



ENGINEERING STUDIES, ANALYSES,  
AND EVALUATIONS COVERSHEET

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| QUALITY LEVEL                              | ER/CTM NO. -       |
| <input checked="" type="checkbox"/> SAFETY | SEA NO. SEA-EE-184 |
| <input type="checkbox"/> ASME              | DGP NO. -          |
| <input type="checkbox"/> OTHER             | PAGE 1 OF 11       |
| <input type="checkbox"/> NON QUALITY       |                    |

EVALUATION OF UNIT 1 ANNUNCIATOR

CLASS 1E - NON-CLASS 1E

INTERFACES

DCCL5.0-A REV. 1

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|--------------|--------|-------------------|------------------|-----------------|
| 1            | 5/3/90 | g.p. arun 4/19/90 | AFS lra 5/1/90   | P.W.B. 11/15/89 |
| 0            |        | g.p. arun 11/7/89 | AFS lra 11/14/89 | J. 11/15/89     |
| REVISION NO. | DATE   | PREPARED BY       | REVIEWED BY      | APPROVED BY     |

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EVALUATION OF UNIT 1 ANNUNCIATOR CLASS 1E - NONCLASS 1E

INTERFACES

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APPENDIX A - ANNUNCIATOR INPUT DATA.

APPENDIX B - ANNUNCIATOR POINTS - INTERFACE DEVICES USED FOR CLASS 1E CIRCUITS.

APPENDIX C - ANNUNCIATOR POINTS - INTERFACE DEVICES USED FOR ALARM AND INDICATION ONLY.

APPENDIX D - ANNUNCIATOR POINTS - CUTLER-HAMMER ARMED PUSH BUTTON.

APPENDIX E - ANNUNCIATOR POINTS - AFFILIATED CIRCUITS.

|          |   |
|----------|---|
| 1        | PLACED HV-E41-1F075 AND HV-E41-1F079 IN GROUP 2 SINCE ANN. LIMIT SWITCHES ARE NOT EXPOSED TO POTENTIAL WELDING DURING NORMAL PLANT LINE-UP. |
| REVISION | DESCRIPTION   |



## 1.0 SCOPE

The purpose of this SEA is to determine the failure modes of the Class 1E - nonClass 1E interface devices used as Unit 1 annunciator inputs and evaluate the affects of these failures on the Class 1E circuits connected to the interface devices. The concern is that the failure of the Class 1E - nonClass 1E interface devices could prevent the Class 1E circuits from meeting their minimum performance requirements.

## 2.0 CONCLUSIONS AND RECOMMENDATIONS

### 2.1 CONCLUSIONS

The open contacts of all Class 1E - nonClass 1E Unit 1 annunciator interface devices are able to withstand the specified impressed voltage across the contact without causing loss of operability of the devices. In other words, these interface devices will not fail in such a manner as to prevent the Class 1E circuits from meeting their minimum performance requirements if 120V AC or 250V DC is spuriously impressed on the open contacts utilized in the Annunciator System. However, the specified impressed voltages across annunciator input closed contacts could weld contacts closed if sufficient current flowed for a sufficient duration.

Analysis of the Class 1E - nonClass 1E Unit 1 annunciator interface devices, except for the HV-151-F007A and HV-151-F007B limit switches, shows that these devices will meet their minimum performance requirements even if the annunciator input contact should perhaps weld shut. This conclusion is based upon the evaluation of the installed Class 1E - nonClass 1E devices that shows:



-- The interface devices change position and meet their minimum performance requirements before the annunciator contacts are exposed to potential contact welding.

#### OR

-- The interface devices are used for alarm and indication only and contacts from these devices are not used in Class 1E circuits.

#### OR

-- The interface devices meet their minimum performance requirements even with annunciator input contacts welded shut.

1 2 3 4 5 6 7 8 9 10



1

2

3

4

OR

-- The interface devices are in affiliated (associated) circuits and contacts from these devices are not used in Class 1E circuits.

In the event annunciator input limit switches for HV-151-F007A and HV-151-F007B weld shut, the limit switch main drive shafts could perhaps break loose internal to the valves causing the valves to jam, thus potentially preventing full closure of the valves. More than likely the welded shut limit switches would cause damage to the limit switch gearing, but would not prevent the subject valves from closing.



2.2 RECOMMENDATION

To assure that the HV-151-F007A and HV-151-F007B valve annunciator input limit switches do not weld shut, qualified Class 1E - nonClass 1E isolation devices are to be installed in the annunciator input limit switch circuits from these valves. The circuit design should be such that the limit switches actuate the Class 1E - nonClass 1E isolation devices with contacts from these devices used as annunciator inputs. This prevents the annunciator input limit switches from welding shut for the specified impressed voltages on the annunciator input cables. This action will be tracked by NCR 87-0021.



In order to preclude the need for future engineering analysis and maintain compliance with Regulatory Guide 1.75, Qualified Electrical Isolators, capable of withstanding 120V AC and 250V DC, should be installed for newly-engineered annunciator inputs developed from Class 1E devices. Also Qualified Electrical Isolators should be installed for existing annunciator inputs when modifications to existing Class 1E - nonClass 1E annunciator interface devices are performed. This recommendation is in-line with NPE-Electrical Group strategy of eliminating potential pitfalls for maintaining compliance to the plant licensing commitments.

This recommendation will be included in the Design Description Manual, Chapter 29 for the Computer/ACR and E1012, "Specification of Electrical Separation."

3.0 INPUTS AND ASSUMPTIONS

3.1 INPUTS

At Susquehanna SES, all annunciator input circuits are nonClass 1E. A large number of these inputs are developed from Class 1E devices.





An exception to Regulatory Guide 1.75, which endorses IEEE 384-1974, and as discussed in FSAR Section 8.1.6.1q(7), allows the connection of low-energy nonClass 1E circuits to Class 1E devices provided an analysis has been performed to demonstrate that the Class 1E circuits are not degraded below an acceptable level for faults on the nonClass 1E circuits.

Annunciator cables are routed in nonClass 1E raceways which also contain 120V AC, 125V DC and 250V DC cables. Potential damage to cables in nonClass 1E raceways may cause accidental imposition of 120 volts AC or 250 volts DC on annunciator input wire(s), and through these wires to the Class 1E device(s).

Both open contacts and closed contacts of the Class 1E - nonClass 1E annunciator interface devices are to be evaluated.

The study is limited to digital annunciator inputs in the Unit 1 Alarm Response Procedures listed in Table A.

### 3.2 ASSUMPTIONS

The study was based on as-built drawings and the documents issued as of the date of task initiation.

Affiliated circuits in this study were treated the same as Class 1E circuits.

A change in state of a annunciator input contact while there is an impressed voltage was not considered. Only the contact in the open or closed position was analyzed.

### 4.0 METHOD

All annunciator inputs listed in the "Table A, Unit 1 Alarm Response Procedures" were examined to identify the system drawings and documents required for detail review.

All of these drawings and documents were reviewed to determine which annunciator inputs are derived from the Class 1E devices and which are derived from nonClass 1E devices. The results of this review are listed in the Annunciator Input Data Tables shown in Appendix A. The tables also include the information on related reference drawings, device tag numbers and locations.

The Class 1E devices were sorted to determine identical devices such as relays, limit switches, contactors, etc. Each device rating, type, manufacturer and model number was identified and documented in the Annunciator Input Data table.

The function and operation of all Class 1E devices was analyzed in order to evaluate the impact of possible device failure on Class 1E circuits.

Evaluation of the failure modes was performed for each Class 1E device, based on the possibility of accidental imposition of 120V AC or 250V DC on annunciator input wires.

The Class 1E - nonClass 1E interface devices were reviewed to determine if the contacts from these devices could perhaps weld shut during impressed voltage faults. For the Class 1E - nonClass 1E interface devices that may weld shut, evaluations were performed to assure that these devices can meet their minimum performance requirements.

## 5.0 RESULTS


Review of the Unit 1 Alarm Response Procedure in Table A revealed that there are the following twenty-nine (29) specific types of Class 1E - nonClass 1E annunciator input interface devices:

1. Westinghouse MOC Auxiliary Switch.
2. Limatorque Limit Switch.
3. NAMCO Limit Switch.
4. GE CR105 Magnetic Contactor.
5. GE HFA51 Relay.
6. GE HMA11 Relay.
7. Cutler-Hammer Reversing Contactor.
8. Cutler-Hammer Type "M" Relay.
9. Agastat EGP Relay.
10. Agastat E7024 Timing Relay.
11. Westinghouse High Speed AR Relay.
12. Magnetrol Model 751 Level Switch.
13. FCI Model 8-66 Liquid Level Controller.
14. Riley 86 T/C Monitor.
15. Potter & Brumfield KH-4690 Relay.
16. Bailey 745 Alarm Unit.
17. GE Type CR2940.
18. AGA Type TR.
19. Cutler-Hammer Type 10250T P.B.
20. Potter & Brumfield Type MDR.
21. GE Type 2820.
22. Westronics Recorder.
23. Barkadale Pressure Switch.
24. Static Inc. Pressure Switch.
25. Barton-Pressure Switch.
26. Square D Pressure Switch.
27. Square D Level Switch.
28. Balsbaugh-Conductivity TI
29. Potter & Brumfield Type KRP

All annunciator points, related reference drawings, device tag numbers and locations, device ratings, type, manufacturer and model numbers are listed in Appendix A.



In the case of accidental imposition of 120V AC or 250V DC on annunciator input wires due to possible cable failure, open contacts of all the identified Class 1E - nonClass 1E interface devices can withstand these impressed voltages.

Impressed voltages across closed contacts of these Class 1E - nonClass 1E interface devices could cause contacts to weld shut if sufficient current flowed for a sufficient duration. However, these Class 1E devices, except for HV-151-F007A and HV-151-F007B limit switches, will still meet their minimum performance requirements with the annunciator input contacts welded shut. Even the Westinghouse MOC auxiliary switches and the Namco limit switches used for annunciator input could weld shut for the specified impressed voltages since the #14 AWG copper conductors used to connect these switches to the annunciator may not melt open before the switches weld shut. This is due to the fact that the continuous thermal capability of these switches approach that of the #14 AWG conductors. | 

The annunciator points in Appendix B are initiated by Class 1E - nonClass 1E interface devices which also initiate Class 1E circuits. During normal plant operation, open contacts from these devices provide the annunciator inputs. For the annunciator input contacts to close the Class 1E - nonClass 1E interface devices have to change the state of their contacts. Once the contact state has changed, these devices have met their minimum performance requirements. Therefore, the Class 1E - nonClass 1E interface devices meet their minimum performance requirements before the computer input contacts are exposed to potential welding.

The annunciator points in Appendix C are initiated by Class 1E - nonClass 1E interface devices which are used for alarm and indication only. Contacts from these devices are not used in Class 1E circuits. Therefore, welded annunciator input contacts do not effect Class 1E circuits.

The annunciator points in Appendix D are initiated by Class 1E Cutler-Hammer armed push-button switches used to manually initiate safety systems. When these switches are changed to the armed positions, the annunciator contacts close, however, the safety systems have not been initiated. The potential welding shut of these annunciator input contacts do not prevent these switches from meeting their minimum performance requirements since the contacts initiating the safety systems are actuated by a push button rather than the roto cam mechanisms used for the annunciator contacts. The push-button action is independent from the roto cam action.

The annunciator points in Appendix E are initiated from interface devices in affiliated circuits. These devices are powered from Class 1E sources; however, contacts from these devices are not used in Class 1E circuits. Therefore, welding computer input contacts do not effect Class 1E circuits.



The Class 1E Limitorque limit switches that provide annunciator inputs are part of motor-operated valves which are in one of the following groups:

1. Require no automatic operation.
2. Require automatic closure.
3. Require automatic opening.
4. Require automatic operation.

The Class 1E motor-operated valves in Groups 1, 2 and 3 are:

| <u>No Automatic Operation</u> |               | <u>Automatic Closure</u> | <u>Automatic Open</u> |
|-------------------------------|---------------|--------------------------|-----------------------|
| HV-E11-1F004A                 | HV-151-F006A  | HV-149-F062              | HV-15703              |
| HV-E11-1F004B                 | HV-151-F006B  | HV-149-F084              | HV-15705              |
| HV-E11-1F004C                 | HV-151-F006C  | HV-E41-1F002             | HV-15711              |
| HV-E11-1F004D                 | HV-151-F006D  | HV-E41-1F003             | HV-15713              |
| HV-C41-1F006                  | HV-149-F060   | HV-E41-1F066             |                       |
| HV-11215A                     | HV-E51-1F059  | HV-E41-1F075             |                       |
| HV-11215B                     | HV-E21-1F001B | HV-E41-1F079             |                       |

These valves have open limit switches for annunciator inputs during normal plant line-up. These limit switches are not exposed to potential welding. In the event the normal plant line-up is changed, the valves change to their new positions before the computer input limit switches are exposed to potential welding. Therefore, welding of the computer input limit switches does not prevent the motor-operated valves from meeting their minimum performance requirements.

The Group 4 valves are the RHR Pump Minimum Flow Valves HV-151-F007A and HV-151-F007B. These valves are required to automatically open and/or close, however, the annunciator input limit switches from these valves could be closed before their automatic operations are required. In the event the annunciator input limit switches weld shut, the limit switch main drive shafts could perhaps break loose internal to the valves causing the valves to jam, thus potentially preventing full closure of the valves. Per Dan Warsing of Limitorque Corp., this is very unlikely. More than likely, the welded shut limit switch will cause damage to the limit switch gearing, but will not prevent the valves from closing.

To assure that the HV-151-F007A and HV-151-F007B valve annunciator input limit switches do not weld shut, qualified Class 1E - nonClass 1E isolation devices are to be installed in the annunciator input limit switch circuits from these valves. The circuit design should be such that the limit switches actuate the Class 1E - nonClass 1E isolation devices with contacts from these devices used as annunciator inputs. This prevents the annunciator input limit switches from welding shut for the specified impressed voltages on the annunciator input cables. This action will be tracked by NCR 87-0021.

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The suppression pool vacuum relief valves use Namco limit switches for annunciator inputs. These affiliated valves are powered from Class 1E sources. However, these valves and their limit switches are not used in Class 1E circuits. Therefore, welding an annunciator limit switch does not effect Class 1E circuits.

6.0 REFERENCES

- 6.1 SEA-EE-183, Rev. 0.
- 6.2 IEEE 279-1971.
- 6.3 IEEE 384-1974.
- 6.4 Regulatory Guide 1.75, Rev. 0.





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TABLE A

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SSES UNIT I ALARM RESPONSE PROCEDURES MANUAL

| PROCEDURE NUMBER   | REV | EFFECTIVE DATE | EXPIRATION DATE | STATUS | STATUS DATE | PCAF                   |
|--|-----|----------------|-----------------|--------|-------------|------------------------|
| AR-101-001<br>RWCU, CONDENSATE & FEEDWATER MONITOR IC651   | 3   | 12/02/87       | 9/30/89         |        |             |                        |
| AR-102-001<br>REACTOR RECIRCULATION SYSTEM IC651   | 5   | 12/18/87       | 9/30/89         |        |             |                        |
| AR-103-001<br>RPS DIV I IC651  | 7   |                |                 |        |             |                        |
| AR-104-001<br>RPS DIV II IC651   | 7   |                |                 |        |             |                        |
| AR-105-001<br>MAIN TURBINE GENERATOR IC651   | 4   | 1/08/87        | 6/30/88         |        |             | 1-87-1117              |
| AR-106-001<br>MAIN TURBINE/GENERATOR, COMPUTER HVAC, INSTRUMENT AC, 24V DC, 125V DC, 250V DC PANEL IC651 | 9   | 9/25/87        | 6/30/88         |        |             |                        |
| AR-107-001<br>CRD SLL DRYWELL Steps IC601  | 7   |                |                 |        |             | 1-87-0917<br>1-87-1172 |
| AR-108-001<br>REACTOR CORE ISOLATION COOLING RCIC SYSTEM IC601   | 6   | 11/25/86       | 11/25/88        |        |             |                        |
| AR-109-001<br>RHR AND CORE SPRAY MONITOR IC601   | 9   | 10/30/87       | 12/30/88        |        |             |                        |
| AR-110-001<br>ADS & ORWL CLG IC601   | 4   | 3/09/87        | 3/30/89         |        |             |                        |
| AR-111-001<br>MAIN STEAM CONTAINMENT & INSTRUMENT GAS DIV I IC601  | 10  | 12/18/87       | 12/30/88        |        |             |                        |
| AR-112-001<br>MAIN STEAM CONTAINMENT & INSTRUMENT GAS DIV II IC601                                       | 9   | 12/18/87       | 12/30/88        |        |             |                        |
| AR-113-001<br>RHR AND CORE SPRAY DIV II IC601  | 8   | 7/14/87        | 3/18/88         |        |             | 1-87-0968              |
| AR-114-001<br>HIGH PRESSURE COOLANT INJECTION (MPCI) SYSTEM IC601  | 7   | 3/09/87        | 6/30/88         |        |             |                        |
| AR-117-001<br>TURBINE BLDG & REFUEL AREA LOAD CENTERS IC668  |     | 11/07/85       | 12/30/89        |        |             |                        |
| AR-118-001<br>MAIN TURBINE BLDG - O RESERVOIR & DRAIN VALVE MONITOR IC668                                | 4   | 6/25/87        | 6/30/90         |        |             |                        |
| AR-119-001<br>MAIN TURBINE STEAM SEALS IC668   | 5   | 2/25/87        | 12/30/88        |        |             |                        |
| AR-120-001<br>FEEDWATER HEATING, REACTOR FEED PUMPS & REACTOR FEED PUMP LUBE OIL IC668                   | 4   | 7/29/87        | 9/30/89         |        |             |                        |
| AR-121-001<br>CONDENSER AIR REMOVAL IC668  | 5   | 12/18/87       | 11/19/88        |        |             |                        |
| AR-122-001<br>CIRCULATING WATER IC668  | 4   | 7/14/87        | 6/30/91         |        |             | 1-87-1095              |
| AR-123-001<br>SERVICE WATER, RBCCW AND TBCCW - IC668   | 3   | 6/25/87        | 6/30/89         |        |             |                        |
| AR-124-001<br>INSTRUMENT/SERVICE AIR IC668   | 3   | 10/22/86       | 9/30/88         |        |             |                        |
| AR-125-001<br>REACTOR & TURBINE BLDG MISCELLANEOUS SUMPS PANEL IC692                                     | 1   | 2/25/87        | 3/30/89         |        |             |                        |
| AR-126-001<br>REACTOR AND TURBINE BUILDING MISCELLANEOUS SUMPS PANEL IC692                               | 3   | 7/20/87        | 3/30/89         |        |             |                        |



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| PROCEDURE NUMBER  | REV | EFFECTIVE DATE | EXPIRATION DATE | STATUS | STATUS DATE | PCAF |
|---|-----|----------------|-----------------|--------|-------------|------|
| AR-127-001<br>DRYWELL REACTOR BLDG & VARIOUS HVAC DIV I 1C681   | 5   | 12/02/87       | 3/30/89         |        |             |      |
| AR-128-001<br>DRYWELL REACTOR BLDG & VARIOUS HVAC DIV II        | .4  | 12/18/87       | 3/30/89         |        |             |      |
| AR-131-001<br>UNIT 1 OFFGAS RECOMBINER 0C673                    | 5   | 7/29/87        | 12/31/88        |        |             |      |
| AR-146-001<br>CONTAINMENT RADIATION DETECTION BLDG DRAINS 1C693 | 3   | 10/08/86       | 9/30/88         |        |             |      |
| AR-147-001<br>MSIV LEAKAGE CONTROL OUTBOARD 1C645               | 4   | 11/19/86       | 11/19/88        |        |             |      |
| AR-148-001<br>MSIV LEAKAGE CONTROL - INBOARD 1C644              | 5   | 6/25/87        | 12/30/88        |        |             |      |

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