer to the NRC responses to Comment Nos. 10 and 12, and the staff's discussion in response to TIA Question 2.j.	No