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Waterford 3

W3F1-2003-0007
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PR

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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
Supplemental Information

Gentlemen:

Entergy is hereby submitting supplemental information in support of Entergy request letter W3F1-2001-0012, dated July 26, 2001. That earlier submittal requested NRC Staff review of and concurrence with an existing deviation from Appendix R requirements at Waterford 3 associated with nonisolation of control circuit neutral wires between the Control Room and the Remote Shutdown Panel (LCP-43). The additional information being provided herein is in connection with the conference call, held on January 16, 2003, between Waterford 3 personnel and members of your staff. The purpose of that conference call was to discuss the technical aspects of the deviation request and to answer the NRC reviewer's questions. The original submittal included technical justification for acceptability of the request in an attached engineering evaluation. Subsequent to the conference call, the original engineering evaluation was revised to document clarifications provided verbally during the conference call. The revised engineering evaluation (ER-W3-2000-0817-001-00) is attached. The only material change to the original engineering evaluation is the inclusion of a new Section 4.0 (Supplemental Information).

A006

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

Very truly yours,

K.J. Peters
Director, Nuclear Safety Assurance

KJP/OPP/cbh
Attachment

cc: E.W. Merschoff, NRC Region IV
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NRC Resident Inspectors Office

**ATTACHMENT**

**TO**

**APPENDIX R DEVIATION REQUEST**

**SUPPLEMENTAL INFORMATION**

**SUBMITTAL**

**W3F1-2003-0007**

**ENGINEERING EVALUATION**

**ER-W3-2000-0817-001-00**

## 1.0 OBSERVATION DESCRIPTION

During the NRC audit of Appendix "R" compliance at Waterford, it was observed that some control wires required for safe shutdown during 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 was rendered inoperable.

## 2.0 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 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.

## 3.0 EVALUATION

A search of power cables entering the Control Room (CR) was performed using the PDMS (ref.1). 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 conductors (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).
*(* See supplemental discussion in section 4)*

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 $250^0$ 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 $1981^0$ F or $1083^0$ 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.

$(I/A)^2\ t = 0.0297\log((T_2 + 234) / (T_1 + 234))$ (ref. 2 page14)

Where:
I = Short Circuit Current in Amperes
A = Conductor Area in circular Mils =2580 for #16 and 4110 for #14 (ref. 2 page 1)
t = Time of short circuit in seconds

$T_1$ = Operating temperature =$90^0$ C
$T_2$ = Maximum Short Circuit Temperature = $1000^0$ 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.

## 4.0 SUPPLEMENTAL INFORMATION

The evaluation discusses the consequences of non safe shut down related *aggressor* cables on a generic bases irrespective of the safety (or non safety) division (or train) that may be the source. As the evaluation enveloped ALL circuits, a detailed circuit by circuit analysis of the safe shutdown cables was not necessary.

Waterford 3 is designed in compliance with Regulatory Guide 1.75, 'Physical Independence of Electrical Systems, Revision 1, January 1975', whereby, train separation is maintained between redundant safety related raceways and between safety and non safety related raceways. The potential 'hot shorts' on the neutral wires, not isolated from the control room, are postulated to occur from the adjacent cables in the raceways. It is not conceivable for 'cross' train cables to be 'live' and make contact with the neutral wire of a safe shutdown circuit through separation barriers or across separation distance as required by Regulatory Guide 1.75.

At Waterford 3, the equipment required for post control room fire and safe shut down from the remote shut down panel (LCP 43), is a sub set of the safety related equipment*. The cables for each safe shutdown division are safety related and maintain separation from non safety related raceways. Only the "B" train 1E equipment is required for safe shut down post fire in the control room. For this case, the potential aggressor circuits for hot shorts on safe shut down circuits are other class 1E 'B' train cables (associated by raceway) that are not isolated from the control room. All the safety related circuits of this train are protected by Class 1E breakers and fuses.

The above analysis relies on the appropriate molded case circuit breakers and fuses, operating as designed, to clear the respective fault current. The breakers and fuses were procured for safety related applications and are maintained by existing Waterford 3 procedures:

- UNT-005-025 Administrative Procedure, Fuse Control Program.
- ME-003-315 Surveillance Procedure Molded Case Circuit Breakers.

This provides assurance that the breakers will perform as desired.

The issues discussed in section 4 above address low voltage control and power circuits. The switchgear breakers are not discussed in this section as they protect medium and high voltage circuits. These circuits were eliminated per the evaluation in section 3 above.

*It should be noted that the Waterford 3 strategy for control room fire includes some enhancements that are NOT 'B' train or NOT safety related circuits. These enhancements are NOT essential for safe shutdown:

1. Manual operation of some breakers that are non safety related. The actions are taken to protect non essential equipment from spurious actuations due to hot shorts. These non safety circuits are run in non safety raceways and are not considered further.

2. Power from a 'B' train uninterruptible power supply (UPS) transformer has been made available (with adequate separation/isolation) to a local control panel LCP 61. This power source and the panel are independent of the control room and cable vault areas. The enhancement provides control power to logic for 'A' train emergency feedwater valves such that both steam generators are available for decay heat removal. For Waterford 3, one steam generator with one set of 'B' train valves is adequate for decay heat removal.

3. Pressirizer heaters ('B' train) are available from LCP 43 to support shutdown. These heaters are not safety related, but the control circuits, including the neutral wire, are isolated from the control room in the event of a control room fire. These circuits are protected from the fire and will not get damaged by other non safety related cables in the raceways.

## 5.0 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
16 UNT-005-025 Administrative Procedure, Fuse Control Program.
17 ME-003-315 Surveillance Procedure Molded Case Circuit Breakers.
18 ECF-00-026 Post Fire Safe Shutdown Analysis

**Figure 1: Associated Circuits in Control Room Panels**