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Waterford 3

W3F1-2001-0012
A4.05
PR

July 26, 2001

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Subject: Waterford 3 SES
Docket No. 50-382
License No. NPF-38
Appendix R Deviation Request

Gentlemen:

Entergy is hereby submitting a request for NRC Staff review of and concurrence with an existing deviation from Appendix R requirements associated with control circuit isolation between the Control Room and the Remote Shutdown Panel (LCP-43). During NRC Baseline Triennial Fire Protection Inspection IR-2000-07, conducted at Waterford 3 on September 25 – 29, 2000, it was determined that the deviation, which had been evaluated by Entergy in February of 1997 (CR-WF3-1997-0477), had not been submitted to the NRC for concurrence. Entergy evaluated the deviation in 1997 relative to NRC Information Notice 97-01, "Improper Electrical Grounding Results in Simultaneous Fires in the Control Room and the Safe-Shutdown Equipment Room". The failure to submit the deviation to the NRC Staff has been evaluated in Waterford 3's corrective action program (CR-WF3-2000-1170). Back in 1997, Engineering had determined that no conditions, associated with the deviation, existed that would prevent the plant from achieving and maintaining safe shutdown in the event of a Control Room fire.

Since May of 2000, Waterford 3 has been in the process of reviewing and revalidating the Waterford 3 fire protection safe shutdown analysis. Considering the low safety significance determined to be involved with the subject Appendix R deviation and based on the potential for observations made during the revalidation effort to affect the Appendix R deviation evaluation, the decision was made to complete the safe shutdown revalidation effort prior to submitting the Appendix R deviation request to the NRC. Extension of the submittal time frame was discussed

A006

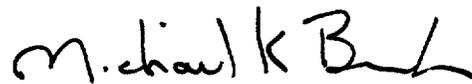
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with NRC Staff and agreement was reached to proceed in that manner. The revalidation effort is now essentially complete.

The attached engineering evaluation (ER W3-00-0817-00-01) documents the acceptability of the deviation.

There are no commitments contained in this submittal. If you have any questions, please contact O. Pipkins at (504) 739-6707.

Very truly yours,



For

A.J. Harris
Director
Nuclear Safety Assurance

AJH/OPP/cbh
Attachment

cc: E.W. Merschoff, NRC Region IV
N. Kalyanam, NRC-NRR
J. Smith
N.S. Reynolds
NRC Resident Inspectors Office

**ATTACHMENT
TO
APPENDIX R DEVIATION REQUEST**

ENGINEERING EVALUATION

ER-W3-00-0817-00-01

ER RESPONSE Sheet

ER No.: ER-W3-00-0817-00-01

Date Accepted: 7/20/01

Page 1

Title: Neutral wire in the Control Room during a fire event.

ER RESPONSE ASSIGNMENT

Assigned Dept: D. E. Electrical/I&C

Project Scope Req'd: YES N/A

Responsible Supv: MATHARU, GS

PRC Appl Req'd: YES N/A

Responsible Engr: MATHARU, GS

ENGINEERING REVIEW SCREEN/ER RESPONSE

<p>Response Type</p> <input checked="" type="checkbox"/> Engineering Reply <input type="checkbox"/> Administrative Change <input type="checkbox"/> Commercial Change <input type="checkbox"/> Engineering Eval. <input type="checkbox"/> Nuclear Change	<p>QA Special Scope Impact</p> <input type="checkbox"/> ALARA/Rad Protection <input type="checkbox"/> ATWS <input type="checkbox"/> Computer Support <input type="checkbox"/> E Plan <input type="checkbox"/> Fire Protection <input type="checkbox"/> Rad Effluent/Env Mon <input type="checkbox"/> Rad Waste Mgmt <input type="checkbox"/> SBO <input type="checkbox"/> Security	<p>Programs Impact</p> <input type="checkbox"/> App J <input type="checkbox"/> Check Valve <input type="checkbox"/> Environ Qual <input type="checkbox"/> FAC <input type="checkbox"/> FP/Safe Shutdown <input type="checkbox"/> Human Factors <input type="checkbox"/> ISI <input type="checkbox"/> IST Program <input type="checkbox"/> Lift Rig <input type="checkbox"/> Lubrication <input type="checkbox"/> Metallurgy <input type="checkbox"/> MIC <input type="checkbox"/> MOV/AOV <input type="checkbox"/> Reactivity Mgmt	<input type="checkbox"/> Repetitive Tasks <input type="checkbox"/> Reg Guide 1.97 <input type="checkbox"/> SA Groundrules <input type="checkbox"/> Seismic (incl II/I) <input type="checkbox"/> Simulator <input type="checkbox"/> Welding	
<p>SSC Classification</p> <input checked="" type="checkbox"/> Safety Related <input type="checkbox"/> Nonsafety Related	<p align="center">Discipline/External Organization Impact</p> <input type="checkbox"/> DE Civil/Struct/App Mech <input checked="" type="checkbox"/> DE Electrical <input type="checkbox"/> DE I & C <input type="checkbox"/> DE Mechanical <input type="checkbox"/> DE Procurement <input type="checkbox"/> DE Safety Analysis <input type="checkbox"/> Chemistry <input checked="" type="checkbox"/> Comp/Prog. Engr			<input type="checkbox"/> Config. Mngt. <input type="checkbox"/> Construction <input type="checkbox"/> Maint, Elect <input type="checkbox"/> Maint, I & C <input type="checkbox"/> Maint, Mech <input type="checkbox"/> Maint Rule Coord <input type="checkbox"/> MP & C <input type="checkbox"/> Operations
<p align="center">Licensing Impact</p> <input type="checkbox"/> Commitments <input type="checkbox"/> FSAR <input type="checkbox"/> Tech Spec <input type="checkbox"/> TRM		<input type="checkbox"/> P & S <input type="checkbox"/> Pri/Sec Depts. <input type="checkbox"/> Project Mngt <input type="checkbox"/> QA/QC <input type="checkbox"/> Reactor Engr <input type="checkbox"/> Safety <input type="checkbox"/> Systems Engr <input type="checkbox"/> Training		
<p align="center">Field Implementation</p> <input type="checkbox"/> Initiate Document Update Upon Implementation <input type="checkbox"/> Field Engineering Required for Implementation <input type="checkbox"/> Field Work Required (ICN Required)				

Resolution: (Attach additional sheets as required)

<<<< SEE ATTACHED >>>>

Print Name, Sign & Date	Print Name, Sign & Date
RE: MATHARU, GS <i>S Matharu</i> 7/20/01	Support Engr: TRAN
Support Engr: BECKER <i>Becker</i> 7/20/01	Support Engr:

ER RESPONSE REVIEW

Indicate Type	Print Name, Sign & Date
Design Verification	Ricky Tran <i>Rtran</i> 7/20/01

ER RESPONSE APPROVAL

<input checked="" type="checkbox"/> Eng. Supervisor/Date: MATHARU, GS <i>S Matharu</i> 7/20/01	<input checked="" type="checkbox"/> Eng. Manager/Date: GROPP, P <i>P Gropp</i> 7/23/01
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R Type:

OBSERVATION DESCRIPTION

During the NRC inspection of Appendix "R" compliance at Waterford conducted in September 2000, it was observed that some control wires required for safe shutdown during a Control Room fire do not have the neutral (ground wire) isolated from the fire zone. There was a concern that a spurious 'hot short' from a high energy wire could potentially burn out the neutral or ground wire such that the circuit from the Remote Shutdown Panel maybe rendered inoperable.

CONCLUSION

NRC Information Notice 97-01 identified a concern of improper grounding resulting in simultaneous fires in the control room and safe shutdown equipment room. In response to this IN, Waterford 3 initiated CR-97-0477. This Condition Report reviewed the concerns addressed in the IN and analyzed the issue related to the neutral wire not being isolated from the Control Room. The Condition Report concluded that the safe shutdown neutral wires would not be damaged due to spurious hot shorts in the Control Room.

This analyses supplements the CR-97-0477 response by extending the review for #16 AWG. *A sample survey of the safe shut down circuits did not identify any #16 wire in the neutral circuits.* However, this size wire has been installed in the control panels and a conservative approach is taken for this concern.

A sample review of various safe shutdown circuits reveals that only the neutral wires for indication lamps at the control room panels are not isolated. The neutral wires for loads other than indication lamps are completely isolated from the control room. Figure 1 depicts this configuration. The analyses has concluded that a spurious hot short on the ground conductor of a safe shut down circuit, required for operation from LCP 43, will not result in burn out of the conductor nor spuriously actuate any safe shutdown loads. This review considered the possible power sources that are available in the safe shutdown associated panels in the Control Room/Cable Vault/LCP 43 areas and analyzed the potential short circuit current that will be available. This value was compared to the protective characteristics of the largest fuse or breaker in the circuit supplying the short circuit current. In all cases, the protective device (located outside the fire area) will trip prior to the safe shutdown conductor reaching its melting temperature. The analyses was conservatively performed for a #16 AWG copper conductor though the neutral wire for the circuits in question is a #14 AWG with a higher current carrying capacity.

EVALUATION

A search of PDMS (ref.1).indicated that there were no cables with voltage levels higher than 120V AC or 125 V DC found in the cable vault area. As this fire area also requires evacuation of the Control Room, this evaluation and conclusions are also applicable for a fire in the cable vault area.

A search of PDMS did not reveal any medium voltage (480V or higher) cables in LCP 43, the remote shutdown panel room. The evaluation is also applicable to this area.

A search of power cables entering the Control Room (CR) areas was performed using the PDMS . The results indicated that the only two sets of 480V (or higher voltage) cables penetrating the CR boundary are those associated with electric heating coils (EHC) 23 and 24 for the Control Room HVAC system. These cables are 31211A and 31212A and are routed in conduits buried in the concrete roof of the CR. They drop into the control panels for the heating coils located in the ductwork above the false ceiling.

There is no potential for these cables to come in contact with the safe shutdown related control panels in the event of a fire.

Power cables associated with the 120V AC and 125V DC lighting systems are routed in conduits above the false ceiling and lead to lighting panels mounted remote from the safe shutdown control panels. These cables will not come in contact with safe shutdown panels in the event of a fire. Hence, the only source for hot shorts to the neutral (or ground) wires of safe shutdown related circuits (not isolated from the CR) are the 120V AC and 125V DC control cables from non-safe shutdown circuits.

The field run control cables connecting components between control power source, auxiliary panels and control devices in the CR are #14 AWG conductor (ref. 7). The wiring within some panels was specified to be a minimum of #16 AWG conductor. The potential for spurious "hot shorts" exists with field run #14 AWG wire used to ground the return path. Several circuits (e.g. dry cooling tower fans) that do not have an isolation contact in the ground leg have #14 AWG wire. Though there were no circuits with #16AWG conductor identified as lacking in isolation, this evaluation considers the potential impact on #16 AWG conductor as the limiting case.

Each division of equipment (A, B, AB and non-safety) has three types of power sources entering the CR panels. There is physical separation between the different divisions and therefore, it is not conceivable for a spurious hot short between divisions (Reg. Guide 1.75 requirements). The following discussion is applicable regardless of this separation. The 'A' train cables are considered for discussion (see Figure 1).

The short circuit calculation is usually performed to ensure that the conductor size is large enough to carry the short circuit current for a sufficient length of time to permit the protective devices to open before the conductor is heated to the point where it damages the insulation. A conductor temperature of 250⁰ C is considered the maximum sustainable temperature for insulation protection (ref. 2). In the particular application at Waterford, the concern is not related to insulation damage, but to conductor melting and isolating the ground path for the circuit for LCP 43. Hence the melting point of copper conductor is the limiting case. (It should be noted that the current carrying capability of termination lugs is much higher than the wire. The wire is therefore the limiting case). The copper melting temperature is 1981⁰ F or 1083⁰ C (ref. 2 page 8). The following formula can be used to calculate the maximum current that can be carried by the conductor prior to reaching the melting point.

$$(I/A)^2 t = 0.0297 \log ((T_2 + 234) / (T_1 + 234)) \text{ (ref. 2 page 14)}$$

Where:

- I = Short Circuit Current in Amperes
- A = Conductor Area in circular Mills = 2580 for #16 and 4110 for #14 (ref. 2 page 1)
- t = Time of short circuit in seconds
- T₁ = Operating temperature = 90⁰ C
- T₂ = Maximum Short Circuit Temperature = 1000⁰ C (approx. for conservatism)

For t = 0.5 sec. (30cycles) the equation simplifies to

$$(I/A)^2 = 0.0345$$

$$(I/A) = 0.1857$$

This yields a fault current carrying capability of 479A for a #16 AWG conductor and 763A for a #14 conductor. ... (1)

For t = 0.25 sec. (15 cycles) the equation simplifies to

$$(I/A)^2 = 0.0690$$

$$(I/A) = 0.2627$$

This yields a fault current capability of 678A for #16 AWG and 1080A for #14 AWG conductor.

.....(2)

(Note, the high magnitude of the short circuit currents, postulated for wire damage, is in the instantaneous region of the protective devices. Typical clearing time for a protective breaker is less than 5 cycles in the instantaneous operating zone. Fuses can operate in less than 3 cycles. The calculations above provide a margin of 300% -600% for operating time)

CASE 1 125V DC SYSTEMS

The 125V DC system is ungrounded and the current path can only be completed when the conductors form a complete circuit to the terminals of the same battery. (See cable 3ADCUG in Figure1). The largest breaker at the DC PDP is rated at 70 amps for the circuits related to switchgear control power. However, the largest fuse in the DC circuit, in series with this breaker, feeding the unique circuit is rated 35 amps (BUSSMAN type NOS-35). This fuse will interrupt a fault current of 200A in less than 0.4 second (max.) and 300A in less than 0.05 second (max.). These fault currents are well within the calculated current values in (1) above.

It can also be observed from Figure 1, (attached), that the positive wire from cable 3ADCUG (or combination of positive wires from other battery systems), making contact with the ground wire of cable 3ACGSD, will not result in any current flow in the grounded lead of the safe shutdown cable 3ACGSD as the circuit to the ungrounded negative is not complete. The same logic applies for the negative wire(s) from cable 3ADCUG.

A combination of multiple hot shorts can result in short circuit current flow when the negative and positive wires from the same battery system come in contact. In this case, if there is simultaneous contact with the safe shutdown conductor, the current will flow only in the DC conductors and the protective fuses will clear the fault. The AC ground wire is not involved in this configuration. A combination of multiple spurious actuations may result in a ground fault in the DC conductors in the Control Room. This may involve the ground conductor of cable 3ACGSD for return path. In this case the fuses in the DC system will function to protect the wires.

CASE 2 UNGROUNDED 120V AC SYSTEMS

This system consists of the loads supplied by the Static Uninterruptible Power Supplies or SUPS. The postulated fault combinations are similar to case 1 discussed above. The largest breaker on the safety related SUPS distribution panels is a 60A Heinemann type CD with trip characteristics similar to curve 30 (ref. 6). The maximum delay times for tripping at various overcurrent values are as follows:

Current (Amps)	Max. Time (sec.)	Min time (sec.)
60	no trip	no trip
75	6.4	0.70
120	0.74	0.10
240	0.16	0.045

There are 20A Heinemann breakers, type CD with tripping characteristics similar to curve 2 (time delay). For a fault current of 120A, this breaker trips in a maximum time of 0.64 seconds. For a current of 160A, the breaker trips in 0.19 seconds.

It can be seen from the above values that the high short circuit current, required to damage the ground conductor of the safe shutdown cable will be cleared by the breaker prior to the wire melting. Hence, the safe shutdown conductor is protected.

CASE 3 GROUNDED 120V AC SYSTEMS

A positive wire from one of these circuits making contact with the safe shutdown ground wire will result in current flow through the 'new' circuit.

The majority of these types of circuits involve control power from a Motor Control Center circuit with a control transformer and a fuse in series. A size 5 starter is selected as an example as it has the largest control transformer rated at 350VA. (E.g. MCC 317B and breaker CCS-EBKR-317B-3M for Containment Fan Cooler AH-1 (ref. 5 B-424 sheet 1135). This control circuit has approximately 3 amp current at rated load. The fuse associated with this control circuit is rated at 6A and would be a BUSSMAN or GOULD with one of the following model #s, OTM6, ATM6, A6Y6, BAN6, or KTK6 (ref.14). These small fuses will isolate the fault current prior to wire damage.

Power supplies for solenoid operated valves have 5A breakers protecting the circuit. The thermal/magnetic tripping elements of these small breakers will isolate the fault current prior to wire damage. A typical 5A breaker will operate for a fault current less than 30A in the instantaneous region.

A sample survey of 120V AC power circuits emanating from 120V AC emergency Distribution Panels did not identify a direct feed to the Control Room Shutdown Panels. These circuits were reviewed as part of CR-97-0477. The evaluation concluded that safe shutdown circuits would not be damaged by this source.

2.0 REFERENCES

- 1 Waterford 3 database for Cable and Conduit details (PDMS)
- 2 OKONITE Bulletin EHB-88 "Engineering Data For Copper and Aluminum Conductor Electrical Cables
- 3 Waterford 3 Design Criteria EC-E89-008
- 4 IEEE S – 135 (IPCEA Pub. No. P-46-426) Volume 1 Copper Conductors
- 5 Waterford 3 Control Wiring Diagrams (B424 series)
- 6 Waterford 3 Power Distribution Panel Details (B289 series)
- 7 EBASCO Specification 1564-267 –Power and Control Cables.
- 8 EBASCO Specification 1564 415 D & E Auxiliary Panels.
- 9 ASM Metals Handbook
- 10 National Electric Code
- 11 Bussman Fuse Catalog
- 12 Vendor Drawing 1564-4263 for GE Switchgear
- 13 Vendor Technical Manual 457000956 Volume 1 Heinemann Breakers.
- 14 Waterford 3 Fuse Data Base
- 15 Condition Report 97-0477

Figure 1: Associated Circuits in Control Room Panels

