

NUCLEAR STEAM SUPPLY SYSTEMS  
PANEL DESIGN EVALUATION  
FOR ELECTRICAL SEPARATION  
1E AND NON-1E INTERFACE

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PREPARED

FOR

SHOREHAM PROJECT  
LONG ISLAND LIGHTING COMPANY

PREPARED

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NSSS PANEL DESIGN EVALUATION  
ELECTRICAL SEPARATION

FOR THE

SHOREHAM PROJECT

I. PREFACE

This document represents an evaluation conducted to confirm that the safety of the Shoreham Plant is not impaired by the presence of non-essential and essential (1E) circuits in proximity to each other inside the General Electric furnished nuclear steam supply system (NSSS) panels.

A detailed evaluation of all wiring inside a sample of the NSSS cabinets was made including device to device and device to terminal board wiring. Two NSSS cabinets H11-P609 and H11-P617 were selected as including wiring representative of all essential and non-essential wiring interfaces within NSSS panels. These panels are typical of the rest of the NSSS panel configurations and the results of the analysis are considered applicable to all NSSS panels furnished by General Electric for the Shoreham Project. The results of this evaluation are presented in the following paragraphs.

II. CONCLUSION

Failure of the non-Class 1E equipment or circuits will not adversely affect safety equipment or circuits. This design complies with IEEE 279-1971.

The safety of the Shoreham Plant is not impaired by the presence of non-essential (non-1E) and essential circuits (1E) in close proximity to each other inside panels.

III. ASSUMPTIONS

The following assumptions were made for this evaluation:

- a. All essential and non-essential wiring is assumed to be bundled together within the panel.
- b. Adequate separation was provided by AE/customer for the cables egressing at the terminal boards between essential and non-essential circuits as per separation requirements.
- c. Bridging circuits (non-1E wires interfacing with more than one division) are not considered. It is assumed that at no instance non-1E wires run with more than one division.

IV. EVALUATION RESULTS

PANEL H11-P617

The following documents were used as reference:

- Elementary diagram for RHR system
- Elementary diagram for HPCI system
- Arrangement drawing panel - H11-P617
- Connection diagram panel - H11-P617
- Parts List
- Electrical separation specification

Evaluation of the devices located on panel H11-P617 were summarized into two categories to identify each instance of 1E and non-1E interface within the panel. Table 1 lists all devices with 1E and non-1E interface circuits. Table 2 lists all devices with 1E circuits only.

TABLE 1

PANEL H11-P617 - DEVICES WITH 1E AND NON-1E CIRCUITS

| DEVICE DESIGNATION | 1E CIRCUIT                          | NON-1E CIRCUIT |          |         |
|--------------------|-------------------------------------|----------------|----------|---------|
|                    |                                     | ANNUN.         | COMPUTER | CONTROL |
|                    |                                     | CONTACT        | CONTACT  | CONTACT |
| E11A-K5A           | COIL, CONTACT 1-2, 9,10             | 11-12          |          |         |
| -K6A               | COIL, CONTACT 1-2, 9-10             | 11-12          |          |         |
| -K7A               | COIL, CONTACT 1-2, 9-10             | 11-12          |          |         |
| -K8A               | COIL, CONTACT 1-2, 9-10             | 11-12          |          |         |
| -K11               | COIL, CONTACT 1-2, 3-4,<br>5-6      |                |          |         |
| -K90A              | COIL, CONTACT 1-2, 3-4,<br>9-10     | 11-12          |          |         |
| -K40A              | COIL, CONTACT 1-2,                  | 3-4            |          |         |
| E41A-K44           | COIL, CONTACT 1-2, 3-4,<br>5-6, 7-8 | 11-12          |          |         |
| E11A-K79A          | COIL, CONTACT 9-10                  | 11-12          |          |         |
| -K80A              | COIL, CONTACT 9-10                  | 11-12          |          |         |
| -K1A               | COIL                                | 2-8,<br>7-3    |          |         |
| E41A-K40           | COIL                                | 7-3,2-8        |          |         |
| -K43               | COIL, CONTACT T1-M1                 | T3-M3          |          |         |
| E11A-K105A         | COIL, CONTACT 1-2,<br>3-4, 9-10     | 11-12          |          |         |
| E11A-S50A          | CONTACT 1-2                         | 7-8            |          |         |

TABLE 2

PANEL H11-P617 - DEVICES WITH 1E CIRCUITS ONLY

| RELAYS    |          | MISCELLANEOUS<br>DEVICES |
|-----------|----------|--------------------------|
| E11A-K10A | E11-K67A |                          |
| -K14A     | -K65A    |                          |
| -K15A     | -K2A     |                          |
| -K16A     | -K84A    |                          |
| -K19A     | -K93A    |                          |
| -K118A    | -K99A    |                          |
| -K39A     | -K66A    |                          |
| -K44A     | -K108A   |                          |
| -K100A    | -K109A   |                          |
| -K58A     | -K103A   |                          |
| -K59A     | -K9A     |                          |
| -K61A     | -K95A    |                          |
| -K94A     | -K69A    |                          |
| -K63A     | -K22A    |                          |
| -K68A     | -K106A   |                          |
| -K73A     | -K42A    |                          |
| -K117A    | -K114A   |                          |
| -K96A     | -K110A   |                          |
| -K38A     |          |                          |
| -K46A     | E41-K45  |                          |
| -K116A    | -K46     |                          |
| -K45A     | -K62     |                          |
|           | -K63     |                          |
|           | -K48     |                          |
|           | -K36     |                          |
|           |          | <u>Indicating Lights</u> |
|           |          | Blue-3                   |
|           |          | White-9                  |
|           |          | <u>Jack</u>              |
|           |          | E11A-J1A                 |

V. PANEL H11-P609

The following documents were used as reference:

- Elementary diagram reactor protection system
- Elementary diagram nuclear steam supply system
- Connection diagram panel P609
- Arrangement drawing panel P609
- Electrical separation specification

Evaluation of the panel H11-P609 devices is separated into two categories to identify IE and non-IE interfaces within the panel. Table 3 lists all devices with IE and non-IE interface circuits. Table 4 lists all devices with IE circuits only.

TABLE 3

## PANEL H11-P609 - DEVICES WITH 1E AND NON-1E CIRCUITS

| DEVICE DESIGNATION | 1E CIRCUIT                                | NON-1E CIRCUIT |          |         |
|--------------------|---|----------------|----------|---------|
|                    |   | ANNUN.         | COMPUTER | CONTROL |
|                    |   | CONTACT        | CONTACT  | CONTACT |
| C71A - K25A        | COIL, CONTACT T1-M1, T2-M2                | M3-R3          | M4-R4    |         |
| - K26A             | COIL                                      | T1-M1          |          |         |
| - K27A             | COIL                                      | M1-R1          |          |         |
| - K25C             | COIL, CONTACT T1-M1, T2-M2                | M3-R3          | M4-R4    |         |
| - K26C             | COIL                                      | T1-M1          |          |         |
| - K27C             | COIL                                      | M1-R1          |          |         |
| - K1A, C           | COIL, CONTACT 1-2, 3-4                    | 5-6            | 7-8      |         |
| - K3A, C           | COIL, CONTACT 1-2, 3-4                    | 5-6            | 7-8      |         |
| - K3E, G           | COIL, CONTACT 1-2, 3-4                    | 5-6            | 7-8      |         |
| - K4A, C           | COIL, CONTACT 1-2, 3-4                    | 5-6            | 7-8      |         |
| - K5A, C           | COIL, CONTACT 1-2, 3-4                    | 5-6            | 7-8      |         |
| - K6A, C           | COIL, CONTACT 1-2, 3-4                    | 5-6            | 7-8      |         |
| - K7A, C           | COIL, CONTACT 1-2, 3-4                    | 5-6            | 7-8      |         |
| - K8A, C           | COIL, CONTACT 1-2, 3-4,<br>9-10           | 5-6            | 7-8      |         |
| - K9A, C           | COIL, CONTACT 1-2, 3-4,<br>11-12          | 5-6            |          |         |
| - K10A, G          | COIL, CONTACT 1-2, 3-4<br>9-10            | 5-6            | 7-8      |         |
| - K10C, E          | COIL, CONTACT 1-2, 3-4                    | 5-6            | 7-8      |         |
| - K11A, C          | COIL, CONTACT 1-2, 3-4                    | 5-6            |          |         |
| - K12A, C, E, G    | COIL, CONTACT 1-2, 3-4<br>9-10            | 5-6            | 7-8      |         |
| - K18A, C          | COIL, CONTACT 1-2, 3-4                    | 5-6            |          |         |
| - K15A, C          | COIL, CONTACT 1-2, 3-4                    | 5-6            | 7-8      | 11-12   |
| - K16A, C          | COIL, CONTACT 1A1-1A2                     | 2A1-<br>2A2    |          |         |
| - K14A, C, E, G    | COIL, CONTACT 1L-1T,<br>2L-2T, 3L-3T, 2-4 | 5-6            | 9-10     |         |
| - K24A             | COIL                                      | 5-6            | 7-8      |         |
| B21H - K1A         | COIL, CONTACT 1-2, 3-4,<br>5-6, 11-12     | 9-10           |          |         |
| - K1C              | COIL, CONTACT 1-2, 3-4,<br>5-6            | 9-10           |          |         |
| - K2A, C           | COIL, CONTACT 1-2                         | 9-10           | 7-8      |         |
| - K3A, C           | COIL, CONTACT 1-2                         | 9-10           | 7-8      |         |
| - K4A, C           | COIL, CONTACT 1-2                         | 9-10           |          |         |
| - K7A,             | COIL, CONTACT 7-8, 3-4,<br>9-10, 11-12    | 5-6            |          |         |
| - K7C              | COIL, CONTACT 3-4, 7-8<br>9-10,           | 5-6            |          |         |
| - K76A, C          | COIL, CONTACT 1-2                         | 9-10           |          |         |

TABLE 4

PANEL H11-P609 - DEVICES WITH 1E CIRCUITS ONLY

| RELAYS      |            | SWITCHES    |
|-------------|------------|-------------|
| C71A - K13A | B21H - K5A | B21H - S23A |
| - K13C      | - K5C      | - S23C      |
| - K19A      | - K6A      | - S24A      |
| - K19C      | - K6C      | - S24C      |
| - K19E      | - K44A     | - S34A      |
| - K19G      | - K44C     | - S34C      |
| - K21A      | - K68A     | - S71A      |
| - K21C      | - K68C     | - S71C      |
| - K22A      | - K78A     | - S72A      |
| - K22C      | - K78C     | - S72C      |
|             | - K79A     | - S74A      |
|             | - K79C     | - S74C      |
|             |            | C71A - S11A |
|             |            | - S12A      |



## VI. ANALYSIS

Damage potential inside the NSSS control panels is considered to be very low. Electrically caused failures are all that can be expected or considered credible. (Petroleum, trash and sources of high energy missiles are excluded from the control areas.)

The interface between non-essential and essential (1E) circuits occurs at 1E qualified devices or wire bundles.

- Relay coil-to-contact and contact-to-contact separation is utilized to assure electrical isolation. The relays are qualified class 1E devices. Nuclear Safety Related relays type HFA, HMA and Agastat are used.
- The Vulkene wiring used internal to the panel is of high quality. Vulkene wire is fire resistant, and is rated for 90°C temperature at 600 volts (continuous). It meets IEEE 383, and is NEMA approved for switch gear. It has passed Underwriters Lab UL-1 fire test (vertical flame). The insulation is chemically cross-linked polyethylene which is heat and fire resistant.

The damage potential is minimal because of the devices used in the panel are class-1E and the wires used are of high quality. However, a further detailed analysis of 1E and non-1E interface circuits is provided as follows:

- Computer and annunciator signals makeup most of the non-1E circuits which interface with Class 1E circuits.

The failure modes of these circuits are as follows:

- Open circuit - Loss of non-1E information only. No impact on safety system.
- Short circuit - These circuits have low power service (<5 watts) because of the design of the connected computer and annunciator loads and conservatively selected circuit protection. The wiring used for these circuits is 16 AWG, of the quality listed above. These circuits are not capable of generating and sustaining energies of the magnitude necessary to damage cable insulation. Thus the short circuit fault will not propagate through class 1E circuits and will not disable safety function.
- Non-1E control and utility power wiring interface with class 1E circuits.

The failure modes of these circuits are as follows:

- Open circuit - Loss of non-1E function and power supply. No impact on safety system.

• Short circuit - Even though such a failure is credible, if it did occur as a single random failure, it would result in failure of the insulation at a single location and perhaps affect the juxtaposed divisional wiring. Failure is considered random because the wiring used for non-essential circuits is the same as qualified for class 1E applications. The panel interior lighting and utility outlet wiring is designed to avoid proximity with the divisional wiring. However, it may run together with only one division wiring wherever it is found impractical to run separate from the divisional circuits. The maximum effect on the safety circuitry could be loss of one division of power. The loss of one division of power as a result of a single random failure is acceptable because of redundancy in the plant design.

## RPS MG Set Missile Analysis

As requested by I&E Inspection Report 50-322/82-08, a review has been conducted to determine the effect of potential missiles generated by failure of the Reactor Protection System (RPS) Motor Generator Sets.

The two RPS motor generator sets are located in the southwest corner of the relay room. The sets are separated by a clear space of approximately 8 ft. and are oriented with their axis perpendicular to the relay panels and most cable raceway runs. This configuration minimizes the consequences of missiles even though this equipment is not considered a credible source of missiles. Nevertheless, a review was conducted to conservatively evaluate the effects of postulated missiles.

The flywheel associated with each motor generator set represents the limiting missile in terms of size and energy. In particular, a missile is postulated which is a 120° segment of the flywheel that weighs nearly 300 lbs., has an energy level of approximately  $130 \times 10^3$  ft-lbs and has dimensions of 14 1/4" x 5 5/8" x 14 1/4". In addition, a conservative trajectory of +25° off the rotating plane is assumed.

The affected area was carefully evaluated with all possible targets considered. It was determined that the affected area does not contain cables from redundant trains of safety related equipment, with the following exceptions:

- 1M50\*WC-003 A Water Chiller
- 1M50\*WC-003 B Water Chiller
- 1X61\*AOV-036 A Control Room Vent Intake Valve
- 1X61\*AOV-036 B Control Room Vent Intake Valve
- 1H11\*PNL-PCM Primary Containment Monitoring Panel
- 1R43\*PNL GP 1 Diesel Generator Trip Circuit
- 1R43\*PNL GP 2 Diesel Generator Trip Circuit

With respect to these cables it was determined that they are widely separated within the affected area and could not be impacted by a single missile. Therefore, the effects are no different than those for systems that have cables from only a single train in the affected area.

In addition, the affected area contains a water line and an air duct which required evaluation. The water line is a supply to the toilet and kitchen in the main control room, and the possible effects of flooding were investigated. It was determined that the leakage through a pipe break is automatically isolated by a valve controlled by loss of pressure. Therefore, the present design eliminates flooding effects.

The air duct through the affected area provides ventilation for the Relay Room, Computer Room and Switchgear Room. Should the air duct be ruptured by a missile, only a partial loss of performance would result. In any case, safety related spaces are monitored by area temperature monitors. Therefore, the operator has sufficient means to determine the status of ventilation systems in order to take appropriate action should it be affected by a missile.

In summary, the review of potential missiles from the RPS motor generator sets has determined that such a missile could not cause effects resulting in adverse safety consequences.