

Docket Nos. 50-269

50-270

and 50-287

NOV 18 1977

Duke Power Company  
ATTN: Mr. William O. Parker, Jr.  
Vice President  
Steam Production  
Post Office Box 2178  
422 South Church Street  
Charlotte, North Carolina 28242

Gentlemen:

On or about November 8, 1977, you should have received IE Bulletin No. 77-05 on Electrical Connector Assemblies from the Regional Office of the NRC Office of Inspection and Enforcement and a supplement to this Bulletin on or about November 15, 1977, (copies enclosed). This Bulletin requests that, within 30 days, you provide information on whether your Oconee 1, 2 and 3 facilities utilize electrical connector assemblies within containment that could be subject to an accident environment and are required to be operable during an accident; and, if they do, to provide documentation of the environmental qualification testing performed for these connectors.

Due to the safety significance of this matter, the staff also conducted a telephone survey of all operating plants to obtain preliminary information on which facilities utilize such connectors and the adequacy of qualification testing of any such connectors. As you know, this survey determined that such connectors are used in your Oconee 1, 2 and 3 facilities. Further, as a result of meetings held with your representatives during the week of November 7, 1977, we determined on a preliminary basis, that the environmental testing of the electrical connectors used in your facilities and the documentation thereof, appear to be satisfactory. Confirmation of this is to be provided by your response to the IE Bulletin and the supplement thereto.

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SURNAME >						
DATE >						

NOV 18 1977

If, however, in responding to the Bulletin, you are not able to provide complete documentation of the required qualification testing of all applicable connectors, the Bulletin requires that you submit plans and programs toward qualifying existing equipment or plans for replacing unqualified connectors with qualified equipment.

This is to advise you that if you are not able to provide the necessary documentation, then, pursuant to 10 CFR 50.54(f), at the same time that you respond to the Bulletin, you are requested to submit to the Office of Nuclear Reactor Regulation, Nuclear Regulatory Commission, Washington, D. C. 20555, justification that continued operation of the facilities for whatever period it will take to environmentally qualify the connectors in accordance with NRC regulations would not create an undue risk to the health and safety of the public.

Please advise us if you have any questions relative to this matter.

Sincerely,

Edson G. Case, Acting Director  
Office of Nuclear Reactor Regulation

Enclosures:

As stated

cc w/enclosures:

See next page

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UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D. C. 20555

November 18, 1977

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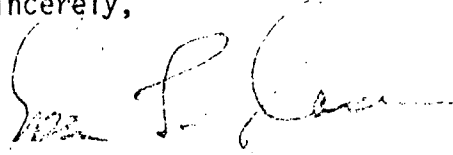
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Please advise us if you have any questions relative to this matter.

Sincerely,



Edson G. Case, Acting Director  
Office of Nuclear Reactor Regulation

Enclosures:  
As stated

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See next page

Duke Power Company

- 3 -

November 18, 1977

cc: Mr. William L. Porter  
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Oconee Public Library  
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Walhalla, South Carolina 29691

NUCLEAR REGULATORY COMMISSION  
OFFICE OF INSPECTION AND ENFORCEMENT  
WASHINGTON, D. C. 20555

November 8, 1977

IE Bulletin 77-05

ELECTRICAL CONNECTOR ASSEMBLIES

Description of Circumstances

Recent tests conducted by the Sandia Laboratories of electrical connector/cable assemblies in a simulated post-LOCA containment environment (LWR) demonstrated that the assemblies failed to perform in an acceptable manner. The connectors are the pin and socket type, with metal shell and screw couplings. The specific test specimens were manufactured by Bendix, ITT Cannon and Gulton Industries using combinations of Anaconda and ITT Surprenant cables. Details of the specific connector/cable combinations, test conditions, test results and other pertinent information are described in the Attachment.

While electrical connectors of the type tested are not normally used in applications that are required to survive LOCA conditions, it is not possible in the absence of specific information to conclude that such applications do not exist. Further, it is unknown whether other manufacturers have supplied similar assemblies, whether such assemblies have been properly qualified for the intended service or whether these types of assemblies are utilized in applications that must continue to operate reliably in a LOCA environment.

Action To Be Taken By Licensees and Permit Holders:

For all power reactor facilities with an operating license or a construction permit:

1. Determine whether your facility utilizes or plans to utilize electrical connector assemblies of the type tested by Sandia Laboratories, or any other similar type, in systems that are located inside containment, are subject to a LOCA environment and are required to be operable during a LOCA.
2. If any such applications are identified, review the adequacy of qualification testing for the assemblies and submit the documentation for NRC review.

3. If evidence is not available to support a conclusion of adequacy, submit your plans and programs toward qualifying existing equipment or your plans for replacing unqualified assemblies with qualified equipment.
4. Provide your response in writing within 30 days for facilities with an operating license and within 60 days for facilities with a construction permit. Reports should be submitted to the Director of the appropriate NRC Regional Office and a copy should be forwarded to the U. S. Nuclear Regulatory Commission, Office of Inspection and Enforcement, Division of Reactor Construction Inspection, Washington, D. C. 20555.

Approved by GAO, B180225 (R0072); clearance expires 7-31-80. Approval was given under a blanket clearance specifically for identified generic problems.

Attachment:

Trip Report by W. R. Rutherford  
Electrical Connector Assemblies

TRIP REPORT  
by  
W. R. Rutherford

ELECTRICAL CONNECTOR ASSEMBLIES

On September 1, 1977 a meeting was held in Albuquerque, New Mexico to investigate the electrical connector assembly malfunctions or failures that occurred during tests under LOCA conditions performed by Sandia Laboratories. The following is a description of the equipment, test scope and results of these tests.

Equipment

The test assemblies of particular interest consisted of three types of connectors: Bendix, ITT Cannon, and Gulton installed on two types of cables; Anaconda and ITT Surprenant.

1. Bendix Connector: A 3 conductor/No. 12 AWG with crimp pin conductors, anodized aluminum shell, silicone rubber insert, rigid back plane potting, pliable over-potting.
2. ITT Cannon Connector; A 3 conductor/No. 12 AWG with crimp pin conductors, anodized aluminum shell, silicone rubber insert, anodized aluminum back shell, rubber packing boot, mechanical retaining clamp.
3. Gulton Connector: A 3 conductor/No. 12 AWG with crimp pin conductor, stainless steel shell, hard fiber insert, pin back sealed with RTV 112, stainless shell, back plane poured with Sylgard potting, mechanical clamp termination.
4. Anaconda Cable: A 3 conductor/No. 12 AWG, tinned copper conductor, 30 mil ethylene propylene rubber insulation 15 mil Hypalon jacket, cable asbestos tape, 60 mil Hypalon jacket, rated 600 volts, cable diameter 0.55".
5. ITT Surprenant Cable: A 3 conductor/No. 12 AWG, tinned copper conductor, 30 mil Exane II insulation, silicone glass tape, 65 mil Exane jacket, rated 600 volts, cable diameter 0.455".



## Test Scope

The three tests performed by Sandia were composed of two sequential and one simultaneous exposure to LOCA environments. In each case the equipment was exposed to radiation and thermal aging prior to operating under the simulated LOCA conditions. Figures 1 and 2 describe the test profiles for sequential and simultaneous tests respectively (Sandia tests were designed to study synergistic effects). Each of the tests satisfy the intent of IEEE 323-1974. The assemblies were electrically loaded to 20 amperes and 600 volts at the start of the tests. Insulation resistance and capacitance measurements were recorded during the tests to indicate damage.

The equipment assemblies with respect to the sequential and simultaneous tests performed were as follows:

### 1. Sequential Tests (Two)

Gulton Connector/ITT Cable	1 Assembly
Gulton Connector/Anaconda Cable	1 Assembly
Bendix Connector/ITT Cable	2 Assemblies
ITT Connector/ITT Cable	1 Assembly

### 2. Simultaneous Test (One)

ITT Connector/ITT Cable	1 Assembly
Bendix Connector/ITT Cable	1 Assembly
Bendix Connector/Anaconda Cable	2 Assemblies

## Test Results

Both ITT Cannon connector assemblies and both Gulton connector assemblies showed almost immediate damage in terms of insulation resistance and capacitance as the 70 psig steam was applied.

The ITT Cannon connector assembly failures appeared to be back plane boot seal leakage failures. The assembly construction did not contain potting compound (by design) to protect the pin backs. Therefore, boot failure leads directly to connector failure.

In the case of the Gulton Assemblies, failures were attributed to both the mating surface interface and the back plane seal. The design uses a rigid insert around the mating pins and the O-ring seals are

bypassed by an alignment key slot. This design may lead to leaks due to non-uniform confinement of the O-ring which could cause arcing between pins. Neutron radiography revealed inadequate amounts of potting compound (voids) and cracking of potting compound. These conditions could account for back plane failures. Neutron radiography performed on untested connectors revealed similar conditions, i.e., voids and cracking, thus indicating an apparent quality control problem at Gulton's facility. Other problems detected were identified as:

1. The shrink tube used over the pin cable interface was split length-wise and had pulled away.
2. The potting material showed virtually no adhesion to, or sealing between, the cable jacket, insulation, and the connector shell.
3. The mechanical clamp had been secured so tightly that it cut the cable jacket.

The Bendix connector assembly was the only type to survive an entire test cycle. One Bendix/Anaconda assembly malfunctioned after about eight days into the 10 psig profile and the Bendix/ITT assembly experienced decreasing resistance and increasing capacitance through the simultaneous tests until both readings were off scale at the end of the 10 psig profile. A second Bendix/Anaconda assembly survived the simultaneous tests. During the sequential tests only Bendix and ITT Cannon assemblies were involved and both assemblies failed. The failures of these assemblies would be difficult to define as either connector or cable failures. The ITT cable exhibited a shrinking characteristic which could have provided a leak path through the sealing medium of the connector.

# SEQUENTIAL TEST PROFILE

PHASE I PHASE II

PHASE III

AGING

LOCA SIMULATION

ELECTRICAL  
LOADING

RATED RATED

RATED

RADIATION/  
DOSE RATE

NONE 200MR  
NR/HR

NONE

CHEMICAL  
SPRAY

NONE NONE

CHEMICAL SPRAY  
24 Hours

157°C/70 PSIG/100%

140°C/40 PSIG/100%

129°C/25 PSIG/100%

113°C/10 PSIG/100%

TEMPERATURE/ 130°C/  
PRESSURE/ 0 PSIG  
REL HUMIDITY Ambient

Ambient

END OF TEST

24 HRS

30 MINS

10 DAYS

30 MINS

4 DAYS

30 MINS

6 HRS

30 MINS

3 HRS

10 SECS

2 HRS

3 HRS

10 SECS

8-1/3 DAYS

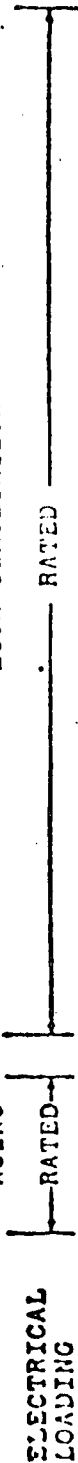
5 DAYS

Figure 1

# SIMULTANEOUS TEST PROFILE

## PHASE I

### AGING



## PHASE II

### LOCA SIMULATION

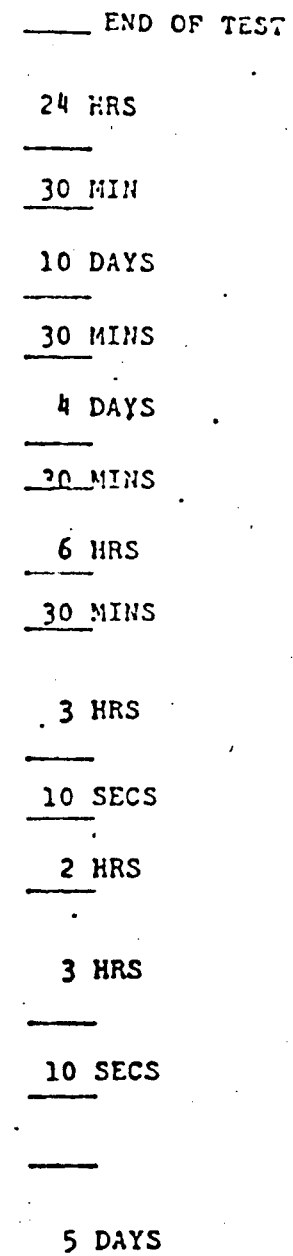
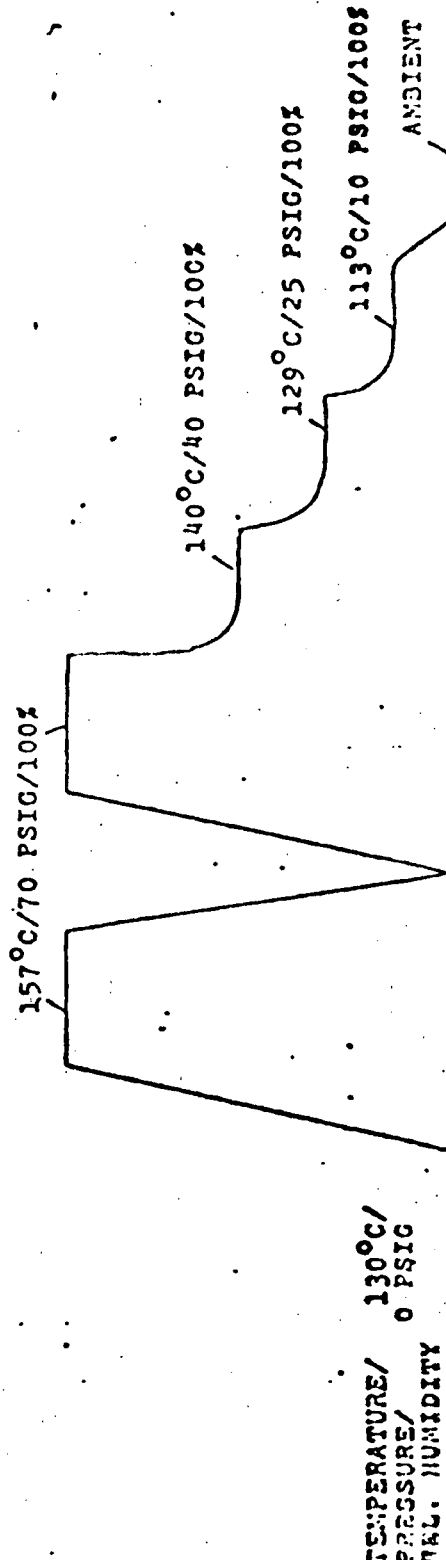
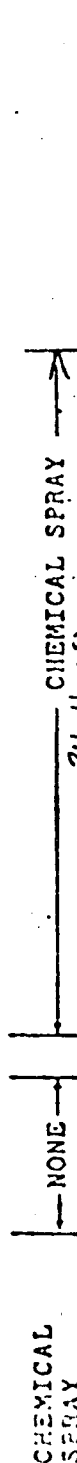
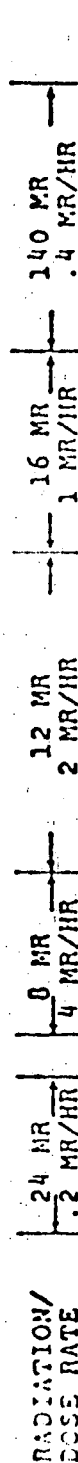
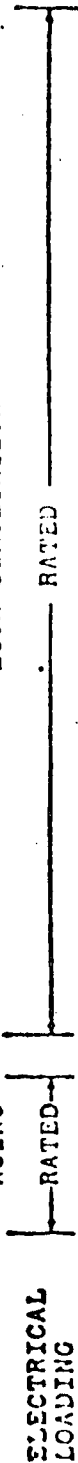


Figure 2

IE Bulletin 77-05  
November 8, 1977

LISTING OF IE BULLETINS  
ISSUED IN 1977

Bulletin No.	Subject	Date Issued	Issued To
77-04	Calculational Error Affecting the Design Performance of a System for Controlling pH of Containment Sump Water Following a LOCA	11/4/77	All PWR Power Reactor Facilities with an Operating License (OL) or Construction Permit (CP)
77-03	On-Line Testing of the W Solid State Protection System	9/12/77	All W Power Reactor Facilities with an Operating License (OL) or Construction Permit (CP)
77-02	Potential Failure Mechanism in Certain W AR Relays with Relays with Latch Attachments	9/12/77	All Holders of Operating Licenses (OL) or Construction Permits (CP)
77-01	Pneumatic Time Delay Set Point Drift	4/29/77	All Holders of Operating Licenses (OL) or Construction Permits (CP)

Enclosure 2  
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NUCLEAR REGULATORY COMMISSION  
OFFICE OF INSPECTION AND ENFORCEMENT  
WASHINGTON, D. C. 20555

November 14, 1977

IE Bulletin 77-05A

ELECTRICAL CONNECTOR ASSEMBLIES

Description of Circumstances

This Bulletin is a supplement to IE Bulletin 77-05, issued November 8, 1977, and the two documents should be considered together.

Bulletin 77-05 described the failure, under test conditions, of a general type of electrical connector. The tests were intended to simulate post-LOCA conditions, therefore the action requested in the Bulletin focussed on the qualification of electrical connectors for use inside containment.

Since issuance of Bulletin 77-05, our attention has been called to circumstances which indicate that the scope of the action requested should be expanded and therefore the response to Bulletin 77-05 should reflect the expanded scope.

Electrical connectors should be qualified to perform their intended function after having been subjected to accident conditions if they are contained in a system whose function is to mitigate that accident.

The location of the connectors that must be qualified is not limited to those inside containment.

Action To Be Taken By Licensees and Permit Holders:

1. Actions requested by Bulletin 77-05 should be expanded to include all connectors in safety systems which are required to function to mitigate an accident where the accident itself could adversely affect the ability of the system to perform its safety function. The examination is not to be limited to only LOCA's nor to areas only within containment.
2. Responses should be provided within 30 or 60 days, as appropriate, of the date of this supplement.

Approved by GAO, B180225 (R0072); clearance expires 7-31-80. Approval was given under a blanket clearance specifically for identified generic problems.