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ONS-16-074

August 15, 2016

U.S. Nuclear Regulatory Commission
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DUKE ENERGY CAROLINAS, LLC.
OCONEE NUCLEAR STATION, UNIT NOS. 1, 2 AND 3
DOCKET NOS. 50-269, 50-270 AND 50-287
RENEWED LICENSE NOS. DPR-38, DPR-47 AND DPR-55

SUBJECT: RESPONSE TO REQUEST FOR FACT CHECK OF DRAFT TASK INTERFACE AGREEMENT (TIA) 2014-05

REFERENCES:

1. NRC Letter, Oconee Nuclear Station, Units 1, 2 and 3 - Request for Fact Check of Draft Task Interface Agreement 2014-05, Related to the Design Analysis for Single Failure and the Integration of Class 1E Direct Current Control Cabling in Electrical Raceways with High Energy Power Cabling (TAC No. MF4626), August 2, 2016 (ADAMS Accession No. ML16214A003).
2. Duke Energy Letter, TIA 2014-05, Potential Unanalyzed Condition Associated with Emergency Power System, May 11, 2015 (ADAMS Accession No. ML15139A049).
3. Duke Energy Letter, Supplemental Information on TIA 2014-05, Potential Unanalyzed Condition Associated with Emergency Power System, August 7, 2015 (ADAMS Accession No. ML15224A370).
4. NRC Memorandum from T. Reis (RII) to A. Mohseni (NRR), Request for Technical Assistance Regarding Oconee Nuclear Station Design Analysis for Single Failure and the Integration of Class 1E Direct Current Control Cabling in Raceways with High Energy Power Cabling (TIA 2014-05), October 16, 2014 (ADAMS Accession No. ML14290A136).
5. Duke Energy Letter, Request for Alternative to Codes and Standards Requirements pursuant to 10 CFR 50.55a(z) to satisfy 10 CFR 50.55a(h)(2) associated with Bronze Tape Wrapped Emergency Power Cables in Use at the Oconee Nuclear Station, February 15, 2016, (ADAMS Accession No. ML16062A052).
6. NRC Letter, Oconee Units 1, 2, and 3 - Request for Additional Information Re. Technical Specification Changes for Keowee Hydro Undergound Path Breaker Control Modification - (TAC Nos. M88556/M88557/M88558), March 30, 1994 (ADAMS Accession Legacy No. 9404060051).
7. Duke Power Company Letter, Response to Request for Additional Information, May 25, 1994 (ADAMS Accession Legacy No. 9405310159).

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8. NRC Letter, Summary of January 19, 1995, Meeting with Duke Power Company (Duke Energy), "Proposed Modification to the Oconee Emergency Electrical System," January 26, 1995 (ADAMS Accession Legacy No. 9502030314).
9. Duke Power Company Letter, January 19, 1995, Meeting Minutes for the Proposed Modification on the Oconee Emergency Power System, March 8, 1995 (ADAMS Accession No. ML15238A049).
10. NRC Letter, Issuance of Amendments - Oconee Nuclear Station, Units 1, 2, and 3 (TAC NOS. M88556, M88557, and M88558), August 15, 1995 (ADAMS Accession No. ML01204206).

In Reference 1, the Nuclear Regulatory Commission (NRC) provided Duke Energy Carolinas, LLC (Duke Energy), with the draft Task Interface Agreement (TIA) response related to an unresolved item at the Oconee Nuclear Station (ONS) involving cable configurations in certain underground cable raceways. Duke Energy has completed a fact check review of the information (Reference 1) and has identified factual errors that are material to the conclusions contained in the letter. In general, Duke Energy's comments focus on the following five (5) areas with supporting information provided in the enclosure to this submittal:

1. The draft TIA response states that the CDBI team's specific concern was that testing did not envelope the cable designs in the underground raceways (Page 7, first sentence of last paragraph). ONS has since performed additional engineering analyses, along with cable crush and electrical fault testing of the bronze tape wrapped cable for the configurations of concern raised by the CDBI team, yet this subsequent testing was not considered in the TIA.

   The draft TIA response does not appear to consider relevant docketed information provided by Duke Energy via the Reference 2, 3 and 5 letters. The Reference 2 letter was provided by Duke Energy in response to the Region II questions to NRR documented in the Reference 4 TIA memorandum. Reference 2 provided clarifying information to the NRC on the ONS licensing basis as well as the results of impact and crush testing of Keowee underground trench power cables. The Reference 3 letter provided the NRC with the results of additional licensing basis reviews that an NRR Peer Team indicated was new information during its visit to ONS in July 2015. The Reference 5 letter includes discussion of testing results. This docketed information is pertinent to the cable separation and single failure design and licensing basis, yet the TIA did not consider its content. In addition, during meetings with NRR staff in November and December, 2015, ONS shared results of cable fault testing, which was witnessed by members of the NRC staff. These results inform the application of the single failure licensing basis at ONS in that the testing demonstrated the design of the cable system precludes the propagation of an electrical fault from phase to phase when the phases are carried in separate cables. The test results speak to the safety significance of the issue as well as the capability of the design to preclude certain types of failures. The exclusion of this information from the draft TIA makes the document incomplete as it is material to the regulatory questions being asked.

2. The draft TIA response section titled "ONS Design Basis – CDBI Team's Observation" states the following:

   - "... the CDBI Team could not verify that the referenced cable test report, MCM-1354.00-0029.01, supported the claim that armored cabling will not be subject to a single failure in one cable propagating to another cable." (Page 7, 2nd paragraph);
   - "that only 2-phases were shorted instead of 3-phases in the test, which limited the

energy released from the cables. In AC circuits, 3-phase short circuits provided the maximum energy released in arc flashes and maximum electromagnetic forces" (Page 7, last paragraph);

- "...the CDBI team could not verify that the tests supported the licensee's conclusion that armored cables (steel interlocked or otherwise) would prevent the propagation of electrical failures between cables" (Page 8, first paragraph, first sentence).

These statements were provided as the view of the CDBI team in the Background section of the document and were not developed in the staff's Technical Evaluation. The opinions of the CDBI team contradict the licensing decisions made by the NRC during the initial licensing of McGuire Nuclear Station and Catawba Nuclear Station, which also are relevant to ONS. Specifically, testing was performed and documented in the McGuire FSAR to demonstrate that armor was sufficient to provide electrical separation for adjacent cables in that a fault of one cable would not result in the failure of an adjacent cable. NUREG-0422, the OL-SER for McGuire, including supplements, also addresses the use of armored cable and refers to the associated testing. The approaches taken at McGuire and Catawba mirror the approach taken at ONS regarding cable separation.

The draft TIA response did not address the ONS design feature for use of armor for electrical separation when rendering their opinions on multi-phase faulting of cables. Through its omission, the evaluation is incomplete and seems to represent a change in regulatory position on the part of the staff. Since ONS relies on armor to provide electrical separation for adjacent cables similar to McGuire and Catawba, it is not new to the NRC that Oconee's position is that the failure of two adjacent cables would be treated as two independent cable failures. As written, the draft TIA response contradicts the ONS licensing basis.

3. With respect to the Trench 3 cables, ONS disagrees with NRR's conclusion that ONS is required to analyze for multi-phase faults within Trench 3. The electrical separation design at ONS relies on armor and, in some cases, bronze tape, to provide protection so that the failure of one cable will not adversely affect the function of adjacent cables.

   Single failure considerations are a function of the cable design and configuration. For example, in configurations where a single multiple-conductor cable carries all three phases of power, ONS agrees with the staff's interpretation that a multi-phase fault must be analyzed as part of assessing compliance with the single failure licensing basis; however, in configurations where separate cables are used to conduct each phase of power, ONS treats each cable independently. As such, when protected by armor, the failure of one cable would not fail the adjacent cable and a multi-phase failure would require multiple, simultaneous independent failures to occur. The design of the cables in Trench 3 (i.e., the single conductor cable construction, no electrical connections within the trench and grounded cable armor), precludes the occurrence of a multi-phase fault.

   In the NRR draft response to TIA questions 2B, 2E and 2J, the staff's conclusion is that the licensee is required to consider a multi-phase fault for the cables in Trench 3. This staff position does not consider the specific ONS designed configuration (i.e., single conductor cables), nor does it consider relevant analysis and testing information provided to the NRC by Duke Energy.

Duke Energy has submitted information related to this topic on the docket via References 2, 3 and 5 and has also discussed the NRC-witnessed cable fault testing in two meetings with staff (November and December 2015). This docketed information describes the custom cable design at the ONS as well as engineering analyses, cable crush testing and cable fault testing under electrical conditions that bound the cables of interest. The testing results demonstrate the ONS design is sufficiently robust and is not susceptible to the propagation of a fault from a single failed cable to multiple cables (i.e., a multi-phase fault does not result from a single cable failure). This docketed information supports a conclusion that multi-phase faults are not credible for the single conductor power cables within Trench 3 and the design complies with IEEE 279-1971, Section 4.2.

4. The current day version of the 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 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 ONS 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."

   Based upon the discussion above, the responses to questions 2E and 2G in the draft TIA response are in error as the NRC acknowledged providing an opinion based on a current day understanding of the term safety-related and, in this instance, NRC views are inconsistent with the ONS licensing basis. Specifically, in response to question 2E, the staff stated, "These standards, although not part of the ONS licensing basis, are useful in understanding general industry practice, and thereby provides a context for the NRC's evaluation of ONS' licensing bases and its action with respect to the design of the cables at issue." In its response to question 2G, the staff gave the opinion 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, 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 as, 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 GDC 39. Using this criterion, ONS performs single failure analysis based upon the design of the system and does not distinguish between safety-related and non-safety-related equipment.

5. The TIA is incorrect in stating "that worst case short circuit single failures are not limited to occur at initial time-of-demand." The ONS emergency power system and emergency power switching logic were designed based on failures occurring on initial demand. The ONS failure-on-demand basis was explicitly communicated to the NRC during the license amendment request efforts associated with a modification to the Keowee underground power path breakers. By the Reference 6 letter dated March 30, 1994, the NRC requested additional information about the use of the KHUs to generate commercial power and supply emergency power for ONS. One of the RAI questions asked ONS to discuss the philosophy of not considering smart failures within control systems in failure analyses, citing concerns related to the vulnerability of both hydro units and the offsite sources when they are tied together. Within the Reference 7 letter to the NRC dated May 25, 1994, Duke Energy quoted a January 1993 internal memorandum in a response to the NRC's concern: "In general it has been the Oconee position to not consider smart failures within control systems. The system is assumed to control as designed or to fail to its as-designed state."

   Further into the review of this LAR, the NRC acknowledged the ONS failure-on-demand position in the Reference 8 letter dated January 26, 1995, which provided a summary of a Duke Energy/NRC meeting on the proposed modification to the ONS emergency power system. The NRC-published meeting minutes stated, in part:

   > *The design basis for the Keowee emergency power system was then presented as the ability to provide emergency power to the Oconee Nuclear Station within the committed time under all applicable conditions assuming a single failure. After some discussion, the licensee stated the position that the switchyard yellow bus is part of the onsite power system at all times. Thus, a component failure which could cause a loss of this bus would be considered the single failure of the onsite electrical system. In addition, the licensee stated that any single failure was assumed to occur simultaneously with the initiating event.*

   In the Reference 9 letter to the NRC dated March 8, 1995, Duke Energy clarified one of the staff's statements from the January 26, 1995 meeting summary that "any single failure was assumed to occur simultaneously with the initiating event." Duke Energy stated, in part:

> *This should be changed to indicate that any single failure was assumed to occur immediately upon demand. Therefore, a failure was assumed to occur when the equipment was called upon to perform its safety function. This failure could be simultaneous to the initiating event or at some time during the mitigation of the event.*

The NRC's acceptance of the modified emergency power system at ONS on August 15, 1995 (Reference 10) indicates that Duke Energy had addressed the NRC's single failure concerns. At a minimum, the staff has been aware of the ONS failure-on-demand basis since 1995 and for the staff to draw a conclusion without considering this information is an omission that renders the draft TIA response statements inaccurate.

The single failure criterion and the consideration of single failures immediately on demand is an original design assumption that ONS utilizes to assure reliable systems as one of the defense in depth approaches to reactor safety. In the specific case of the ONS electrical distribution system, the large number of power sources, the relatively large capacity of the power sources and the high reliability of the KHUs all provide additional defense in depth. These concepts of defense in depth and reliability establish the basis for acceptability of ONS considering single failures immediately on demand for emergency power.

Throughout the draft TIA response, several references were cited that do not constitute nor reflect the current licensing basis for ONS for the SSCs in question. Below are some examples (see enclosure for more specific details):

- SRP Section 8.2,
- RG 1.53,
- IEEE 379,
- IEEE 603,
  Note: IEEE 603 was committed to for the "digital portion" of the replacement hardware during the RPS/ESFAS Replacement LAR. The remainder of RPS/ESPS and any interconnecting or interfacing systems is beyond the scope of this commitment.
- IEEE 279-1971 [sections other than Single Failure (4.2) for AC and DC Emergency Power Systems],
- SECY-77-439.

Duke Energy appreciates the opportunity to review and fact check the draft TIA response and will continue to work with the staff to ensure that the final document is technically correct and accurately reflects the ONS design and licensing basis.

There are no new regulatory commitments contained in this letter or the enclosure.

Should the NRC require any additional information, please contact Chris Wasik, Oconee Regulatory Affairs Manager, at (864) 873-5789.

Sincerely,

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Enclosure: Duke Energy Fact Check of NRR Draft Response to TIA 2014-05

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Enclosure

Duke Energy Fact Check of NRR Draft Response to TIA 2014-05

Below are Duke Energy's comments on the draft TIA 2014-05 response. Duke Energy encourages future dialogue on these items before finalization of the TIA document.

1. Draft Response to TIA 2014-05: "Introduction"

Duke Energy Comment #1: Duke Energy did not identify any factual inaccuracies in this section of the draft TIA response.

2. Draft Response to TIA 2014-05: "Background"

NRR Statement: "The separation requirements for medium voltage power cables, control cables, and safety related and non-safety related cables in common raceways could not be determined based upon a review of the ONS licensing basis."

Duke Energy Comment #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.

NRR Statement: "The CDBI team noted that since the 13.8-kVac Fant line is Non-Class 1E, the CDBI team could postulate a worst-case fault on the non-safety-related Fant line source that is routed with the Class 1E power system in addition to a single failure in the Class 1E system, consistent with SRP Section 8.2 and IEEE Standard 379."

Duke Energy Comment #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, 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 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. An 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 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." Therefore, the staff erred in its reliance on IEEE-379 in making its conclusion. This error appears in multiple locations within the document.

NRR Statement: "The CDBI team noted that a letter from W. O. Parker (Duke Power Company (Duke Energy)) to B. C. Rusche (NRC), dated May 13, 1976 (ADAMS Accession Legacy No. 7912060762), states that the onsite AC and DC systems conform to IEEE Standard 279-1971, "Criteria for Protection systems for Nuclear Power Generating Stations."

Duke Energy Comment #4: The wording in the May 13, 1976 (Ref. 7), letter states that "the Oconee onsite emergency AC and 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.

NRR Statement: "The CDBI team identified that these raceways contained 13.8-kVac power cabling, 4.16-kVac power cabling, Class 1E 125-volt direct current (Vdc) cabling, and associated non-Class 1E 125-Vdc cabling adjacent to one another, in close proximity, along the entire route of raceways. The as-installed configuration contained Class 1E and non-Class 1E power cables mixing with protection and control cables of onsite power systems."

Duke Energy Comment #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 UFSAR Section 8.3.1.4.6.2 (Ref. 1) and other station cable separation requirements (e.g., Ref. 27 and Ref. 29).

NRR Statement: "The CDBI team noted that a high impedance ground scheme, such as the one on the KHUs, was not simulated during these tests. A high impedance grounded system would contribute to the magnitude of energy release during AC arc flashes."

Duke Energy Comment #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.

3. Draft Response to TIA 2014-05: "Staff's Technical Evaluation"

NRR Statement: "Section 8.3.1.4.6.2, "Cable Separation," in part, states: "Control, instrumentation, and power cables are applied and routed to minimize their vulnerability to damage from any source." In addition it states, in part, "Power and control cables for redundant auxiliaries or services are run by different routes to reduce any probability of an accident disabling more than one piece of redundant equipment."

Duke Energy Comment #7: 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 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 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."

NRR Statement: The last paragraph of Page 15 of the staff's draft response through the first two paragraphs of Page 16 discusses the ONS Digital RPS/ESPS upgrade and associated License Amendment Request (LAR). The staff points out that ONS stated in the LAR that "the new digital RPS/ESPS equipment is required to conform with both IEEE Standard 279-1971 and IEEE Standard 603-1991." Then, in the NRR draft response to TIA questions 1, 2A, 2B, 2C and 2F, it appears the staff considers IEEE 603-1991 (Ref. 12) and, by extension, IEEE 379-2000 (Ref. 13), to be a part of the ONS licensing basis for the cables that are the subject of the TIA.

Duke Energy Comment #8: The staff's interpretation of the ONS licensing basis with respect to the applicability of IEEE 603 and IEEE 379 to systems beyond 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 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 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.

3.1 Response to Requested Actions

Question 1: What are the ONS licensing basis, design basis, and NRC regulations and requirements for analyzing electrical failure vulnerabilities (single failure or otherwise) between medium voltage AC power and low voltage DC circuits as presented in this TIA?

NRR Statement: "ONS' licensing basis included the elements described in Section 3.0."

Duke Energy Comment #9: 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.

Question 2A: Within ONS's Licensing Basis:

Are medium voltage power cables that are intended to provide emergency power to the RPS/ESPS equipment as well as provide the motive force to the actuated ESPS equipment during a chapter 15 event within the scope of IEEE Standard 279-1971?

- Must such power cables be considered under Section 3 "Design Basis" item 7 for transient conditions?
- Must potential multiphase short circuits or ground faults from such power cables be considered under Section 3, "Design Basis," Item 8 for unusual events, etc.?

NRR Statement: "Yes. The medium voltage power cables that are intended to provide emergency power to the RPS/ESPS equipment as well as provide the motive force to the actuated ESPS equipment during an UFSAR Chapter 15 event are within the scope of IEEE Standard 279-1971. In addition, such power cables must be considered, as stated in Section 3, item 7, for transient and steady-state conditions. Lastly, malfunctions or failures caused by faults such as multiphase short circuits or ground faults from such power cables must be considered under Section 3, Item 8 for normal and abnormal operation, transient conditions, and accidents."

Duke Energy Comment #10: 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 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 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 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.

Question 2B: Do 3-phase medium voltage power cables, intended to provide Class 1E emergency power to the RPS/ESPS equipment, represent "interconnecting signal or power cables," as discussed in Section 4.2 of IEEE-279?

NRR Statement: "The 3-phase medium voltage power cables, intended to provide Class 1E emergency power to the RPS/ESPS equipment do represent "interconnecting signal or power cables" as discussed in Section 4.2 of IEEE-279 and must be included within the scope of single failure evaluations as discussed in Section 4.2 of IEEE-279-1971. They are also considered part of the Class 1E power system or safety system as defined in IEEE Standard 603-1991."

Duke Energy Comment #11: 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 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 2B 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 I&C cables is not credible and would require more than a single failure.

<u>NRR Statement</u>: "The staff concludes that the evaluation of short circuits between shielded power cables are credible single failures that must be evaluated as part of the ONS design and licensing basis."

<u>Duke Energy Comment #12</u>: 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.

<u>Question 2C</u>: Can the timing of electrical failures assumed in the analyses be limited to reduce the consequential damage as described in the "internal memo to file"?

- How is single failure timing applied to the commercial "Fant" power feeders and the QA-1 power feeders from the KHUs to the PSW different than the Class 1E power feeders to the CT-4 transformer?

<u>NRR Statement</u>: "The IEEE Standard 279-1971 is part of the ONS licensing basis and does not provide exclusions for single failures that resulted in unacceptable assessments of the licensee's design. In addition, IEEE Standard 279-1971 does not restrict the timing of when single failures may occur. Single failures may occur at any time and are deemed by the staff to be applicable to the licensee's design basis whether or not these failures result in unacceptable outcomes."

<u>Duke Energy Comment #13</u>: 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 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.

<u>NRR Statement</u>: "Based on the above [excerpt from IEEE Standard 379-2000], the staff has determined that the licensee must consider single failures to occur at whatever time

produces the most limiting conditions (worst-case) to ensure safe operation of the three ONS units."

Duke Energy Comment #14: See Duke Energy Comment #3 regarding the application of IEEE Standard 379-2000 requirements.

NRR Statement: "All potential maximum short circuits and worst-case consequential failures (no credit on timing of failures) must be considered to determine the adequacy of the existing as-built design (i.e., failure of the most limiting high energy power cables and their impacts on power, control, and protection system cables interacting on a common raceway are considered, consistent with SRP Section 8.2 and IEEE 379). The single failure criterion only applies to safety-related (Class 1E) systems and components. Therefore, the licensee must postulate, in their analysis, the most limiting failure of any non-Class 1E related cables concurrent with a single failure in the Class 1E system to demonstrate safe shutdown capability."

Duke Energy Comment #15: 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).

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.

Question 2D: Can ONS make any distinctions between passive and active electrical single failures as described in the "internal memo to file"?

NRR Statement: No. ONS cannot distinguish between passive and active electrical single failures as described in the "internal memo to file" document because that internal ONS memo is not included in ONS UFSAR and is not part of the ONS licensing and design basis documents the staff has relied upon to evaluate compliance with NRC regulations 10 CFR 50.55a(h)(2) and 10 CFR 50.54 (jj). The licensee's interpretation of single failure as stated in the "internal memo to file" is contrary to industry practices, has no technical basis, and is not a part of the ONS UFSAR or TS.

Duke Energy Comment #16: 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.

Question 2E: Is ONS required to analyze for combinations of multi-phase short circuits as well as ground faults within Trench 3 in order to be compliant with the regulations and/or the current licensing basis for ONS?

NRR Statement: Yes. 10 CFR 50.54 (jj) requires that " Structures, systems, and components subject to the codes and standards in 10 CFR 50.55a must be designed, fabricated, erected, constructed, tested, and inspected to quality standards commensurate with the importance of the safety function to be performed."

IEEE Standards such as 279 and 379 also require that electrical single failures be addressed. In addition, voluntary consensus standards such as IEEE Standard 141 and IEEE Standard 242 contain provisions addressing combinations of multi-phase short circuits as well as ground faults in determining the worst-case single failure and multiple consequential failures affecting a power circuit. These standards, although not part of the ONS licensing basis, are useful in understanding general industry practice, and thereby provides a context for the NRC's evaluation of ONS' licensing bases and its action with respect to the design of the cables at issue.

ONS' licensing and design bases include the requirements to consider the full effects and consequences from electrical single failures in the onsite power system such as (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).

Duke Energy Comment #17: 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.

<u>Question 2F</u>: Is the licensee required to analyze for consequential damage from electrical failures to the adjacent Class 1E safety systems?

<u>NRR Statement</u>: "ONS has stated that it conforms to IEEE 279-1971."

<u>Duke Energy Comment #18</u>: 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.

<u>NRR Statement</u>: "The NRC staff was not able to identify any licensee documentation demonstrating, by analyses and tests, that the present as-built configuration has adequate physical separation and that the Class 1E system protective devices actuate prior to any consequential damage to the redundant ESF circuits."

<u>Duke Energy Comment #19</u>: 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.

<u>Question 2G</u>: Are all commercial, non-quality related (i.e., not QA-1 or QA-5) electrical components assumed to fail in the most limiting way possible?

- Does the failure of one of these commercial components represent a "single failure," in the context of the ONS licensing basis?

<u>NRR Statement</u>: Yes. 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, Chapter 15 for SSCs credited in the accident analysis assumptions). Therefore, the licensee must assume failure of non-Class 1E circuits along with a single failure of Class 1E equipment.

Response to bulleted question:

No. The single failure criterion only applies to safety-related (Class 1E) SSCs. Therefore, the licensee must postulate in its analysis the failure of any non-Class 1E cables in the most limiting way possible concurrent with a single failure in the Class 1E system. For example, a failure of the "Fant" line 13.8kVac power cables is assumed to occur at any time with its protective device failed and thus unable to protect the cables from worst-case fault conditions. The integrity of the Class 1E systems in the common underground raceway must be demonstrated by the licensee with the above failure and a single failure of the

Class 1E equipment. This must not result in loss of safety function of a system or introduce a common cause failure within the electrical power system(s).

Duke Energy Comment #20: The NRR draft response to this question is inconsistent with the ONS licensing basis. The current day version of the 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, 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 GDC 39. Using this criterion,

ONS performs single failure analysis based upon the design of the system and does not distinguish between safety-related and non-safety-related equipment.

Question 2H: Can unrestrained cable whip in Trench 3 be assumed to cause cable damage leading to secondary short circuits that could cause damage to the DC systems and should these effects of cable whip be analyzed?

NRR Statement: "Yes. The detrimental effects of cable whip for a worst-case cable fault in trench 3 must be analyzed in accordance with single failure criteria, independence, and separation criteria requirements specified in response to Question 1 above. The electromagnetic forces produced by a short circuit condition can cause whipping of the cables, which exerts significant forces on cable restraints and any adjacent cables. Hence, the electromagnetic forces generated from a postulated short circuit (single failure) in medium voltage AC cables in trench 3 must be considered in the analysis and demonstrated by tests to validate that there is no collateral damage to adjacent DC and protection system cables."

Duke Energy Comment #21: 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 to 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.

Question 2I: Are overload currents as well as short circuit currents required to be evaluated to determine the most limiting results from electrical faults and component failures?

- Do the results of such an analysis influence the required component separation to meet regulatory requirements and the ONS licensing basis?

NRR Statement: No. Only the worst-case short circuit currents are required to be evaluated to determine the most limiting results from electrical faults and component failures. Cables are designed to operate under overload conditions without causing consequential damage to other cables. The licensee must follow the requirements for maintaining cable separation, redundancy, and independence to permit the required functioning of the ESF equipment in accordance with AEC GDCs (principal design criteria).

Duke Energy Comment #22: 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.

Question 2J: Can cable shielding or armor prevent short circuits or limit faulted currents and voltages?

- Can the two wraps of bronze shielding tape in the licensee's current power cable configuration be considered equivalent to the steel interlocked armored cable as described in the test report MCM-1354.00-0029.001?
- Are the results of test report MCM-1354.00-0029.001 sufficient to demonstrate that electrical faults cannot propagate from one cable to another as described in the single failure DBD, Section 3.3.6.1?

NRR Statement: "No. Both Cable shielding and Armor cannot be credited for preventing short circuits or limiting fault currents and voltages. Cable shielding and cable armor serve different functions. A shield is employed in the subject cable design to preclude excessive voltage stress on voids between the conductor and insulation, and to confine the electric field of the cable to the insulation of the conductor or conductors."

Duke Energy Comment #23: 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 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.

NRR Statement: Page 33, "Definition of Shielding" and "Functions of Shielding."

Duke Energy Comment #24: 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 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.

NRR Statement: "Therefore, the licensee has not demonstrated that electrical faults will not propagate from one cable to another."

Duke Energy Comment #25: 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.

NRR Statement: "Testing was only conducted on one 600 V, one 4160 V, and one 6900 V cable. This is not a sufficient sample size to properly determine the behavior of the cables that are being tested." In addition, "The testing was not conducted with reducing separation criteria in mind. The purpose was to show that fire propagation would not occur."

Duke Energy Comment #26: 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 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 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.

NRR Statement: "Contrary to ONS' assertions, the 6900 V test resulted in the armor around the fault area being 'melted and blown back.' Additionally, it was noted that a loading crate six feet from the cable was set on fire. These results tend to point toward a High Energy Arc Fault (HEAF) occurring, which is indicative of the type of event that could result in catastrophic failure of other cabling depending upon where in the path of the HEAF that the cabling is routed."

Duke Energy Comment #27: 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 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 PVC jacket damage."

Question 2K: Does the interconnected nature of the Class 1E DC systems in the ONS KHU start panels and the Keowee hydro-station KHU start panels present vulnerabilities where DC to DC interactions could disable the Keowee emergency power systems?

NRR Statement: "Yes. A single failure vulnerability exists for DC-to-DC short circuits in the KHU emergency start and switchyard isolation features because of how it is interconnected between both KHU start panels (at the KHS and ONS). The staff noted that both sets of ESPS and the supervisory controls for each KHU enable and operate the same start

circuits, governors, and field controls; and that they are interconnected at KHS and between KHS and the ONS units. The interconnected nature of the ONS/KHS designs could expose the cables to single point vulnerability such as DC-to-DC short circuit at the terminal blocks that may disable both KHUs.

The staff has concluded that the licensee's interpretation of the single failure criterion was incorrect and there is a single failure vulnerability at ONS that can impact redundant safety related equipment. The licensee has not demonstrated that existing routing of power and control cables, including the ESPS protection circuits to KHU units from each ONS unit have adequate separation, independence, and redundancy such that no potential exists to disable functional requirements of redundant onsite AC power system. In accordance with 10 CFR 50.34 (b)(2), the licensee must provide a description and analysis of the SSCs in the UFSAR to include the design bases and limits on operation to show that the safety functions will be accomplished. UFSAR Section 8.3.1.4.6.2, "Cable Separation," and AEC GDCs 19, 20, 21, 22, 23, 24, and 39, provide descriptions for the licensee's conformance to applicable requirements."

<u>Duke Energy Comment #28</u>: 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 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.

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.

4. Draft Response to TIA 2014-05: "Conclusion"

NRR Statement: "The staff reviewed...documents considered in the evaluations by the licensee."

Duke Energy Comment #29: As discussed throughout this enclosure, this NRR statement is inaccurate by omission since it does not appear that NRR has considered information provided by Duke Energy.

NRR Statement: "Based on this review, the staff concludes that the current design of cables associated with emergency power, PSW, ESPS, RPS, and the KHUs supervisory control systems, as installed in the common raceway (trench 3), is not in conformance with the single failure criterion as delineated in the ONS current licensing basis."

Duke Energy Comment #30: 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.

NRR Statement: "The staff also concludes that the cables are not armored (steel interlocked or otherwise) and cannot prevent the propagation of electrical failures in trench 3. The staff further concludes that a single failure, such as a short circuit in the medium voltage cables currently installed in the common raceways, has the potential to adversely impact power and control cables associated with the KHUs such that redundant onsite power systems could be disabled for all three ONS units."

Duke Energy Comment #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).

NRR Statement: "The staff also reviewed separation criteria for safety and non-safety-related systems and concludes that the non-safety related cables associated with the Fant line and installed in sections of a common raceway could potentially disable safety-related equipment."

Duke Energy Comment #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.

LIST OF REFERENCES:

1. Oconee Nuclear Station Updated Final Safety Analysis Report (UFSAR), Revision 25, effective date of contents 12/31/15. UFSAR Chapters/Sections consulted:
   - 8.3.1.4.6.2, "Cable Separation,"
   - 8.3.1.2, "Analysis,"
   - 3.1.39, "Criterion 39 – Emergency Power for Engineered Safety Features (Category A),"
   - 3.1.1.1, "Oconee QA-1 Program,"
   - 3.1.1.2, "Oconee QA-5 Program,"
   - 8.3.2.1.3, "125 Volt DC Keowee Station Power System,"
   - 8.3.2.2, "Analysis,"
   - 8.3.2.1.1, "125 Volt DC Instrumentation and Control Power System,"
   - 8.3.2.2.1, "Single Failure Analysis of the 125 Volt DC Instrumentation and Control Power System,"
   - 8.2.3.3, "Reliability Considerations (FSAR Rev. 37),"
   - 15.1.9, "Credit for Control Systems and Non-Safety Components and Systems."
2. NUREG-0800, Standard Review Plan (SRP) Section 8.2 "Offsite Power System." (ML100740246).
3. IEEE Std. 379, "IEEE Standard Application of the Single Failure Criterion to Nuclear Power Generating Station Safety Systems."
4. OSS-254.00-00-4013, "Design Basis Specification for the Oconee Single Failure Criterion," Revision 5.
5. Duke Energy Letter to NRC, "Response to Request for Additional Information on Oconee Electrical System Issues," dated November 17, 1995, (ML15238A178).
6. NRC Letter to Duke Energy, "FINAL REPORT - OCONEE NUCLEAR STATION, UNITS 1,2, AND 3 - EMERGENCY ELECTRICAL POWER SYSTEM (TAC NOS. MA0886, MA0887, AND MA0888)," dated January 19, 1999.
7. Duke Power Company Letter to NRC (Response to Mr. R. A. Purple's Letter dated April 6, 1976), dated May 13, 1976, (ML16014A501).
8. IEEE Std. 279-1971, "IEEE Standard: Criteria for Protection Systems for Nuclear Power Generating Stations."
9. Duke Energy Letter to NRC, "Supplemental Information on TIA 2014-05, Potential Unanalyzed Condition Associated with Emergency Power System," dated August 7, 2015, (ML15224A370).
10. Atomic Energy Commission Letter to Duke Power Company, "Adequate Separation of Redundant Instrumentation and Control Cables," dated January 26, 1972.
11. Atomic Energy Commission Safety Evaluation Report (SER) December 29, 1970, (ML12276A270).
12. IEEE Std. 603-1991, "Criteria for Safety Systems for Nuclear Power Generating Stations."
13. IEEE Std. 379-2000, "Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems."
14. Oconee Nuclear Station License Amendment Request (LAR) for Reactor Protective System/Engineered Safeguards Protective System Digital Upgrade, Technical Specification Change Number 2007-09, (ML080730339).

<u>LIST OF REFERENCES</u> (continued):

15. OSC-3348 "RPS/ESPS Failure Modes and Effects Analysis Summary Calculation," Revision 7.
16. NRC Letter to Duke Energy, "OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3, ISSUANCE OF AMENDMENTS REGARDING ACCEPTANCE OF THE REACTOR PROTECTIVE SYSTEM AND ENGINEERED SAFEGUARD PROTECTIVE SYSTEM (RPS/ESPS) DIGITAL UPGRADE (TAC NOS. MD7999, MD8000, AND MD8001)," dated January 28, 2010, (ML100220016).
17. Atomic Energy Commission Letter to Duke Power Company "Notice of Issuance of Provisional Construction Permits," dated November 6, 1967, (ML012200250).
18. Duke Energy Letter to NRC, "TIA 2014-05, Potential Unanalyzed Condition Associated with Emergency Power System," dated May 11, 2015, (ML15139A049).
19. Duke Energy Letter to NRC, "January 19, 1995 Meeting Minutes for the Proposed Modification on the Oconee Emergency Power System," dated March 8, 1995, (ML15238A049).
20. NRC Letter to Duke Energy, "ISSUANCE OF AMENDMENTS – OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3 (TAC NOS. M88556, M88557 AND M88558)," dated August 15, 1995, (ML012040206).
21. Duke Power Company Letter to NRC, "Oconee QA-1 Licensing Basis and Generic Letter 83-28 Section 2.2.1, Subpart 1 Supplemental Response," dated April 12, 1995, (ML15238A066).
22. NRC Letter to Duke Power Company, "GENERIC LETTER 83-28 SUPPLEMENTAL RESPONSE - OCONEE UNITS 1, 2, AND 3 (TAC NOS. M92023, M92024, AND M92025)," dated August 3, 1995, (ADAMS Legacy Accession #9508090111).
23. NRC Letter to Duke Power Company (Re: request for required information to complete review) dated June 13, 1975, (ADAMS Legacy Accession #7912180877).
24. IEEE Std. 141-1993(R1998), "IEEE Recommended Practice for Electric Power Distribution for Industrial Plants."
25. IEEE Std. 242-2001, "IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems."
26. Duke Energy Letter to NRC, "Request for Alternative to Codes and Standards Requirements pursuant to 10 CFR 50.55a(z) to satisfy 10 CFR 50.55a(h)(2) associated with Bronze Tape Wrapped Emergency Power Cables in Use at the Oconee Nuclear Station," dated February 15, 2016, (ML16062A052).
27. Duke Energy Design Specification, OSS-0218.00-00-0019, "Cable and Wiring Separation Criteria," Revision 17.
28. Duke Energy Corrective Action Program, PIP O-14-3915 (Action Request 01867655).
29. DC-3.13. Oconee Nuclear Station Cable and Wiring Separation Criteria, Revision No. 11.