



## Oconee Nuclear Station

Duke Energy Presentation to the NRC Committee to Review Generic Requirements (CRGR) – October 24, 2017



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- Opening Remarks
- New Regulatory Positions
  1. Crediting Cable Armor for Electrical Separation
  2. Single Failure Criteria for Separate Cables
  3. Single Failure Considerations Regarding Equipment Quality Classification
  4. Timing of Single Failures for Emergency AC Power
- Closing Remarks

Ed Burchfield, Oconee Nuclear Plant Manager

- Oconee Nuclear Station continues to be operated safely.
- The PSW modification resulted in a significant plant risk reduction.
- The associated risk of the issue continues to be very low.
- The subject TIA is an outcome of the CDBI conducted in 2014.
- Some issues in the draft TIA appear to be changes in accepted and established positions.

- Engineering judgement was used to support the use of bronze tape.
  - Oconee could have performed testing to support the change.
- Bronze tape used as a safety enhancement to eliminate splices in Trench 3.
- Oconee has previously communicated its position on bronze tape.
- Oconee has been proactive in responding to NRC Staff concerns:
  - Testing,
  - Modifications,
  - 10 CFR 50.55(a) Alternative Submittal.
- Oconee's concern with the TIA is related to issues, other than bronze tape, that challenge the licensing basis for the Station:
  - Crediting Cable Armor for Electrical Separation,
  - Single Failure Criteria for Separate Cables,
  - Single Failure Considerations Regarding Equipment Quality Classification,
  - Timing of Single Failures for Emergency AC Power.

Todd Grant, Oconee General Manager, Nuclear Engineering

Ed Burchfield, Oconee Nuclear Plant Manager

## 1. Crediting Cable Armor for Electrical Separation

- Duke Energy design standards for the original construction and licensing of Oconee, McGuire and Catawba employed armored cable (ONS U1 SE 12/29/70, ONS U2&3 SE 7/6/73, MNS U1&2 SE Supp. 2 3/1/79, CNS U1&2 SE 2/22/1983).
- The decision to use armored cable was made by Oconee Chief Electrical Engineer CJ Wylie (ACRS Member 1984 to 1996) to provide a more robust, resilient design.
  - In a 1976 industry letter, Mr. Wylie notes that this decision was made in response to cable fires at other power plants around the world, coupled with the need to protect redundant safety channels from outside influences of damage including electrical, electrostatic, or electromagnetic interferences.
  - Armored cable provides physical protection against abuse during installation.
  - With the armor, essentially each cable is contained within its own conduit.
  - Cable armor also factored into segregation of cables based on voltage class as it eliminated the need for elaborate segregation. Duke testing concluded that blow-ups of properly installed armored power cable would not affect adjacent control cables.
- Armored cable was a great investment by the company, and it was deemed prudent based upon previous experience with non-armored cables.



# 1. Crediting Cable Armor for Electrical Separation

## Draft TIA Position

- The draft response to TIA Question 2.j states that cable armor cannot be credited for preventing short circuits or limiting fault currents and voltages.

## Oconee Position

- The draft TIA position documented in Question 2.j does not address Duke Energy's licensing history and accepted practices in regards to armored cable.
- Oconee's cable design and installation practices, including routing and separation distances, were based upon the NRC accepted use of armored cable.

## New Regulatory Position

Armored cable may not be credited with respect to cable separation.

# 1. Crediting Cable Armor for Electrical Separation

## Oconee Position (cont'd)

- Separation is accomplished through the use of distance and/or barriers. Information on cable routes, separation distances, cable construction (including armor), and barriers has been contained within Oconee FSAR Chapters 7 & 8 since initial licensing.
- Oconee SERs for initial licensing document that the provisions for installation and separation of cables were reviewed and found to be acceptable.
- In addition to the Oconee FSAR content, Oconee correspondence to the AEC on 12/22/1970 described the philosophy around the use of armored cable. The Duke Energy design incorporates cable armor to serve as a protective barrier that acts in much the same manner as flexible conduit. Essentially, each cable has its own conduit “built-in” by the armor.

## New Regulatory Position

Armored cable may not be credited with respect to cable separation.

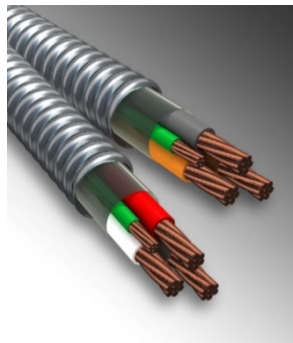
# 1. Crediting Cable Armor for Electrical Separation

## Oconee Position (cont'd)

- NRC endorsed guidance on separation (IEEE Std 384, RG 1.75) reaffirms the design principle of separation being accomplished through distance and barriers. For enclosed-to-enclosed configurations, such as adjacent conduits, the endorsed guidance prescribes a separation distance of at least 1 inch horizontal and vertical. Upon comparing metal conduit to armored cable, it is not clear why conduit would be considered acceptable and armor would not. Oconee maintains 5 inches of rail-to-rail separation on cable trays.



Conduit



Armored Cable

For Information Only

## New Regulatory Position

Armored cable may not be credited with respect to cable separation.

# 1. Crediting Cable Armor for Electrical Separation

## Oconee Position (cont'd)

- Additional Regulatory Review:
  - 5/7/1993 The Electrical Distribution System Functional Inspection Report noted the following:  
“The safety significance of running the two cables in the same tray was mitigated by a unique design feature at Oconee of installing cables in armored jackets.”
  - 12/29/2010 Safety Evaluation for NFPA 805 stated:  
“the NRC staff finds that the licensee has adequately addressed the issue of grounding of armored cable to preclude inter-cable shorts.”
- Oconee requests the CRGR recommend reconsideration of the draft TIA response to Question 2.j with respect to the crediting of armor for cable separation on the basis that it represents a new regulatory position.

## New Regulatory Position

Armored cable may not be credited with respect to cable separation.

## 2. Single Failure Criteria for Separate Cables

### Draft TIA Position

- The draft response to TIA Questions 2.b and 2.e implies Oconee is required to analyze for combinations of multi-phase short circuits as well as ground faults in separate cables to meet the single failure requirements of IEEE Std. 279-1971, as clarified by SECY-77-439.

### Oconee Position

- Design attributes can preclude certain failure modes from occurring or consequentially impacting equipment.

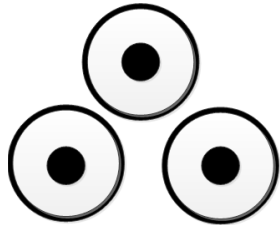
### New Regulatory Position

Oconee is required to analyze for multi-phase short circuits in separate cables to meet single failure requirements.

## 2. Single Failure Criteria for Separate Cables

### Oconee Position (cont'd)

- Oconee has precluded a 3-phase failure by making each phase a separate cable, thereby requiring 3 component failures to induce a 3-phase fault in these cables.
  - When a single multiple-conductor cable carries all three phases of power inside the same metallic sheath, a multi-phase fault must be further analyzed; however, when separate cables in separate sheaths are used, Oconee treats each cable as an independent component, thereby precluding consequential failures from the single cable failure.
  - A plausible single cable failure along the cable route is a phase-ground fault on one of the single conductor cables. The design of the protective features preclude this fault from cascading further.



Single-Conductor Cables



Three-Conductor Cables

For Information Only

### New Regulatory Position

Oconee is required to analyze for multi-phase short circuits in separate cables to meet single failure requirements.

## 2. Single Failure Criteria for Separate Cables

### Oconee Position (cont'd)

- This design attribute is endorsed in NUREG-CR 6850 (adopted as part of NFPA 805 License Amendment (SE December 29, 2010) defines faults:
  - 7.2.1.1 “Because nonsegmented bus ducts (category 1) and cable ducts (category 3) have no transition points other than the terminations at the end device, no treatment of bus duct faults/fires independent from the treatment of fires for the end devices is required. That is, arc faults for these two categories of bus ducts, 1 and 3, are inherently included in the treatment of the end device, and no further treatment is needed.”
  - 9.5.2.2 “Plant-specific design features can preclude certain circuit failures from occurring. For example, the use of grounded, metallic, armored cable or dedicated conduit, shorting switches, or rugged (e.g., braided metal) shielding are considered in most cases to preclude external hot shorts from further consideration. Design and construction attributes such as these should be considered in the evaluation.”

### New Regulatory Position

Oconee is required to analyze for multi-phase short circuits in separate cables to meet single failure requirements.

## 2. Single Failure Criteria for Separate Cables

### Oconee Position (cont'd)

- Oconee requests the CRGR recommend reconsideration of the draft TIA response to Questions 2.b and 2.e with respect to the analysis of faults of separate cables on the basis that it represents a new regulatory position.

### New Regulatory Position

Oconee is required to analyze for multi-phase short circuits in separate cables to meet single failure requirements.



### 3. Single Failure Considerations Regarding Equipment Quality Classification

#### Draft TIA Position

- All commercial, non-quality related (i.e. not QA-1 or QA-5) electrical components are assumed to fail in the most limiting way possible.
- These failures must be considered in addition to the single failure of Class 1E equipment.
- The licensee may not credit any non-safety equipment unless it is specifically evaluated and approved in the plant licensing basis.

#### Oconee Position

- The requirement to consider the failure in the most limiting way of all Non-QA equipment coincident with one single failure of Class 1E equipment is not supported by Oconee's licensing basis for single failure analysis.

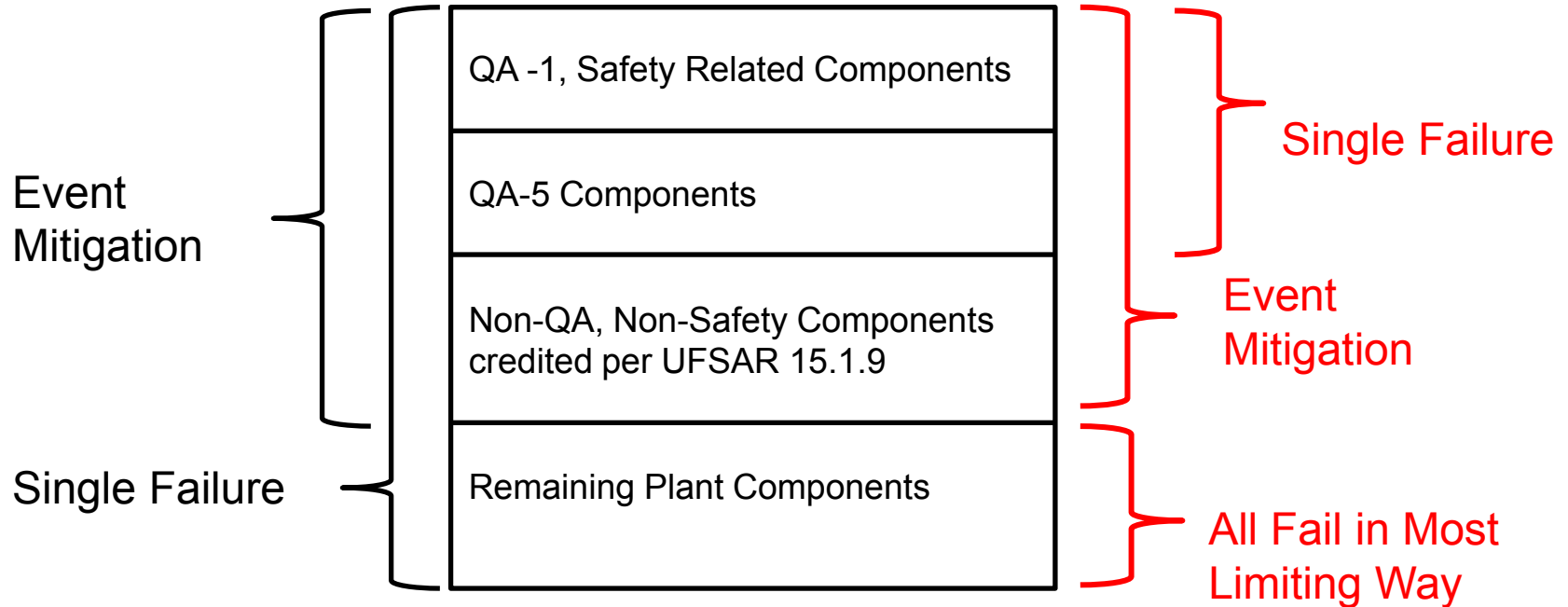
#### New Regulatory Position

All non-safety related electrical components are assumed to fail in the most limiting way in addition to the Single Failure.

### 3. Single Failure Considerations Regarding Equipment Quality Classification

Licensing Basis

New Regulatory Position



### 3. Single Failure Considerations Regarding Equipment Quality Classification

#### Oconee Position (cont'd)

- The Oconee licensing basis predates the conventional use and application of the term 'Safety-Related.'
- As initially licensed, QA-1 equipment was classified as those components necessary to mitigate the LB LOCA/LOOP DBA. Mitigation of other accidents required Oconee to utilize both QA and non-QA equipment for accident mitigation. This issue was reviewed by the NRC staff during response to GL 83-28.
- As evidenced by GL 83-28 correspondence in the mid-1990s, the NRC acknowledged this aforementioned condition.
- On April 12, 1995 Duke Energy submitted a GL 83-28 supplemental response summarizing the station licensing basis:
  - Some SSC's required for accident mitigation were not originally procured per 10 CFR Appendix B requirements.
  - Qualification and Single Failure are separate criteria.
  - The scope of the Oconee QA-1 program was not required to encompass all SSCs requiring seismic design criteria or single failure design criteria.

#### New Regulatory Position

All non-safety related electrical components are assumed to fail in the most limiting way in addition to the Single Failure.

### 3. Single Failure Considerations Regarding Equipment Quality Classification

#### Oconee Position (cont'd)

- The NRC SE approved this position on August 3, 1995:
  - It is clear that some seismically designed single failure proof systems were not classified as QA-1 when ONS received its license.
  - ONS is an early nuclear plant design whose nuclear safety guideline requirements has some differences from current design requirements.
- The ONS Single Failure Criterion is that one singular component failure (and it's consequential failures), will not preclude the safety functions from being performed. The Oconee PDCs specify that single failure is applied at the component level, irrespective of safety classification.
- Oconee requests that CRGR recommend reconsideration of the draft TIA response to Question 2.g with respect to requiring the failure of all non-safety equipment in the worst way in addition to the single failure on the basis that it represents a new regulatory position.

#### New Regulatory Position

All non-safety related electrical components are assumed to fail in the most limiting way in addition to the Single Failure.

## 4. Timing of Single Failures for Emergency AC Power

### Draft TIA Position

- Based on IEEE Std. 279-1971, as clarified by SECY-77-439, single failures must be assumed to occur at whatever time produces the most limiting conditions.

### Oconee Position

- The Oconee single failure criterion analysis is predicated on single failures occurring at the time of demand of the component.
- SECY-77-439 is not part of the Oconee Licensing Basis.
- The Oconee Emergency Power System is robust in both its capacity and its capabilities. This introduces a level of uniqueness within the industry that has been reviewed numerous times throughout Oconee's history.

### New Regulatory Position

Single failures shall be analyzed to occur at explicit times either before, during or after an event.

## 4. Timing of Single Failures for Emergency AC Power

### Oconee Position (cont'd)

- The Oconee Emergency Power System design is substantially robust and is predicated on the ability to swap power sources. An inherent premise of this design is that failures are evaluated as demand failures:
  - Two on-site emergency power sources:
    - Each capable of supplying a significant amount of plant auxiliaries to provide operators with several paths available to cope with an incident and/or safe shutdown other units,
    - Each capable of carrying all trains of engineered safeguards loads.
  - Double-bus double-breaker distribution -- each load center fed by redundant buses with redundant feeder breakers, each able to supply full capacity.

### New Regulatory Position

Single failures shall be analyzed to occur at explicit times either before, during or after an event.

## 4. Timing of Single Failures for Emergency AC Power

### Oconee Position (cont'd)

- The Oconee design, including failure at time of demand, has been reviewed by the NRC in numerous forums over the last 50 years:
  - Staff Reports to ACRS: 6/16/1967 and 7/24/1970,
  - Safety Evaluations: U1 12/29/1970, U2&3 7/6/1973,
  - EDSFI Report 5/7/1993,
  - LAR 2/24/1994,
  - EPS Review Final Report 1/19/1999.

### New Regulatory Position

Single failures shall be analyzed to occur at explicit times either before, during or after an event.

## 4. Timing of Single Failures for Emergency AC Power

### Oconee Position (cont'd)

- The December 29, 1970 Safety Evaluation for Oconee Unit 1 approved the design.
  - Three 4.16 kV buses serving engineered safety feature loads are provided for Unit 1 and these buses are connected to both of the Unit 1 4.16kV main feeder buses. The sources of power which are automatically connected to the main feeder buses, in the order that they are connected, are:
    - (1) the 230-kV switchyard via the unit's startup transformer;
    - (2) the preselected hydro unit via the 13.8-kV underground feeder and the station's standby buses; and
    - (3) the other hydro unit via a 230-kV overhead line, the 230-kV switchyard and the unit's startup transformer.

### New Regulatory Position

Single failures shall be analyzed to occur at explicit times either before, during or after an event.



## 4. Timing of Single Failures for Emergency AC Power

### Oconee Position (cont'd)

During review of a License Amendment Request submitted in 1994, the NRC looked at single failure considerations.

- In a NRC summary of a January 19, 1995, meeting the staff noted “the licensee stated that any single failure was assumed to occur simultaneously with the initiating event”
- A Duke letter dated March 8, 1995, provided clarification to the above summary that “This should be changed to indicate that any single failure was assumed to occur immediately upon demand.”
- On August 15, 1995 approval of this review was received in an SE, including references to the May, 1994 response and the January, 1995 meeting.

### New Regulatory Position

Single failures shall be analyzed to occur at explicit times either before, during or after an event.

## 4. Timing of Single Failures for Emergency AC Power

### Oconee Position (cont'd)

- 1999 NRC Final Report on the Oconee Emergency Electrical Power System documents an extensive review of the system and did not identify any vulnerabilities in the design.
  - Purpose was to assess the overall reliability of the emergency power system as it currently exists and determine whether any additional staff actions might be required to address unacceptable vulnerabilities or risks that may exist in the design or operation.
  - Report recognized the unique nature of the Oconee design, stating: “It is important to note and emphasize that the Oconee emergency electrical power system was designed, reviewed, and approved in the 1960s prior to the development and implementation of most of the current requirements and guidance (industry standards, Regulatory Guides, etc.) related to emergency (Class 1E) electrical systems.”
  - In response to Open Item 5 in the report development, Duke responded “The original licensing and design basis of Oconee consists of postulating a voltage regulator or governor failure at the time of initial demand.”

### New Regulatory Position

Single failures shall be analyzed to occur at explicit times either before, during or after an event.

## 4. Timing of Single Failures for Emergency AC Power

### Oconee Position (cont'd)

- In the 1999 Final Report for this review the staff acknowledged that a plant specific single failure criterion is employed at Oconee. “. . . there is no reason to believe that Oconee does not continue to be in compliance with the requirements of 10 CFR 50.46 and 10 CFR 50, Appendix K. With regard to single failure, Oconee uses a plant-specific definition.”
- The draft TIA position reference to SECY-77-439 is inappropriate with respect to the Oconee licensing basis.
  - The SECY post-dates Oconee licensing.
  - The SECY is neither a licensing document, nor is it referenced in the Oconee licensing basis.
  - The draft TIA position suggests the SECY represents a uniform and consistent approach was applied to plant licensing in the 1960s and 1970s, which is contrary to industry experience.

### New Regulatory Position

Single failures shall be analyzed to occur at explicit times either before, during or after an event.

## 4. Timing of Single Failures for Emergency AC Power

### Oconee Position (cont'd)

- The draft TIA response to Question 2.c represents a new regulatory position and is generic in nature, describing a licensing basis that encompasses the entire Oconee design; it is not limited to the Trench 3 and PSW cables.
- Oconee requests that CRGR recommend reconsideration of the draft TIA response to Question 2.c with respect to the timing of failures on the basis that it represents a new regulatory position.

### New Regulatory Position

Single failures shall be analyzed to occur at explicit times either before, during or after an event.

Scott Batson, Senior Vice President, Nuclear Operations  
South Carolina

- Oconee appreciates the opportunity to provide our views.
- The associated risk of the issue continues to be very low.
- The staff position challenges our original design and licensing basis.
- We believe these positions represent new or different interpretations.
  - We do not believe that the TIA is the appropriate process.
- The draft TIA is complex and subject to multiple interpretations.
  - Multiple issues are addressed concurrently.
- Oconee asks the CRGR to recommend reconsideration for the items presented:
  - Crediting Cable Armor for Electrical Separation,
  - Single Failure Criteria for Separate Cables,
  - Single Failure Consideration Regarding Equipment Quality Classification,
  - Timing of Single Failure for Emergency AC Power.
- Responses contained within the draft TIA create the potential for unintended or unanalyzed backfits.

