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ARKANSAS POWER & LIGHT COMPANY  
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July 13, 1979

1-079-7  
2-079-9

Mr. K. V. Seyfrit, Director  
Office of Inspection & Enforcement  
U. S. Nuclear Regulatory Comm.  
Region IV  
611 Ryan Plaza Drive, Suite 1000  
Arlington, TX 76011

Subject: Arkansas Nuclear One-Units 1 & 2  
Docket Nos. 50-313 and 50-368  
License Nos. DPR-51 and NPF-6  
IE Bulletin Nos. 79-01 and 79-01A  
(Files: 1510.1, 2-1510.1)

Gentlemen:

In response to IE Bulletins 79-01 and 79-01A, the following is provided.

Attached is a summary of environmental qualification for both ANO-1 and ANO-2.

We do not now use or intend to use any of the stem mounted limit switches of the type discussed in IE Bulletin 79-01 or Automatic Switch Company solenoid valves of the type discussed in IE Bulletin 79-01A at our facilities.

Very truly yours,

*David C. Trimble*

David C. Trimble  
Manager, Licensing

DCT/JTE/gp

Attachment

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## Summary

### ANO-1 Environmental Qualification of Safety-Related Electrical Equipment Inside The Reactor Building

During the time frame in which ANO-1 was designed, equipment procured, and constructed, no general environmental qualification standards existed. Specifically, the bulk of ANO-1 design and procurement was completed previous to the issuance of IEEE 323-1971. As such, the licensing requirements for ANO-1 did not require conformance to any specific environmental qualification requirements or the qualification of designated Post Accident Monitors.

However, engineering practice during this period considered environmental qualification although not necessarily to the degree of sophistication we now place on qualification based on our evolution on appropriate learning curves.

Environmental Qualification requirements for ANO-1 equipment was specified on the Purchase Order Specification when the equipment was procured. Engineering judgment was the basic rule which prevailed when determining qualification requirements due to the lack of industry, etc. standards. As such, we interpret the ANO-1 environmental qualification requirements as those which were required on the Purchase Order Specification.

In responding to IE Bulletin 79-01 for ANO-1, we have researched our Purchase Orders and reported the specifications found there as the "Environmental Qualification Requirements." Due to the massive documents requiring research, not all of the Purchase Order requirements have been identified.

Efforts are still underway to identify all Purchase Order requirements and will be forwarded to you. However, even in those cases, we have identified qualification reports and have reported such.

Unless otherwise specified, all qualification test reports are available in the offices of Arkansas Power & Light, Little Rock, Arkansas.

## 1. On Electric Cable

All control, power, and some instrument cable was supplied by the Okonite Cable Company and uses Okonite insulation. Pre-aged cable samples were exposed to a total integrated dose of  $2.8 \times 10^7$  rads and subjected to a LOCA environment consisting of the following:

- (1) Steam autoclave at 60 psig, 153 C (307F) = 12 hrs., with chemical spray of NaOH,  $\text{Na}_2\text{S}_2\text{O}_3$ , KOH, Boric Acid.
- (2) Steam Autoclave at 5 psig, 107 C (225 F) = 7 days with chemical spray.
- (3) Steam autoclave at 120 psig, 177 C (350 F) = 10 hrs. but no voltage under (3).

Test results are documented in Okonite Engineering Report No. 110E.

The remaining instrument cable is triaxial cable supplied by Boston Insulated Wire & Cable Co. (BIW). This cable has been certified by BIW to a temperature of 122F and 75 psia (75% relative humidity) for periods of 48 hours once a year (during reactor building leak rate test). Radiation certification for a 40 year integrated radiation exposure of  $2.8 \times 10^7$  rads at a radiation level of 100 rads/hr has also been verified by BIW.



2. Valves and Valve Operation For The Containment Isolation System (CIS), Sample Containment Isolation system (SCIS), and The Decay Heat Removal System (DHRS).

Only valve actuators are classified as IE equipment. Two types are supplied in the above systems, Limitorque Type SMB and Rotork Type NAI. The Limitorque SMB's have been extensively tested with results summarized in Franklin Institute Reports F-C3341 and F-C2232-01. Figure 3, pages 3-5 of the former (Attachment 1) shows the test envelope. In addition, the second report documents a 7-day test in which a borated spray with a pH of 7.67 was applied. Radiation exposure of  $2 \times 10^8$  rads was applied to the A-C motor actuators.

The Rotork Type NAI operators are used in the CIS and DHRS are specially tested submersible operators. Radiation aging to  $2 \times 10^8$  rads was performed except for seals and "O" rings which received  $6 \times 10^7$  rads. Test report No. TR. 116 documents qualification. The test profile was:

| <u>Time</u>                     | <u>Pressure (psig)</u> | <u>Temperature (F)</u> |
|---------------------------------|------------------------|------------------------|
| 0 - 10 sec                      | 0 - 80                 | 140 - 300              |
| 10 sec - 5 min                  | 80                     | 300 - 380              |
| 5 min - 3 hr                    | 67                     | 380 - 330              |
| 3 hr - 5 hr                     | 67 - 0                 | 330 - 60               |
| 2 days delay, then second cycle |                        |                        |
| 0 - 10 sec                      | 0 - 67                 | 60 - 280               |
| 10 sec - 5 min                  | 67                     | 280 - 380              |
| 5 min - 3 hr                    | 64                     | 380 - 330              |
| 3 hr - 6 hr                     | 64 - 100               | 330 - 270              |
| 6 hr - 4 da                     | 100 - 30               | Approx 250             |
| 4 da - 36 da                    | Approx 20              | Approx 250             |

Water spray was applied after 5 min in both cycles of the test.

The operator was cycled 35 times during the test. After the second test cycle, the operator was completely submerged for 6 hours. The operator functioned properly at the beginning, middle and end of the six-hour test.

A supplemental test on a Rotork operator is documented in Report TR-178, Rev. 1. This test consisted of 30 days of submerged operation in a solution of sodium hydroxide, boric acid and sodium thiosulfate with a pH of 10.5. Test chamber pressure was cycled 0-70 psig in 10 seconds twice and long term pressure was at least 15 psig. This test was run at 50F.

3. Containment Cooling Units - The only Class IE parts are the main cooling fan motors and damper motors.

The bypass motors are manufactured by General Electric and have been verified by G.E. to operate properly at temperatures and pressures of 286F and 59 psig saturated steam for the required time of 4 sec.

The cooling fan motors are manufactured by Reliance and were tested by Joy Manufacturing Co. as part of a Joy axivane fan unit. The test program is detailed in a report entitled "Qualification Test of a Fan and Motor Designed for Service in Nuclear Containment."

The prototype was pre-aged thermally and seismically. All materials of construction were selected to be capable of withstanding  $10^9$  rads. Radiation aging was not done. The unit was subjected to two sequential long term tests, each of which began with five temperature/pressure cycles from ambient to approximately 80 psig/300F over a period of 25 hours. The first test was followed by 7 days at 15 psig/200F. The second test was followed by 11 days at approximately 20 psig/200F. Combinations of chemical spray including boric acid, sodium hydroxide, sodium thiosulfate and potassium hydroxide were injected individually and in combination throughout the entire long term test. Additionally, a series of short term transient tests were run wherein chamber pressure was raised from 0 to 80 nsig in 8-10 seconds. Motor internal pressure equalized with external pressure within 12 seconds for all modes of operation.

#### 4. Electrical Penetration Assemblies (EPA)

The penetration assemblies are manufactured by Conax and have undergone extensive testing as recorded in Conax Corporation Report No.'s IPS-48, ER-1097 and IPS-27. The prototype assemblies were subjected to a LOCA environment consisting of 325F, 85 psig with saturated steam and a chemical spray of 1900 ppm Boron for two hours as documented in Report No. IPS-48. In a separate test (Report No. ER-1097), a thermal analysis comprised of exposure to 565F saturated steam for one minute was performed. In a final test (Report No. IPS-27), radiation qualification of the conductors and sealant used in the assemblies was conducted. The test module first underwent a two-hour hold at 325F in a steam/air/environment followed by an integrated dose of  $1 \times 10^8$  rads. Afterwards, the test samples successfully passed a He leak test.

## 5. Reactor Coolant Flow Transmitters

The coolant flow transmitters are Bailey Model BY 3X41-A. The Bailey Transmitters were subjected to a LOCA test of 24-hours duration followed by a gamma radiation test. The test unit was subjected to temperatures and pressures greater than 286F and 60 psig saturated steam for the first 8-10 minutes. The temperature and pressure were maintained at a level of at least 150F and 5 psig for the remainder of the test. The radiation environment consisted of exposure to 200 rads/hr until the total accumulated gamma dose exceeded  $2 \times 10^4$  rads. Test results are documented in Babcock and Wilcox topical report 10003A-Rev. 4.

## 6. Reactor Coolant Pressure Transmitters

Two types of pressure transmitters are used in the reactor coolant system, Fisher & Porter Model 50EN and Foxboro Model E11GH-1NM2. Radiation Qualification of the Fisher & Porter Model is documented in Franklin Institute Report F-C2815. The test units qualified in this report were exposed to Co-60 irradiation for 53 hours, yielding a total integrated dose of  $5.7 \times 10^6$  rads. Fisher and Porter has also verified that when radiation hardened transistors are substituted and teflon capacitors are replaced with radiation resistant high temperature capacitors as in ANO-Unit 1, transmitter will function properly to at least a cumulative gamma radiation dose of  $10^7$  rads.

LOCA testing is summarized in Fisher & Porter Report DP-2204-51-3-006 during which the units were subjected to the pressure-temperature profile shown in Figs. 1 and 2 of this report (Attachments 2 & 3).

The Foxboro Model was qualified by the same testing procedure used for the Bailey Model in Section 5 of this report. Maximum temperatures and pressures obtained during testing were 288F and 90 psig. The integrated dosage for the test was  $2.4 \times 10^4$  rads.

## 7. Reactor Coolant Temperature Element

The temperature elements utilized are Rosemount RTD-17764. Qualification was accomplished as reported in Babcock and Wilcox Topical Report 10003A Rev. 4. The temperature test was performed during a calibration procedure during which the unit was submerged in a silicone oil bath of a maximum temperature of 600F. Pressure testing was performed to a level of 3125 psig with helium for two minutes while mounted in a test apparatus simulating the actual equipment mounting. Submersion testing of the connecting head was achieved by pressurizing a test sample to a level of 80 psig followed by a 45 min immersion in water for evidence of leakage. All materials in the connection head have been selected for use at temperatures of at least 240F.

8. Linear Neutron Flux Monitor (Excore)

The neutron flux monitors are supplied by the Bailey Meter Company and are used to monitor the reactor power level. Environmental testing was accomplished by subjecting a sample unit to the following pressure-temperature profile. The ambient temperature was increased at approximately 50F/hr until the temperature of the detector reached 212F. After allowing the steam-air mixture to stabilize, the pressure was increased to 150 psig by a nitrogen loading tank and maintained for 72 hours. Qualification procedures and results are detailed in BAW Topical Report 10003A, Rev. 4. These monitors are not necessary once the reactor is tripped.



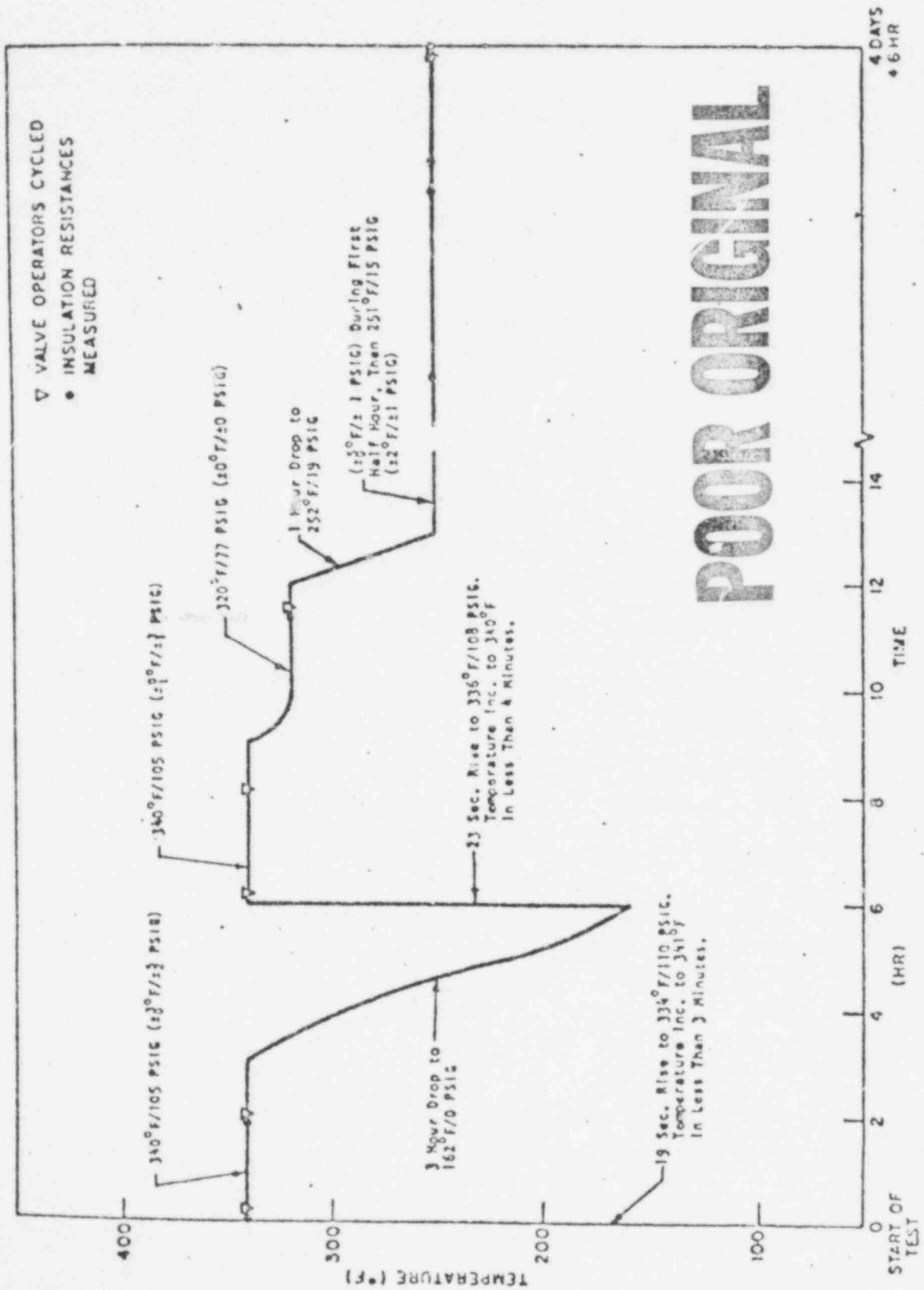


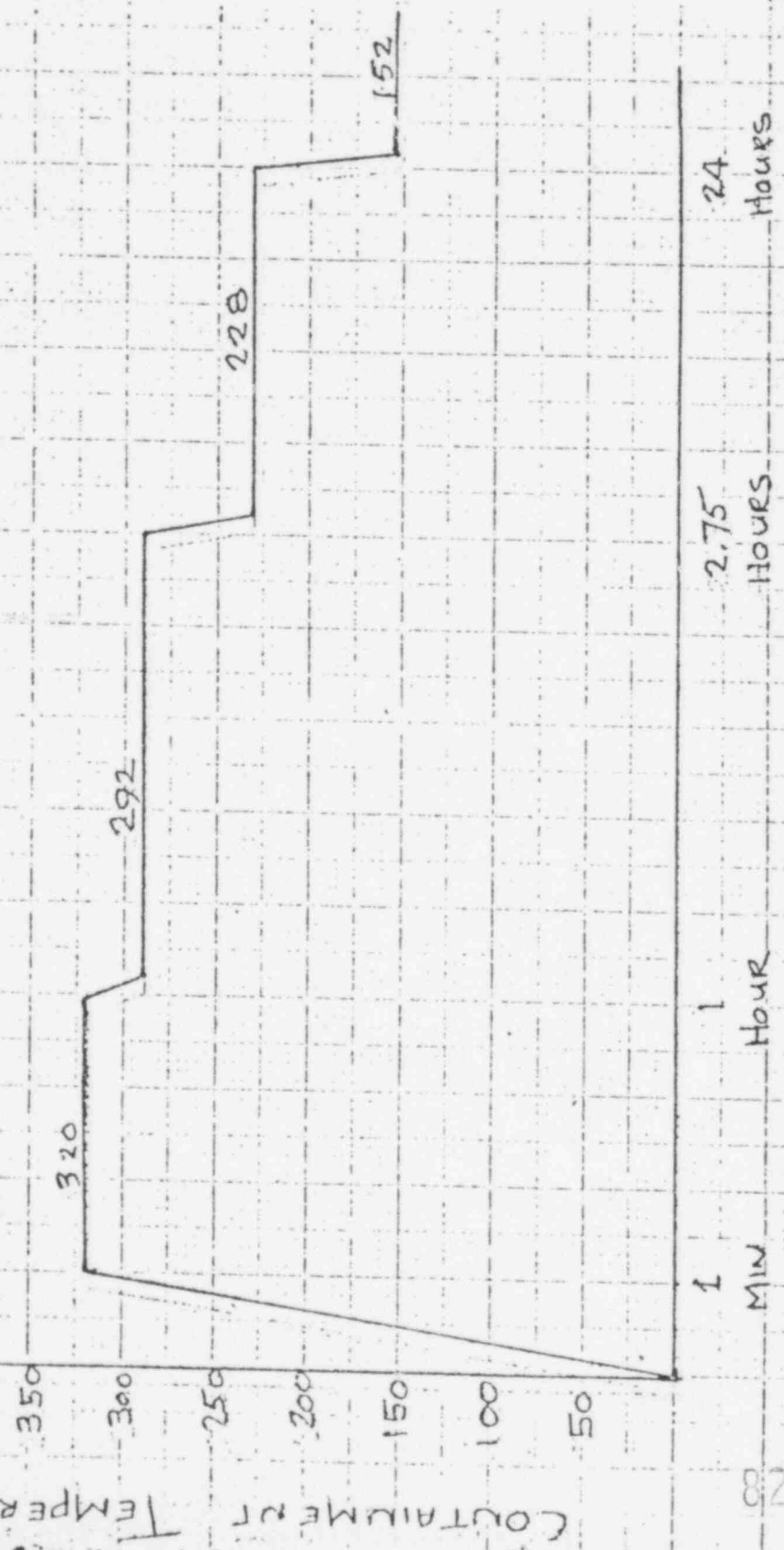
Figure 3. Actual Steam Exposure Profile

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POOR ORIGINAL

# CONTAINMENT ENVIRONMENT CONDITIONS

TEMPERATURE VS TIME

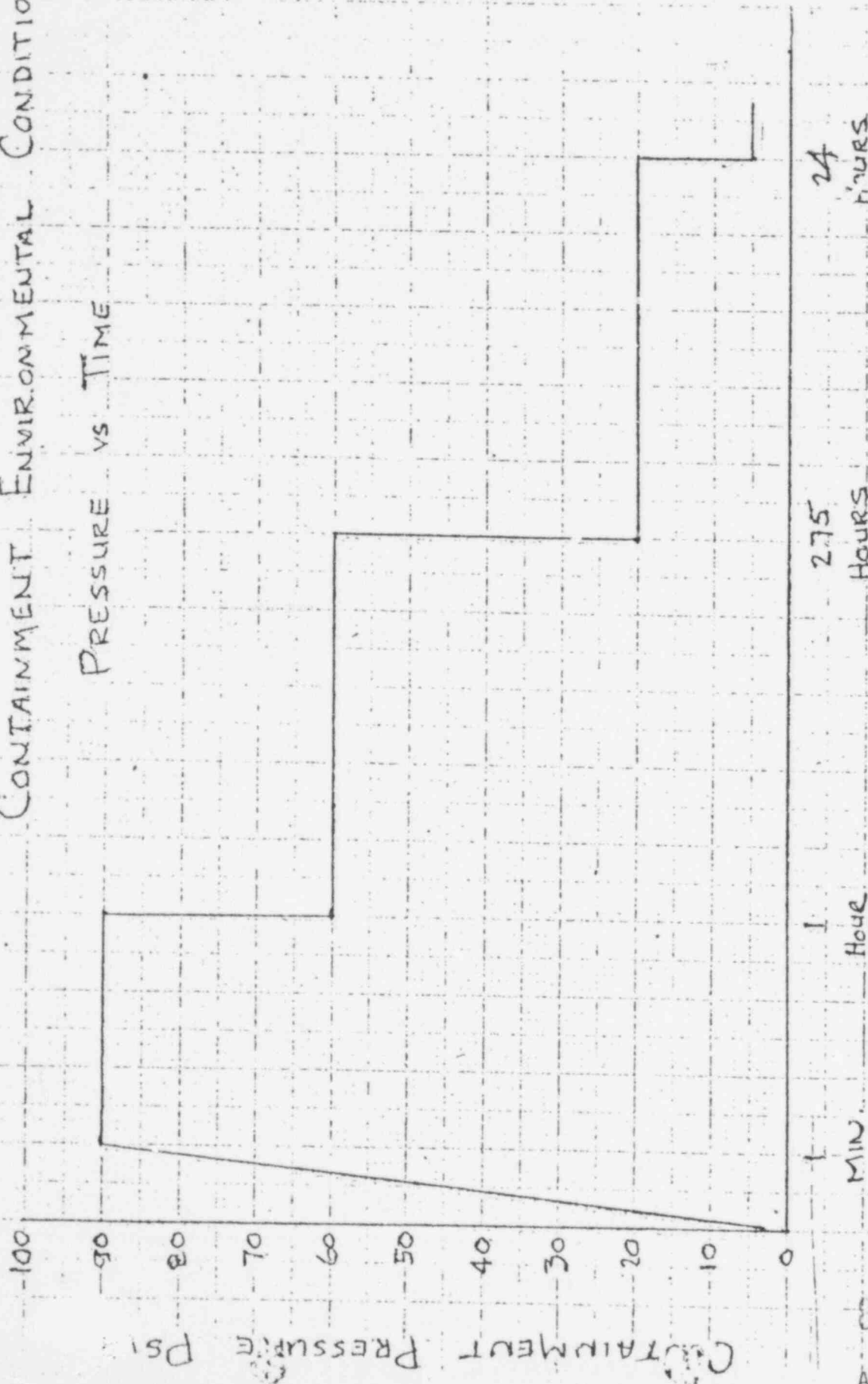


ELAPSED TIME

FIGURE 1

# CONTAINMENT ENVIRONMENTAL CONDITIONS

PRESSURE VS TIME



ELAPSED TIME

Figure 2

POOR ORIGINAL

PLANT NAME: Arkansas Nuclear One - Unit 1

| ITEM | EQUIPMENT DESCRIPTION       | TIME REQ'D | ENVIRONMENT (LOCATION) |                        |                        | QUAL. METHOD* | DOC. REF** | REMARKS                 |
|------|-----------------------------|------------|------------------------|------------------------|------------------------|---------------|------------|-------------------------|
|      |                             |            | PARAMETER              | SPEC.                  | QUAL.                  |               |            |                         |
| 1    | Cable                       | Long Term  | Containment            |                        |                        |               |            | Tests were performed on |
| a)   | Control Cable               |            | Temp. (°F)             | 122                    | 307                    | Sequential    | 1          | aged samples            |
|      | Okonite Company             |            | Press. (psia)          | 75                     | 85                     | Test          |            |                         |
|      | 2/C, 3/C, 4/C, 5/C, 7/C,    |            | Rel. Hum.              | 100%                   | 100%                   |               |            |                         |
|      | #14 AWG Okonite Insulation  |            | Radiation              | $2.8 \times 10^7$ rads | $3.5 \times 10^7$ rads |               |            |                         |
|      |                             |            | Chem.                  | Boric acid spray       | Boric acid spray       |               |            |                         |
| b)   | Triaxial Cable              | Long Term  | Containment            |                        |                        |               | 2          | Aged samples were used  |
|      | Boston Insulated Wire &     |            | Temp. (°F)             | 122                    | 122                    | Test          |            | in testing              |
|      | Cable Co. RG11/U            |            | Press. (psia)          | 75                     | 85                     |               |            |                         |
|      | Polyethylene Insulation     |            | Rel. Hum.              | 100%                   | 100%                   |               |            |                         |
|      | Polyvinyl Chloride Jacket   |            | Radiation              | $2.8 \times 10^7$ rads | $2.8 \times 10^7$ rads |               |            |                         |
|      |                             |            | Chem.                  |                        |                        |               |            |                         |
| c)   | Power Cable                 | Long Term  | Containment            |                        |                        |               | 1 *        | Tests were performed    |
|      | Okonite Company             |            | Temp. (°F)             | 122                    | 307                    | Sequential    |            | on aged samples         |
|      | 1/C #8 AWG                  |            | Press. (psia)          | 75                     | 85                     | Test          |            |                         |
|      | 1/C #250 KCMIL              |            | Rel. Hum.              | 100%                   | 100%                   |               |            |                         |
|      | 3/C #12 AWG,                |            | Radiation              | $2.8 \times 10^7$ rads | $3.5 \times 10^7$ rads |               |            |                         |
|      | All with Okonite insulation |            | Chem.                  | Boric acid spray       | Boric acid spray       |               |            |                         |
| d)   | Instrument Cable            | Long Term  | Containment            |                        |                        |               | 1          | Tests were performed on |
|      | Okonite Company             |            | Temp. (°F)             | 122                    | 307                    | Sequential    |            | aged samples            |
|      | 2/C #14 AWG with OAS        |            | Press. (psia)          | 75                     | 85                     | Test          |            |                         |
|      | RG22 B/U                    |            | Rel. Hum.              | 100%                   | 100%                   |               |            |                         |
|      | Okonite Insulation          |            | Radiation              | $2.8 \times 10^7$ rads | $3.5 \times 10^7$ rads |               |            |                         |
|      |                             |            | Chem.                  | Boric acid spray       | Boric acid spray       |               |            |                         |

This list is a compilation of items by component. Do not list the same type of component more than once. \*ie, separate effects, sequential, etc.  
 Use limiting environment where more than one applies. \*\*Please attach typed lists of reference documents

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PLANT NAME: Arkansas Nuclear One - Unit 1

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| ITEM | EQUIPMENT DESCRIPTION        | TIME REQ'D. | ENVIRONMENT (LOCATION) |                        |                      | QUAL. METHOD* | DOC. REF.** | REMARKS                                                            |
|------|------------------------------|-------------|------------------------|------------------------|----------------------|---------------|-------------|--------------------------------------------------------------------|
|      |                              |             | PARAMETER              | SPEC.                  | QUAL.                |               |             |                                                                    |
| 2    | Containment Isolation Valve  | Short Term  | Containment            |                        |                      |               |             |                                                                    |
|      | and Operators                |             | Temp. (°F)             | 286                    | 370                  | Sequential    | 3, 4, 5     | Radiation aging of $2 \times 10^8$ rads was performed seals and O- |
| a)   | Anchor/Darling Gate Valve    |             | Press. (psia)          | 74                     | 85                   | Test *        |             | rings were aged with $6 \times 10^7$                               |
|      | Rotork 7NA1 Syn. Rosset II   |             | Rel. Hum.              | 100%                   | 100%                 |               |             | rads *Borated spray was used                                       |
|      | Rotork 16NA1Z                |             | Radiation              | $3.8 \times 10^7$ rads | $2 \times 10^8$ rads |               |             | in a separate test (ref 5)                                         |
|      |                              |             | Chem.                  | See Note 1             | pH=10.5              |               |             |                                                                    |
| b)   | Anchor/Darling Gate Valve    | Short Term  | Containment            |                        |                      |               | 6, 7        | *Borated Spray was used in                                         |
|      | Limatorque SMB - 00-10       |             | Temp. (°F)             | 286                    | 340                  | Sequential    |             | a separate test (ref. 7)                                           |
|      |                              |             | Press. (psia)          | 74                     | 120                  | Test*         |             |                                                                    |
|      |                              |             | Rel. Hum.              | 100%                   | 100%                 |               |             |                                                                    |
|      |                              |             | Radiation              | $2.8 \times 10^7$ rads | $2 \times 10^8$ rads |               |             |                                                                    |
|      |                              |             | Chem.                  | See Note 1             | pH=7.67              |               |             |                                                                    |
| c)   | Velan Engineering Gate Valve | Short Term  | Containment            |                        |                      |               |             |                                                                    |
|      | Limatorque SMB - 000-2       |             | Temp. (°F)             | 286                    | 340                  | Sequential    | 6, 7        | *Borated Spray was used in                                         |
|      | Limatorque SMB - 000-5       |             | Press. (psia)          | 74                     | 120                  | Test *        |             | a separate test (ref. 7)                                           |
|      | Limatorque SMB - 000         |             | Rel. Hum.              | 100%                   | 100%                 |               |             |                                                                    |
|      |                              |             | Radiation              | $2.8 \times 10^7$ rads | $2 \times 10^8$ rads |               |             |                                                                    |
|      |                              |             | Chem.                  | See Note 1             | pH=7.67              |               |             |                                                                    |
| d)   | Henry F. At Company          |             | Containment            |                        |                      |               | 6,7         | *Borated Spray was used in a                                       |
|      | Butterfly Valve              | Short Term  | Temp. (°F)             | 286                    | 340                  | Sequential    |             | separate test (ref. 7)                                             |
|      |                              |             | Press. (psia)          | 74                     | 120                  | Test*         |             |                                                                    |
|      | Limatorque SMB-3             |             | Rel. Hum.              | 100%                   | 100%                 |               |             |                                                                    |
|      |                              |             | Radiation              | $2.8 \times 10^7$ rads | $2 \times 10^8$ rads |               |             |                                                                    |
|      |                              |             | Chem.                  | See Note 1             | pH=7.67              |               |             |                                                                    |

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PLANT NAME: Arkansas Nuclear One - Unit 1

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| ITEM | EQUIPMENT DESCRIPTION             | TIME REQ'D. | ENVIRONMENT (LOCATION) |                        |                      | QUAL. METHOD* | DOC. REF.** | REMARKS                                 |
|------|-----------------------------------|-------------|------------------------|------------------------|----------------------|---------------|-------------|-----------------------------------------|
|      |                                   |             | PARAMETER              | SPEC.                  | QUAL.                |               |             |                                         |
| e)   | Hammel Dahl (ITT) Butterfly Valve |             | Containment            |                        |                      |               | 6,7         | *Borated Spray was used in              |
|      | Limitorque SMB-3                  | Short Term  | Temp. ( $^{\circ}$ F)  | 286                    | 340                  | Sequential    |             | a separate test (ref. 7)                |
|      |                                   |             | Press. (psia)          | 74                     | 120                  | Test*         |             |                                         |
|      |                                   |             | Rel. Hum.              | 100%                   | 100%                 |               |             |                                         |
|      |                                   |             | Radiation              | $2.8 \times 10^7$ rads | $2 \times 10^8$ rads |               |             |                                         |
|      |                                   |             | Chem.                  | See Note 1             | pH=7.67              |               |             |                                         |
| f)   | Hammel Dahl (ITT) Globe Valve     |             | Containment            |                        |                      |               | 6,7         | *Borated Spray was used in              |
|      | Limitorque SMB-000-2              | Short Term  | Temp. ( $^{\circ}$ F)  | 286                    | 340                  | Sequential    |             | a separate test (ref. 7)                |
|      |                                   |             | Press. (psia)          | 74                     | 120                  | Test*         |             |                                         |
|      |                                   |             | Rel. Hum.              | 100%                   | 100%                 |               |             |                                         |
|      |                                   |             | Radiation              | $2.8 \times 10^7$ rads | $2 \times 10^8$ rads |               |             |                                         |
|      |                                   |             | Chem.                  | See Note 1             | pH=7.67              |               |             |                                         |
| 3    | Sample System Containment         |             | Containment            |                        |                      | Sequential    | 6,7         | *Borated Spray was used in              |
|      | Isolation Valve                   | Long Term   | Temp. ( $^{\circ}$ F)  | 286                    | 340                  | Test*         |             | a separate test (ref. 7)                |
|      |                                   |             | Press. (psia)          | 79                     | 120                  |               |             |                                         |
|      | Velan Engineering Gate Valve      |             | Rel. Hum.              | 100%                   | 100%                 |               |             |                                         |
|      | Limitorque SMB-000-5              |             | Radiation              | $2.8 \times 10^7$ rads | $2 \times 10^8$ rads |               |             |                                         |
|      |                                   |             | Chem.                  | Boric acid spray       | pH=7.67              |               |             |                                         |
| 4    | Decay Heat Removal Letdown        | Long Term   | Containment            |                        |                      |               |             | Radiation aging of $2 \times 10^8$ rads |
|      | Valve                             |             | Temp. ( $^{\circ}$ F)  | 286                    | 370                  | Sequential    | 3,4,5       | was performed, seals and                |
|      |                                   |             | Press. (ps)            | 74                     | 85                   | Test*         |             | O-rings were aged with $6 \times 10^7$  |
|      |                                   |             | Rel. Hum.              | 100%                   | 100%                 |               |             | rads.                                   |
|      | Velan Engineering                 |             | Radiation              | $2.8 \times 10^7$ rads | $2 \times 10^8$ rads |               |             | *Borated Spray was used in a            |
|      | Rotork Type NAL                   |             | Chem.                  | Boric acid spray       | pH=10.5              |               |             | separate test (ref. 5)                  |

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| ITEM | EQUIPMENT DESCRIPTION                                                                                                   | TIME REQ'D. | ENVIRONMENT (LOCATION)                                                                   |                                                               |                                                                | QUAL. METHOD*               | DOC. REF.** | REMARKS                                                                                                |
|------|-------------------------------------------------------------------------------------------------------------------------|-------------|------------------------------------------------------------------------------------------|---------------------------------------------------------------|----------------------------------------------------------------|-----------------------------|-------------|--------------------------------------------------------------------------------------------------------|
|      |                                                                                                                         |             | PARAMETER                                                                                | SPEC.                                                         | QUAL.                                                          |                             |             |                                                                                                        |
| 5    | Containment Cooling Unit Supply Fan<br>Joy Manufacturer Company<br>Model 42-26-1770<br>Reliance Motor (TEAO) 1.0/75 hp. | Long Term   | Containment<br>Temp. ( $^{\circ}$ F)<br>Press. (psia)<br>Rel. Hum.<br>Radiation<br>Chem. | 286<br>74<br>100%<br>$2.8 \times 10^7$ rads                   | 300<br>95<br>100%<br>$9 \times 10^8$ rads                      | Sequential<br>Test          | 8           | Spray included combinations of boric acid, Sodium Hydroxide Sodium Thiosulfate and Potassium Hydroxide |
| 6    | Containment Cooling Unit Damper Operator<br>General Electric<br>5BCD56BAY                                               | Short Term  | Containment<br>Temp. ( $^{\circ}$ F)<br>Press. (psia)<br>Rel. Hum.<br>Radiation<br>Chem. | 286<br>71.3<br>100%<br>—<br>—                                 | 286<br>74<br>100%<br>—<br>—                                    | Test                        | 9           | Short term-no radiation or chemical spray required                                                     |
| 7    | Electrical Penetration Assemblies,<br>Conax 2325-8076<br>Conax 2325-8077<br>Conax 2325-8205                             | Long Term   | Containment<br>Temp. ( $^{\circ}$ F)<br>Press. (psia)<br>Rel. Hum.<br>Radiation<br>Chem. | 300<br>80<br>100%<br>$3 \times 10^6$ rads<br>Boric acid spray | 325<br>100<br>100%<br>$1 \times 10^8$ rads<br>Boric acid spray | Separate<br>Effects<br>Test | 10,11,12    | Chemical solution was 1900 ppm Boron.                                                                  |
| 8    | Reactor Coolant Flow Transmitter<br>Bailey Meter Company<br>BY 3X41-A                                                   |             | Containment<br>Temp. ( $^{\circ}$ F)<br>Press. (psia)<br>Rel. Hum.<br>Radiation<br>Chem. | 286<br>74<br>100%<br>$2.8 \times 10^7$ rads<br>See Note 1     | 296<br>85<br>100%<br>$5 \times 10^4$ rads<br>N/A               | Sequential<br>Test          | 13          |                                                                                                        |

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 Use limiting environment where more than one applies. \*\*Please attach typed lists of reference documents

| ITEM | EQUIPMENT DESCRIPTION                | TIME REQ'D. | ENVIRONMENT (LOCATION)  |                          |                          | QUAL. METHOD* | DOC. REF** | REMARKS                         |
|------|--------------------------------------|-------------|-------------------------|--------------------------|--------------------------|---------------|------------|---------------------------------|
|      |                                      |             | PARAMETER               | SPEC.                    | QUAL.                    |               |            |                                 |
| 9    | Reactor Coolant Pressure Transmitter | Short Term  | Containment             |                          |                          |               |            | Provides a trip function        |
|      |                                      |             | Temp. ( <sup>o</sup> F) | 286                      | 318                      | Sequential    | 13         | in the short term. Should       |
|      |                                      |             | Press. (psia)           | 74                       | 105                      | Test          |            | not see chemical spray.         |
| a)   | Foxboro E11GM-1NM2                   |             | Rel. Hum.               | 100%                     | 100%                     |               |            | Radiation equal to normal       |
|      | Foxboro E11GM-SAE1                   |             | Radiation               | 2.8x10 <sup>7</sup> rads | 2.4x10 <sup>4</sup> rads |               |            | operating dose                  |
|      |                                      |             | Chem.                   | See Note 1               | N/A                      |               |            |                                 |
| b)   | Fischer and Porter 50EN              |             | Containment             |                          |                          |               |            |                                 |
|      |                                      |             | Temp. ( <sup>o</sup> F) | 286                      | 320                      | Separate      | 14,15,16   | Provides trip function          |
|      |                                      |             | Press. (psia)           | 74                       | 90                       | Effects       |            | short term. Will not see        |
|      |                                      |             | Rel. Hum.               | 100%                     | 100%                     | Test          |            | chemical spray. Actual          |
|      |                                      |             | Radiation               | 2.8x10 <sup>7</sup> rads | 1x10 <sup>7</sup> rads   |               |            | radiation dosage equal to       |
|      |                                      |             | Chem.                   | See Note 1               | N/A                      |               |            | normal operating dosage         |
| 10   | Reactor Coolant Temperature Element  |             | Containment             |                          |                          |               |            |                                 |
|      |                                      |             | Temp. ( <sup>o</sup> F) | 286                      | 600F                     | Separate      | 13         | Silicone rubber electrical      |
|      |                                      |             | Press. (psia)           | 74                       | 3140                     | Effects       |            | insulation was radiation tested |
|      |                                      |             | Rel. Hum.               | 100%                     | 100%                     | Test          |            | to 1x10 <sup>8</sup> rads.      |
|      |                                      |             | Radiation               | 2.8x10 <sup>7</sup> rads | 1x10 <sup>8</sup> rads   |               |            |                                 |
|      | Rosemount RTD-177GY                  |             | Chem.                   | See Note 1               | N/A                      |               |            |                                 |
| 11   | Linear Neutron Flux Monitor          |             |                         |                          |                          |               |            |                                 |
|      |                                      |             | Temp. ( <sup>o</sup> F) | See Note 2               | 212                      |               | 13         |                                 |
|      |                                      |             | Press. (psia)           |                          | 165                      |               |            |                                 |
|      |                                      |             | Rel. Hum.               |                          | 100%                     |               |            |                                 |
|      |                                      |             | Radiation               |                          | —                        |               |            |                                 |
|      | Neutron Flux Monitor                 |             | Chem.                   |                          | N/A                      |               |            |                                 |

This list is a compilation of items by component. Do not list the same type of component more than once. \*ie, separate effects, sequential, etc.  
 Use limiting environment where more than one applies. \*\*Please attach typed lists of reference documents

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Notes:

1. These devices are required for short term operation only (i.e., within the first minute after an accident), and therefore would not be affected by chemical spray.
2. The power range detectors are not required for LOCA protection. These detectors are provided for protection against abnormal power excursions and are required to function within the first 15 seconds following an excursion. Therefore, because of the short-term actuating time and the protection afforded by the detector well, the power range detectors will not be exposed to a hostile environment prior to performing their protective function.

## References

1. Okonite Engineering Report No. 110E, "Nuclear Qualification Tests on Insulating Compounds."
2. Boston Insulated Wire and Cable Company letter, "Specification for Instrumentation and Special Cable for Arkansas Power & Light Company, Arkansas Nuclear One."
3. Rotork NA Equipment Specification Manual, "Valve Actuators for Nuclear Service."
4. Rotork Technical Report TR 116, "Qualification Records for Type NA Valve Actuators (Nuclear Class IE)."
5. Rotork Rechnical Report No. NQR 050-TR178, "Submersion Test of Type NA Actuator."
6. Franklin Institute Report F-C3441, "Qualification Test of Limitorque Valve Operators in a Simulated Reactor Containment Post-Accident Steam Environment."
7. Franklin Institute Report F-C2232-01, "Test of a Limitorque Valve Operator under a Simulated Reactor Containment Post-Accident Steam Environment."
8. Joy Axivane Fan Test, "Qualification Test of a Fan and Motor Designed for Service in Nuclear Containment."
9. General Electric letter, December 6, 1971.
10. Conax Corporation Report No. IPS-48, Prototype Test Report of Penetration Assemblies."
11. Conax Corporation Report No. ER-1097, "Thermal Analysis of Steam Jet Impact on Penetration Enclosure."
12. Conax Corporation Report No. IPS-27, "Gamma Irradiation of Kapton Insulated Conductors and Polysuflone Sealant in Conax Electrical Feedthrough Assembly."
13. Babcock and Wilcox Topical Report BAW-10003A, Rev. 4, "Qualification Testing of Protection System Instrutmentation," January, 1976.
14. Franklin Institute Research Laboratories Report F-C2815, "Qualification Tests of Differential Pressure Transmitters Under Nuclear Irradiation".
15. Fisher & Porter Letter, April 30, 1973.
16. Fisher & Porter Engineering Report #DP-2204-51-006, "Special High Temperature Steam Application."

SUMMARY  
ANO-2 - ENVIRONMENTAL QUALIFICATION OF SAFETY-RELATED  
ELECTRICAL EQUIPMENT INSIDE CONTAINMENT

Equipment which is located inside containment and required to be operational following a postulated LOCA or MSLB is listed in FSAR Section 3.11.1, paragraphs A and B. The integrated LOCA Temperature - Pressure profile for ANO-2 is considerably more severe than the MSLB Temperature - Pressure profile defined in accordance with the CSB Interim Evaluation Model. The peak MSLB temperature exceeds the peak LOCA temperature for a short period of time. However, heat transfer calculations indicate that component internal temperatures are lower for MSLB than LOCA due to the short lifetime of the high MSLB temperatures. Therefore qualification of equipment to the LOCA spectrum is more severe than qualification to the MSLB spectrum and will justify qualification for MSLB.

The required qualification envelope is defined in Section 6.2 of the ANO-2 FSAR. Figure 6.2-8 shows the DBA pressure profile, Figure 6.2-13 shows the DBA temperature profile and Figures 6.2-26 and 6.2-27 show the spray pH envelope. Those requirements are the same for all of the equipment although some equipment may not have to operate during all phases of the accident (e.g., hydrogen recombiners and containment isolation valves). The required integrated lifetime radiation dose, including a LOCA, for all of the equipment is  $3.3 \times 10^7$  rads unless otherwise stated in the summary. Because of the conservatism

of the calculations which determined the above requirements, additional margin was not always a requirement.

Unless otherwise specified, all qualification test reports are available in the offices of Arkansas Power and Light, Little Rock, Arkansas.

A. Category I-A - Short Term Operability Required

1. Pressurizer Pressure Sensor - See B.6 below.
2. Steam Generator Pressure Sensor - See B.8 below
3. Valves and Valve Controllers for the SIS, CIS and CSS -  
Only valve actuators are classified as IE equipment.  
The safety injection tank isolation valves do not have to change position and thus actuator qualification is not required. However, the actuators are Limitorque type SMB's which are qualified for post LOCA service.  
Two types of valve operators are supplied for containment isolation valves. All CIS motor operators are Limitorque type SMB. These operators have been extensively tested on numerous occasions under conditions much more severe than the ANO-2 requirements. Figure 3, page 3-5 of Franklin Institute Report F-C3441 (attachment 1) shows the test envelope. In addition, Franklin Institute Report F-C2232-01 documents a 7-day test in which a borated spray with a pH of 7.67 was applied. Radiation exposure of  $2 \times 10^8$  rads was applied to the a-c motor actuators.

The second type of CIS valve operator is a direct acting solenoid valve supplied by Target Rock Corp. (TRC). A prototype valve was irradiated to  $3.3 \times 10^7$  rads and then subjected to a steam/air atmosphere with the following profile (100% relative humidity):

| <u>Time</u>    | <u>Pressure (psig)</u> | <u>Temperature (F)</u>     |
|----------------|------------------------|----------------------------|
| 0 - 10 sec     | 0-70                   | ambient to 300             |
| 10 sec - 5 min | 70-104                 | 300 - 340                  |
| 5 min - 3 hr   | 104                    | 340                        |
| 3 hr - 5 hr    | 104-0                  | 340 to ambient             |
| 5 hr - 10 hr   |                        | Repeat 0 - 5 hour sequence |
| 10 hr - 14 hr  | 25                     | 250                        |
| 14 hr - 30 da  | 0                      | 200                        |

An additional test, following a similar test profile, was performed on another TRC valve of the same type with the addition of borated water to the steam (boric acid, sodium thiosulfate and sodium hydroxide - pH 10.5). Each test had a minor malfunction, neither of which was directly attributable to the adverse environment. A careful review of TRC reports 1500 and 1827B concluded that the TRC valves are acceptable for containment isolation service after coils which may have been manufactured with a defect are replaced with coils manufactured by a revised process which eliminated the potential defect (kink in wire). These coils have been replaced in valves used at ANO-2.

There are no valve actuators associated with the containment spray system inside the containment (see B.12 below for a discussion of the containment sump isolation valves).

4. Electrical Cables and Penetration Assemblies - See B.13 below.

B. Category I-B - Long Term Operability Required

1. Containment Sump Level Sensors - These are float operated reed switch type units supplied by GEMS/DeLaval. Radiation exposure prior to environmental test was  $2 \times 10^8$  rads. The unit underwent two tests, one long term and a subsequent short term test under more severe conditions.

| <u>Time</u>        | <u>Temperature (F)</u> | <u>Pressure (psia)</u> | <u>Humidity</u> |
|--------------------|------------------------|------------------------|-----------------|
| 0 to 10 sec        | 70 to 280              | Atm to 63              | 100%            |
| 10 sec to 1 hr     | 282                    | 59                     | 100%            |
| 1 to 1-1/2 hr      | 282 to 150             | 59 to 13.5             | 100%            |
| *1-1/2 hr to 14 da | 150                    | 13.5                   | 100%            |

\*(During this period, the failure of a vacuum control valve and a heater caused the pressure to drop to 3 psia and the temperature to drop to 95F respectively at the 6th and 296th hour. The first incident lasted overnight and the second lasted 16 hours.)

In addition to the above, the same sensor was exposed to steam and chemical spray as follows:

| <u>Time</u>   | <u>Temperature (F)</u> | <u>Pressure (psig)</u> | <u>Remarks</u>                                                                                 |
|---------------|------------------------|------------------------|------------------------------------------------------------------------------------------------|
| 0 to 8 min    | 70 to 300              | Atm to 56              | Steam and chemical spray (15,000 ppm boric acid with sodium hydroxide added to obtain 10.5 pH) |
| 8 min to 4 hr | 298 ± 2                | 55 ± 5                 | Intermittent steam and chemical spray.                                                         |

These results are documented, respectively, in Franklin Institute Report F-C3834 and Isomedix Report "Environmental Exposure of Liquid Level Sensor" dated November 1975.

2. Containment Spray Headers - No Class IE parts.
3. Containment Cooling Units - The only Class IE parts are the main cooling fan motors and the bypass damper motors.

The cooling fan motors are manufactured by Reliance and were tested by Joy Manufacturing Co. as part of a Joy axivane fan unit. The test program is detailed in a report entitled "Qualification Test of a Fan and Motor Designed for Service in Nuclear Containment".

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The prototype was pre-aged thermally and seismically. All materials of construction were selected to be capable of withstanding  $10^9$  rads. Radiation aging was not done. The unit was subjected to two sequential long term tests, each of which began with five temperature/pressure cycles from ambient to approximately 80 psig/300F over a period of 25 hours. The first test was followed by 7 days at 15 psig/200F. The second test was followed by 11 days at approximately 20 psig/200F. Combinations of chemical spray including boric acid, sodium hydroxide, sodium thiosulfate and potassium hydroxide were injected individually and in combination throughout the entire long term test. Additionally, a series of short term transient tests were run wherein chamber pressure was raised from 0 to 80 psig in 8-10 seconds. Motor internal pressure equalized with external pressure within 12 seconds for all modes of operation.

In addition, environmental qualification testing was performed on the bypass damper motor. The bypass damper motor is manufactured by Baldor and is totally enclosed and fan cooled. The Baldor motor was radiation aged to  $1 \times 10^5$  rads and was then subjected to random bi-axial seismic testing in accordance with IEEE 344-1975. Due to the location of the bypass damper motors within the containment and since they will have performed their intended function prior to being subjected to post-LOCA radiation levels, radiation aging the motor to  $1 \times 10^5$  rads is conservative.



Following radiation aging and seismic testing, the motor was placed in the test chamber and the temperature was raised to 120F for a period of 2 hours. After this soaking period, the motor was verified to be operable and was then subjected to a temperature/pressure transient from 0 psig/120F to approximately 60 psig/300F within 60 seconds. The motor was operated for periods of 15 seconds at 30 seconds into the transient and again at 60 seconds into the transient. The steam flow into the chamber was terminated following the second functional test and the test chamber environment was allowed to reach approximately 0 psig/300F and the motor was again verified to be functional. These results are documented in Wyle Test Report No. 58315.

Since the bypass damper motors are only required to be functional for less than 2.5 seconds following a LOCA or MSLB, the environmental test of the Baldor motor adequately qualifies it for use as a bypass damper motor.

4. Containment Recirculation Fans - These are Joy axivane fans qualified as in B.3 above.
5. Hydrogen Recombiners - The hydrogen recombiners are Westinghouse units which thermally recombine hydrogen and oxygen by the use of electric heating coils. The environmental qualification program consisted of a series of tests, some of which were run on a prototype recombiner and the

balance of which were run on production components. Because the recombiners have no moving parts, this combined program was deemed acceptable.

The recombiners are manually energized some time after a LOCA. Conservative calculations indicate that the recombiners will not be required earlier than 3 days post LOCA (see FSAR Section 6.2.5).

Spray tests on a prototype unit were performed with sodium tetraborate and sodium hydroxide at a pH of 10. Steam and air were applied to raise the ambient temperature to 225F. Ambient temperature is not a significant parameter as the internal temperature is above 1200F for all modes of operation.

Individual production components were tested for radiation resistance,  $2 \times 10^8$  rads; long term temperature and pressure, 70 psig for four hours followed by 22 days at 20 psig/155F ambient; and a long term spray test, 10 days at a pH of 10. The test results are documented in Westinghouse proprietary report WCAP-7709-L, Supplements 1, 2, 3 and 4. These units are identical to Westinghouse units supplied to numerous utilities for use inside containments on at least 28 nuclear plants.

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6. Pressurizer Pressure Sensors - There are two types of pressure transmitters. The high pressure trip utilizes Foxboro E11GM transmitters. The low pressure trip utilizes Rosemount 1153-GA9 transmitters. Both the Foxboro model and the entire 1153-A series were qualified by sequential testing as documented in Wyle Test Report No. 26304 Rev. 1 and its corresponding supplement. The transmitters were irradiated at a rate of  $1 (10^6)$  rads per hour to a total integrated dose of  $3.7 (10^7)$  rads. Following irradiation, seismic testing was performed in accordance with IEEE 344-1975 (biaxial, randomwave form) over a frequency range of 1.25 to 35 Hz in the horizontal and vertical axes. The seismic random motion for each horizontal axis was excited separately, but each one was excited simultaneously with the vertical axis. A total of five Operating Basis Earthquake (OBE) tests and two Safe Shutdown Earthquake (SSE) tests (all of thirty seconds duration) were performed in each axis. Final testing consisted of exposure to a pressure/temperature profile of 100% relative humidity for a simulated LOCA as shown in Figure 3, page 21 of the above report (attachment 2).

During the first 24 hours of the test profile the transmitters were subjected to chemical spray composed of an  $H_3BO_3$  - NaOH mixture of pH equal to 11.

7. Pressurizer Level Sensors - These are Rosemount 1153 HA5 discussed above in B.6.

8. Steam Generator Pressure Sensors - These are Rosemount 1153 GA9 discussed above in B.6.
9. Steam Generator Level Sensors - These Rosemount 1153 DA4 discussed above in B.6.
10. Containment Pressure Transmitters - These are Rosemount Model 1153 GA7 discussed in B.6.
11. Containment Radiation Monitors (PAM) - At the present time radiation detectors are undergoing qualification. In the interim, monitoring of post LOCA radiation can be accomplished using shielding calculations discussed in FSAR 12.1.2.7 and handheld radiation detectors outside containment at specified locations. This method (described in detail in our letters from Daniel H. Williams to J. F. Stolz dated August 31, 1978, and September 14, 1978) will remain in plant procedures until our permanent Post Accident Radiation Monitors are acceptably qualified.
12. Associated Valves and Piping - The only Class IE components not previously discussed are the containment sump isolation valve actuators and two pressurized vent valves which are d-c Limitorques.

The containment sump isolation valve actuators are specially tested submersible Rotork Type NA1. Radiation aging to  $2 \times 10^8$  rads was performed except for seals and "O" rings which received  $6 \times 10^7$  rads. Rotork Technical Report No. TR 116 documents qualification. The test profile was:

| <u>Time</u>                    | <u>Pressure (psig)</u> | <u>Temperature (F)</u> |
|--------------------------------|------------------------|------------------------|
| 0 - 10 sec                     | 0 - 80                 | 140 - 300              |
| 10 sec - 5 min                 | 80                     | 300 - 380              |
| 5 min - 3 hr                   | 67                     | 380 - 330              |
| 3 hr - 5 hr                    | 67 - 0                 | 330 - 60               |
| 2 days delay then second cycle |                        |                        |
| 0 - 10 sec                     | 0 - 67                 | 60 - 280               |
| 10 sec - 5 min                 | 67                     | 280 - 380              |
| 5 min - 3 hr                   | 64                     | 380 - 330              |
| 3 hr - 6 hr                    | 64 - 100               | 330 - 270              |
| 6 hr - 4 da                    | 100 - 30               | Approx 250             |
| 4 da - 36 da                   | Approx 20              | Approx 250             |

Water spray was applied after 5 min in both cycles of the test. The operator was cycled 35 times during the test. After the second test cycle, the operator was completely submerged for 6 hours. The operator functioned properly at the beginning, middle and end of the six-hour test.

A supplemental test on a Rotork operator is documented in Rotork Technical Report TR-178, Rev. 1. This test consisted of 30 days of submerged operation in a solution of sodium hydroxide, boric acid and sodium thiosulfate with a pH of 10.5. Test chamber pressure was cycled 0-70 psig in 10 seconds twice and long term pressure was at least 15 psig. This test was run at 50F.

The d-c Limitorque valves are used in the pressurizer ECCS vent line. They are required to be operable only in the event of a small break in order to allow a minimum flow through the core. The actuator is a standard SMB except that a d-c motor is used. A limited test was run on a pre-aged d-c operator. The operator was subjected to 340F for 1 hour followed by 2 hours at 330F, 3 hours at 310F and 18 hours at 212F. This is documented in Limitorque Corporation Test Laboratory Test No. B-0009 dated 4-30-76. Radiation qualification of the d-c motor is  $1 \times 10^7$  rads. This is acceptable because the source term for small LOCA's is 3 to 4 orders of magnitude lower than for a large LOCA.

13. Electrical Cable and Penetration Assemblies - Penetration assembly qualification has been documented in Amphenol Test reports #123-1247 and #123-2045 Rev. A.

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Following irradiation to a total integrated dose of  $1 \times 10^8$  rads, the test modules (EPAs) were subjected to a LOCA environment of maximum temperature and pressure of 309F - 63 psig saturated air for 25 hrs. The pH of the steam vapor was adjusted until a pH value of 10.5 was obtained. Based on the test data for irradiation and LOCA the EPAs fully meet the qualification requirements.

Electrical power cable (low and medium voltage) and some control cable required to remain functional post LOCA were supplied by Anaconda Wire and Cable Company. Franklin Institute Report F-C3341 documents qualification of energized cable under simultaneous exposure to radiation, steam and chemical spray. The test samples were pre-aged to  $5 \times 10^7$  rads with thermal exposure to 250F for 7 days. The LOCA simulation profile was as follows:

| <u>Time</u>          | <u>Pressure (psig)</u> | <u>Temperature (F)</u> |
|----------------------|------------------------|------------------------|
| 0 - 30 sec           | 0 - 40                 | 75 - 266               |
| 30 sec - 3 hr        | 40 - 105               | 266 - 340              |
| 3 hr - 6.5 hr        | 75                     | 320                    |
| 6.5 hr - 4 da        | 15                     | 250                    |
| 4 da - 13 da + 15 hr | 5                      | 210                    |

Chemical spray of 3000 ppm boron as boric acid buffered with sodium hydroxide to a pH of 9.5 was applied throughout the above LOCA test. Irradiation of  $1 \times 10^8$  rads was applied

during the LOCA test. Post test aging to simulate long term exposure was also conducted. An additional  $5 \times 10^7$  rads was applied over 5 days at 75F and 0 psig. Then the cables were subjected to an additional 47 days at 200F/0 psig and the same chemical spray noted above.

A subsequent test was performed to IEEE-323-1974 standards including radiation exposure to  $2 \times 10^8$  rads and exposure to 346F and 113 psig for 8 hours, with the spray pH in the 9-11 range. This test is documented in Franklin Test Report F-C4350-3.

The balance of the control cable and all coaxial cable required for post-LOCA operation was supplied by Raychem Corp. The control cable was subjected to numerous tests involving pre-aged (thermal and radiation) and non-aged samples. Radiation aging was to  $1 \times 10^8$  rads on some samples. Transients to 370F/65 psig were accomplished. The cable was subjected to temperatures above 360F (maximum 370F) for twenty-four (24) hours, and pressures above 54 psig (maximum 75 psig) for twenty-five (25) hours.

Test duration was approximately 31 hours. Specimens were irradiated as well as being immersed in a boric acid solution buffered to a pH of 7-8. Raychem report EM#517A provides this documentation. Raychem has also supplied



copies of tests run for other utilities and these are available either at the plant site or at Bechtel in San Francisco.

Coaxial cable was subjected to a very similar test program. Water pH was also 7-8. Peak values of temperature and pressure were on the order of 360F and 80 psig.

The cable was subjected to temperatures above 340F for eight (8) hours (maximum 413F) and continuously above 360F for over five (5) hours, and pressures above 52 psig (maximum 78 psig) for over seven (7) hours and continuously above 58 psig for over five (5) hours. Results are documented in Raychem test report EM#518A.

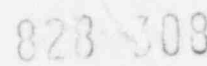
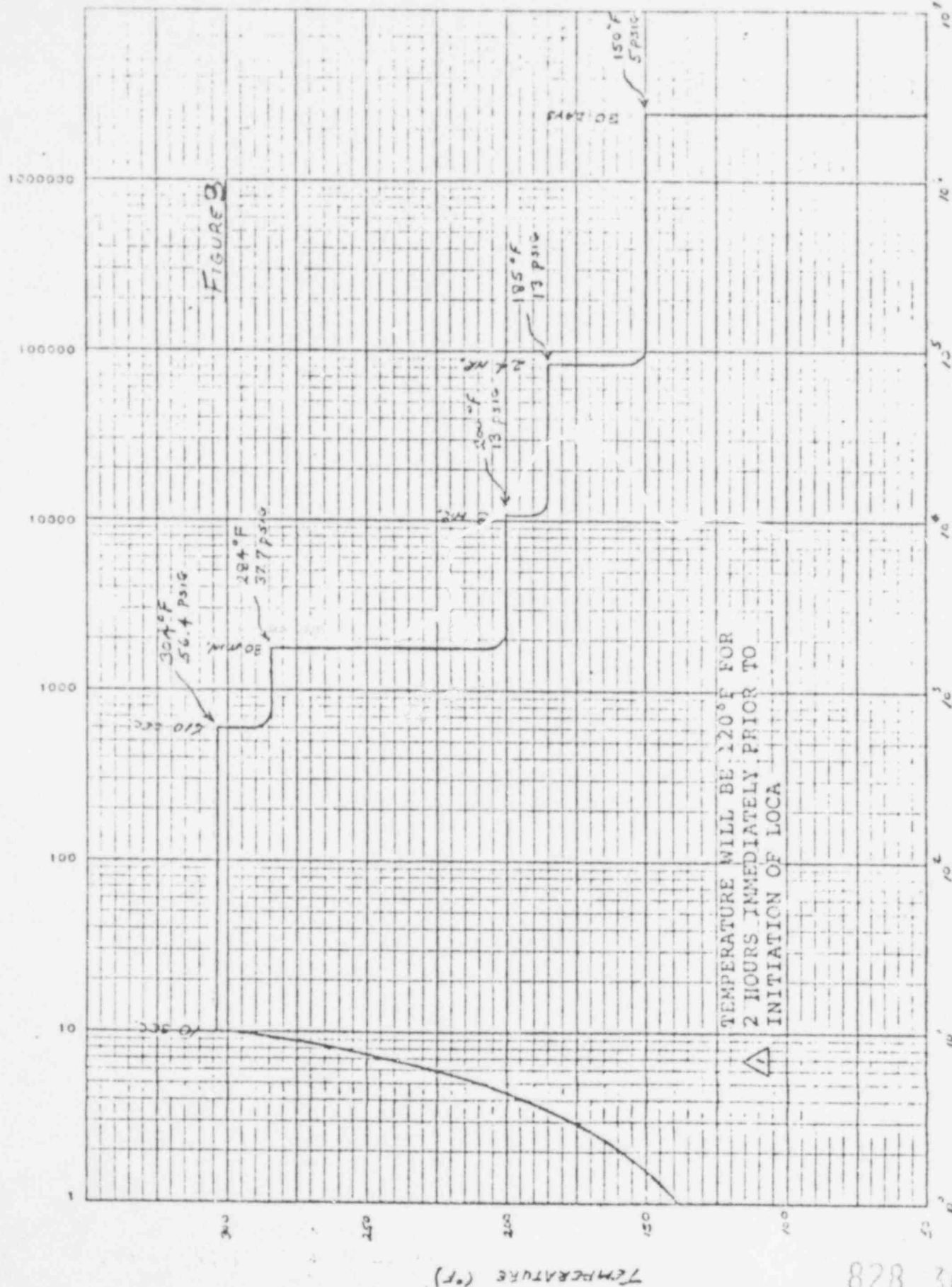


Figure 3. Actual Steam Exposure Profile



Time - AIRR LOC - SEC.

FIGURE 3 LOCA PROFILES

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| ITEM | EQUIPMENT DESCRIPTION       | TIME REQ'D. | ENVIRONMENT (LOCATION) |                               |                        | QUAL. METHOD* | DOC. REF.** | REMARKS                                            |
|------|-----------------------------|-------------|------------------------|-------------------------------|------------------------|---------------|-------------|----------------------------------------------------|
|      |                             |             | PARAMETER              | SPEC.                         | QUAL.                  |               |             |                                                    |
| 1    | Valve operators for SIS,    |             | Containment            |                               |                        |               |             |                                                    |
| a)   | CIS, and CSS                | Short Term  | Temp. ( $^{\circ}$ F)  | 289                           | 340                    | Sequential*   | 1, 2        |                                                    |
|      | (a-c) Limitorque Type       |             | Press. (psia)          | 69                            | 120                    | Test          |             |                                                    |
|      | SMB-0                       |             | Rel. Hum.              | 100%                          | 100%                   |               |             | *Borated spray was used in a separate test (ref.2) |
|      |                             |             | Radiation              | $3.3 \times 10^7$             | $2 \times 10^8$ rads   |               |             |                                                    |
|      |                             |             | Chem.                  | pH=10.5(nominal) <sup>+</sup> | pH=7.67                |               |             |                                                    |
| b)   | Target Rock Corporation     |             | Containment            |                               |                        |               |             |                                                    |
|      | Solenoid Valves             | Short Term  | Temp. ( $^{\circ}$ F)  | 289                           | 340                    | Sequential*   | 3, 4        | *Borated spray was used in a separate test (ref.4) |
|      | "I" Y pattern               |             | Press. (psia)          | 69                            | 120                    | Test          |             |                                                    |
|      |                             |             | Rel. Hum.              | 100%                          | 100%                   |               |             |                                                    |
|      |                             |             | Radiation              | $3.3 \times 10^7$             | $3.3 \times 10^7$ rads |               |             | Sodium Hydroxide Boric acid                        |
|      |                             |             | Chem.                  | pH=10.5(nominal)              | pH=10.5                |               |             | Sodium Thiosulfate Solution                        |
| 2    | Containment Sump Isolation  | Long Term   | Containment            |                               |                        |               |             | Radiation aging of $2 \times 10^8$                 |
|      | Valve Operators             |             | Temp. ( $^{\circ}$ F)  | 289                           | 370                    | Sequential*   | 5, 6        | rads was performed, Seals                          |
|      | Rotork Type NAI             |             | Press. (psia)          | 69                            | 85                     | Test          |             | and O-rings were aged with                         |
|      |                             |             | Rel. Hum.              | 100%                          | 100%                   |               |             | $6 \times 10^7$ rads                               |
|      |                             |             | Radiation              | $3.3 \times 10^7$             | $2 \times 10^8$ rads   |               |             | *Borated spray was used in a                       |
|      |                             |             | Chem.                  | pH=10.5(nominal)              | pH=10.5                |               |             | separate test(ref.6) same                          |
|      |                             |             |                        |                               |                        |               |             | solution as above.                                 |
| 3    | Pressurizer Vent Valve      | Long Term   | Containment            |                               |                        |               |             | Test was run on a pre-aged                         |
|      | Operators                   | (only for   | Temp. ( $^{\circ}$ F)  | 289                           | 340                    | Sequential    | 7           | operator.                                          |
|      | (d-c) Limitorque Type SMB-0 | small break | Press. (psia)          | 69                            | 118                    | Test          |             |                                                    |
|      |                             | LOCA)       | Rel. Hum.              | 100%                          | 100%                   |               |             |                                                    |
|      |                             |             | Radiation              | $3.3 \times 10^7$             | $1 \times 10^7$ rads   |               |             |                                                    |
|      |                             |             | Chem.                  | pH=10.5(nominal)              | -                      |               |             |                                                    |

This list is a compilation of items by component. Do not list the same type of component more than once. \*ie, separate effects, sequential, etc.  
 Use limiting environment where more than one applies. \*\*Please attach typed lists of reference documents  
<sup>+</sup>Post Accident Spray pH ranges from 8.9-11.

POOR ORIGINAL

PLANT NAME: \_\_\_\_\_

2

115 828 311

| ITEM            | EQUIPMENT DESCRIPTION         | TIME REQ'D. | ENVIRONMENT (LOCATION) |                   |                      | QUAL. METHOD* | DOC. REF** | REMARKS                 |
|-----------------|-------------------------------|-------------|------------------------|-------------------|----------------------|---------------|------------|-------------------------|
|                 |                               |             | PARAMETER              | SPEC.             | QUAL.                |               |            |                         |
| 4               | Electrical Penetration        | Long Term   | Containment            |                   |                      | Sequential    | 8, 9       |                         |
|                 | Assemblies Amphenol Unitized  |             | Temp. ( $^{\circ}$ F)  | 289               | 309                  | Test          |            |                         |
| Header          | PCA's medium voltage 750 MCM  |             | Press. (psia)          | 69                | 78                   |               |            |                         |
| module,         | low voltage 5x350 MCM module, |             | Rel. Hum.              | 100%              | 100%                 |               |            |                         |
| Hybrid          | low voltage #4 AWG & #8AWG    |             | Radiation              | $3.3 \times 10^7$ | $1 \times 10^8$ rads |               |            |                         |
| Instrumentation | #16 AWG                       |             | Chem.                  | pH=10.5(nominal)  | pH=10.5              |               |            |                         |
| 5               | Power and Control Cable       | Long Term   | Containment            |                   |                      | Sequential    | 10, 11     | Tests were done on pre- |
|                 | Anaconda Wire and Cable Co.   |             | Temp. ( $^{\circ}$ F)  | 289               | 346                  | Test          |            | aged samples            |
| a)              | Control Cable                 |             | Press. (psia)          | 69                | 125                  |               |            |                         |
|                 | Ethylene Propylene Rubber     |             | Rel. Hum.              | 100%              | 100%                 |               |            |                         |
|                 | Insulation,                   |             | Radiation              | $3.3 \times 10^7$ | $2 \times 10^8$ rads |               |            |                         |
|                 | Hypalon Jacket                |             | Chem.                  | pH=10.5(nominal)  | pH=9-11              |               |            |                         |
| b)              | Low Voltage Power Cable       | Long Term   | Containment            |                   |                      | Sequential    | 10, 11     | Tests were done on pre- |
|                 | Ethylene Propylene Rubber     |             | Temp. ( $^{\circ}$ F)  | 289               | 346                  | Test          |            | aged samples            |
|                 | Insulation,                   |             | Press. (psia)          | 69                | 125                  |               |            |                         |
|                 | Hypalon Jacket                |             | Rel. Hum.              | 100%              | 100%                 |               |            |                         |
|                 |                               |             | Radiation              | $3.3 \times 10^7$ | $2 \times 10^8$ rads |               |            |                         |
|                 |                               |             | Chem.                  | pH=10.5(nominal)  | pH=9-11              |               |            |                         |
| c)              | Medium Voltage Power Cable    | Long Term   | Containment            |                   |                      | Sequential    | 10, 11     | Tests were done on pre- |
|                 | Ethylene Propylene Rubber     |             | Temp. ( $^{\circ}$ F)  | 289               | 346                  | Test          |            | aged samples            |
|                 | Insulation,                   |             | Press. (psia)          | 69                | 125                  |               |            |                         |
|                 | Chlorinated Polyethylene      |             | Rel. Hum.              | 100%              | 100%                 |               |            |                         |
|                 | Jacket                        |             | Radiation              | $3.3 \times 10^7$ | $2 \times 10^8$ rads |               |            |                         |
|                 |                               |             | Chem.                  | pH=10.5(nominal)  | pH=9-11              |               |            |                         |

This list is a compilation of items by component. Do not list the same type of component more than once. \*ie, separate effects, sequential, etc.  
 Use limiting environment where more than one applies. \*\*Please attach typed lists of reference documents

POOR ORIGINAL

PLANT NAME: \_\_\_\_\_

828 312 3

| ITEM | EQUIPMENT DESCRIPTION       | TIME REQ'D. | ENVIRONMENT (LOCATION)       |                   |                      | QUAL. METHOD* | DOC. REF** | REMARKS                            |
|------|-----------------------------|-------------|------------------------------|-------------------|----------------------|---------------|------------|------------------------------------|
|      |                             |             | PARAMETER                    | SPEC.             | QUAL.                |               |            |                                    |
| 6    | Coaxial and Control Cable   | Long Term   | Containment                  |                   |                      | Sequential    | 12         | Radiation aging of $1 \times 10^8$ |
|      | Raychem Corp.               |             | Temp. ( $^{\circ}\text{F}$ ) | 289               | 370                  | Test          |            | radiation was done on some         |
|      | Flamtrol Jacket             |             | Press. (psia)                | 69                | 80                   |               |            | samples.                           |
|      |                             |             | Rel. Hum.                    | 100%              | 100%                 |               |            |                                    |
|      |                             |             | Radiation                    | $3.3 \times 10^7$ | $1 \times 10^8$ rads |               |            |                                    |
|      |                             |             | Chem.                        | pH=10.5(nominal)  | pH = 7-8             |               |            |                                    |
| 7    | Coaxial Cable               | Long Term   | Containment                  |                   |                      | Sequential    | 13         |                                    |
|      | Raychem Corp. 10483 Coaxial |             | Temp. ( $^{\circ}\text{F}$ ) | 289               | 370                  | Test          |            |                                    |
|      | Cable Flamtrol Jacket with  |             | Press. (psia)                | 69                | 80                   |               |            |                                    |
|      | 2 layers of insulation of   |             | Rel. Hum.                    | 100%              | 100%                 |               |            |                                    |
|      | Rayolin R and Alkane-Imide  |             | Radiation                    | $3.3 \times 10^7$ | $1 \times 10^8$ rads |               |            |                                    |
|      | Polymer.                    |             | Chem.                        | pH=10.5(nominal)  | pH = 7-8             |               |            |                                    |
| 8    | Hydrogen Recombiners        | Long Term   | Containment                  |                   |                      | Separate      | 14         | Temperature is unimportant as      |
|      | Westinghouse Hydrogen       |             | Temp. ( $^{\circ}\text{F}$ ) | 289               | -                    | Effects       |            | the internal temperature is        |
|      | Recombiners                 |             | Press. (psia)                | 69                | 85                   | Test          |            | above 1200 F for all modes of      |
|      |                             |             | Rel. Hum.                    | 100%              | 100%                 |               |            | operation.                         |
|      |                             |             | Radiation                    | $3.3 \times 10^7$ | $2 \times 10^8$ rads |               |            | Testing was done on individual     |
|      |                             |             | Chem.                        | pH=10.5(nominal)  | pH = 10              |               |            | components.                        |
| 9    | Containment Sump Level      | Long Term   | Containment                  |                   |                      | Sequential    | 15, 16     |                                    |
|      | Sensors                     |             | Temp. ( $^{\circ}\text{F}$ ) | 289               | 300                  | Test          |            |                                    |
|      | Gems/De Laval               |             | Press. (psia)                | 69                | 71                   |               |            |                                    |
|      | Model NM-56495              |             | Rel. Hum.                    | 100%              | 100%                 |               |            |                                    |
|      |                             |             | Radiation                    | $3.3 \times 10^7$ | $2 \times 10^8$ rads |               |            |                                    |
|      |                             |             | Chem.                        | pH=10.5(nominal)  | pH = 10.5            |               |            |                                    |

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POOR ORIGINAL



PLANT NAME: \_\_\_\_\_

POOR ORIGINAL

828 313

| ITEM | EQUIPMENT DESCRIPTION            | TIME REQ'D. | ENVIRONMENT (LOCATION) |                   |                        | QUAL. METHOD* | DOC. REF** | REMARKS                      |
|------|----------------------------------|-------------|------------------------|-------------------|------------------------|---------------|------------|------------------------------|
|      |                                  |             | PARAMETER              | SPEC.             | QUAL.                  |               |            |                              |
| 10   | Bypass damper motors             | 2.5 seconds | Containment            |                   |                        | Sequential    | 17         | Test conducted on pre-       |
|      | Baldor Part No. M3534            |             | Temp. ( $^{\circ}$ F)  | 289               | 300                    | Test          |            | aged motor.                  |
|      | 1/3 HP 460 vac. 3 phase motor    |             | Press. (psia)          | 69                | 75                     |               |            | Functions before being sub-  |
|      |                                  |             | Rel. Hum.              | 100%              | 100%                   |               |            | jected to LOCA environment.  |
|      |                                  |             | Radiation              | —                 | $1 \times 10^5$ rads   |               |            | Radiation equal to normal    |
|      |                                  |             | Chem.                  | pH=10.5(nominal)  | —                      |               |            | plant operating levels.      |
| 11   | Containment Recirculation        | Long Term   | Containment            |                   |                        | Sequential    | 18         | Spray included combinations  |
|      | Fans and Fan Motors              |             | Temp. ( $^{\circ}$ F)  | 289               | 300                    | Test          |            | of Boric acid, Sodium        |
|      | Joy Axivane Fans                 |             | Press. (psia)          | 69                | 95                     |               |            | Hydroxide, Sodium Thio-      |
|      | Model 42-26-1770                 |             | Rel. Hum.              | 100%              | 100%                   |               |            | sulfate and Potassium        |
|      | Reliance Motor (TEAO) 150/75 hp. |             | Radiation              | $3.3 \times 10^7$ | $9 \times 10^8$ rads   |               |            | Hydroxide                    |
|      |                                  |             | Chem.                  | pH=10.5(nominal)  | yes                    |               |            |                              |
| 12   | Hi-Pressure Transmitters         | Long Term   | Containment            |                   |                        | Sequential    | 19, 20     | Spray was a $H_3BO_3$ - NaOH |
|      | Foxboro E11GM                    |             | Temp. ( $^{\circ}$ F)  | 289               | 304                    | Test          |            | mixture                      |
|      |                                  |             | Press. (psia)          | 69                | 71                     |               |            |                              |
|      |                                  |             | Rel. Hum.              | 100%              | 100%                   |               |            |                              |
|      |                                  |             | Radiation              | $3.3 \times 10^7$ | $3.7 \times 10^7$ rads |               |            |                              |
|      |                                  |             | Chem.                  | pH=10.5(nominal)  | pH = 11                |               |            |                              |
| 13   | Low-Pressure and Pressure        | Long Term   | Containment            |                   |                        | Sequential    | 19, 20     |                              |
|      | Level - Transmitters             |             | Temp. ( $^{\circ}$ F)  | 289               | 304                    | Test          |            |                              |
|      | Rosemount Models , 1153 HA5      |             | Press. (psia)          | 69                | 71                     |               |            |                              |
|      | 1153 GA9                         |             | Rel. Hum.              | 100%              | 100%                   |               |            |                              |
|      | 1153 GA7                         |             | Radiation              | $3.3 \times 10^7$ | $3.7 \times 10^7$ rads |               |            |                              |
|      | 1153 DA4                         |             | Chem.                  | pH=10.5(nominal)  | pH = 11                |               |            |                              |

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PLANT NAME: \_\_\_\_\_

POOR ORIGINAL

828 114 5

| ITEM | EQUIPMENT DESCRIPTION          | TIME REQ'D. | ENVIRONMENT (LOCATION) |       |               | QUAL. METHOD* | DOC. REF** | REMARKS |
|------|--------------------------------|-------------|------------------------|-------|---------------|---------------|------------|---------|
|      |                                |             | PARAMETER              | SPEC. | QUAL.         |               |            |         |
| 14   | Containment Radiation Monitors | Long Term   | Containment            |       | Undergoing    |               |            |         |
|      |                                |             | Temp. (°F)             |       | Qualification |               |            |         |
|      |                                |             | Press. (psia)          |       |               |               |            |         |
|      |                                |             | Rel. Hum.              |       |               |               |            |         |
|      |                                |             | Radiation              |       |               |               |            |         |
|      |                                |             | Chem.                  |       |               |               |            |         |
|      |                                |             | Temp. (°F)             |       |               |               |            |         |
|      |                                |             | Press. (psia)          |       |               |               |            |         |
|      |                                |             | Rel. Hum.              |       |               |               |            |         |
|      |                                |             | Radiation              |       |               |               |            |         |
|      |                                |             | Chem.                  |       |               |               |            |         |
|      |                                |             | Temp. (°F)             |       |               |               |            |         |
|      |                                |             | Press. (psia)          |       |               |               |            |         |
|      |                                |             | Rel. Hum.              |       |               |               |            |         |
|      |                                |             | Radiation              |       |               |               |            |         |
|      |                                |             | Chem.                  |       |               |               |            |         |
|      |                                |             | Temp. (°F)             |       |               |               |            |         |
|      |                                |             | Press. (psia)          |       |               |               |            |         |
|      |                                |             | Rel. Hum.              |       |               |               |            |         |
|      |                                |             | Radiation              |       |               |               |            |         |
|      |                                |             | Chem.                  |       |               |               |            |         |

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- 1). Franklin Institute Report F-C3441, "Qualification Test of Limitorque Valve Operators in a Simulated Reactor Containment Post-Accident Steam Environment."
- 2). Franklin Institute Report F-C2232-01, "Test of a Limitorque Valve Operator Under a Simulated Reactor Containment Post-Accident Steam and Chemical Environment."
- 3). Target Rock Corporation Report 1500, "Environmental Test Report on TFC Model 72V Type, 1" 'Y' Pattern Solenoid Motor Valve Per Provisions of TR Test Procedure #1383."
- 4). Target Rock Corporation Report 182/B, "Environmental Test Report on TRC Model 75G-002, 1" 'Y' Pattern Solenoid Motor Valve Soft Seated, High Pressure Version Per Provisions of TR Test Procedure #1674."
- 5). Rotork Technical Report No. TR116, "Qualification Records for Type NA Valve Actuators (Nuclear Class 1E)."
- 6). Rotork Technical Report No. NQR 050-TR178 "Submersion Test of Type NA Actuator."
- 7). Limitorque Corporation Report No. B-0009, "Qualification Type Test Report Limitorque DC Valve Actuators for Nuclear Power Station Service Conditions."
- 8). Amphenol Report #123-1247 of "Loss of Coolant Accident Testing of Unitized Header Penetration Assemblies."
- 9). Amphenol Report #123-2045 Rev. A "Special Prototype Radiation and Environmental (LOCA) Tests of Medium and Low Voltage Electric Penetration Assembly."
- 10). Franklin Institute Report F-C3341 "Long Term Testing of Electrical Cables Under Simultaneous Exposure to Gamma Radiation, Steam and Chemical Spray."
- 11). Franklin Institute Report F-C4350-3 "Tests of Electrical Cables Subjected to Thermal Aging, Gamma Radiation, and a Loss of Coolant Accident Simulation."
- 12). Raychem Report #517A "The Effects of Radiation and Aging on Flamtrol Insulated Wire."
- 13). Raychem Report #518A "The Effects of Radiation and Aging on a Coaxial Cable."
- 14). Westinghouse Proprietary Report WCAP-7709-L, Supplements 1,2,3 and 4, "Electric Hydrogen Recombiner for PWR Containments."
- 15). Franklin Institute Report F-C3834 "Supplementary Test of a Liquid Level Sensor Under Conditions Simulating a Loss-of-Coolant Accident within the Containment of a Nuclear Power Generating Station."

- 16). Isomedix Report "Environmental Exposure of Liquid Level Sensor."
- 17). Wyle Labs Report #58315, "Loss of Coolant Accident (LOCA) Test on 3 Phase Electric Motor for Bechtel Power Corporation."
- 18). Joy Axivane Fan Test "Qualification Test of a Fan and Motor Designed for Service in Nuclear Containment."
- 19). Wyle Test Report #26304 Rev. 1 "Environmental Qualification Test Report on Foxboro Model E11AII, F & P Model 50EP1041 and 13D2496 and Rosemount Model 1153GA9 Transmitters."
- 20). Supplement to Wyle Test Report #26304 Rev. 1.

828 316