VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

R. H. LEASBURG
VICE PRESIDENT
NUCLEAR OPERATIONS

October 8, 1981

Mr. Harold R. Denton
Office of Nuclear Reactor Regulation
Attention: Mr. Robert A. Clark, Chief
Operating Reactors Branch No. 3
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Serial No. 550
PSE&C/JEW

Docket Nos. 50-338
50-339

License Nos. NPF-4
NPF-7

Dear Mr. Denton:

IE BULLETIN 79-01B SUPPLEMENT 3
TMI REVIEW
NORTH ANNA POWER STATION UNITS 1 AND 2

On August 31, 1981, Mr. L. B. Engle of the NRC requested that VEPCO supply certain Equipment Qualification information to Franklin Research Center (FRC). This information is required by FRC to complete the technical review of the TMI related equipment submitted in the VEPCO response to IE Bulletin 79-01B Supplement 3. The following documents were requested by FRC:

1. Babcock & Wilcox transmittal 86-1119091-00, Relief Valve Acoustical Monitoring.

2. Isomedix Inc., Component Testing Division, Environmental Exposure of Liquid Level Sensor dated November 17, 1975, for GEMS level detector, plant ID #LT-DA110A & B.

3. Environmental test report summaries of Foxboro products, the Foxboro Company transmitters, plant ID #PT-LM110A & B.

4. Westinghouse Electric Corporation letter NS-SS-79287 dated November 28, 1979, subject, Qualification of Electrical Equipment for Near Term OL Plants.

5. Letter from Milton Aron, (DeLaval, GEMS Sensor Division) to Arthur Murphy, Stone & Webster Engineering Corporation dated 7 May 1974.

6. GEMS level transmitter, plant ID #LT-RS-151A & B (test reports).

A048
S/1
Limited Distribution

By a copy of this letter, items 1 through 6 are being forwarded to Mr. C. J. Crane, FRC. Item 4, Westinghouse letter NS-SS-79287, was substituted for the originally requested item, Westinghouse document NAW-3601, per telecon between Mr. C. J. Crane, FRC and Mr. J. E. Wroniewicz, VEPCO on September 28, 1981.

Very truly yours,

R. H. Leasburg

JEW:cdk

cc: Mr. J. P. O'Reilly, Director w/o enclosure
Office of Inspection and Enforcement
Region II
101 Marietta Street, Suite 3100
Atlanta, Georgia 30303

Dr. Zoltan R. Rosztoczy, Branch Chief w/o enclosure
NRC Equipment Qualification Branch
Division of Engineering
Washington, D. C. 20555

Mr. Cyril J. Crane w/enclosure
Franklin Research Center
Parkway at Twentieth
Philadelphia, Pennsylvania 19103

CALCULATION DATA/TRANSMITTAL SHEET

DOCUMENT IDENTIFIER

CALC. 32 - ______ - ______

TRANS. 86 - 1119091 - 00

TYPE: ___ RESEARCH & DEVELOPMENT ___ SAFETY ANALYSIS REPORT ___ NUC. SERV. INPUT ___ DESIGN RQMT. X DESIGN VERIF. ___ OTHER

TITLE Valve Monitoring System Seismic and Environmental Test Program

PREPARED BY E. F. Pardue REVIEWED BY [signature]

TITLE Structural Engr. DATE 4-24-80 TITLE [illegible] DATE [illegible]

PURPOSE:

This package defines the environmental and seismic requirements to which the B&W valve monitoring system will be tested. The customer's individual requirements, as defined, are enveloped in this test program.

SUMMARY OF RESULTS (INCLUDE DOC. ID'S OF PREVIOUS TRANSMITTALS & SOURCE CALCULATIONAL PACKAGES FOR THIS TRANSMITTAL)

This report transmits the specific envelope requirements to which the VMS will be tested.

ED
For your info

Bob Carroll

Received NOTED [illegible] 1980 E.J.Adamson

Copy sent to Unit 2, R. DEMING

NOTED [illegible] 1980 E.J.Adamson

DISTRIBUTION

CONTENTS

1.0 INTRODUCTION

The Babcock & Wilcox Company Valve Monitoring System (VMS) is an acoustic based system which will monitor a valve and provide the plant operator with information as to whether the valve is open or closed. The VMS utilizes accelerometers mounted on the valve to detect the noise caused by flow through the valve. The VMS has been sold to several customers throughout the nuclear industry and is in operation on several types of nuclear steam supply systems. The VMS equipment is to be tested to determine its ability to function through normal and worst case accident conditions. This package outlines the enveloping test requirements necessary for the testing program to produce meaningful results for all customers.

1.1 PURPOSE

This package defines the environmental and seismic requirements to which the VMS will be tested. The customer's requirements, as defined, are enveloped by this test program.

The following tables (1.1 and 1.2) provide a listing of system variations that exist. Each of these variations will be tested to the envelope requirements.

App II	Utility	Plant (s)	No. Channels VMS	Hardline Cable Length	Preamplifier Not In Containment
1.	Arkansas Power & Light	ANO-1 & 2	1 & 2	30' HL & 40' SL	
2.	Carolina Power & Light	H. B. Robinson	3	30' & 40' HL	
3.	Commonwealth Edison	Zion 1 & 2	3 each	10' & 30' HL	
4.	Consumer's Power Company	Palisades	5	10' HL & 40' SL	
		Big Rock	6	20' HL & 40' SL	
5.	Florida Power Corporation	Crystal River	6	30' HL	
6.	Jersey Central Power & Light	Oyster Creek	21	10-20' HL	
7.	General Public Service Utilities	TMI-I	1	10' HL	
8.	Niagara Mohawk	Nine Mile Point-1	22	200' HL	X
9.	Northeast Utilities Service Company	Millstone-1	6	10' HL	
		Millstone-2	4	10' HL	
		Conn-Yankee	2	30' HL	
10.	Northern States Power Co.	Prairie Island 1 & 2	3 each	20' HL & 30' HL	
11.	Power Authority State of NY	J. A. Fitzpatrick	11	30' HL	
12	Wisconsin Pulbic Service	Kewaunee	2	10' HL & 30' HL	
13.	Virginia Electric & Power Co.	North Anna 1 & 2	5 each	10' HL	
		Surry 1 & 2			
14.	Yankee Atomic Electric Co.	Maine Yankee	3	30' HL	
		Yankee Rowe	3	30' HL	
		Vermont Yankee	2	30' HL	

Table 1.2-1

SUMMARY OF CONTROL ROOM EQUIPMENT VARIATIONS

App II	Utility	Plant(s)	No. Channels VHS	Control Room Cabinets	Audio Monitor	Master Alarm	Auxiliary Relay	Visual Display	Edgewise Meter
1.	Arkansas Power & Light	ANO-1 & 2	3 & 2			X		X	
2.	Carolina Power & Light	H. B. Robinson	3				A/B		
3.	Commonwealth Edison	Zion 1 & 2	3 each				A/B		
4.	Consumer's Power Company	Palisades	5		X	X			
		Big Rock	6		X	X			
5.	Florida Power Corporation	Crystal River	6	X	X	X			X
6.	Jersey Central Power & Light	Oyster Creek	21	X	X	X			X
7.	General Public Serviwe Utilities	TMI-I	1	ONLY CAX	ONLY OAX			X	
8.	Niagara Mohawk	Nine-Mile Point-1	22	X	X		A/B		
9.	Northeast Utilities Service Co.	Millstone-1	6				A/B		
		Millstone-2	4				A/B		
		Conn-Yankee	2				A/B		
10.	Northern States Power Company	Prairie Island 1 & 2	3 each				A/B		
11.	Power Authority State of NY	J. A. Fitzpatrick	11	X	X		SSR		X
12.	Wisconsin Public Service	Kewaunee	2		X		A/B		
13.	Virginia Electric & Power Co.	North Anna 1 & 2	5 each	X		X	P&B	X	
		Surry I & 2		X		X	P&B	X	
14.	Yankee Atomic Electric Co.	Maine Yankee	1			X	A/B	X	
		Yankee Rowe					A/B		
		Vermont Yankee							

2.0 TEST PROGRAM REQUIREMENTS

The valve monitoring system components for both the control room and containment equipment will be tested to determine the systems ability to meet the customers seismic and environmental requirements. The testing for these conditions will be performed to IEEE std. 344-1975 for seismic and IEEE std. 323-1974 for the environmental conditions. These testing guidelines were accepted by all owners at the 3-21-80 owners meeting.

2.1 TEST REQUIREMENTS

The test will demonstrate by type testing that the equipment will maintain functional operability under all service conditions postulated to occur during the installed life. The service conditions include:

1. Aging
   - o Environmental effects contributing to failure

2. Seismic
   - o Containment
   - o Control Room

3. Accident Condition
   - o Temperature conditions
   - o Pressure conditions
   - o Chemical Spray
   - o Radiation

4. Post Accident Condition

2.2 TESTING SEQUENCE

The sequence of testing is specified in IEEE std. 323-1974. The test sequence specified for all equipment is:

1. inspection of equipment after shipping
2. operation of equipment to establish baseline data for later comparison
3. equipment operation to the extremes of the normal operating range specified, this excludes design basis events.
4. equipment aging in accordance with IEEE std. 323-1974 to simulate expected end-of-life condition; aging test will include radiation (design basis radiation will be included at this time) and vibration; equipment will be checked out after aging to verify satisfactory operation
5. seismic test in accordance with IEEE 344-1975, equipment will be monitored during and after the test to determine satisfactory operation
6. accident condition (LOCA) testing will be performed using the required components of temperature, pressure, humidity, and chemical spray (radiation for the accident condition is previously included in step 4); the equipment function will be monitored during the test
7. operation and monitoring of equipment in post accident conditions for thirty (30) days after transient
8. inspection to determine the status and condition of equipment and a record of all findings will be made, components will be disassembled to allow inspection to determine status and condition of equipment

2.3 TEST PLAN

The initial phase of the test program will be the preparation of a testing plan by the testing laboratory. This plan will present the approach to testing, methods, equipment, and general procedure to be utilized for the VMS testing program. This plan will also detail the aging plan and an evaluation of the system's design with respect to seismic and LOCA events upon completion.

The test plan will be submitted to all VMS owners for their information and customer submittal to the NRC if desired.

2.4 QA REQUIREMENTS

All customer requirements, enveloping conditions test requirements, test records, equipment calibration, and performance conditions will be documented and placed in a readily auditable package. The testing lab's procedures will be monitored by B&W as the owner's agent.

2.5 REPORT

The laboratory performing the test will produce a comprehensive report which is readily auditable, and a copy will be sent to all participants. The report will include but not be limited to the following:

1. summary of test/analysis results
2. test equipment used and test equipment accuracy
3. functional monitoring information of test conditions, i.e., temperature, pressure, "g" level, frequency, etc.
4. locations of all sensors
5. performance data for equipment tested
6. discussion of test results and test abnormalities

3.0 EQUIPMENT TO BE TESTED

The equipment used in the VMS system is standard for all customers with only four exceptions. The equipment will be tested on a generic basis with either a worst case envelope for varying equipment or inclusion of all types of equipment requiring test.

The differences from the base system are:

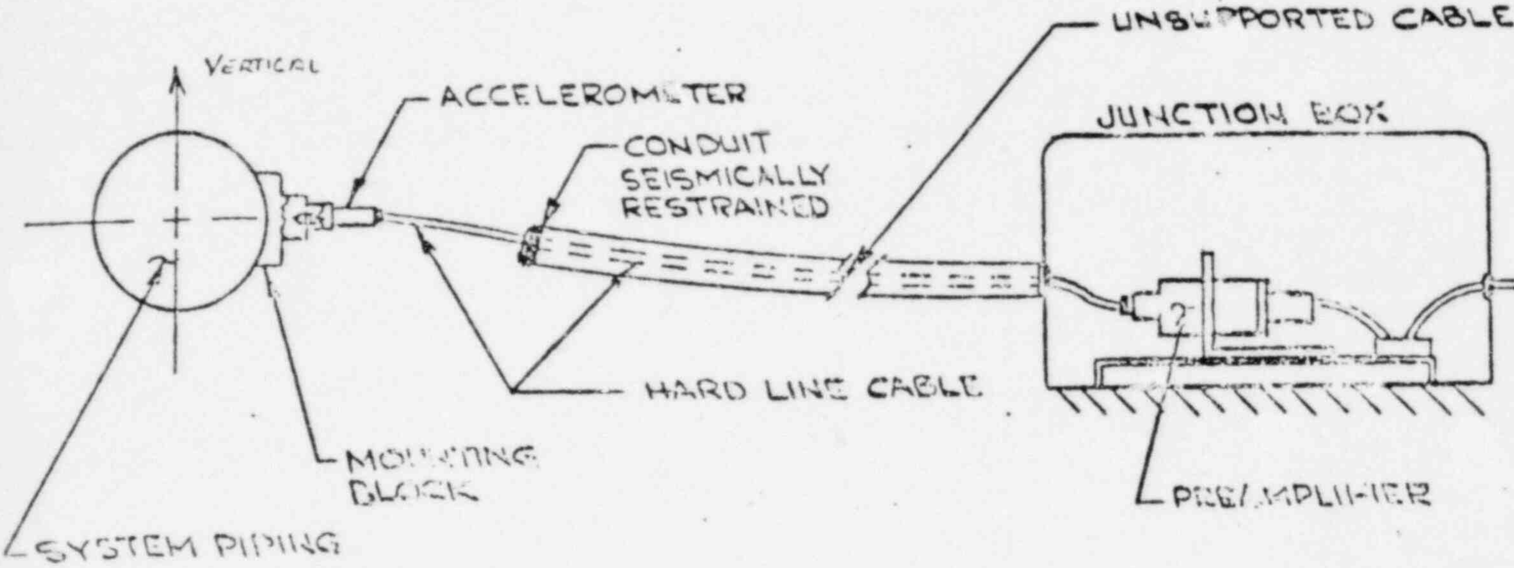
1. Hardline coaxial cable for interconnection between the junction box and the sensor varies in length from 10 feet to 200 feet as shown in table 1.1.
2. Control room equipment mounting cabinets have not been supplied to all customers. The cabinets supplied are shown in table 1.2.
3. TMI-1 utilizes a different signal conditioner from all other units.
4. Options such as master alarm, audio monitor, edgemeters, and auxiliary relays are utilized by the customers as shown in table 1.2-2.

3.1 CONTAINMENT EQUIPMENT

The following equipment is housed inside the plant containment and must be tested. Geometric size and layout are also given:

1. Accelerometer Endevco 2273AM20
2. Mounting block with pretensioned strap
3. Hardline coaxial cable Endevco 3075M6--0.068 in. OD
4. Unholtz-Dickie 22CA-2TR preamplifier (see contingency section for other types to be tested)
5. Preamplifier mounting junction box Hoffman 8064CHNESS Nema 4X--8 X 6 X 4 in.
6. Pyrogell acoustical coupler
7. RTV potting compound (GE RTV 106)
8. Cable couplers Endevco EJ34

LAYOUT OF EQUIPMENT

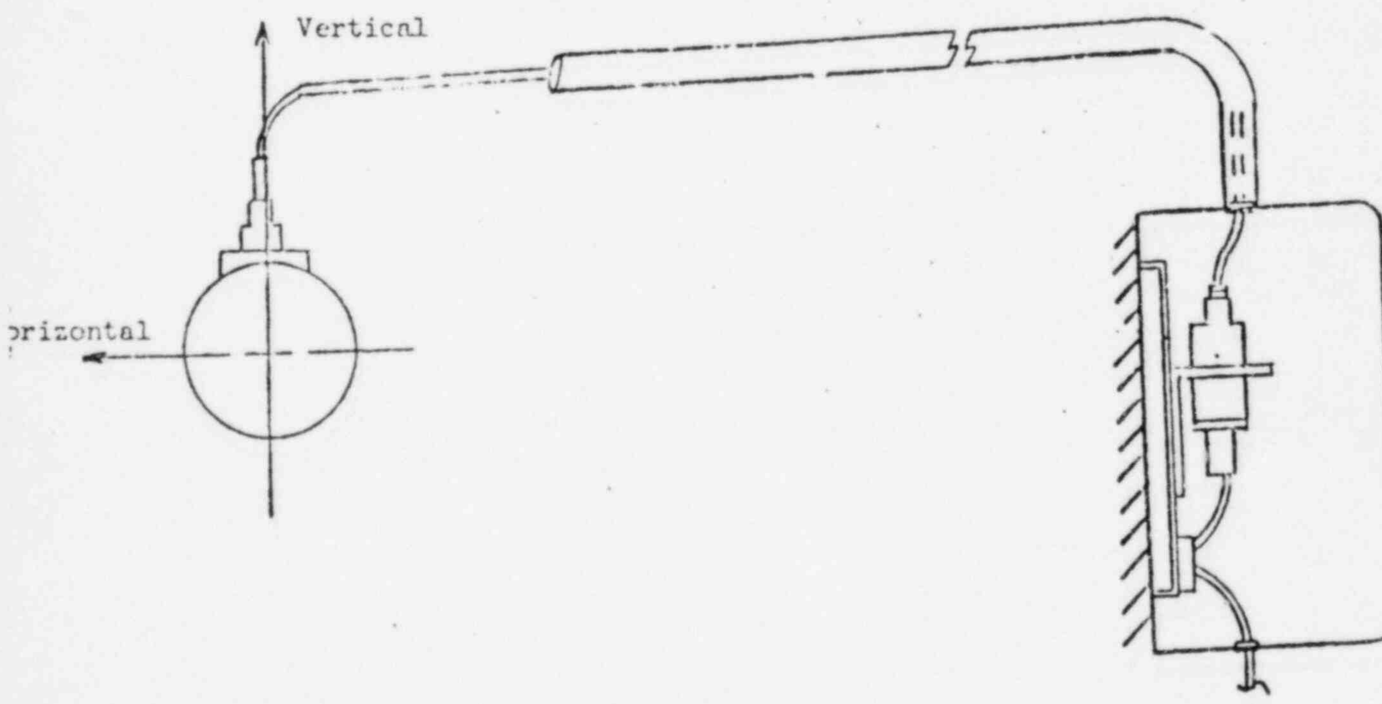


3.2 ORIENTATION OF CONTAINMENT EQUIPMENT

Two orientations of containment equipment will be considered. These are horizontally oriented sensor and junction box and vertically oriented. These two orientations are shown below:

Horizontal Orientation (Shown Above)

Vertical Orientation



3.3 CONTROL ROOM EQUIPMENT

The following equipment is housed inside the control room and must be qualified:

1. Signal Conditioning Amplifier, Unholtz-Dickie Model P22MHA-1
2. Unholtz-Dickie Audio Monitor
3. Visual Display Module, International Instruments Model 9270
4. Auxiliary Relay Box (Three types: Allen Bradley, Potter & Brumfield, and Solid State Relay)
5. Edgewise Meter, International Instruments Model 2603
6. Unholtz-Dickie Master Alarm

3.4 ADDITIONAL EQUIPMENT FOR CONTINGENCY TESTING

A critical review of the VMS equipment has been made and two in containment components have been identified as potential problem areas. Problems may occur in the preamplifier and long spans of hardline cable. Since the potential for problems exists in the containment equipment, B&W proposes to test five complete channels of VMS in-containment hardware. The makeup of the five channels will be as follows:

1. Generic installed equipment with a hardline cable of 200 feet
2. Generic installed equipment with a hardline cable of 60 feet
3. Modified U-D preamplifier with 60-foot hardline cable
4. Modified U-D preamplifier with 30-foot hardline cable
5. Competitive brand preamplifier with 30-foot hardline cable

Note: Some of the mounting blocks tested will have the lip ground down while others will not in order to simulate mounting conditions at the various plants

One preamplifier and junction box assembly will be tested in an out of containment environment to simulate Niagara Mohawk's mounting conditions.

This configuration provides a contingency for all other customers.

4.0 CONTAINMENT ENVIRONMENTAL REQUIREMENTS

The environmental capabilities of the Valve Monitoring will be demonstrated by type testing actual equipment under simulated service conditions. The VMS owners have specified the service conditions for both normal operation and accident conditions. All testing will be performed to the worst case envelope conditions. The following principles have been followed in designating the test requirements.

1. The severity of the testing method equals or exceeds the maximum anticipated service conditions.
2. Testing requirements have been taken from the customer requirements transmitted to B&W. Each utility must document their individual requirements against the generic test requirements to back up the test.
3. When possible, a test will be conducted so that an upper bound of operation will be established.
4. Modified and/or different brand equipment will be tested as a contingency option.
5. Equipment will be monitored before, during, and after service condition testing.

4.1.0 AGING ✓

The aging simulation is chronologically the first test to be conducted. The objective of the equipment aging test is to put the sample components in a state equivalent to its end-of-life condition. The aging test consists of a two-phase analysis. The first phase is an analytical calculation of critical components, probable failure modes, and environmental effects which contribute to failure. The second phase is a physical aging test to verify the analytical work.

The aging program will result in determining the expected life of each component and a maintenance program to replace or inspect equipment in a planned sequence. The physical accelerated aging test will produce a set of components in their expected end-of-life condition. This end-of-life condition will include the recommended maintenance and calibration.

4.1.1 NORMAL OPERATING CONDITIONS

The normal environmental influences on VMS equipment in containment are temperature, pressure, humidity, and radiation. The containment equipment is to be tested to simulate a 40-year life under the following conditions. Equipment is to be monitored during aging test to allow determination of ultimate life.

<u>Component--Sensor - Hardline Cable</u>

	Normal	Expected Range	Cycles
Temperature	650°F	60-670° F	200
Pressure	Atmosphere	70 PSI	40
Relative Humidity	100%	20-100%	200
Integrated Radiation RAD	---	up to 5×10^9 (Rads)	---
Vibration	Normal back-ground: 0.5g	Max. during flow 200g Range 2K-8K CPS	400 valve cycles

<u>Component--Junction Box and Preamplifier</u>

	Normal	Expected Range	Cycles
Temperature	130°F	60- 156° F	200
Pressure	Atmosphere	-1.25-48.3	200
Relative Humidity	100%	20-100%	200
Integrated Radiation	---	up to 2×10^8 (Rads)	---

4.1.2 ADDITIONAL REQUIREMENTS

The accident condition radiation exposure will be included during the aging test for IEEE-323-1974.

4.2.0 ACCIDENT CONDITION TEST

The accident condition for containment equipment is the worst case LOCA transient. The LOCA is simulated by applying the transient condition of temperature, pressure, humidity, radiation, and chemical spray. All conditions except the radiation are applied simultaneously, and the equipment will be monitored during the transient test.

The accident-condition test is the last test event in the IEEE-323 specification. After the LOCA transient conditions have died away, the equipment will be maintained in a post-LOCA environment and monitored in operation for a period of thirty (30) days.

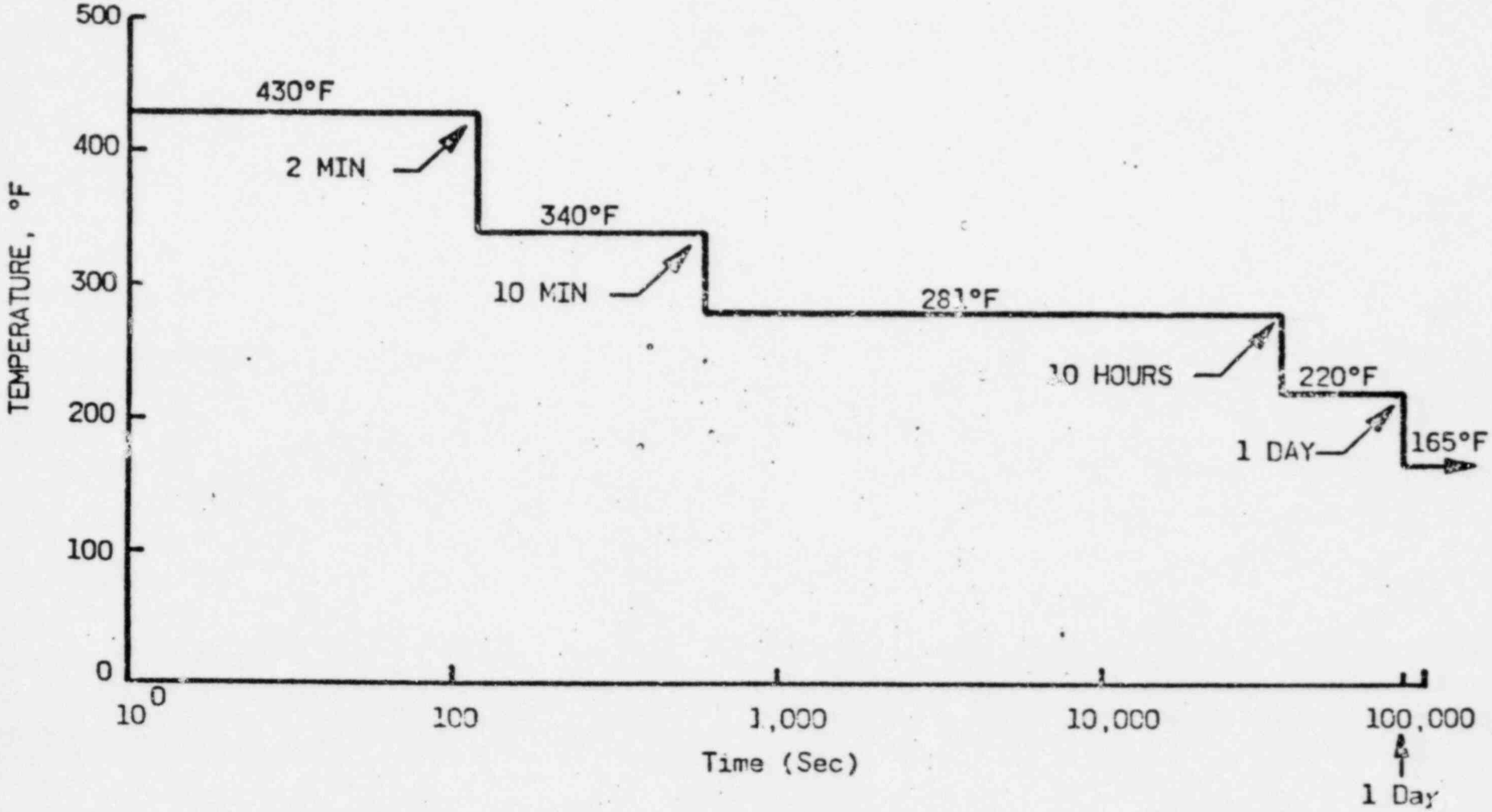
Each of the applied test requirements are given in the following sections. A worst case envelope condition is presented, and each utility's specific requirement is also provided. Each utility should verify that the specifications shown for the plants are accurate and that documentation exists to show that the requirements are conservative.

4.2.1 TEMPERATURE

The containment atmosphere temperature transient is given in figure 4.2.1-1. This is an envelope of all customer specified temperature transients. The initial temperature ramp will be within a 10-second duration. Each utility's requirements are plotted in figure 4.2.1-2.

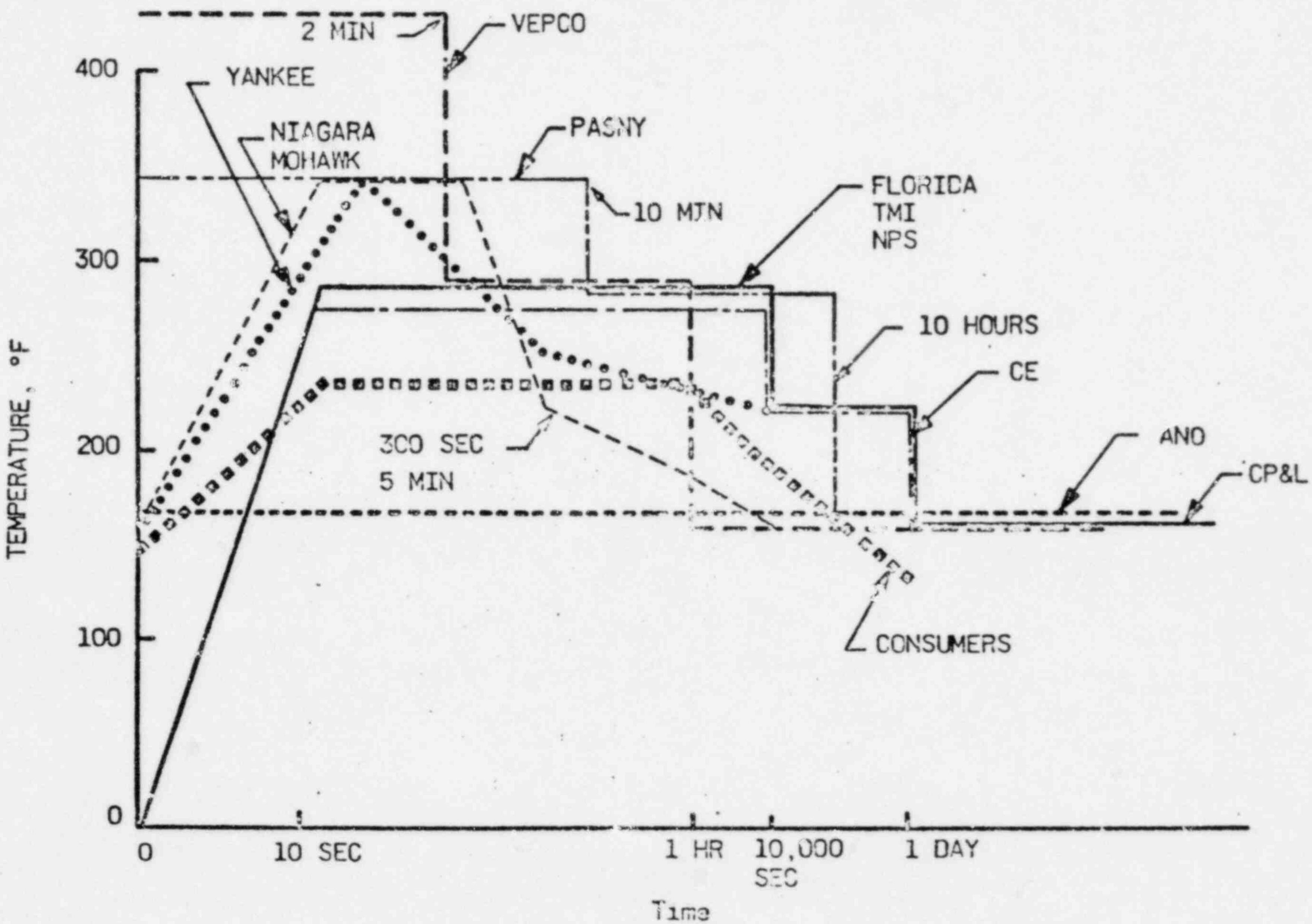
Temperature of Containment vs Time
Envelope of Owners

FIGURE 4.2.1-1



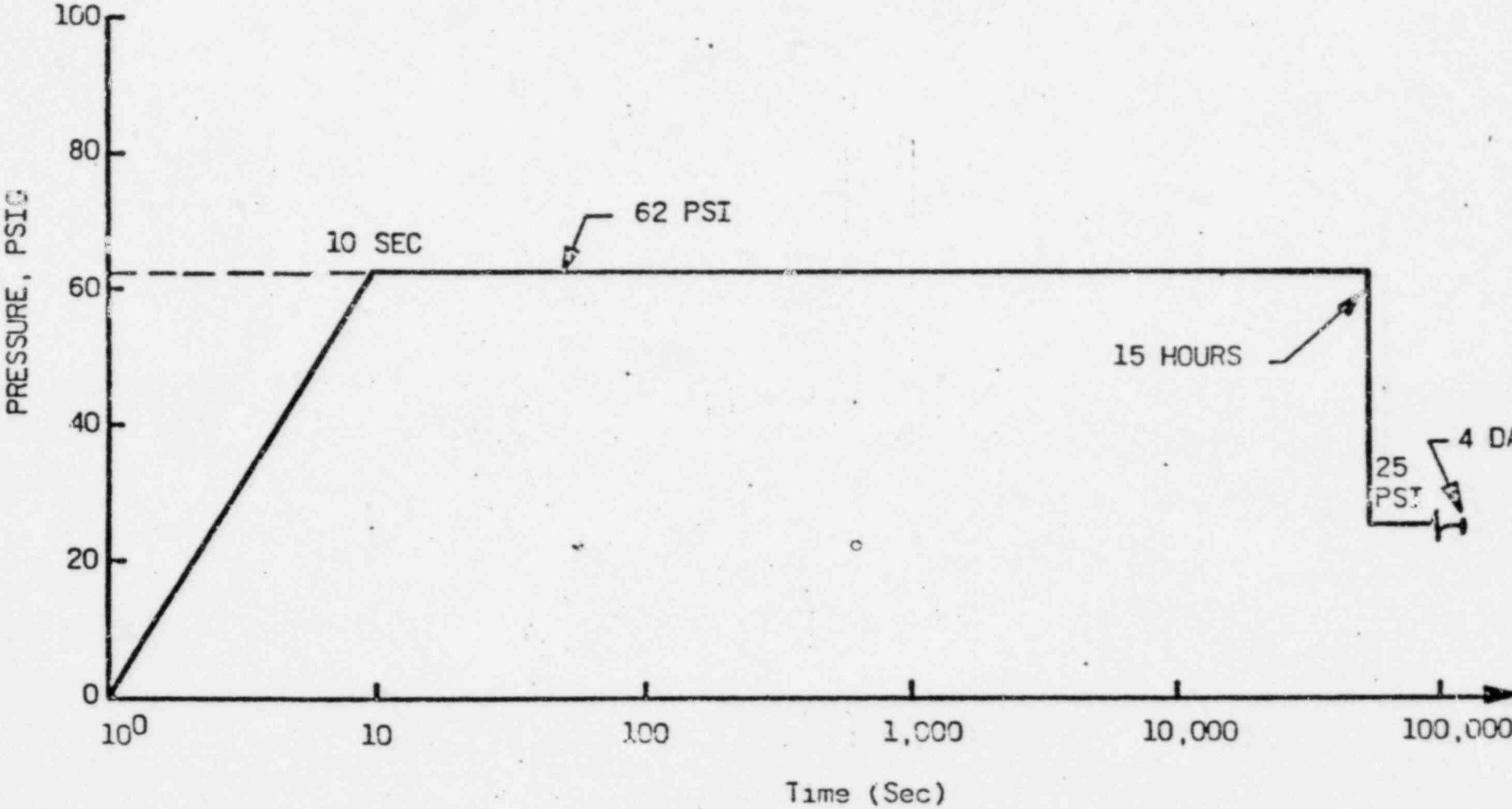
Temperature of Containment vs. Time

FIGURE 4.2.1-2



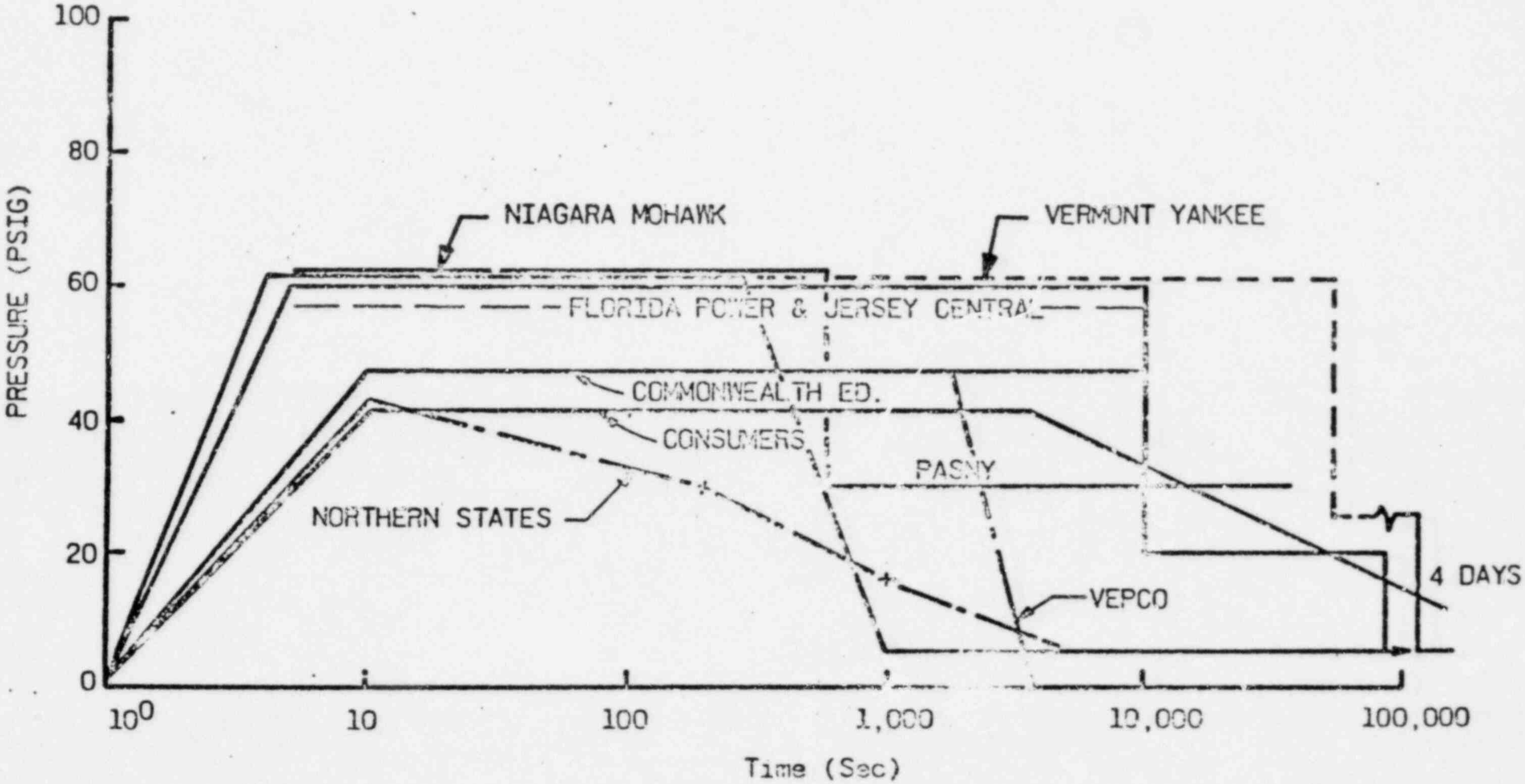
Pressure in Containment vs. Time
Envelope of Owners

FIGURE 4.2.2-1



Containment Pressure vs. Time
Specific Customer Specifications

FIGURE 4.2.2-2



As shown by figure 4.2.1-2, all utilities' requirements are grouped closely with the exception of the initial peak temperature provided by VEPCO. Testing labs contacted have indicated a problem with reaching the 430° F peak with 10 seconds. There will probably be a cost increment between testing to a peak temperature of 340° F and 430° F.

4.2.2 PRESSURE

The containment pressure transient is given in figure 4.2.2-1. This is an envelope of all customer specified pressure requirements. The initial pressure ramp will peak within a 10-second duration. Each utility's requirements are plotted in figure 4.2.2-2.

As shown by figure 4.2.2-2, all utilities' requirements are grouped closely with the exception of the peak pressure.

Appendix A to IEEE std. 323-1974 recommends a double peak temperature/pressure test profile be used. The double peak temperature/pressure test envelopment is specified in the section on testing margins.

4.2.3 CHEMICAL SPRAY EXPOSURE

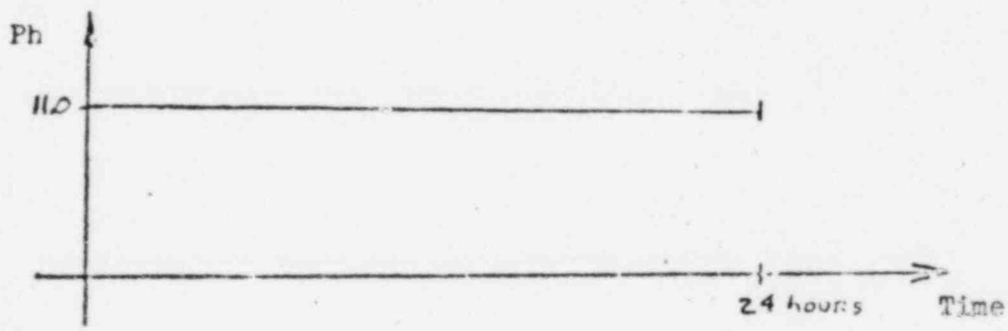
During the accident condition test, a chemical spray will be imposed. The chemical spray will be applied for a duration of 24 hours with a constant ph of 11.0 maintained through the entire test period. The spray will be continious and oriented in the vertically downward direction. The flow rate will be a minimum of 0.15 (gal/min)/ft^2 over the projected horizontal plane.

The following chemicals will be included in the test spray:

1. Boric Acid
2. Sodium Hydroxide
3. Chromated Water
4. Sodium Thiosulphate

The possibility of spraying all chemicals at the same time is now being investigated by the testing labs. If a separate test is required, the utilities requiring a unique spray will be notified of the additional cost increment.

SPRAY HISTORY



4.2.4 HUMIDITY

The in-containment humidity ranges between 20% and 100% relative humidity. All testing will be performed utilizing 100% relative humidity.

4.2.5 RADIATION

The envelope radiation environmental requirement for the containment equipment under accident conditions is:

> 7.2×10^7 Rads integrated dose with ... least 4×10^6 Rads occurring during the first hour and 9×10^6 Rads occurring during the first three hours.

The plant specific requirements for all radiation exposure is given in the following table.

As discussed in section 4.1.0, the radiation exposure required for aging will be added to the accident radiation dose. All radiation will be induced during the aging test.

B&W Valve Monitoring System

Summary of Gamma Radiation Dose In Containment

Required by Customers for Testing

Utility	40-Year Dose Rads	Post Accident Integrated Dose Rads	Instantaneous Dose Rads
1. Arkansas Power & Light	3.3×10^7-- Preamp & Cable	---	---
	5.0×10^9-- Sensor	---	---
2. Carolina Power & Light	---	1.5×10^8* 6×10^7***	9×10^6**
3. Commonwealth Edison	4×10^4	2.0×10^8 * 6×10^7***	2×10^6**
4. Consumers' Power Co.	2×10^7	1.3×10^6***	1.7×10^5 @ 1 hour
5. Florida Power & Light	---	1×10^8 TID	---
6. Jersey Central	5×10^6	---	---
7. General Public Util.	2×10^8	---	---
8. Niagara Mohawk	---	---	---
9. Northeast Utilities	---	---	---
10. Northern States Power	Pre--3.5×10^6 Sen & Cab.- 5.26×10^7	---	---
11. Power Authority State of New York	1×10^8		
12. Wisconsin Public Service	---	---	---
13. Virginia Electric & Power Company	---	7.2×10^7	---
14. Yankee Atomic	---	---	---

* 1-year duration
** 3-hour duration
*** 30 days

4.3 POST ACCIDENT CONDITION

The VMS will be monitored in the post accident environment after completion of all accident condition testing. The post accident condition monitoring will be conducted for a period of 30 days.

The post accident condition are:

Temperature	165° F
Pressure	5 PSI
Humidity	100%

The post accident condition radiation dose is specified in the accident dose.

5.0 CONTROL ROOM EQUIPMENT

ENVIRONMENTAL REQUIREMENTS

The temperature, pressure, and humidity conditions in the control room are specified well within the operating range of all control room VMS equipment. There have been no accident condition environmental requirements specified by any customer for the control room equipment. The only environmental condition that is significant is aging.

5.1 NORMAL ENVIRONMENTAL CONDITIONS

The control room environmental conditions are given below. The range of the parameters is given as well as the normal operating value.

	Normal	Expected Range
Temperature	75° F	40° - 120° F
Pressure	Atmospheric	---
Relative Humidity	40%	10 - 90%
Integrated Radiation (RAD)	10^3	up to 10^4

5.2.0 AGING TEST

The aging simulation is chronologically the first test to be conducted. The objective of the equipment aging test is to put the sample components in a state equivalent to its end-of-life condition. The aging test consist of a two-phase analysis. The first phase is an analytical calculation of critical components, probable failure modes, and environmental effects which contribute to failure. The second phase is a physical aging test to verify the analytical work.

The aging program will result in determining the expected life of each component and a maintenance program to inspect or replace equipment in a planned sequence.

The physical accelerated aging test will produce a set of components in their expected end-of-life condition. This end-of-life condition will include the recommended maintenance and calibration.

6.0 SEISMIC TESTING

The containment and control room portions of the VMS equipment have distinctly different characteristics and seismic test requirements. All seismic testing will be performed with the equipment mounted in a typical arrangement. The equipment to be tested and mounting details are discussed in section three.

All seismic testing will be performed to meet the guidelines presented in IEEE std. 344-1975. All owners' seismic requirements will be enveloped by the seismic test.

6.1 CONTAINMENT EQUIPMENT SEISMIC TESTING

The VMS equipment in containment presents a problem in obtaining seismic information for the pipe mounted equipment and the seismically restrained conduit. Since the seismic requirements cannot be well defined, sine-beat testing of all in-containment equipment will be performed. The sine-beat testing defined in this section corresponds to IEEE std. 344-1975 requirements with the only customer defined variable being the maximum acceleration "g" level. The maximum acceleration of 4.5 g's has been specified as a conservative value. A review of several architect engineers' pipe-mounted component seismic requirements showed that 4.5 g's is the maximum required. Each VMS owner should verify the acceptibility of the proposed maximum acceleration. The following testing requirements will be followed:

1. The specimens shall be mounted on the testing table (shaker table) in such a way to simulate typical mounting configurations as specified.

2. Test procedures shall be in accordance with IEEE std. 344-1975.

3. Single sine-beat testing shall be used to test all in-containment equipment.

4. The equipment signals shall be monitored before, during, and after the test, and any unusual characteristics will be noted.

5. A low level sine sweep resonance search shall be performed in the frequency range of 1-35 Hz in each of the three principal directions of the specimen independently.

6. A single frequency biaxial vibration test shall be performed in front to back/vertical plane with a 4.5 g input in each direction. A test at every resonance frequency of the component and at every frequency spaced at 1/3 octave intervals will be performed. This test shall be repeated six times.

7. Four tests as described in 6 above will be performed: first, with the inputs in phase; second, with one input 180° out of phase; third with the equipment rotated 90° horizontally; fourth, with the equipment oriented as in test 3. One input is to be induced 180° out of phase.

6.2 CONTROL ROOM SEISMIC TESTING

The VMS control room equipment consist of several different electronic mponents mounted in a B&W supplied cabinet or in a customer supplied panel. Many different mounting configurations exist for the VMS equipment. To accommodate the large variety of mounting configurations, each component will be seismically tested individually. For systems mounted in the customer's racks, it will be the customer's responsibility to assure that the control room seismic levels at the mounting rack do not exceed the specified levels. A program will be established to verify the acceptability of the components in B&W supplied cabinets. This additional program will apply only to the utilities purchasing the B&W cabinets.

The following testing procedures will be followed:

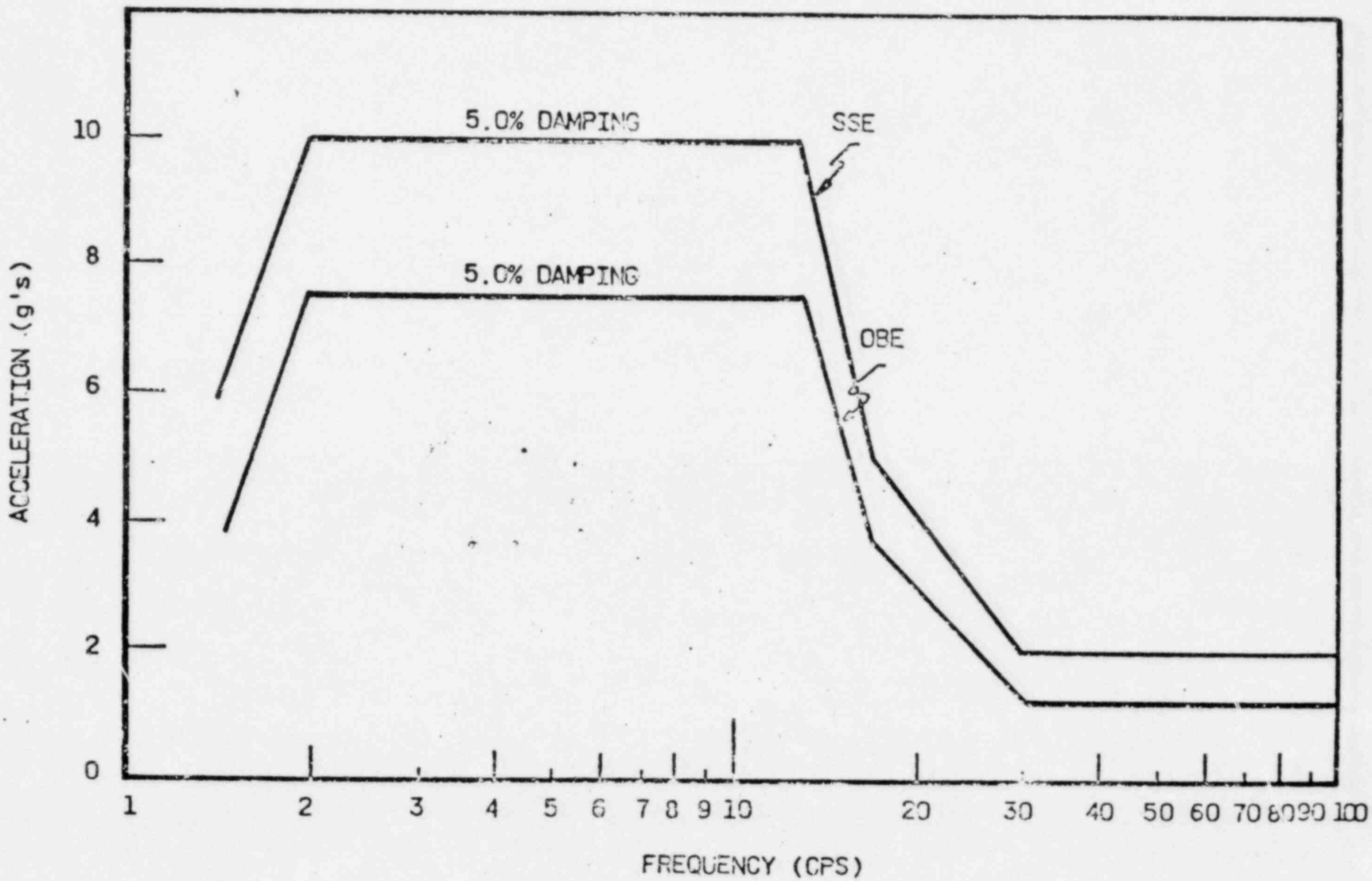
1. The specimens shall be mounted on the testing table (shaker table) in such a way as to simulate typical mounting configurations as specified.
2. Test procedures shall be in accordance with IEEE std. 344-1975. (Test response spectra - required response spectra TRS-RRS).
3. Random motion (TRS-RRS) method shall be used for the qualification of all control room equipment, if possible.
4. The equipment's electronic functions shall be monitored before, during and after the test and any unusual characteristics shall be noted.
5. A low level sine sweep resonance search shall be performed in the frequency range of 1-35 Hz in each of the three prinicpal directions of the specimen independently.
6. Each horizontal axis of the equipment shall be excited simultaneously but phase incoherently with the vertical axis.
7. Equipment shall be subjected to 30-second duration simultaneous horizontal and vertical inputs of random wave form motion consisting to frequency band widths spaced one-third octave apart over the range of 1 Hz to 35 Hz.
8. The required response spectrum for control room equipment horizontal excitation is given in figure 6.2-1. The vertical spectrum is given in figure 6.2-2. The SSE and OBE are both defined.
9. The test table motion shall be analyzed by a spectrum analyzer at 1-5% damping for OBE and SSE. 5% damping is specified in IEEE std. 344-1975 for equipment with unknown damping.

10. The test shall consist of five (5) OBE tests and one (1) SSE test in each orientation of the equipment.

Required Response Spectra

Control Room Components — Horizontal Direction

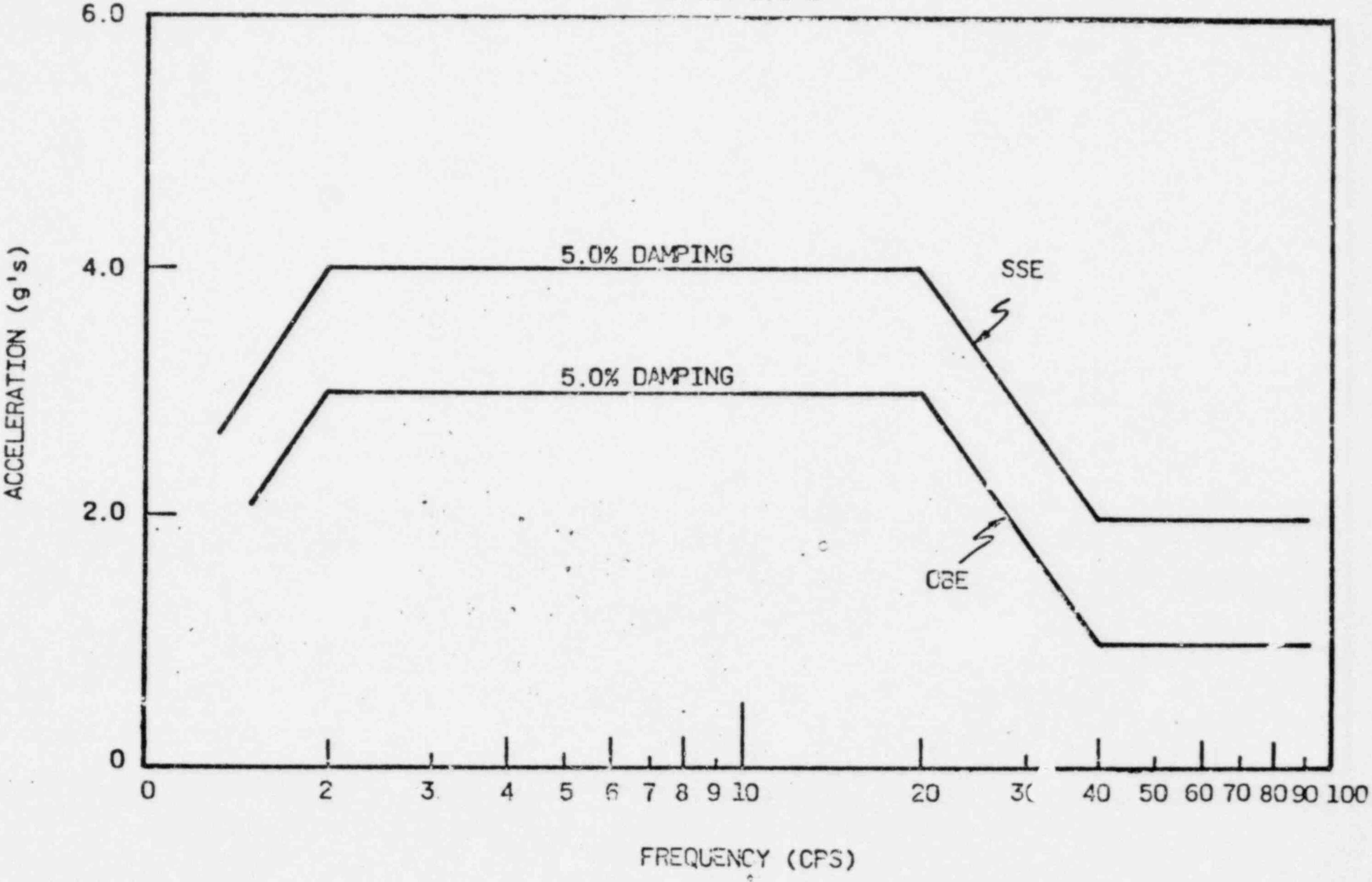
FIGURE 6.2-1



Required Response Spectra

Control Room Components — Vertical Direction

FIGURE 6.2-2

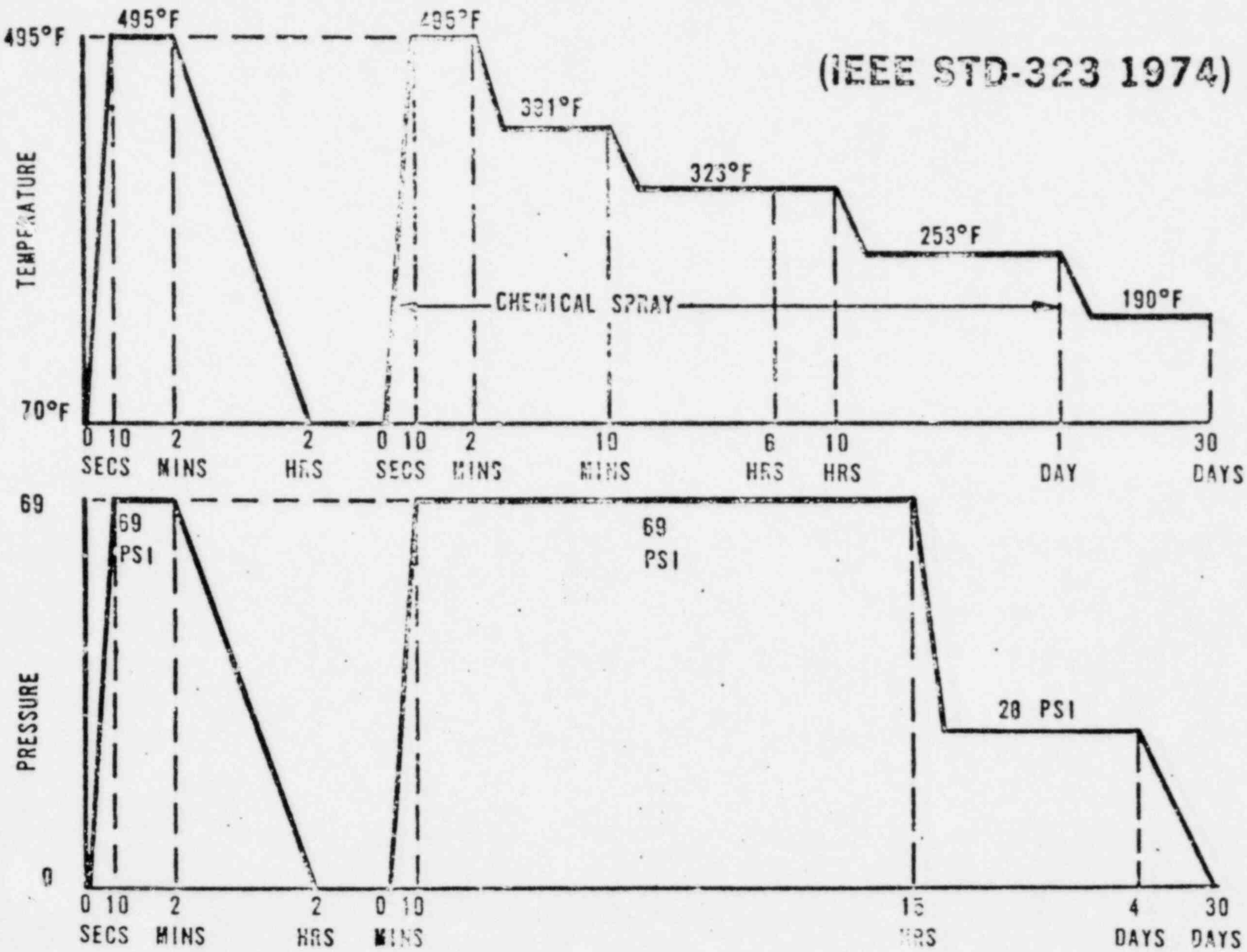


7.0 TEST REQUIREMENT MARGINS

Each customer's requirements have been examined and worst case envelope conditions derived. The enveloping test conditions are specified in tje this package as well as the requirements for each customer. No additional margins have been added to the utility supplied requirements. IEEE std. 323-1974 suggests the following margins. These margins will be added to the specified test envelope.

1. Temperature: +15° (8° C). When qualification testing is conducted under saturated steam conditions, the temperature margin shall be such that test pressure will not exceed saturated steam pressure corresponding to peak service temperature by more than $10 lb_f/in^2$
2. Pressure: +10 percent of gauge
3. Radiation: +10 percent (on accident dose)
4. Voltage: ±10 percent of rated value
5. Frequency: ±5 percent of rated value
6. Time: +10 percent of the period of time the equipment is required to be operational following the design basis event
7. Environmental Transients: The initial transient peak temperature shall be applied at least twice. (See figure 7.0-1)
8. Vibration: +10 percent added to the acceleration of the response spectrum at the mounting points of the equipment.

Accident Condition Test Environment



TEMPERATURE/PRESSURE LOCA DBE PROFILES

Figure 7.0-1

8.0 FAILURE CRITERIA/FAILURE AVOIDANCE

The operation of the Valve Monitoring System will be checked during and after test as specified. The equipment will be considered failed if at any time it does not perform its intended task. The large VMS operating margins allow significant signal degradation to occur while the system remains functional. The test will be conducted so that an upper limit of endurance can be established for any failed component. Any failed component will be replaced and the remaining components in the system qualified to completion.

8.1 PRE-TEST FAILURE PREDICTION

Each component of the VMS is being examined and accessed a failure probability. Contingency testing of modified and competitive brand equipment will be performed to establish a tested component replacement in case of a failure.

8.2 IN-TEST MODIFICATIONS

If it becomes obvious during testing that a modification to the system is necessary, the modification will be made at the test facility if possible and tested.

8.3 RECOMMENDATION FOR SYSTEM IMPROVEMENT

Should a component fail or be expected to fail, B&W will recommend modifications for the VMS to improve the system reliability. If possible, any recommended component will be tested as specified previously. Notification of problems and recommended modifications will be made as quickly as possible if problems occur.

9.0 SCHEDULE

The milestone in the valve monitoring system test program and expected completion dates are provided below:

o Transmit request for quote to testing labs	May 5, 1980
o Receive quote from testing lab	June 2, 1980
o Complete B&W review of quotes/select test lab	June 20, 1980
o Issue revisions to program & cost	June 20, 1980
o Receive customer authorization/issue purchase order	July 1, 1980
o Start of test planning	July 1, 1980
o Release of test plan	October 1, 1980

Balance of schedule depends on testing lab selected.

ISOMEDIX

8.3-6

#2

ENVIRONMENTAL EXPOSURE OF LIQUID LEVEL SENSOR

Performed by

Component Testing Division

Isomedix, Inc.

Parsippany, New Jersey

for

DeLaval

GEMS Sensor Division

Farmington, Connecticut

November 1975

Isomedix Inc. • 25 Eastmans Road, Parsippany, New Jersey (201) 887-4700
Mailing Address: Post Office Box 177, Parsippany, New Jersey 07054

CHICAGO DIVISION • 7828 Nagle Ave., Morton Grove, Illinois 60053 (312) 966-1160

CONTENTS

List of Figures

List of Tables

1. Introduction

This report describes the steam and chemical-spray environmental exposure of a liquid level sensor. The environmental test was in accordance with Bechtel Specification 6600-M-2218 paragraph 4.3. The test program consisted of an exposure to environments of steam and chemical-spray for a four hour period at nominal conditions of 59 psig/300°F.

The float assembly, used as an indication of fluid level, was fixed to the stem of the unit by stainless steel music wire, while a constant input voltage was applied. The input and output voltages were recorded throughout the test period.

The unit performed satisfactorily during the four hour environmental exposure period.

This program was performed at the test facilities of Isomedix, Inc. of Parsippany, New Jersey, during October 1975.

2. Sample Description

The unit tested was a Model XM-36495 Level Sensor, manufactured by the GEMS Sensor Division/DeLaval Co.

3. Test Program

3.1 Environmental Exposure

The sensor was supported by an aluminum tripod secured at the bolt holes of the support flange of the head assembly. A 3/c lead wire was connected to the three electrical output leads of the sensor. Both ends of the lead wire were potted in aluminum tubes. One end was fitted in the sensor, while the other end was fitted through an opening in the top of the pressure vessel and secured by a tube fitting. Figure 1 is a photograph of the unit installed inside the pressure vessel prior to the exposure.

The sensor assembly was filled with approximately one quart of silicone fluid, supplied by GEMS.

The probe assembly was subjected to an environmental exposure in accordance with the pressure/temperature profile given in Figure 2.

A chemical-spray solution was sprayed into the test chamber at a rate corresponding to 0.15 gmp per square ft. of the chamber cross-section area during the steam exposure period. The solution consisted of 15,000 ppm boric acid in solution with sodium hydroxide to obtain a pH of 10.5 at room temperature.

3.2 Test Measurements

A d.c. power supply provided an input voltage measured as 10.725 volts d.c. across terminal leads 1 and 2. The sensor float was positioned in the middle of the stem to provide an output signal simulating a fluid level.

The output voltage was recorded as 4.787 volts d.c. and was read across sensor terminals 1 and 3. Throughout the test, both input and output voltages were monitored in order to detect changes in the voltage levels.

A record of the readings taken during the exposure period is presented in Table 1.

TABLE 1

MEASUREMENTS OF SENSOR PERFORMANCE

Elapsed Time (Min.)	Input (Volts d.c.)	Output (Volts d.c.)
0	10.725	4.787
5	10.725	4.787
10	10.725	4.787
20	10.725	4.786
30	10.725	4.787
50	10.725	4.788
60	10.725	4.788
90	10.725	4.788
120	10.725	4.788
150	10.725	4.788
180	10.725	4.788
210	10.725	4.788
240	10.725	4.788
270	10.725	4.788

4. Test Results

The vessel was at room ambient temperature of 75°F prior to starting the exposure. Steam was rapidly admitted causing the conditions to increase from room ambient to 300°F at 56 psig within 8 minutes. The conditions were maintained at 298°F ± 2°F and 55 ± 5 psig for the four hour exposure period, as shown in Figure 2.

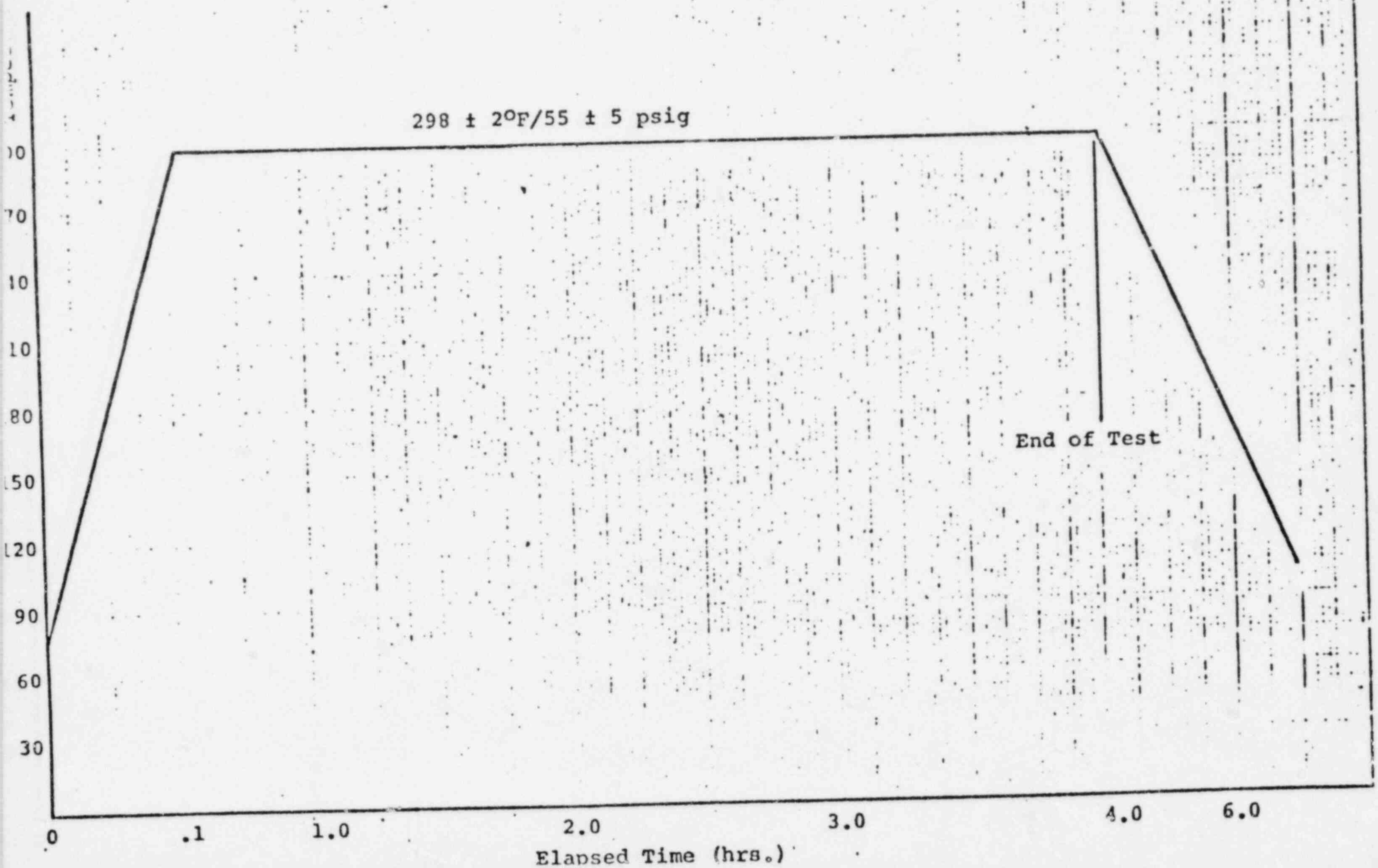
The input voltage remained constant at 10.725 volts d.c. throughout the test. The output voltage was maintained at a value of 4.787 ± .001 volts d.c.

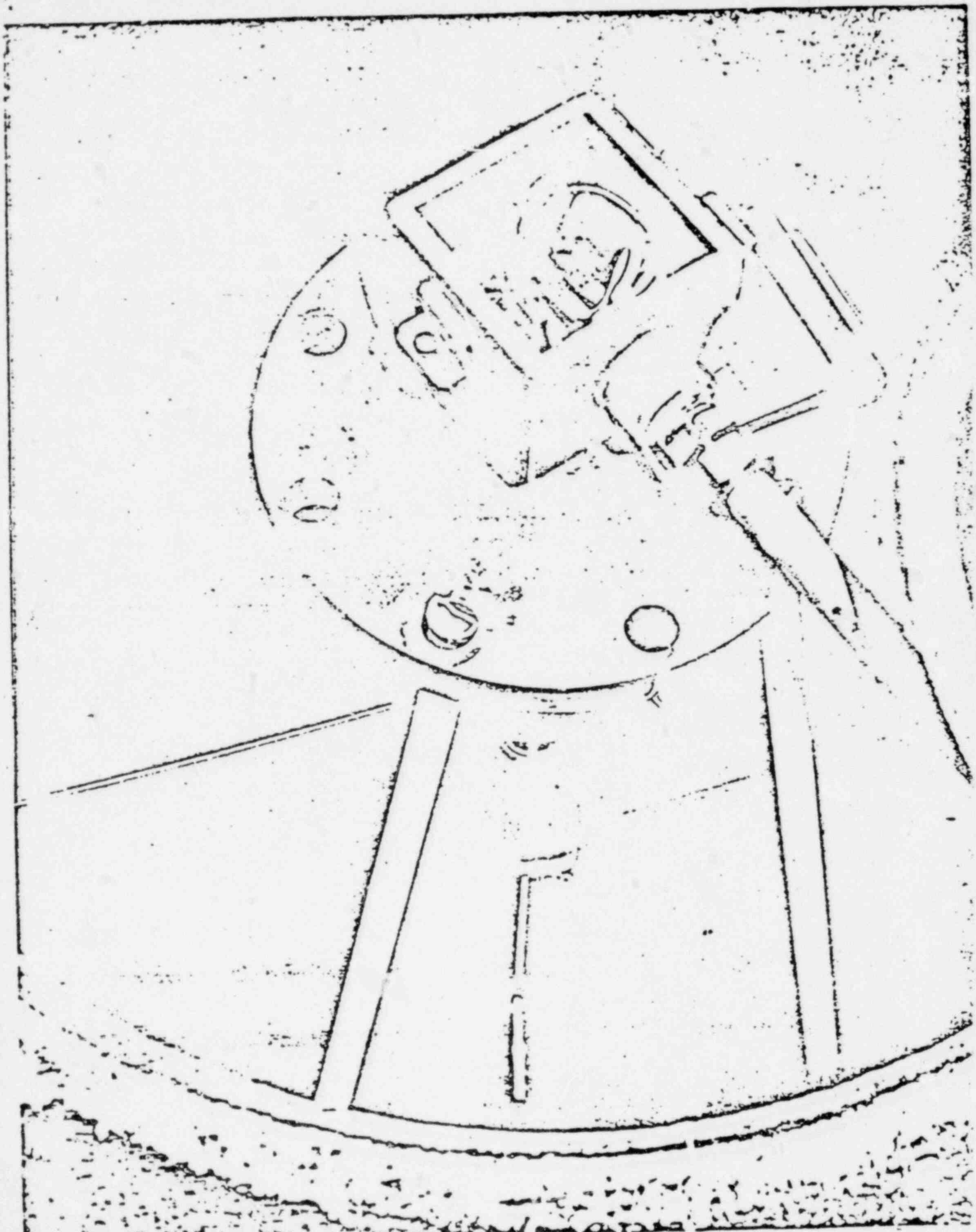
The silicone fluid in the sensor leaked through the insulation of the three conductors of the lead wire. At the end of the test, it was found that the level of silicone fluid dropped 1 inch from its original level before the exposure. Figure 3 shows the unit after the exposure period.

5. Summary and Conclusions

A liquid level sensor was exposed to environments of steam and chemical-spray at 300°F/59 psig for a period of four hours. The unit functioned satisfactorily throughout the entire test.

Figure 2 TEMPERATURE PROFILE OBTAINED DURING THE ENVIRONMENTAL EXPOSURE PERIOD





6. Certification

The undersigned certifies that this report presents a true account of the test program and results obtained. Any questions relating thereto should be addressed to same.

Nissen M. Burstein
Manager, Component Testing

NOTES OF TELEPHONE CONVERSATION
NORTH ANNA POWER STATION- UNITS 1 & 2

STONE & WEBSTER ENGINEERING CORPORATION

J. O. NO. 13075.49
ETA NO. 0206

Call Date: 5 March 81
Time: 11:45 a

From	To		
			of VEPCO
X		RT Grisdale	of S&W
	X	Joe Kata of Gems Delaval Co	of

SUBJECT a) Status of New Testing of Level Xmtrs
b) Request for Gems Dwgs for internal temperature calculations

SUMMARY a) Made 2nd request (1st on 2/10) for status of additional testing of level xmtrs for Bechtel (also applicable to our project). He apologized for not getting back to me earlier and promised to get back with this information by 3/10/81.

b) Also 2nd request for dwgs - these are required for analysis that hopefully will show that the internal temp rise during subjection of the xmtr to 435°F [illegible] (MSLB environment) is less than the temperature to which the part was tested (282°F). Kata will try to find these dwgs and get back to me on this status on 3/10/81.

ACTION REQUIRED

J. Barnhart
C. Woodworth
RT Grisdale

Preparer R T Grisdale

VEPCO Proj. Engr.

File Job Book
All Participants

Proj. Engr.
Concurrence
(required for any changes scope or schedule)

VEPCO

L NSING AND QUALITY ASSURANCE

VENDOR SURVEILLANCE

INSPECTION REPORT

☐ FINAL REPORT

☐ TRIP REPORT NO. ___

PROJECT North Anna Power Station Units 1 & 2	J. O. NO. 11715/12050	MARK NO.	
VENDOR Gems Sensor Division - DeLaval Turbine Inc.	CAT. NO. I	ITEM NO.	
SUBVENDOR	P. O. NO. NA-333/1333		
DESCRIPTION Level Transmitters and Indicators	CHANGE ORDER NO.		
	CONTRACT NO.		
DRAWING NO.(S)	VENDOR SHOP NO.		
SPECIFICATIONS NAS-90-22	REPORT PERIOD	FROM	TO

	INSPECTION AND DOCUMENT RECORD	ITEM REQ'D	S&W APP. REQ'D	RECORD REQ'D IN VENDOR FILE	COPIES REQ'D BY VEPCO	VERIFIED *	WITNESSED **	PERFORMED	BY	DATE
1	Test Per Manufacturer's Std. Proceedure	X	X		5		X			
2	Cleaning	X				X				
3	Preparation For Shipment	X				X				
4	Seismic Certification	X	X			X				
5	Environmental Certification(Probes only)	X	X			X				
6	VEPCO Certificate of Conformance	X			10					
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										

LIST ALL DEVIATIONS FROM SPECIFICATIONS OR DRAWINGS. (SEE PAGE 2)

DISTRIBUTION

* Inspector may satisfy himself with properly notorized documentation.

** Inspector shall witness. Applicable to Cat. I items only.

Line 5: Applicable where indicated on data sheets.

REPORTED BY (SIGNATURE)	DATE

J.O. Nos. 11715/12050
NAS-90-22
P.O. No. NA-333/1333

February 24, 1972
Revised July 28, 1972
Revised January 12, 1973
Revised December 14, 1973
Revised May 14, 1974
Revised April 1, 1975
Revised December 24, 1975
Revised August 29, 1977
Revised April 18, 1978

SPECIFICATION

FOR

LEVEL TRANSMITTERS AND INDICATORS

FOR

NORTH ANNA POWER STATION
NORTH ANNA UNITS 1 & 2

VIRGINIA ELECTRIC AND POWER COMPANY

RICHMOND, VIRGINIA

-:-

EQUIPMENT
CATEGORY I, II, III

SELLER: "GEMS SENSORS DIV." DELAVAL TURBINE"

ENGINEERING APPROVAL

REVISIONS	REV. 8	REV. 9	REV. 10	REV. 11
PREPARED BY / LEAD ENGINEER APPROVAL	RBD / ADM			
EQUIPMENT SPECIALIST	[illegible]			
PROJECT ENGINEER	R. J. Bradburn 18 April 78			

OTHER REVIEWS

QUALITY ASSURANCE COORDINATOR	R. J. Sweeney 4/14/78			
SAR COMPLIANCE REVIEW	ADM			

STONE & WEBSTER ENGINEERING CORPORATION

A 104.47

J.O. Nos. 11715/12050

Revision 8
April 18, 1978

CHANGES MADE IN SPECIFICATION REVISION
SPECIFICATION NAS- 90-22
LEVEL TRANSMITTERS AND INDICATORS
NORTH ANNA UNITS 1&2
VIRGINIA ELECTRIC AND POWER COMPANY

Data Sheet	Unit 1 Mark No.	Unit 2 Mark No.	Revision
18	LT-SW102	--	
19	LT-SW103A&B	--	All revisions are dimensional changes per E&DCR 7120-1
Sketches			
11715-ISK-1K	LT-SW102	--	
11715-ISK-1L	LT-SW103A&B	--	

There are no E&DCR's or N&D's outstanding against this Specification.

SPECIFIC REQUIREMENTS

LEVEL TRANSMITTERS AND INDICATORS

The transmitters and indicators included in this specification shall provide level indication and alarms for containment sump levels, valve pit levels, oil levels, and oil-water interface levels in the underground fuel oil storage tanks for the emergency diesel generators in a pressurized water reactor nuclear power station. Specific and detailed conditions are shown on the attached data sheets. The equipment furnished for this specification shall conform to all requirements of this section of the specification. In case of conflict between the specific requirements and the general requirements, the specific requirements shall govern.

CONSTRUCTION

All transmitters shall consist of a stainless steel tube containing hermetically sealed reed switches spaced at equal intervals activated by a magnet equipped stainless steel float. The electrical connection head on the transmitter shall be stainless steel and waterproof. The conduit connections shall be 3/4 in. NPT female.

All control units shall be housed in weatherproof NEMA 4 metal enclosures suitable for wall mounting. The units shall be supplied with 7 in. indicators and shall be suitable for operation on 120 v, 60 Hz power supply.

Terminations are to be manufacturer's standard.

The sump level transmitters, Mark Nos. LT-RS-151A and B, and LT-DA110, shall be supplied with 6 in., 150 lb ANSI RF stainless steel mounting flanges. Stilling wells will be supplied by the Purchaser. Refer to attached sheet ISK-1A. The transmitters are located inside the reactor containment and shall be capable of continuous operation under the following normal conditions:

Temperature	105 F
Pressure	10 Psia
Relative Humidity	40 Percent
Radiation	10^5 R Lifetime

The remote indicators on the main control board for the sump level transmitters will be supplied by the Purchaser.

The oil level transmitters, Mark Nos. LT-EG100A and B, for the underground storage tanks, shall be supplied and mounted on a 5 in., 150 lb ANSI RF stainless steel mounting flange. The transmitter shall have an operating range of 0-11 ft-6 in. The control unit for the oil level transmitters shall be supplied with one N.O. contact to sound an alarm on the main control board when the level of the oil in the tanks drops to 12 in.

Ambient conditions are as follows:

Pressure = atmospheric
Temperature = 50-70 F

The interface level transmitters, Mark Nos. LT-EG102A and B, shall be supplied and mounted on a 5 in., 150 lb ANSI RF stainless steel mounting flange. The normal operating range for this transmitter is 0-6 in. The control unit for the interface level transmitters shall be supplied with two N.O. contacts to sound a local alarm and one on the main control board when the level of the water in the bottom of the tank rises to 5 in.

Ambient conditions are as follows:

Pressure = atmospheric
Temperature = 50-70 F

The valve pit level switches, LS-RS101A and B, shall be supplied with 4 in., 150 lb ANSI RF stainless steel flanges. Stilling wells will be supplied by the Purchaser. Refer to attached sheet LSK-1C.

ELECTRICAL CONTACT RATINGS

The minimum electrical ratings for alarm contacts shall be as follows:

Type of Load	Rating Make and Break
Inductive	0.5 amp at 120 v d-c

EARTHQUAKE REQUIREMENTS

The ability to withstand earthquake effects is a requirement prescribed by regulatory bodies having jurisdiction over this nuclear project. See the attached "Earthquake Requirements" form NA-1 for details. The level transmitters must satisfy these requirements. During and subsequent to any earthquake, these transmitters must maintain their calibration and operability.

LOSS-OF-COOLANT ACCIDENT

Subsequent to a loss-of-coolant accident, the transmitters, Mark Nos. LT-RS151A and B shall be capable of operating under the following conditions:

1st Hour

Pressure	60 Psia
Temperature	280 F
Humidity	100 Percent
Radiation	10^6 R

After 1 Hour

Pressure	13.5 Psia
Temperature	140-150 F
Humidity	100 Percent
Radiation	10^8 R

The transmitters shall be type tested to show that they conform to the above requirements.

DATA SUPPLIED BY SELLER

Information marked with an asterisk (*) is furnished by the Seller. Data furnished by the Seller are included herein for Purchaser's information and use. The Seller is not relieved of responsibility for the correctness of design and details represented by the data. The Seller shall be responsible to advise the Engineers promptly, in writing, of any changes in the data required to describe accurately the characteristics of the equipment as it is to be shipped and erected.

IDENTIFICATION

A stainless steel tag shall be securely attached to each assembly. Each tag shall be stamped with the complete mark number.

CLEANING

The above instrument shall be cleaned in accordance with the manufacturer's standard procedure, using demineralized water and a suitable detergent, both with a halide content of not more than 1.0 ppm for cleaning and flushing.

TESTING

All transmitters and indicators shall be tested per the manufacturer's standard procedure. Engineers' approval of test procedures is required. Testing to be witnessed by Purchaser's authorized representative.

INSPECTION 182

Seller shall provide Purchaser's inspector with 184
certification of manufacturer's standard test, manufacturer's 185
data sheets, and proposed shipping preparation to ensure that the 187
requirements on "VEPCO Vendor Surveillance Inspection Report" 188
incorporated in this specification, are complied with by the
Seller.

PREPARATION FOR SHIPMENT 191

The transmitters shall be prepared for shipment in such 193
a manner as to prevent contamination of cleaned surfaces or 194
damage during transit. 195

INSTALLATION 198

Site installation of the above equipment shall be the 201
responsibility of the Purchaser.

Services of the Seller's engineer shall be furnished, 203
when requested by the Engineers, on a per diem basis at the 204
installation site, to check the equipment and instruct operators 205
on approved operation and maintenance methods.

HARDWARE FOR UNIT NO. 2 - J.O.NO. 12050 208

A duplicate transmitter shall be supplied for Unit No. 2 210
where noted on the data sheets. Mark numbers for Unit No. 2 are 211
duplicates of Unit No. 1, except as illustrated in the following
examples:

Unit No. 1	Unit No. 2	214
LT-RS151A	LT-RS251A	216
LI-RS151A	LI-RS251A	217

STONE & WEBSTER ENGINEERING CORPORATION

GENERAL REQUIREMENTS

INSTRUMENTS

SCOPE

This section covers general requirements regarding manufacturers' prints, instrument instructions, parts lists and spare parts.

Pertinent SERVICE and DESIGN DATA are included in the Instrument Specifications.

SELLER-CONTRACTOR

Whenever this section is attached to and made a part of a formal contract, the word "Seller," as hereinafter used means the party described in the contract as the "Contractor."

MANUFACTURERS' PRELIMINARY PRINTS

The Seller shall submit with his proposal prints of outline drawings or catalog cuts showing the approximate dimensions and construction features of the proposed equipment.

MANUFACTURERS' PRINTS

Information required by the Seller for instrument design will be supplied by the Engineers in the Instrument Specifications.

The Seller shall submit for approval certified prints of outline and detail drawings required for designing the complete installation in accordance with the schedule.

These drawings shall include the following information:

All necessary dimensions and details such as position, size and type of all connections for main and instrument piping, conduits, drains and other services.

Clearances and space required around the equipment for dismantling and repairs.

Wiring diagrams where electrical equipment is involved.

Details of special features.

Engineers' job order number, purchase order number and mark numbers of the equipment.

Arrangement for procurement of necessary materials and production scheduling shall not be deferred pending approval of drawings.

SK2-7.55

One print each of the outline and detail drawings submitted by the Seller will be returned to the Seller, marked "Approved" or "Approved as Revised," together with the Engineers' comments, if necessary, within two weeks from their receipt.

Upon receipt of "Approved as Revised" prints, drawings shall be corrected promptly and new prints submitted to the Engineers for final approval and record purposes. One print will be returned to the Seller. The Seller shall then promptly submit, in accordance with schedule, certified prints as finally approved by the Engineers. When required by the Engineers, the Seller shall furnish additional sets of prints of all final approved drawings.

Approval of the Seller's drawings by the Engineers shall be construed to apply only to general arrangement and shall not relieve the Seller from entire responsibility for correctness of design, details and dimensions.

The shipment offered by the Seller shall be based on the approval of drawings within two weeks from their receipt and shall be stated as a definite period after date of award of order.

INSTRUMENT OPERATING INSTRUCTIONS AND PARTS LIST

The Seller shall submit, in accordance with schedule, complete installation, operating and maintenance instructions, including parts identification list for use in ordering spare or replacement parts. Accompanying this parts list shall be sectional and/or outline drawings marked to identify each numbered part and locate it in relation to the equipment as a whole. The above instructions and parts list are not required for items such as orifice plates, thermocouple assemblies, thermowells, thermometers, pressure gages and gage glasses.

QUOTATION FOR SPARE PARTS

In accordance with schedule, the Seller shall furnish the Engineers a quotation for recommended replacement parts for each size and type of equipment. This recommendation shall include the minimum number of parts to be carried in stock to assure reasonably continuous service of the equipment for one year with a minimum of outage.

DEVIATIONS FROM SPECIFICATIONS

No modification to or deviation from the Instrument Specifications shall be made unless authorized in writing by the Engineers. Any conflicting requirements shall be brought to the attention of the Engineers, in writing, for their decision.

J.O. Nos. 11715/12050

CORRESPONDENCE AND MANUFACTURERS' INSTRUCTIONS FOR INSTRUMENTATION AND CONTROL EQUIPMENT NORTH ANNA POWER STATION 1975 EXTENSION - NORTH ANNA POWER STATION VIRGINIA ELECTRIC AND POWER COMPANY

NOTE: Data on the specification sheets marked with an asterisk (*) to be filled in by Seller.

MANUFACTURERS' PRELIMINARY PRINTS

The Seller shall submit with his proposal prints of outline drawings or catalog cuts showing the approximate dimensions and construction features of the proposed equipment.

DRAWINGS

One transparency each, preferably to scale, of the outline, detail, and finally approved drawings, per schedule on page 1 of the specification suitable for producing prints shall be submitted by the Seller to the Engineers at the following address:

Stone & Webster Engineering Corporation
Attention Mr. A.J.Murphy
Control Systems Division
P. O. Box 2325
Boston, Massachusetts 02107

Drawing transmittal letters, each included drawing, and all related correspondence shall include the following information:

Job Order Number 11715 or 12050
Purchase Order Number
Mark Number
Equipment Name

The above mentioned drawings shall indicate, where necessary, the clearance required for dismantling equipment when in service.

The information specified in the paragraphs above shall apply to the initial and all subsequent issues of the outline and detail drawings. Prints will be stamped "Approved" or "Approved as Revised" by the Engineers and returned to the Seller. "Approved as Revised" prints shall be corrected promptly and resubmitted for approval. If a print is stamped "Approved as Revised," the manufacturer is to proceed on the basis of the marked print, without any extra delivery time allowed.

J. O. Nos. 11715/12050

Drawings for Unit No. 2, J.O.No. 12050, shall be supplied and handled in the same manner as Unit No. 1, J.O.No. 11715.

BIDS

Bids shall be submitted on an "As Requested" basis. Any deviation from the specification will be submitted separately as an alternate bid.

INSPECTION AND TEST REPORTS

The original and four copies of all tests and inspection reports necessary to fulfill the requirements of this order/contract shall be delivered to the Purchaser's inspector if assigned, or sent to:

Virginia Electric & Power Company
Vendor Surveillance Engineer Office
Attention: Mr. Gunther Helm
P.O. Box 26666
Richmond, Virginia 23261

Reports shall be identified with North Anna Power Station, Purchase Order Number, J.O.No. 11715.50 and/or 12050.50, and Equipment Title and/or Mark Number, as well as Seller's name and address to expedite any required communication.

GENERAL

In case of conflict between the instructions on this sheet and the General Requirements, the instructions on this sheet shall govern.

J.O.Nos. 11715
12050

February 11, 1971

EARTHQUAKE REQUIREMENTS
NA-1

The necessity for equipment defined in this specification to withstand an Operating Basis Earthquake and Design Basis Earthquake effect is a requirement prescribed by regulatory agencies having jurisdiction over this nuclear project.

The Vendor shall confirm, in writing, and shall submit calculations or test data for approval by the Engineers which support his statement that the equipment furnished under this specification meets the requirements for the Operating Basis Earthquake and Design Basis Earthquake listed below. A necessary condition to justify utilizing this specification requires that the Vendor shall, as a part of his report, provide natural frequency data, determined by either analysis or test. The analysis or test shall confirm that the resulting deflections shall not cause damage to the equipment to the detriment of its capability to function as specified elsewhere.

The equipment shall be qualified in the OPERATING * mode.

The Vendor is afforded the options noted x for qualifying his equipment to the specified seismic environment.

- Static Analysis per Attachment I ☒
- Dynamic Analysis per Attachment II ☐
- Test Procedure per Attachment III ☒

Within (2) two weeks from the receipt of this order, the Vendor shall submit a brief summary of the effort to be undertaken by him to certify that the equipment meets the seismic requirements set forth herein. If more than one option is afforded above, the summary shall include a statement as to which of the options the Vendor intends to utilize to qualify his equipment. The summary shall also include a schedule of submittals, approvals, interface resolutions and certificates to be submitted to or received from the Engineers. Any exceptions, clarifications and unique interpretations should be stated clearly in the summary.

If static analysis or dynamic analysis is used to qualify the equipment, the following applies. Within (6) six weeks from the receipt of this order, the Vendor shall, where applicable, calculate and submit to the Engineers preliminary allowable end reactions at each connection to the equipment. The Engineers will develop detail plans and will calculate the actual thermal and seismic end reactions on the equipment and will resolve these with the Vendor. The Engineers will transmit the actual thermal and seismic end reactions to the Vendor for incorporation in the Vendor's final calculations. The Vendor shall combine the thermal and seismic end reactions given by the Engineers with the normal operating loads and seismic loads on the equipment, as appropriate, and shall certify that his equipment is capable of withstanding the actual end reactions given by the Engineers.

Operating Basis Earthquake

The equipment shall be designed to be capable of continued operation with all normal operating loads acting simultaneously with both horizontal and vertical components of the Operating Basis seismic loadings. The horizontal and vertical seismic loadings are:

(1) Static Analysis

(a) 0.33 g** horizontal

(b) 0.63 g** vertical

(2) Dynamic Analysis (if applicable)
See attached response data

The horizontal and vertical seismic loads shall be added directly considering a single horizontal direction earthquake to act concurrently with the vertical direction earthquake. One or more directions of the horizontal earthquake shall be considered on a "most severe basis." The stress levels due to these combined loading conditions shall not exceed the maximum stress levels permitted under all applicable codes. If no codes are used in the design of the equipment, then the stress level under the above combined loading shall not exceed 90 percent of the minimum yield strength per the ASTM or equivalent specification for the material.

Design Basis Earthquake

The equipment shall be designed to withstand the combined effects of all normal operating loads acting simultaneously with Design Basis seismic loads without loss of function or structural integrity. The horizontal and vertical seismic loadings, respectively, are:

(3) Static Analysis

(a) 0.36 g** horizontal

(b) 0.88 g** vertical

(4) Dynamic Analysis
See attached response data

The horizontal and vertical seismic loads shall be added directly considering a single horizontal direction earthquake to act concurrently with the vertical direction earthquake. One or more directions of the horizontal earthquake shall be considered on a "most servere basis." The stress levels due to these combined loading conditions shall not exceed 90 per cent of the minimum yield strength per the ASTM or equivalent specification for the material.

If the Vendor can show that his equipment (including critical components) has a base natural frequency above a value of 60 cps, the following g values may be used in place of values listed in (1) and (3) above.

(5) Operating Basis Earthquake - Static Analysis

(a) 0.08 g** horizontal

(b) 0.1 g** vertical

(6) Design Basis Earthquake - Static Analysis

(a) 0.1 g** horizontal

(b) 0.1 g** vertical

The Certificate of Compliance must be stamped and signed by a Registered Professional Engineer with the statement that he has seen and reviewed the adequacy of the method for establishing that the seismic design requirements have been met. A summary of the calculated method and/or test data must be included in the compliance statement. The summary need be only a short paragraph but should include codes, equations, and test results if applicable. The certificate must also be signed by a knowledgeable officer of the Company.

*"Operating" or "not operating" as applicable.

**Equals acceleration due to gravity (static analysis specified).

ATTACHMENT I TO NA-1

INSTRUCTIONS FOR STATIC ANALYSIS

1. Formulate a program for qualifying the equipment in accordance with the conditions specified in the earthquake requirements NA-1. A summary of the effort to be undertaken shall be submitted to the Engineers as specified in NA-1.

2. The Engineers will confirm whether the program for qualifying the equipment is acceptable within (2) two weeks of receipt of the summary.

3. Per the second paragraph of NA-1 the base natural frequency of the equipment must be determined. If the base natural frequency of the equipment and its parts is above the value specified in NA-1, the lower acceleration value specified (5) and (6) may be used. Below this frequency, the larger acceleration values given in (1) a and b and (3) a and b must be used.

4. The Vendor is required to multiply the appropriate masses of the equipment components by the acceleration values in three orthogonal directions, so as to load the equipment in these directions. One direction of horizontal earthquake shall be considered concurrently with the vertical direction earthquake.

5. Where applicable, the Vendor will submit preliminary allowable end reactions for each connection to the Engineers. The Engineers will determine the actual end reactions at each connection and will resolve major disparities with the Vendor. The Vendor will combine the actual end reactions given by the Engineers, in his final calculations which must be submitted to the Engineers for approval.

6. The structural load-carrying members, whether internal components or external components such as hold-down bolts, must be checked to ensure adequacy of design under seismic loading.

7. The equipment is to be analyzed on a worst case basis with regard to operating condition. A check of critical area deflections must be made to ascertain that detrimental damage will not occur.

8. A final analysis report must be compiled by the Vendor and submitted to the Engineers for approval. Upon receipt of approval the Vendor will submit a Certificate of Compliance in accord with NA-1.

ATTACHMENT III TO NA-1

INSTRUCTIONS FOR SEISMIC TESTING

1. Formulate a program for qualifying the equipment in accordance with the conditions specified here and in the earthquake requirements NA-1. A summary of the effort to be undertaken shall be submitted to the Engineers, as specified in NA-1. If the qualifying program is predicated upon existing test data either partly or entirely, the data and reasons why it is considered applicable should be sumitted with the summary.

2. The Engineers will confirm whether the program for qualifying the equipment is acceptable within (2) two weeks of receipt of the summary.

3. The acceleration values listed as (5) and (6) in NA-1 may be used as base input to qualify the equipment by test procedure for the Operating Basis Earthquake and the Design Basis Earthquake.

4. The equipment should be mounted as closely as possible to the in-service orientation during testing. Also, the appurtenances and attachment to the equipment such as connecting piping, attached components and anchoring devices should be the same or at least similar to that of the intended service condition. If insufficient information concerning the intended service conditions or the interface connections is presented in this specification, the Vendor should contact the Engineers for further definition.

5. The equipment should be tested under conditions which practicably approximate the worst case operating conditions; i.e., at pressure, at temperature, energized, in the operating mode, etc. as applicable.

6. A frequency scan (standard logarithmic sweep) at a constant acceleration of "g" shall be performed for as much of the range between 2 and 200 cycles per second as practicable. The objective of this test is to determine the natural frequencies and amplification factors of the tested equipment and its critical components or appurtenances. The acceleration constants to be used would be the higher value of those listed as (5) and (6) in NA-1. The horizontal direction "g" value shall be applied in two perpendicular axes oriented to consider equipment orientation and worst case results.

   Alternatives to sine wave forcing, such as "sine beat" or random excitation may also be considered.

7. A "Dwell Test" of the equipment shall be included. This would include as a minimum, a test of from 1 to 15 min duration at the frequency and input for which the maximum component response was noted in (6). Additionally, other frequencies would be selected if (a) they are deemed severe - amplification factor equal or greater than 2.0, and (b) the frequency of the response is sufficiently removed from the major peak such that it can be regarded as discrete, i.e., the new frequency falls outside of the band of ±50 percent of the old frequency.

8. The Vendor shall identify the critical areas of the equipment. The number and type of tests and examinations of the equipment in general, and the critical areas in particular, to be conducted prior to, during and after vibration or shock testing shall be clearly delineated and recorded by the Vendor. As a minimum, sufficient examinations must be made to ascertain that damage detrimental to the continued safe operation of the equipment has not occurred.

9. The Vendor shall notify the Engineers two weeks prior to the conduct of the testing and shall afford the Engineers' inspector the opportunity to witness any or all parts of the tests and inspections.

10. A final test report must be compiled by the Vendor and submitted to the Engineers for approval. Upon receipt of approval the Vendor will submit a Certificate of Compliance in accord with NA-1.

(Supplementary Sheet) STONE & WEBSTER ENGINEERING CORPORATION

SUMP LEVEL TRANSMITTER AND INDICATOR

Page 1
Spec. No. NAS-90-22
J.O. No. 11715 / 12050
By WGA / JT Date 2-29-72

Client VIRGINIA ELECTRIC AND POWER COMPANY
Project NORTH ANNA POWER STATION

TRANSMITTER:

MARK NO.	LT-RS151 A, B
SERVICE	CONTAINMENT SUMP
QUANTITY	2
TYPE	POSITION INDICATOR, ACTUATED BY MAGNETIZED FLOAT, CLOSING SERIES CONNECTED REED SWITCHES IN VOLTAGE DIVIDER CIRCUIT
MATERIAL TUBE	STAINLESS STEEL
MATERIAL FLOAT	STAINLESS STEEL
ELECTRICAL CONN. HEAD	STAINLESS STEEL
FLANGE	STAINLESS STEEL
FLANGE SIZE AND RATING	6 IN. 150 lb ANSI RF
PROBE LENGTH	10'9"
OPERATING RANGE	0-10'
PROCESS DATA:	
MEDIUM	H_2O, NAOH BORIC ACID MIXTURE
OPER. PRESS.	10 PSIA
OPER. TEMP.	105°F 77°F DEW POINT
SPECIFIC GRAVITY	1.05
RADIATION	10^8 R LIFETIME
ELECTRICAL ENCLOSURE	WATERPROOF (SUBMERSIBLE)
ELECTRICAL CONNECTION	3/4 IN. NPT (F)
POWER SUPPLY	12 V d-c FROM CONTROL UNIT
CABLE	3 C 16 AWG (BY OTHERS)
MFG. *	△2 GEMS
MODEL NO. *	△2 XM-29400

CONTROL UNIT

MARK NO.	LIT-RS151 A, B
MOUNTING	WALL
POWER SUPPLY	120 V a-c 60 Hz
INDICATOR	7 IN.
SCALE	0-10 FT.
OUTPUT 1	TO BOARD MTD. INDICATOR, 0-10 V
ENCLOSURE	WEATHERPROOF
MFG. *	△2 GEMS
MODEL NO. *	△2 RE-31320 / 31411

NOTES:

1. TRANSMITTER LOCATED INSIDE REACTOR CONTAINMENT - MUST BE OPERABLE DURING LOSS-OF-COOLANT ACCIDENT - CONTAINMENT CONDITIONS:

	PRESSURE	TEMPERATURE	HUMIDITY	RADIATION
1st HOUR	60 PSIA	280°F	100%	10^8 R
AFTER 1 HOUR	13.5 PSIA	140-150°F	100%	10^8 R

2. ABOVE TRANSMITTER MUST SATISFY EARTHQUAKE REQUIREMENTS. SEISMIC CERTIFICATION REQUIRED
3. DUPLICATE TRANSMITTERS REQUIRED FOR UNIT 2, J.O. NO. 12050
4. Enviromental Certification Required.

Rev. 3 By Date
Rev. 2 By Date
Rev. 1 By Date

(Supplementary Sheet) STONE & WEBSTER ENGINEERING CORPORATION

OIL LEVEL TRANSMITTER AND INDICATOR

Page 2
Spec. No. NAS-90-22
J.O. No. 11715/12050
By WGG/JT Date 2-24-72

Client VIRGINIA ELECTRIC AND POWER COMPANY
Project NORTH ANNA POWER STATION

TRANSMITTER:

MARK NO.	LT-EG 100A, B
SERVICE	EG-TK 2A, 2B (UNDERGROUND STORAGE TK)
QUANTITY	2
TYPE	POSITION INDICATOR ACTUATED BY MAGNETIZED FLOAT CLOSING SERIES CONNECTED REED SWITCHES IN VOLTAGE DIVIDER CIRCUIT
MATERIAL TUBE	STAINLESS STEEL
MATERIAL FLOAT	STAINLESS STEEL
ELECTRICAL CONN. HEAD	STAINLESS STEEL
FLANGE	STAINLESS STEEL
FLANGE SIZE AND RATING	5 IN. 150 lb. ANSI RF
PROBE LENGTH	12' 4"
OPERATING RANGE	0 - 11' 6"
PROCESS DATA:	
MEDIUM	NO.2 FUEL OIL
OPER PRESS.	ATM
OPER TEMP.	50 - 70°F
SPECIFIC GRAVITY	0.83 - 0.89
ELECTRICAL ENCLOSURE	WATERPROOF
ELECTRICAL CONNECTION	3/4 IN. NPT (F)
POWER SUPPLY	12 Vd-c FROM CONTROL UNIT
CABLE	3 C 16 AWG (BY OTHERS)
MFG *	△2 GEMS
MODEL NO. *	△ XM-29400

CONTROL UNIT

MARK NO.	LI-EG100A, B △5
MOUNTING	△3 PANEL
POWER SUPPLY	120 Va-c, 60 Hz
INDICATOR	7 IN.
SCALE	0 - 11' 6"
OUTPUT 1	12 Vd-c TO TRANSMITTER
ENCLOSURE	WEATHERPROOF
CONTACT RATING *	
MFG *	△ GEMS
MODEL NO. *	△ RE-31320/3 [illegible]

NOTES:

1) LEVEL TRANSMITTER WILL SOUND ALARM WHEN OIL LEVEL DROPS TO 12".

2) ONE N.O. ALARM CONTACT REQUIRED FOR EACH UNIT.

Rev. 3 By Date
Rev. 2 By Date
Rev. 1 By Date

(Supplementary Sheet)

STONE & WEBSTER ENGINEERING CORPORATION

INTERFACE LEVEL SWITCH

Page 3 (3)
Spec. No. NAS-90-22
J.O. No. 11715/12050
By RBD Date 12-10-73

Client: Virginia Electric and Power Company
Project: North Anna Power Station

LEVEL SWITCH

Mark No.	LS-EG 102A&B
Service	EG-TK-2A,2B (UNDERGROUND STORAGE TANK)
Quantity	TWO
Type	MAGNETIC FLOAT
Tube material	STAINLESS STEEL
Float material*	
Flange material	STAINLESS STEEL
Electrical head conn.	STAINLESS STEEL
Flange size	5" 150# ANSI RF
Probe length	12'4"
Operating range	0-6"
Process Data:	
Fluid	No. 2 FUEL OIL, H2O
Oper. press.	16 PSIG
Oper. temp.	50°F
Specific gravity	0.83-0.89, 1.0
Radiation	N/A
Electrical enclosure	WATER PROOF (SUBMERSIBLE)
Electrical connection	3/4" NPT (F)
Power supply	N/A
Cable	2C #16 AWG (BY OTHERS)
Mfg. *	GEMS (5)
Model No. *	XM-29400 (5)
Control Unit:	N/A
Mounting	
Power supply	
Output	
Enclosure	
Mfg. *	
Model No. *	
Stilling Well:	N/A
Material	
Dimensions	
Mfg. *	

NOTES:
1) CONTACT CLOSES WHEN WATER LEVEL IN BOTTOM OF STORAGE TANK RISES TO 1.5"
2) SPDT CONTACT REQUIRED

Rev. 3 By Date
Rev. 2 By Date
Rev. 1 By Date

5801-1.80

(Supplementary Sheet) STONE & WEBSTER ENGINEERING CORPORATION

SUMP LEVEL TRANSMITTER

Page 4 △3
Spec. No. NAS-90-22
J.O. No. 11715/12050
By RBD Date 12-10-73

Client: Virginia Electric and Power Company
Project: North Anna Power Station

Transmitter with control unit

Mark No.	LT-DA110A	△5
Service	CONTAINMENT SUMP	
Quantity	ONE	
Type	MAGNETIC FLOAT	
Tube material	300 SERIES STAINLESS STEEL	
Float material*	STAINLESS STEEL	△5
Flange material	300 SERIES STAINLESS STEEL	
Electrical head conn.	300 SERIES STAINLESS STEEL	
Flange size △4	5" 150# ANSI R.F. FLANGE	
Probe length	20"	
Operating range	MINIMUM LEVEL TO 12"	
Process Data:		
Fluid	WATER, NAOH, BORIC ACID MIXTURE	
Oper. press.	10 PSIA	
Oper. temp.	105°F 77°F DEW POINT	
Specific gravity	1.05	
Radiation	10^6 RAD LIFETIME	
Electrical enclosure	WATER PROOF (SUBMERSIBLE)	
Electrical connection	3/4" NPT (F)	
Power supply	FROM CONTROL UNIT	
Cable	3C #16 AWG (BY OTHERS)	
Mfg. *	GEMS	△5
Model No. *	XM-36495	△5
Control Unit:	LQ/LS-DA110A	△4
Mounting	WALL	
Power supply	120 VAC 60 HZ	
Output	0-10 VOLT NO METER	
Enclosure	WEATHER PROOF	
Mfg. *	GEMS	△5
Model No. *	RE-39425	△5
Stilling Well:		
Material	300 SERIES STAINLESS STEEL	
Dimensions	SEE ISK-1E	
Mfg. *	TO BE FIELD FABRICATED △4	

NOTES:
1) Duplicate transmitter required for Unit 2

Rev. & By	Date
Rev. & By	Date
Rev. & By	Date
Rev. & By	Date

(Supplementary Sheet) STONE & WEBSTER ENGINEERING CORPORATION

VALVE PIT LEVEL SWITCH

Page 5
Spec. No. NAS-90-22
J.O. No. 11715 / 12050
By C.E.B. Date 2-26-72

Client: Virginia Electric and Power Co.
Project: North Anna Power Station

LEVEL SWITCH

MARK NO.	LS-RS101 A, B
SERVICE	VALVE PIT
QUANTITY	2
TYPE	MAGNETIC FLOAT
TUBE MATERIAL	STAINLESS STEEL
FLOAT MATERIAL	STAINLESS STEEL
FLANGE MATERIAL	STAINLESS STEEL
ELECTRICAL CONN.	STAINLESS STEEL
FLANGE SIZE	4 IN 150 LB RF ANSI
PROBE Length	12"
Operating Range	0 - 6"
Set POINT	

PROCESS DATA

FLUID	WATER, NAOH, Boric Acid Mixture
OPER. PRESS.	MAX. 60PSIG / NORMAL ATMOS.
OPER. TEMP.	MAX. 203°F / NORMAL 120°F
Specific Gravity	1.05
RADIATION	10^8 R LIFETIME
ELECTRICAL ENCLOSURE	WATERPROOF (SUBMERSIBLE)
ELECTRICAL CONN	3/4" NPT (F)
CABLE	BY OTHERS
MFG. (2)	* GEMS
MODEL NO. (2)	* 11715-1SK-1C
CONTACT RATINGS	*

NOTES:

1) DUPLICATE LEVEL SWITCHES FOR UNIT 2.

Rev. 3 By Date
Rev. 2 By Date
Rev. 1 By Date

(Supplementary Sheet) STONE & WEBSTER ENGINEERING CORPORATION

Interface Level Switch

Page 6 (3)
Spec. No. NAS-90-22
J.O. No. 11715/12050
By PBD Date 12-10-73

Client: Virginia Electric and Power Company
Project: North Anna Power Station

Level Switch

Mark No.	LS-FO102
Service	FO/WATER INTERFACE 1-FO-TK-1
Quantity	ONE
Type	MAGNETIC FLOAT
Tube material	304 STAINLESS STEEL
Float material *	BUNA N (4)
Flange material	304 STAINLESS S. EL
Electrical head conn.	304 STAINLESS STEEL
Flange size	3" 150 # ANSI ~~R.F.~~ (3)
Probe length	5 " (4)
Operating range	MINI UM LEVEL TO 4"

Process Data:

Fluid	No. 2 FUEL OIL, H_2O
Oper. press.	8 PSIG
Oper. temp.	45-90°F
Specific gravity	0.83-0.89, 1.0
Radiation	N/A
Electrical enclosure	WATER PROOF (SUBMERSIBLE
Electrical connection	3/4" NPT (F)
Power supply	N/A
Cable	2C #16 AWG (BY OTHERS)
Mfg. *	GEMS (4)
Model No. *	LS-41520 (3)

Control Unit: N/A

Mounting	
Power supply	
Output	
Enclosure	
Mfg. *	
Model No. *	

Stilling Well: N/A

Material	
Dimensions	
Mfg. *	

NOTES:

1) CONTACT CLOSES WHEN WATER LEVEL IN BOTTOM OF STORAGE TANK RISES TO 1.5"
2) SPDT CONTACT REQUIRED

Rev.	By	Date
Rev. 3	By	Date
Rev. 2	By	Date
Rev. 1	By	Date

E&S1-1.00

(Supplementary Sheet)

STONE & WEBSTER ENGINEERING CORPORATION

5

SUMP LEVEL TRANSMITTER

Page 7
Spec. No. NAS-90-22
J.O.No. 11715/12050
By RBC Date 12-12-79

Client: Virginia Electric and Power Company
Project: North Anna Power Station

Transmitter with control unit

Mark No.	LT-DA 110B
Service	CONTAINMENT SUMP
Quantity	ONE
Type	MAGNETIC FLOAT
Tube material	300 SERIES STAINLESS STEEL
Float material*	STAINLESS STEEL
Flange material	300 SERIES STAINLESS STEEL
Electrical head conn.	300 SERIES STAINLESS STEEL
Flange size	5 IN. 150 LB R.F.
Probe length	20 IN.
Operating range	MINIMUM LEVEL TO 12 IN.
Process Data:	
Fluid	WATER, NAOH, BORIC ACID MIXTURE
Oper. press.	10 PSIA
Oper. temp./HUMIDITY	105°F 77°F DEW POINT
Specific gravity	1.05
Radiation	10^8 RAD LIFETIME
Electrical enclosure	WATERPROOF (SUBMERSIBLE)
Electrical connection	3/4 IN. NPT (F)
Power supply	FROM CONTROL UNIT
Cable	3C #16 AWG (BY OTHERS
Mfg. *	GEMS
Model No. *	XM-36495
Control Unit:	LQ/LS-DA110B
Mounting	WALL
Power supply	120 VAC 60 HZ
Output	0-10VDC NO METER. ALARM CONTACT AT 10 IN.
Enclosure	WEATHER PROOF
Mfg. *	GEMS
Model No. *	RE-42880
Stilling Well:	
Material	300 SERIES STAINLESS STEEL
Dimensions	SEE ISK-1E
Mfg. *	TO BE FIELD FABRICATED

6

NOTES:
1) Duplicate transmitter required for Unit 2
2) ALARM CONTACTS TO CLOSE ON A RISE TO 10 IN.
3) SEISMIC QUALIFICATION REQUIRED
4) ENVIRONMENTAL QUALIFICATION REQUIRED, PROBE ONLY.

Rev. 3 By	Date
Rev. 2 By	Date
Rev. 1 By	Date

5601-1.00

(Supplementary Sheet) STONE & WEBSTER ENGINEERING CORPORATION Page 8 (5)

SUMP LEVEL TRANSMITTER Spec. No. NAS-90-22

Client: Virginia Electric and Power Company J.O. No. 11715/12050

Project: North Anna Power Station By KED Date 12-12-7?

Transmitter with control unit

Mark No.	LT-DA 111 A&B
Service	AUXILIARY BUILDING SUMP
Quantity	TWO
Type	MAGNETIC FLOAT
Tube material	STAINLESS STEEL
Float material*	STAINLESS STEEL
Flange material	STAINLESS STEEL
Electrical head conn.	STAINLESS STEEL
Flange size	5 IN 150 # R.F.
Probe length	36 IN
Operating range	MINIMUM LEVEL TO 30 IN.

Process Data:	
Fluid	WATER
Oper. press.	ATMOSPHERIC
Oper. temp.	70°-90°F
Specific gravity	1.0
Radiation	N/A
Electrical enclosure	WATER PROOF (SUBMERSIBLE)
Electrical connection	3/4 IN. NPT (F)
Power supply	FROM CONTROL UNIT
Cable	3C #16 AWG (BY OTHERS)
Mfg. *	GEMS
Model No. *	XM-36495

Control Unit:	LQ/LS-DA111A&B (6)
Mounting	WALL
Power supply	120 VAC 60 HZ
Output	0-10 VDC NO METER. ALARM CONTACT AT 25 IN
Enclosure	WEATHER PROOF
Mfg. *	GEMS
Model No. *	RE-42880

Stilling Well:	
Material	300 SERIES STAINLESS STEEL
Dimensions	SEE ISK-1F
Mfg. *	TO BE FIELD FABRICATED

NOTES:

1) ALARM CONTACTS TO CLOSE ON A RISE TO 25 IN.
2) SEISMIC QUALIFICATION REQUIRED

Rev. 3 By	Date
Rev. 2 By	Date
Rev. 1 By	Date

ESBI-1.00

(Supplementary Sheet)

STONE & WEBSTER ENGINEERING CORPORATION

Page 9

SUMP LEVEL SWITCHES

Spec. No. NAS-90-22

J.O. No. 11715/12050

By RBD Date 12-12-77

Client: Virginia Electric and Power Company

Project: North Anna Power Station

Mark No.	LSH-DA 112
Service	MAIN STEAM VALVE HOUSE SUMP
Quantity	1
Type	MAGNETIC FLOAT
Construction:	
Tube material	STAINLESS STEEL
Float material	STAINLESS STEEL
Flange material	N/A
Electrical head conn.	STAINLESS STEEL
Flange size	N/A
Probe length	~3 IN
Operating point	18 IN. FROM SUMP FLOOR
Switch type	SPDT REED SWITCH
Switch action	CLOSE ON INCREASING LEVEL
Process Data:	
Fluid	WATER
Oper. press.	ATMOSPHERIC
Oper. temp.	70°-90° F
Specific gravity	1.0
Radiation	N/A
Electrical enclosure	WATERPROOF (SUBMERSIBLE)
Electrical connection	3/4 IN NPT (F)
Manufacturer*	GEMS
Model No.*	LS-41740
Stilling Well:	
Material	STAINLESS STEEL
Dimensions	SEE ISK-1G
Mfg.	SUPPLIED AS PART OF LEVEL SWITCH

NOTES:

1) DUPLICATE SWITCH REQUIRED FOR UNIT 2
2) SEISMIC QUALIFICATION REQUIRED

Rev. 3 By	Date
Rev. 2 By	Date
Rev. 1 By	Date

0601-1.00

SUMP LEVEL TRANSMITTER

Spec. No. NAS-90-22
Client: Virginia Electric and Power Company — J.O. No. 11715/12050
Project: North Anna Power Station — By RBD — Date 12-13-74

Transmitter with control unit

Mark No.	LT-DA 113A&B
Service	CHILLER ROOM SUMP
Quantity	TWO
Type	MAGNETIC FLOAT
Tube material	STAINLESS STEEL
Float material*	STAINLESS STEEL
BRACKET material	STAINLESS STEEL
Electrical head conn.	N/A
BRACKET size	MFR. STD.
Probe length (OVER ALL)	44 IN.
Operating range	MINIMUM LEVEL TO 36½ IN
Process Data:	
Fluid	WATER
Oper. press.	ATMOSPHERIC
Oper. temp.	70°-90°F
Specific gravity	1.0
Radiation	N/A
Electrical enclosure	N/A
Electrical connection	BY MFR
Power supply	FROM CONTROL UNIT
Cable	SUBMERSIBLE CABLE ASSY. DWG # 36880
Mfg. *	GEMS
Model No. *	XM-36460
Control Unit:	LQ/LS-DA 113A&B ⚠
Mounting	WALL
Power supply	120 VAC 60 HZ
Output	0-10VDC NO METER ALARM CONTACT AT 36 IN.
Enclosure	WEATHER PROOF
Mfg. *	GEMS
Model No. *	RE-42880
Stilling Well:	N/A
Material	
Dimensions	
Mfg. *	

NOTES:
1) SEISMIC QUALIFICATION REQUIRED
2) ALARM CONTACT TO CLOSE ON A RISE TO 36 IN.
3) SEE ISK-1H FOR INSTALLATION DETAILS

Rev. 1 By — Date
Rev. 2 By — Date
Rev. 3 By — Date

5501-1.00

(Supplementary Sheet)

STONE & WEBSTER ENGINEERING CORPORATION

Page 11 (5)

Spec. No. NAS-90-22

J.O. No. 11715/12050

By RED Date 12-13-7?

SUMP LEVEL TRANSMITTER

Client: Virginia Electric and Power Company
Project: North Anna Power Station

Transmitter with control unit

Mark No.	LT-DA 213 A&B
Service	CHILLER ROOM SUMP
Quantity	TWO
Type	MAGNETIC FLOAT
Tube material	STAINLESS STEEL
Float material*	STAINLESS STEEL
BRACKET material	STAINLESS STEEL
Electrical head conn.	N/A
BRACKET size	MFR. STD.
Probe length (OVERALL)	48 IN.
Operating range	MINIMUM LEVEL TO 40½ IN.

Process Data:	
Fluid	WATER
Oper. press.	ATMOSPHERIC
Oper. temp.	70°-90° F
Specific gravity	1.0
Radiation	N/A
Electrical enclosure	N/A
Electrical connection	BY MFR
Power supply	FROM CONTROL UNIT
Cable	SUBMERSIBLE CABLE ASS'Y. DWG # 36860
Mfg. *	GEMS
Model No. *	XM-36460

Control Unit:	LQ/LS-213A&B
Mounting	WALL
Power supply	120VAC 60 HZ
Output	0-10VDC NO METER ALARM CONTACT AT 40 IN
Enclosure	WEATHER PROOF
Mfg. *	GEMS
Model No. *	RE-42880

Stilling Well:	N/A
Material	
Dimensions	
Mfg. *	

NOTES:

1) SEISMIC QUALIFICATION REQUIRED
2) ALARM CONTACT TO CLOSE ON A RISE TO 40 IN.
3) SEE ISK-1H FOR INSTALLATION DETAILS

Rev. 3 By Date
Rev. 2 By Date
Rev. 1 By Date

5501-1.00

(Supplementary Sheet) STONE & WEBSTER ENGINEERING CORPORATION

SUMP LEVEL SWITCHES

Page 12 △5

Spec. No. NAS-90-22

Client: Virginia Electric and Power Company

J.O. No. 11715/12050

Project: North Anna Power Station

By KED -21-75

Mark No.	LSH-DA 114
Service	SERVICE WATER VALVE PIT
Quantity	1
Type	MAGNETIC FLOAT

Construction:

Tube material	STAINLESS STEEL
Float material	STAINLESS STEEL
Flange material	N/A
Electrical head conn.	STAINLESS STEEL
Flange size	N/A
Probe length	~ 3 IN
Operating point	17 IN. FROM SUMP FLOOR
Switch type	SPDT REED SWITCH
Switch action	CLOSE ON INCREASING LEVEL

Process Data:

Fluid	WATER
Oper. press.	ATMOSPHERIC
Oper. temp.	70°-90°F
Specific gravity	1.0
Radiation	N/A

Electrical enclosure	WATERPROOF (SUBMERSIBLE)
Electrical connection	3/4 IN NPT (F)

Manufacturer*	GEMS
Model No.*	LS-43482 A

Stilling Well:

Material	STAINLESS STEEL
Dimensions	SEE ISK-1G
Mfg.	SUPPLIED AS PART OF LEVEL SWITCH

NOTES:

1) SEISMIC QUALIFICATION REQUIRED
2)

Rev. 1 By Date
Rev. 1 By Date
Rev. 1 By Date

5601-1.00

(Supplementary Sheet) STONE & WEBSTER ENGINEERING CORPORATION

SUMP LEVEL SWITCHES

Spec. No. NAS-30-22
J.O. No. 11715/12050
By RBD Date 3-21-75

Client: Virginia Electric and Power Company
Project: North Anna Power Station

Mark No.	LSH-DA 116A △7
Service	ELECTRICAL MANHOLE △7
Quantity	1
Type	MAGNETIC FLOAT
Construction:	
Tube material	STAINLESS STEEL
Float material	STAINLESS STEEL
Flange material	N/A
Electrical head conn.	STAINLESS STEEL
Flange size	N/A
Probe length	~3 IN
Operating point	MID RANGE △7
Switch type	2 SPST REED SWITCH △5
Switch action	1 CONT. OPENS ON LEVEL INCREASE
	1 CONT. CLOSES ON LEVEL INCREASE
Process Data:	
Fluid	WATER △7
Oper. press.	ATMOSPHERIC
Oper. temp.	70°-90°F
Specific gravity	0.9-1.0
Radiation	N/A
Electrical enclosure	WATERPROOF (SUBMERSIBLE)
Electrical connection	3/4 IN NPT (F)
Manufacturer*	GEMS
Model No.*	LS-43482 △5
Stilling Well:	
Material	STAINLESS STEEL
Dimensions	SEE ISK-1G
Mfg.	SUPPLIED AS PART OF LEVEL SWITCH

NOTES:
1)
2)

Rev
Rev. # By Date
Rev. # By Date
Rev. 7 By RBD Date 8-8-77

5801-1.00

LTI-28A

LEVEL SWITCHES

Client: Virginia Electric and Power Company
Project: North Anna Power Station

Mark No.	LS-EG1HA, LS-EG1JA
Service	EMERGENCY GENERATOR DAY TANK
Quantity	TWO
Type	MAGNETIC FLOAT (TWO FLOATS EACH SWITCH)
Construction:	
Tube material	STAINLESS STEEL
Float material	BUNA N (3½ IN. DIA.)
Flange material	STAINLESS STEEL
Electrical head conn.	STAINLESS STEEL
Flange size	4 IN. 150#
Probe length	40 IN.
Operating points:	22¾", 28¾", 34¼" FROM FLANGE
Switch type	3 SPST N.O. REED SWITCHES
Switch action	CLOSE AS FLOAT PASSES
Process Data:	
Fluid	NO. 2 FUEL OIL
Oper. press.	ATMOS.
Oper. temp.	AMBIENT
Specific gravity	.83 - .89
Radiation	N/A
Electrical enclosure	WATER PROOF (SUBMERSIBLE)
Electrical connection	3/4 IN. NPT. (F)
Manufacturer*	GEMS
Model No.*	LS-36494
Stilling Well:	N/A
Material	
Dimensions	
Mfg.	

NOTES:
1) SEISMIC QUALIFICATION REQ'D
2) DUPLICATE FOR UNIT 2 MK. NOS. LS-EG2HA, LS-EG2JA
3) REF. DWG. ISK-1J

Rev. 3 By Date
Rev. 2 By Date
Rev. 1 By Date

5501-1.00

(Supplementary Sheet) STONE & WEBSTER ENGINEERING CORPORATION

LEVEL SWITCHES

Page 15 (6)
Spec. No. NAS-30-22
J.O. No. 11715/12050
By Date

Client: Virginia Electric and Power Company
Project: North Anna Power Station

Mark No.	LS-EG1HB, LS-EG1JB
Service	EMERGENCY GENERATOR DAY TANK
Quantity	TWO
Type	MAGNETIC FLOAT (TWO FLOATS ON EACH SWITCH)

Construction:

Tube material	STAINLESS STEEL
Float material	BUNA N (3½ IN. DIA)
Flange material	STAINLESS STEEL
Electrical head conn.	STAINLESS STEEL
Flange size	4 IN. 150#
Probe length	40 IN.
Operating points	22", 22¾", 34¾" FROM FLANGE
Switch type	3 SPST N.O. REED SWITCHES
Switch action	CLOSE AS FLOAT PASSES

Process Data:

Fluid	NO. 2 FUEL OIL
Oper. press.	ATMOS.
Oper. temp.	AMBIENT
Specific gravity	.83-.89
Radiation	N/A
Electrical enclosure	WATERPROOF (SUBMERSIBLE)
Electrical connection	¾ IN NPT (F)
Manufacturer*	GEMS
Model No.*	LS-36494

Stilling Well: N/A

Material
Dimensions
Mfg.

NOTES:
1) SEISMIC QUALIFICATION REQ'D
2) DUPLICATE FOR UNIT 2 MK. NOS. LS-EG2HB, LS-EG2JB
3) REF. DWG. ISK-2I

Rev. 3 By Date
Rev. 2 By Date
Rev. 1 By Date

LEVEL SWITCHES

Spec. No. NAS-90-22
J.O. No. 11715/12050
By RCD Date 10-15-75

Client Virginia Electric and Power Company
Project North Anna Power Station

Mark No. LS-FP1202
Service FIRE PUMP DIESEL ENGINE FUEL OIL TANK
Quantity ONE
Type MAGNETIC FLOAT

Construction:

Tube material	STAINLESS STEEL
Float material	STAINLESS STEEL
Mounting material	STAINLESS STEEL
Electrical head conn.	STAINLESS STEEL
Mounting size	2 IN NPT (M)
Probe length	30 IN.
Operating point	25 IN. FROM BOTTOM OF MOUNTING
Switch type	SPDT REED SWITCH
Switch action	CONTACT CLOSES ON DECREASING LEVEL

Process Data:

Fluid	NO. 2 FUEL OIL
Oper. press.	ATMOS.
Oper. temp.	AMBIENT
Specific gravity	0.83 - 0.89
Radiation	N/A
Electrical enclosure	WATER PROOF (SUBMERSIBLE)
Electrical connection	3/4 IN. NPT (F)
Manufacturer*	GEMS
Model No.*	SERIES LS-800 TYPE 3

Stilling Well: N/A
Material
Dimensions
Mfg.

NOTES:
1) SEISMIC QUALIFICATION REQUIRED
2) SUPPLY FOR UNIT 1 ONLY

Rev. 3 By Date
Rev. 2 By Date
Rev. 1 By Date

BESH-1.08

(Supplementary Sheet)

STONE & WEBSTER ENGINEERING CORPORATION

SUMP LEVEL SWITCHES

Page 17 (Rev. 7)

Spec. No. NAS-90-22

J.O. No. 11715/12050

By RED Date 11-5-76

Client: Virginia Electric and Power Company

Project: North Anna Power Station

Mark No. LS-VP112
Service CIRC. WATER TUNNEL DE-AERATING
Quantity ONE
Type MAGNETIC FLOAT

Construction:
Tube material STAINLESS STEEL
Float material BUNA-N (10558)
MOUNT material STAINLESS STEEL
Electrical head conn. STAINLESS STEEL
MOUNT size 2" NPT (M)
Probe length 36"
Operating point 28" FROM MOUNTING
Switch type SPST 100W
Switch action CLOSE & MAINTAIN ON INCREASING LEVEL

Process Data:
Fluid LAKE WATER
Oper. press. ATMOSPHERIC
Oper. temp. 40° - 90°F
Specific gravity 1.0
Radiation N/A

Electrical enclosure SUBMERSIBLE (15 FT H2O)
Electrical connection N/A

Manufacturer* GEMS
Model No.* LS-800 TYPE 3

Stilling Well: N/A
Material
Dimensions
Mfg.

NOTES:
1) DUPLICATE SWITCH REQUIRED FOR UNIT 2
2)

Rev. 5 By Date

Rev. 6 By Date

Rev. 7 By RED Date 8-8-77

(Supplementary Sheet) STONE & WEBSTER ENGINEERING CORPORATION

Page 18 (Rev. 7)

Spec. No. NAS-90-22

J.O. No. 11715/12050

By RBD Date 5-21-77

LEVEL TRANSMITTER

Client: Virginia Electric and Power Company

Project: North Anna Power Station

Transmitter with control unit

Mark No.	LI-SW-102
Service	1-SW-TK-4
Quantity	ONE
Type	MAGNETIC FLOAT
Tube material	PVC
Float material*	PVC
Flange material	PVC
Electrical head conn.	PVC
Flange size	6" 150# FLAT FACE
Probe length	44"
Operating range	6" – 39 1/4" FROM FACE OF FLANGE (Rev. 8)
	~14.5–100% VOLUME
Process Data:	
Fluid	CL-14 (DEPOSIT INHIBITOR)
Oper. press.	ATMOSPHERIC
Oper. temp.	70°F
Specific gravity	~1.15
Radiation	N/A
Electrical enclosure	WATER PROOF
Electrical connection	1/2" NPT(F)
Power supply	12 VDC FROM CONTROL UNIT
Cable	3C #16 AWG. (BY OTHERS)
Mfg. *	GEMS
Model No. *	36488
Control Unit:	LQ/LS-SW 102
Mounting	WALL
Power supply	120 VAC 60 Hz
Output	0-200ua/METER SCALE 0–100% NON-LINEAR
Enclosure	WEATHERPROOF
Mfg. *	GEMS
Model No. *	RE-36545 WITH DUAL ALARMS
Stilling Well:	NOT REQUIRED
Material	
Dimensions	
Mfg. *	

NOTES:

~~1) Duplicate transmitter required for Unit 2~~

1.) (NON-LINEAR SCALING FOR HORIZONTAL CYLINDRICAL TANK)

2.) PROVIDE ONE (3-GANG) BULKHEAD MOUNTING RACK WITH RECEIVER

3.) REF. DWG. 11715-ISK-1K

Rev. 8 By: Date:

Rev. 8 By: Date:

Rev. 7 By: EGD Date: 8-8-77

6601-1.00

(Supplementary Sheet) STONE & WEBSTER ENGINEERING CORPORATION

Page 19 (7)

LEVEL TRANSMITTER

Spec. No. NAS-90-22

Client: Virginia Electric and Power Company — J.O. No. 11715/12050

Project: North Anna Power Station — By RBD — Date 5-21-77

Transmitter with control unit

Mark No. LT-SW103A & 103B
Service 1-SW-TK-3A & 3B
Quantity TWO
Type MAGNETIC FLOAT

Tube material PVC
Float material * PVC
Flange material PVC
Electrical head conn. PVC
Flange size 6" 150 # FLAT FACED
Probe length 47"
Operating range 6" - 42¼" FROM FACE OF FLANGE (8)
~14.5% - 100% VOLUME

Process Data:
Fluid SODIUM HYPOCHLORITE
Oper. press. ATMOSPHERIC
Oper. temp. 70° F
Specific gravity 1.24
Radiation N/A
Electrical enclosure WATERPROOF
Electrical connection ½" NPT(F)
Power supply 12VDC FROM CONTROL UNIT
Cable 3C #16 AWG (BY OTHERS)
Mfg. * GEMS
Model No. * 36488

Control Unit: LG/LS-SW103A & 103B
Mounting WALL
Power supply 120 VAC 60HZ
Output 0-200 μA / METER SCALE 0-100% NON LINEAR
Enclosure WEATHERPROOF
Mfg. * GEMS
Model No. * RE-36545 WITH DUAL ALARMS

Stilling Well: NOT REQUIRED
Material
Dimensions
Mfg. *

NOTES:
~~1) Duplicate transmitter required for Unit 2~~
1) (NON-LINEAR SCALING FOR HORIZONTAL CYLINDRICAL TANK)
2) REF. DWG. 11715-ISK-1L

Rev. 3 By Date
Rev. 2 By Date
Rev. 1 By RBD Date 8-8-77

5684-1,00

(Supplementary Sheet)

STONE & WEBSTER ENGINEERING CORPORATION

SUMP LEVEL TRANSMITTER

Page 20 (7)
Spec. No. NAS-90-22
J.O. No. 11715/12050
By RBD Date 9-8-77

Client: Virginia Electric and Power Company
Project: North Anna Power Station

Transmitter with control unit

Mark No.	LT-DB 108
Service	1-DB-TK-05
Quantity	ONE
Type	MAGNETIC FLOAT
Tube material	STAINLESS STEEL
Float material*	STAINLESS STEEL
Flange material	STAINLESS STEEL
Electrical head conn.	STAINLESS STEEL
Flange size	5 IN. 150# R.F.
Probe length	87 IN.
Operating range	MINIMUM TO 6 IN. FROM FLANGE
Process Data:	
Fluid	WASTE LUBRICATING OIL (≈ SAE 30 WT)
Oper. press.	ATMOSPHERIC
Oper. temp.	50°-70°F
Specific gravity	0.898
Radiation	N/A
Electrical enclosure	WATERPROOF
Electrical connection	3/4 IN NPT(F)
Power supply	12 VDC (FROM CONTROL UNIT)
Cable	3C #16 AWG (BY OTHERS)
Mfg. *	GEMS
Model No. *	
Control Unit:	LQ/LS-DB108
Mounting	WALL
Power supply	120 VAC 60 HZ
Output	METER SCALE 0-100% LEVEL
Enclosure	WEATHERPROOF
Mfg. *	GEMS
Model No. *	RE-36545 WITH HI ALARM CONTACT
Stilling Well:	NOT REQUIRED
Material	
Dimensions	
Mfg. *	

NOTES:
1) ~~Duplicate transmitter required for Unit 2~~
2.) PROVIDE ONE BULKHEAD MOUNTING RACK WITH RECEIVER
3.) ALARM SETPOINT 90% LEVEL ≈ 14 IN. FROM FLANGE

Rev. & By Date
Rev. & By Date
Rev. & By Date

(Supplementary Sheet)

STONE & WEBSTER ENGINEERING CORPORATION

SUMP LEVEL TRANSMITTER

Page 21 (7)
Spec. No. NAS-90-22
J.O. No. 11715/12050
By RED Date 8-26-77

Client: Virginia Electric and Power Company
Project: North Anna Power Station

Transmitter with control unit

Mark No.	LT-BC 126
Service	1-BC-TK-2
Quantity	ONE
Type	MAGNETIC FLOAT
Tube material	PVC
Float material*	PVC
Flange material	PVC
Electrical head conn.	PVC
Flange size	6" 150# FLAT FACE
Probe length	111 INCHES
Operating range	92 IN. (16" FROM FLANGE FACE TO WITHIN 3 IN. OF PROBE END)
Process Data:	
Fluid	SODIUM HYPOCHLORITE
Oper. press.	ATMOSPHERIC
Oper. temp.	70°F
Specific gravity	1.24
Radiation	N/A
Electrical enclosure	WATERPROOF
Electrical connection	1/2" NPT(F)
Power supply	12 VDC FROM CONTROL UNIT
Cable	3C #16 AWG (BY OTHERS)
Mfg. *	GEMS
Model No. *	36488
Control Unit:	LQ/LS-BC126
Mounting	WALL
Power supply	120 VAC, 60 Hz
Output	0-200 μA / METER SCALE 0-100% LINEAR
Enclosure	WEATHERPROOF
Mfg. *	GEMS
Model No. *	RE-36545 WITH DUAL ALARMS
Stilling Well:	NOT REQUIRED
Material	
Dimensions	
Mfg. *	

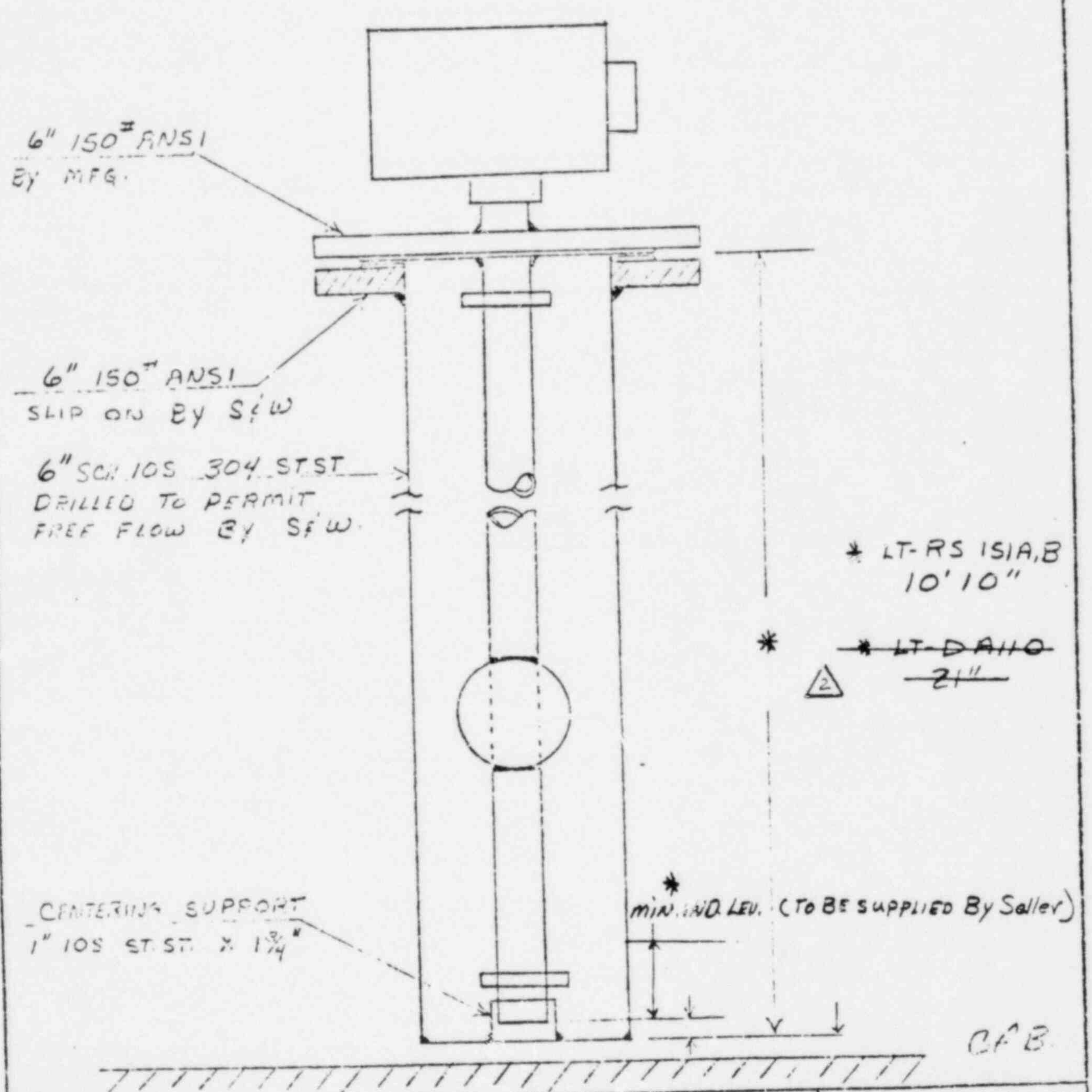
NOTES:

1) ~~Duplicate transmitter required for Unit 2~~

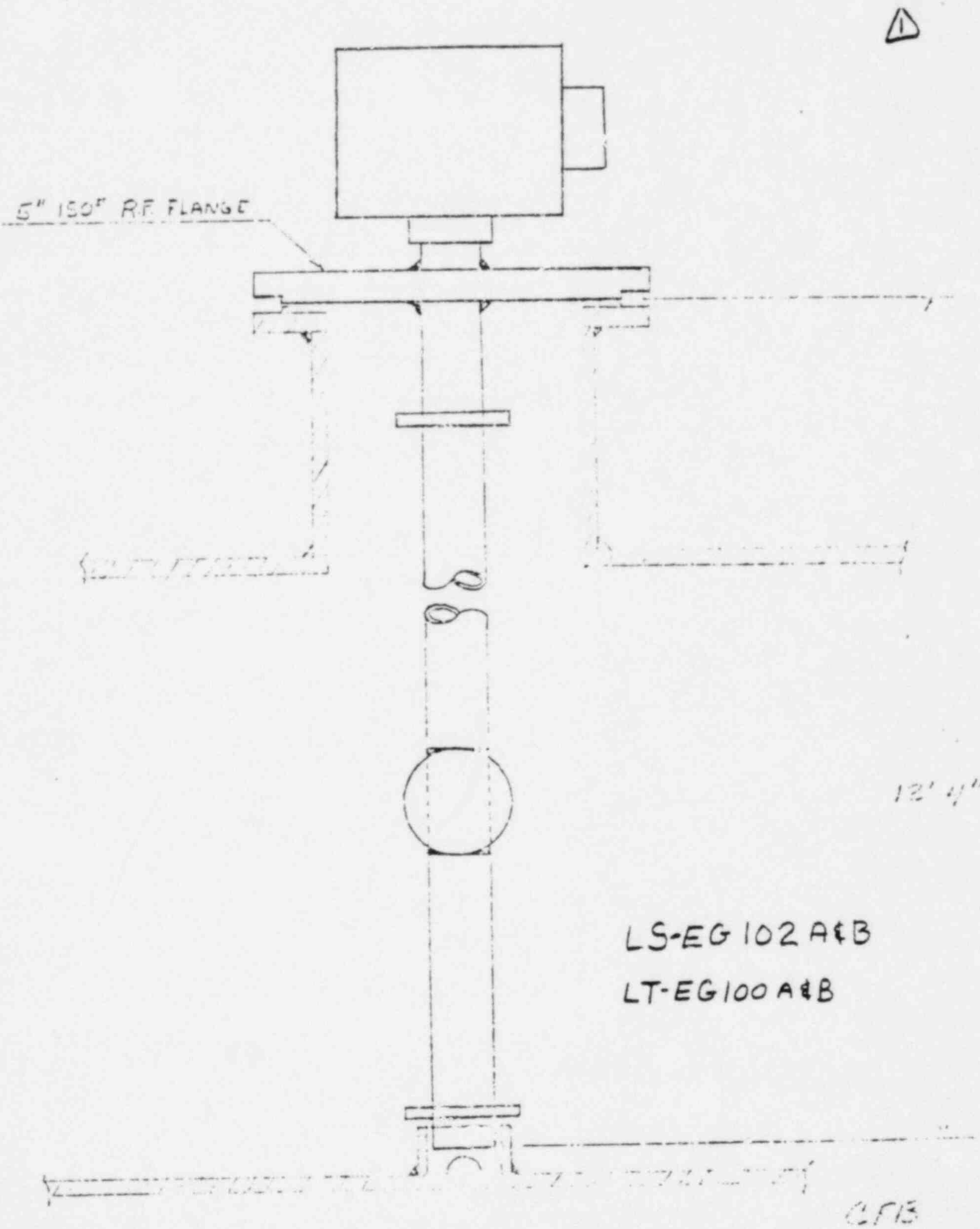
Rev. 3 By Date
Rev. 2 By Date
Rev. 1 By Date

5681-1.00

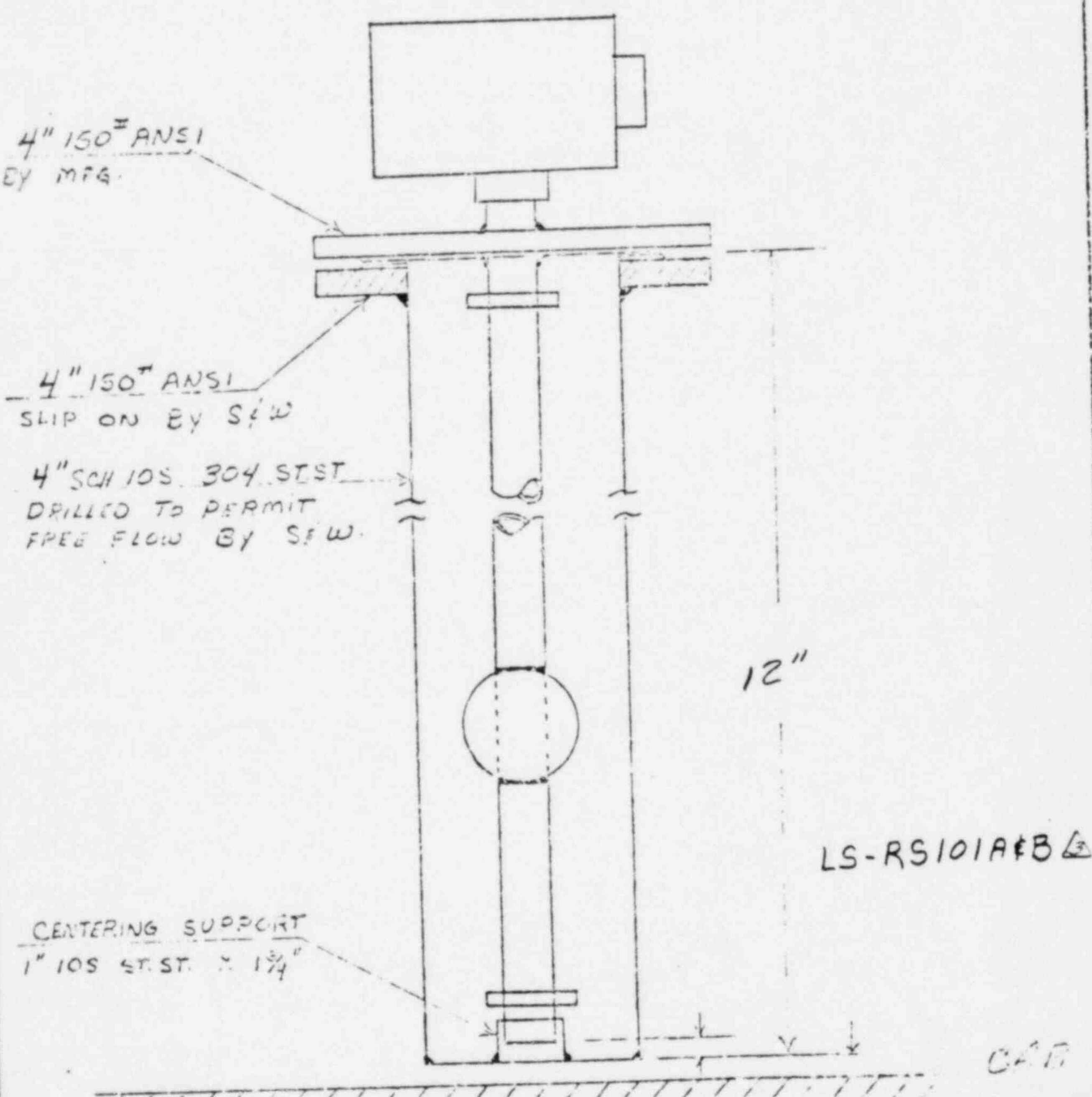
LTI-35B



CHECKED		STILLING WELL AND SUMP LEVEL TRANSMITTER DETAILS	JO NO 11715/11050 NAS-90-22
CORRECT			
APPROVED			
DATE			11715-TSK-1A
REVISIONS			



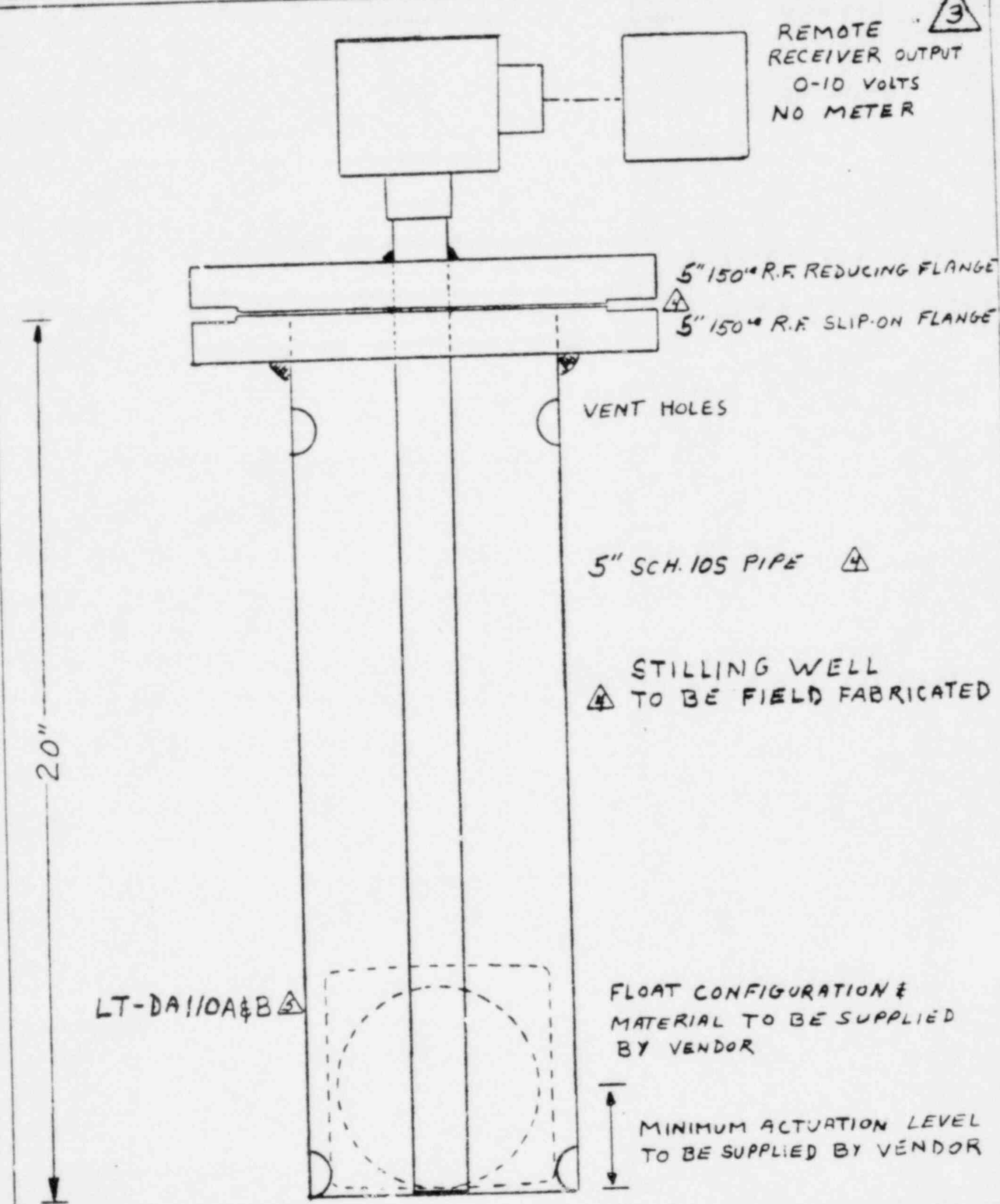
CHECKED		TANK LEVEL TRANSMITTER	JO NO 11715/12050 NAS-90-22
CORRECT			
APPROVED			11715-ISK-1B
DATE			
REVISIONS			



CHECKED	
CORRECT	
APPROVED	
DATE	
REVISIONS	

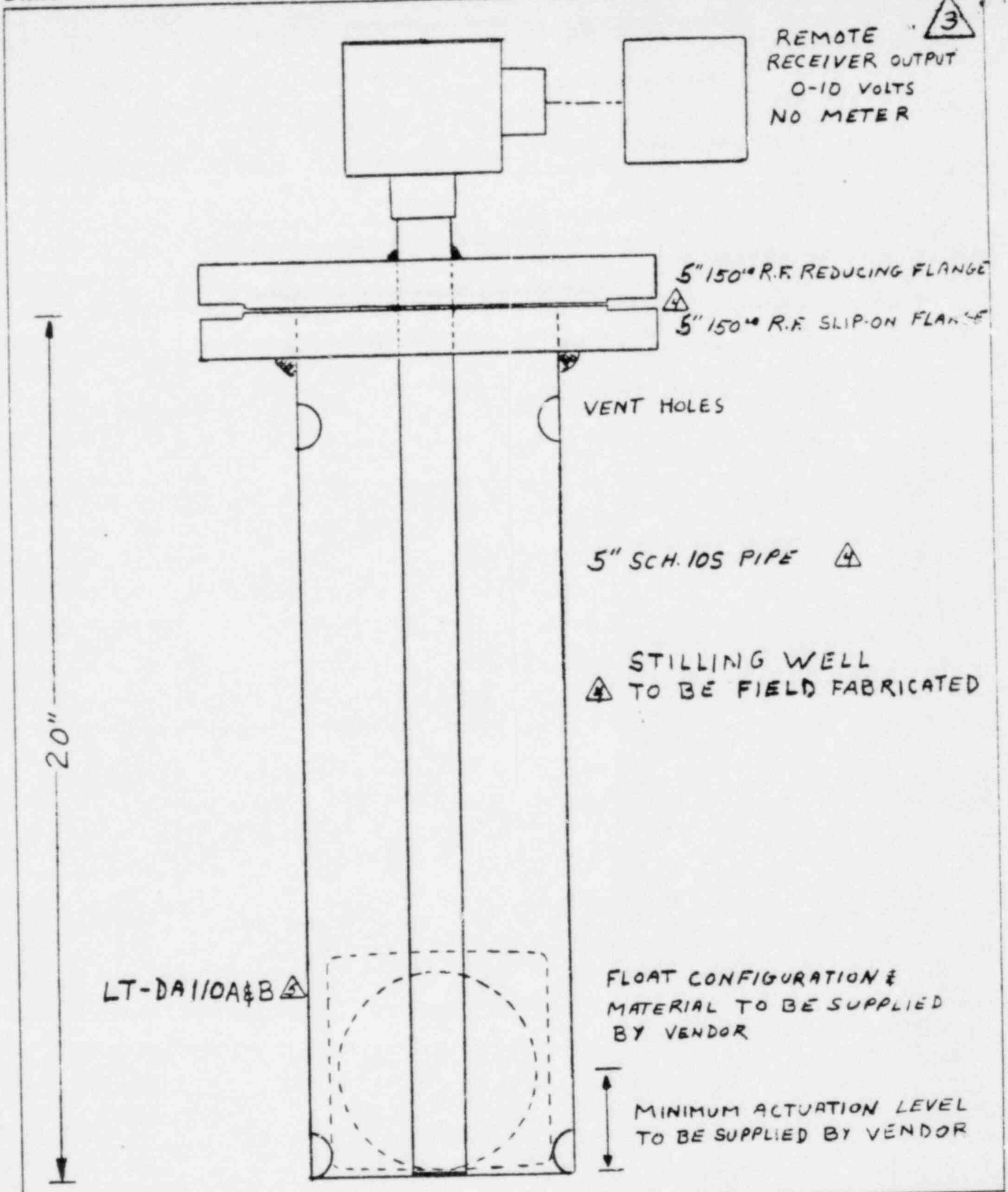
STILLING WELL AND SUMP LEVEL TRANSMITTER DETAILS

1C

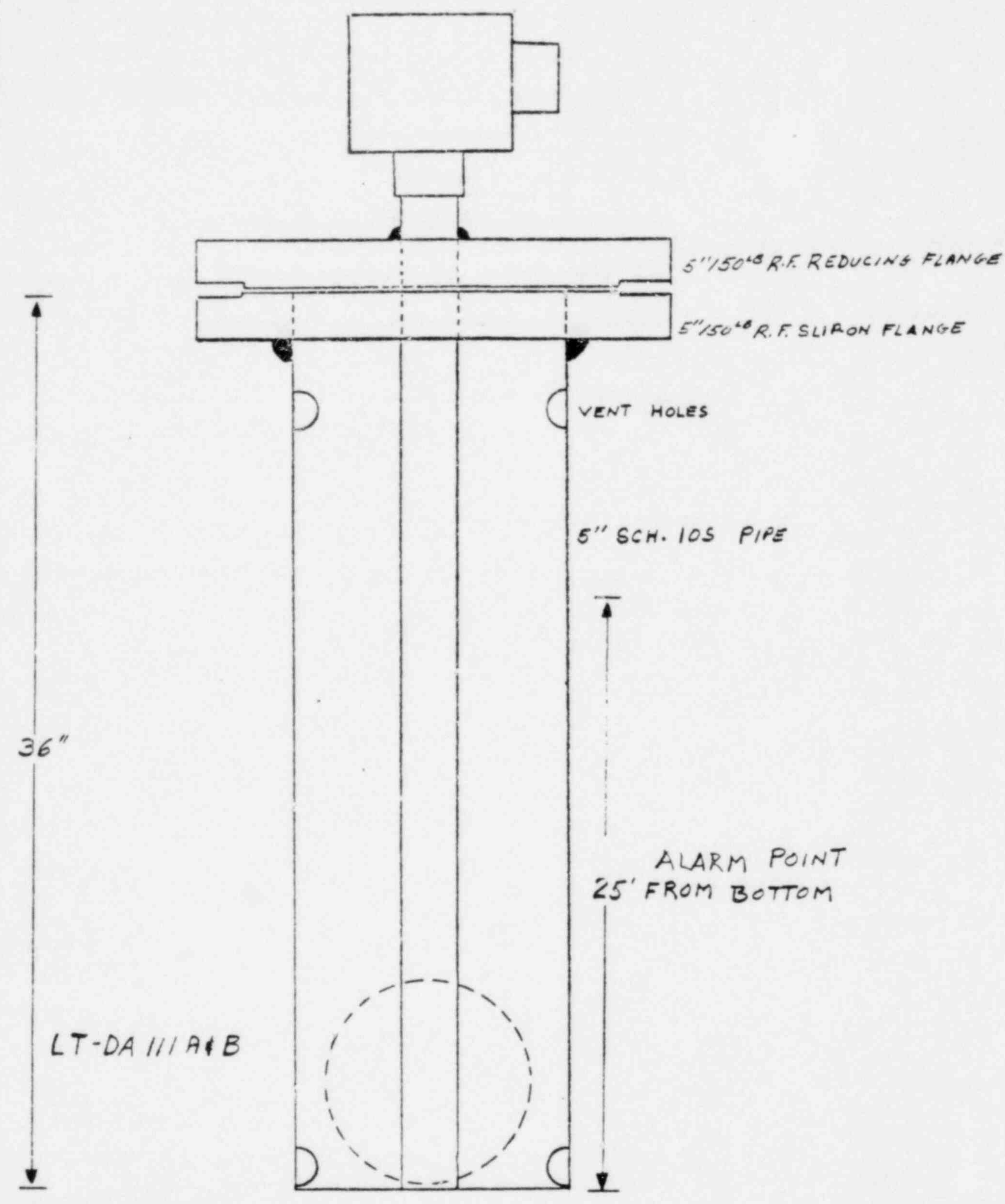


POWER INDUSTRY GROUP	TITLE	SCALE
CHECKED	REACTOR CONTAINMENT SUMP	DATE 12-5-73
CORRECT RBD	LEVEL TRANSMITTER	SKETCH NUMBER 11715 ISK-1E
APPROVED		
REVISIONS ② ③ ④ ⑤		

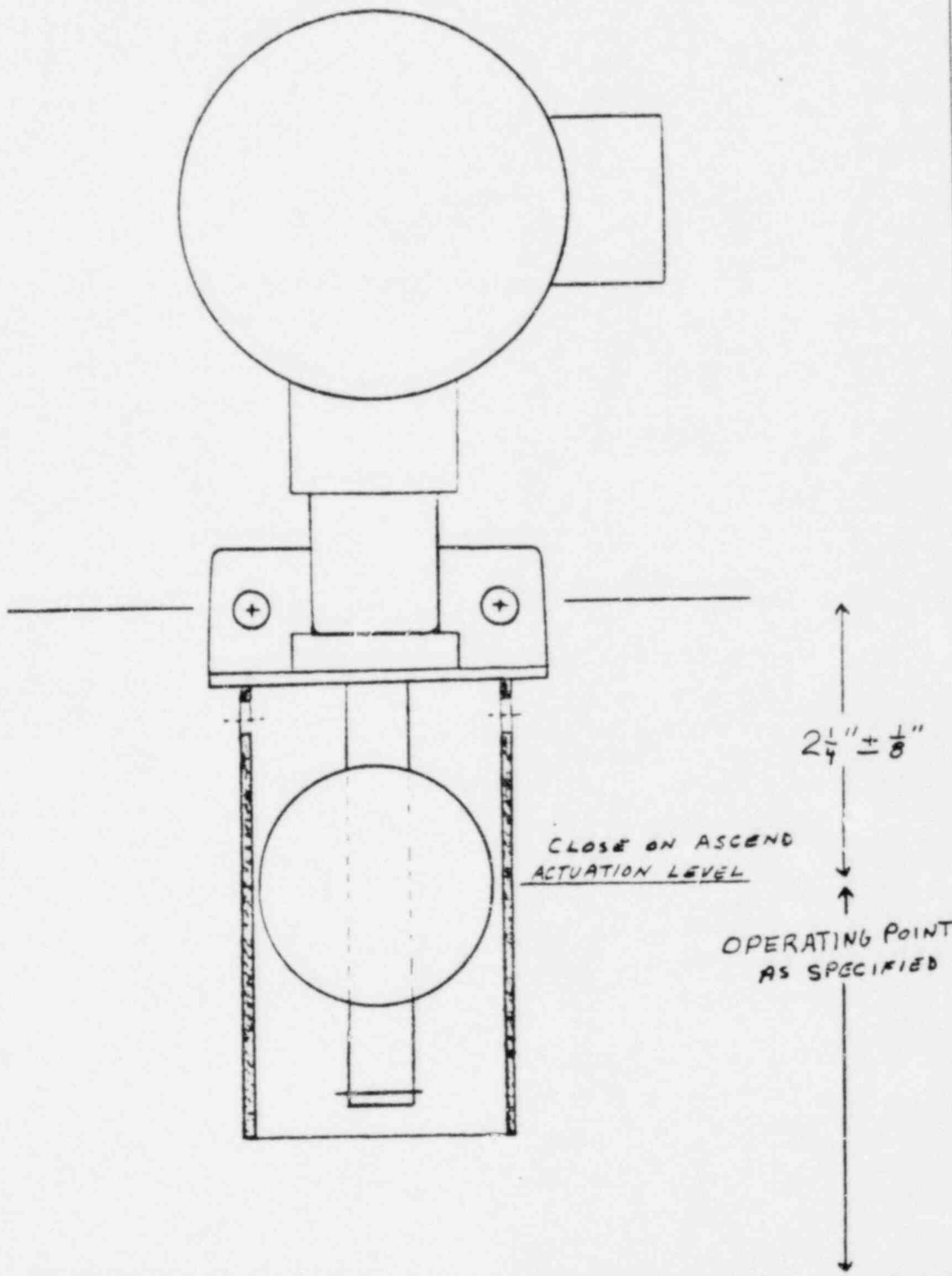
STONE & WEBSTER ENGINEERING CORPORATION



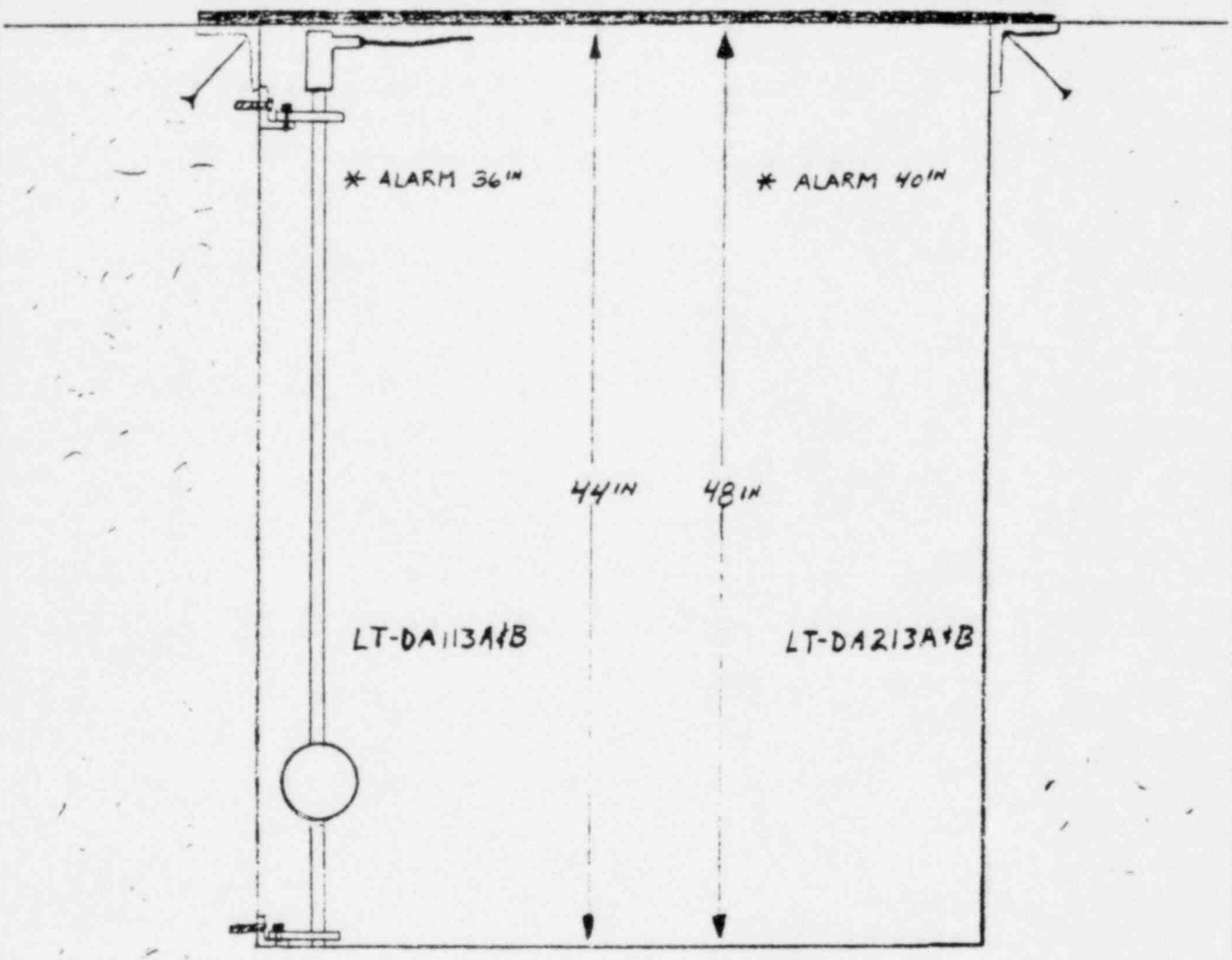
POWER INDUSTRY GROUP		TITLE	SCALE
CHECKED	RBD	REACTOR CONTAINMENT SUMP	DATE 12-5-73
CORRECT		LEVEL TRANSMITTER	SKETCH NUMBER
APPROVED			11715 ISK-1E
REVISIONS	② ③ ④ ⑤		



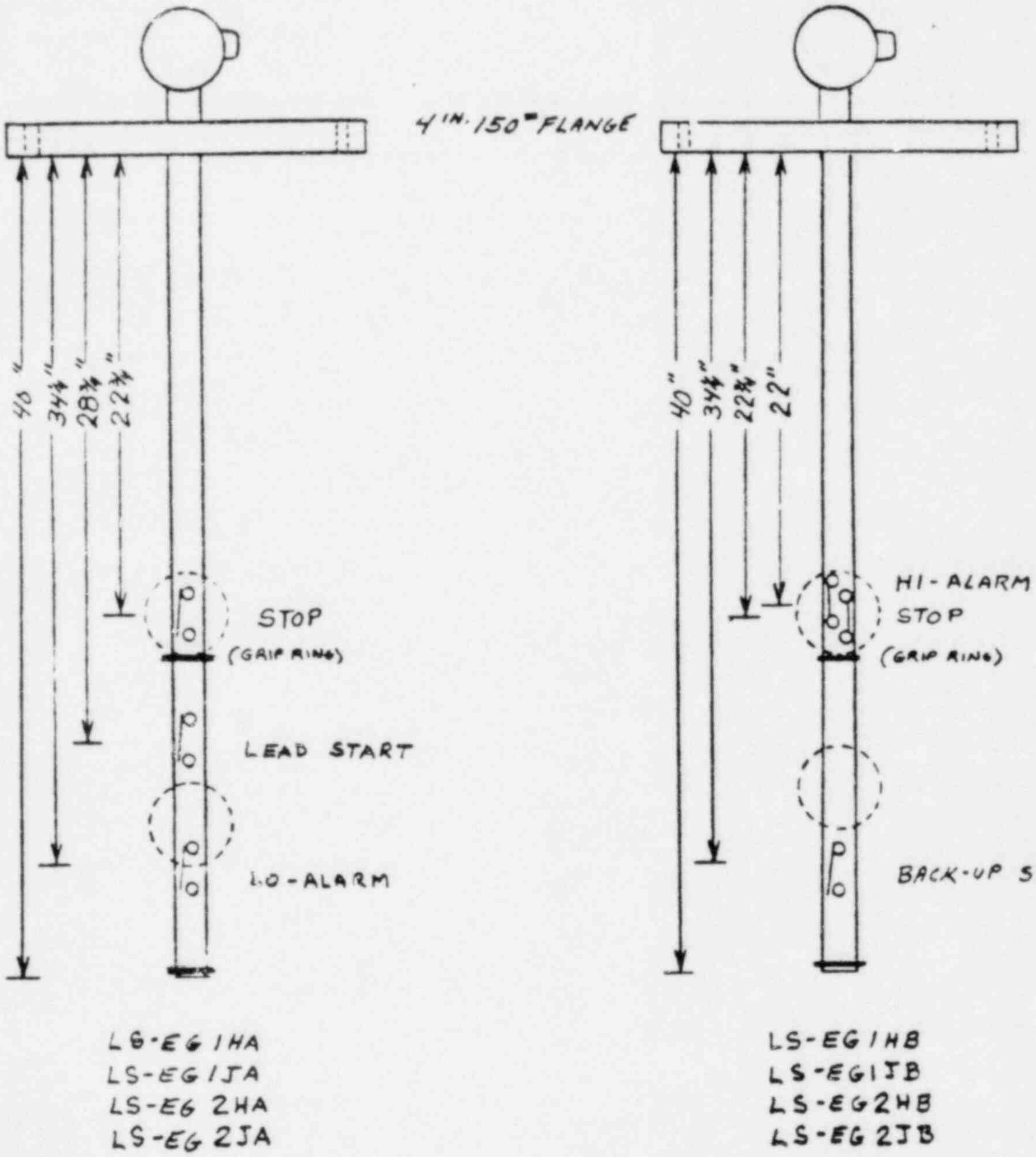
POWER INDUSTRY GROUP		TITLE	
CHECKED		AUX. BUILDING SUMP	SCALE:
CORRECT	KBD		DATE: 11-20-74
APPROVED		LEVEL TRANSMITTER	SKETCH NUMBER
REVISIONS	② ③ ④ ⑤		ISK-1F



POWER INDUSTRY GROUP		TITLE	SCALE: NONE
CHECKED		SUMP LEVEL SWITCH	DATE: 12-12-74
CORRECT	RBD		SKETCH NUMBER
APPROVED			ISK-1G
REVISIONS	② ③ ④ ⑤		

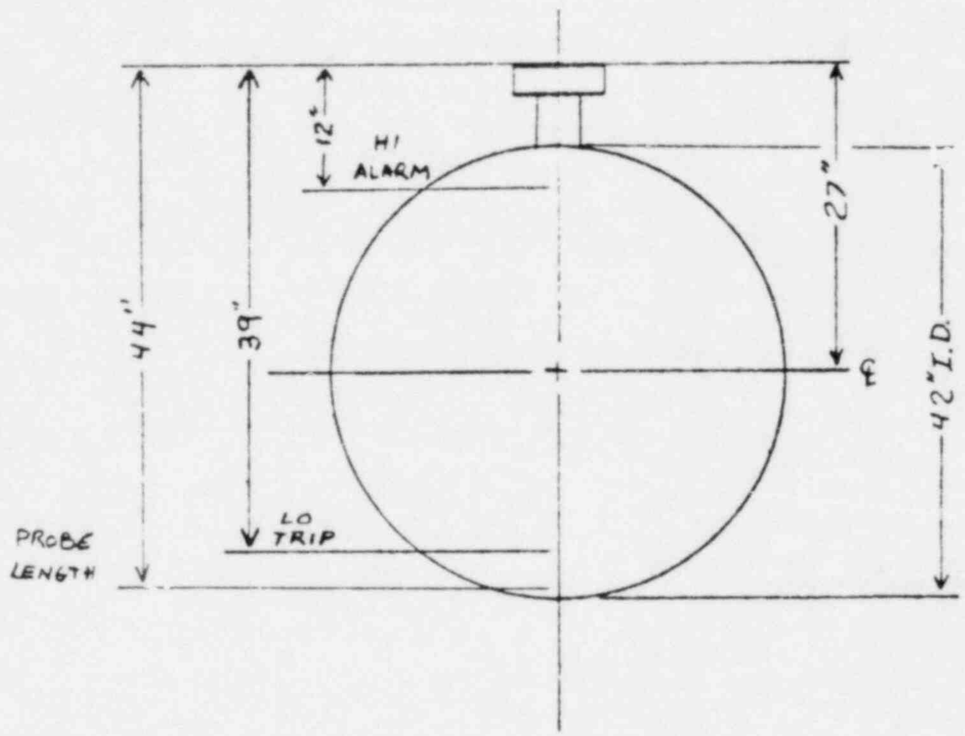


POWER INDUSTRY GROUP		TITLE	SCALE:
CHECKED		CHILLER ROOM SUMP	DATE 12-13-74
CORRECT	RBD	LEVEL TRANSMITTER	SKETCH NUMBER
APPROVED			ISK-1H
REVISIONS	② ③ ④ ⑤		



POWER INDUSTRY GROUP		TITLE	SCALE: NONE
CHECKED		EMERG. GEN. DAY TANK LEVEL CONTROL & ALARM	DATE: 10-23-75
CORRECT	RBD		SKETCH NUMBER
APPROVED			ISK-1J
REVISIONS	② ③ ④ ⑤		

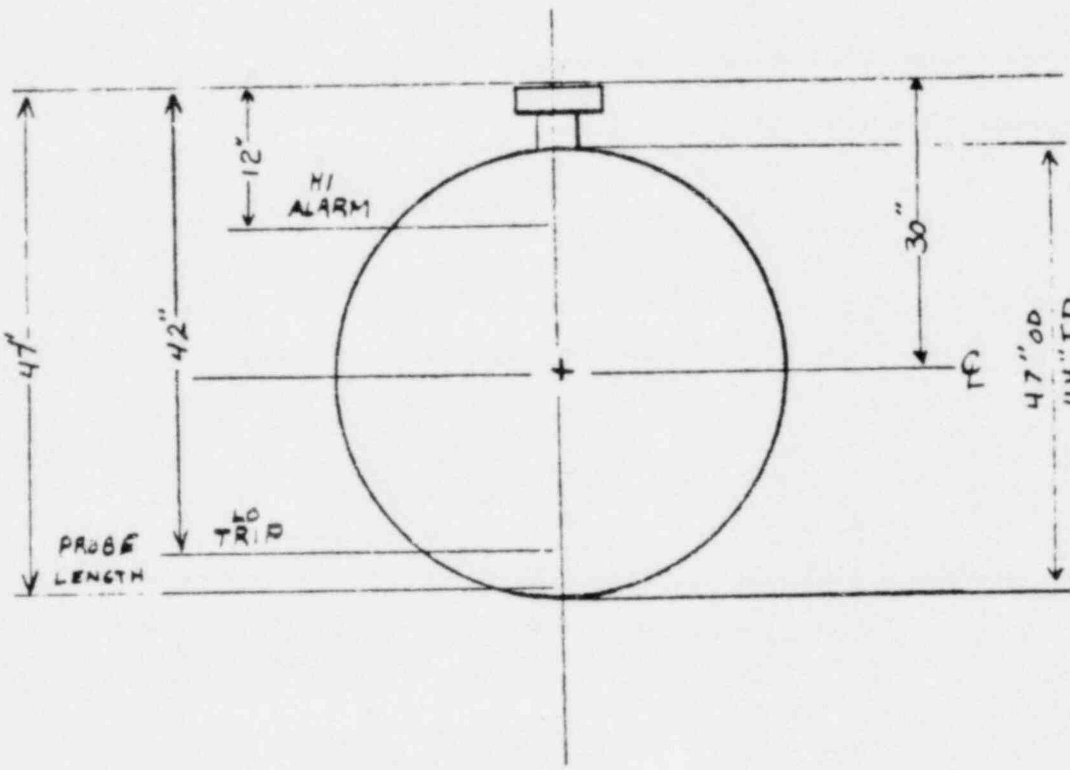
LT-SW102



POWER INDUSTRY GROUP	TITLE			SCALE: NONE
CHECKED	RBD	CALGON CL-14 TANK		DATE: 5-21-77
CORRECT	R	(1-SW-TK-4)		
APPROVED	JJM			SKETCH NUMBER
REVISIONS	② 4-10-78	③	④ ⑤	11715-ISK-1 K

△7

LT- SW 103A & 103B



POWER INDUSTRY GROUP	TITLE	SCALE: NONE
CHECKED RBD	SODIUM HYPOCHLORITE TANKS (1-SW-TK-3A & 3B)	DATE: 5-21-77
CORRECT		SKETCH NUMBER 11715-ISK-1L
APPROVED AJM.		
REVISIONS ② 4-10-78 ③ ④ ⑤		

INSTRUCTIONS FOR COMPLETING VEPCO'S
CERTIFICATE OF CONFORMANCE

The vendor shall complete the lines numbered below in duplicate:

LINE NO.	INSTRUCTIONS
1.	NORTH ANNA POWER STATION - (UNITS 1,2,3, AND 4 AS APPLICABLE)
2.	VENDORS NAME
3.	VENDORS ADDRESS
4.	NAME OF COMPONENT OR SERVICE PERFORMED
5.	S&W MARK NUMBER OF COMPONENT AS REQUIRED
6.	THE SPECIFICATION NUMBER, REVISION AND DATE INCLUDING TITLE APPEARING ON SPECIFICATION
7.	S&W's PURCHASE ORDER NUMBER PLUS ANY CHANGE ORDERS AS APPLICABLE
8.	S&W's JOB ORDER NUMBER AS APPLICABLE: NORTH ANNA UNIT 1 - 11715.50 NORTH ANNA UNIT 2 - 12050.50 NORTH ANNA UNIT 3 - 12180.50 NORTH ANNA UNIT 4 - 12181.50
9.	VENDORS JOB NUMBER OR SHOP NUMBER
10.	S&W APPROVED FABRICATION DRAWINGS AND LATEST REVISIONS
11.	ALL VENDOR DEVIATIONS FROM THE SPECIFICATION WITH APPROVAL LETTERS ETC. TO VERIFY ACCEPTANCE OF DEVIATION
12.	Q.A. MANAGER OR EQUIVALENT RESPONSIBLE VENDOR REPRESENTATIVE. ALL SUCH SIGNATURES MUST BE NOTARIZED.

VIRGINIA ELECTRIC AND POWER COMPANY
CERTIFICATE OF CONFORMANCE

PROJECT NAME ______________________________

SELLER ______________________ ADDRESS ____________

ITEM OR SERVICE ____________________ MARK NO. ____________

SPECIFICATION NO. AND TITLE ______________________________

____

PURCHASE ORDER NO. ____________________ J.O.NO. ____________

SELLER IDENTIFYING NO. __________________ DRAWING NO. ____________

DEVIATIONS FROM SPECIFICATION REQUIREMENTS: (IF NONE, SO STATE)
ATTACH COPIES OF DEVIATION APPROVAL DOCUMENTS.

1. ____________________ 4. ____________________

2. ____________________ 4. ____________________

3. ____________________ 6. ____________________

The Seller, including his subsuppliers, hereby certifies that the item or service, supplied on this order complies with the above listed specifications, drawings, applicable codes, standards and procedures. The Seller certifies that all deviations from specification requirements are listed above and that deviation approval documents are attached.

NOTARIZED SIGNATURE ______________________________
QUALITY ASSURANCE MANAGER OR EQUIVALENT

8.3-1 #3

ENVIRONMENTAL TEST REPORT SUMMARIES OF FOXBORO PRODUCTS

FORWARD

This summary of environmental test reports available from The Foxboro Company is a direct result of the many inquiries received for information concerning the performance of various products under conditions typical to nuclear power plant environments.

It is believed that the summaries contained herein will allow Foxboro product users to access whether or not a particular product has been tested and to what extent. The user can then order the report for a detailed description of procedures, data and conclusions. Caution should be used in making any assumptions or conclusions from these reports that are not expressly referenced within the report.

Appendix A of the document contains a type test report ordering guide for N-E10 Series Nuclear Transmitters.

Please note that the environmental test reports covering qualification of SPEC 200 to IEEE 323-1974, 344-1975 have not been included in this summary. Contact The Foxboro Company for information about reports available.

All test reports described in this summary are available at a cost of $75.00 per report. Please send invoice to:

The Foxboro Company
38 Neponset Avenue
Foxboro, MA 02035

Attn: Manager, Nuclear Power Systems Engineering (Dept. 983)

All reports, procedures, data and conclusions are the property of The Foxboro Company and shall not be loaned or otherwise transferred to a third party or reproduced, copied or used for any purpose, without written consent of The Foxboro Company.

TABLE OF CONTENTS

PAGE | REPORT SUMMARY

REPORT SUMMARIES

Q9-6005 - Maximum Credible Accident (MCA)

Devices Tested:

E13DM-KAM-2 d/p, E11GM-SAB-2 gauge pressure,
E11GH gauge pressure, all 10-50 mA, 63-95 Vdc supply voltage, all with MCA modifications per Special Instruction 1-00209, (aluminum topworks housings).

Summary:

This was a "devised" test, that is; there were no recognized guidelines available. Hence, the test was based upon the best user judgement of MCA conditions at that time (19[illegible]).

The test conditions and program arrived at were:

Start, 80F for reference
Rise to, 318F in steam at 90 psi in fifteen minutes or less
Hold at, 318F for one hour
Drop to, 288F in steam at 56 psi
Hold at, 288F for twelve hours
Drop to, 80F and hold for twelve hours
Finish, 80F for return conditions

Maximum E13, E11 output shifts were about 5% including transients, with return to 80F shifts of 2% or less.

T1-1059 - Seismic Vibration Tests

Devices Tested:

E13FM-HSAM1 - 0-100"H20 Max. Static Pre - 2000 psi
E13DH-HSAM5 - 0-100"H20 Max. Static Pre - 6000 psi
E11GM-HSAB1 - 0-175 psig Overrange Pressure 500 psi
E11GM-HSAE1 - 0-1750 psig Overrange Pressure 4000 psi

Summary:

The purpose of this test was to determine the effect of seismic vibration on performance of the subject transmitters, and also to establish whether seismic vibration affects the ability of the subject transmitters (standard construction) to hold rated static (d/p transmitters) and overrange (pressure transmitters) pressures. Maximum acceleration levels were 3.5g, horizontal, and 2.5g, vertical.

The test results show that no leaks were detectable after seismic resonance search and sine beat vibration. Calibration data before and after vibration are included. Variations in transmitter outputs at 50% span were monitored during 10-cycle sine beat vibration.

T1-1059A - Seismic Vibration Tests

Devices Tested:

Same as T1-1059 except E13DL-HS, 0-20"H20 and 500 psig static pressure substituted for E13DH-HSAM5.

Summary:

The E13DL-HS showed a -4% zero shift at 5 Hz and a bandwidth of 10.25% at 1 Hz on sine beat test.

T1-1070A - Seismic Vibration

Devices Tested:

a. M/62HF-5E-OH-L Style C Controller
b. M/62HB-4E-OH Style C Batch Controller
c. M/6420HF-0 Style A Recorder
d. M/63U-AC-OHAA Style B Alarm
e. M/66DC-OH-4 Style B Multiplier/Divider
f. M/66 Special Low Selector
g. M/66AC-OH-XP Style E Square Root Converter
h. M/693AT-OA-6 Style C Converter
i. M/610AC-OH Style C Power Supply
j. N0140AB Power Supply
k. N0140MA Distribution Panel
l. EH4-D Consotrol Shelf
m. 2075-E Thermocouple Assembly

Summary:

Test was sine-sweep at one octave/min., three planes, 1 to 30 Hz with 1g at 1 Hz ramped to 2g's at 1.5 Hz, then constant 2g's to 30 Hz.

With the exception of a -0.45% shift in the M/66D-OH-4 and 0.9% shift in the M/6420HF Recorder, all calibration data taken after vibration was within 0.1% of pre-vibration reference.

T2-1075 - Radiation Test (See Also T3-1097)

Devices Tested:

a. (Two) (2) E13DM-ISAM2 w/N0148TE (Prototype, Std. as of Jan. 1975) Amplifier integrally mounted.

b. One (1) E13DM-ISAM2 w/N0148TE (Prototype, Std. as of Jan. 1975) Amplifier remotely mounted (i.e., not irradiated).

c. Two (2) E13DM-ISAM2 w/N0143XS Standard (as of 1972) Amplifier integrally mounted.

d. One (1) E13DM-ISAM2 w/N0143XS Standard (as of 1972) Amplifier remotely mounted (i.e., not irradiated).

e. Two (2) E13DM-HSAM2 w/N0143S" Amplifier integrally mounted.

Summary:

Test was designed to determine effects upon E10 Series Transmitters of standard construction when exposed to a total dosage of 1×10^7 rads from a GAMMA source.

Units with Standard (as of 1972) N0143XS Amplifiers had less than 0.5% errors. Units with Prototype N0148TE Amplifiers (Jan. 1975) had maximum error of -4.2%. Units with remote amplifiers had less than 0.3% changes due to exposure to the total dose of 1×10^7 rads.

T3-1013 - Maximum Credible Accident (MCA)

Devices Tested: The following units of MCA/RR design with cast iron bases and covers were tested:

a. E11GH-IINM2 Electronic Gauge Pressure Transmitter
b. E11GM-ISAE2 Electronic Gauge Pressure Transmitter
c. E13DH-ISAM5 Electronic Differential Pressure Transmitter
d. E13DM-ISAMX Electronic Differential Pressure Transmitter
e. 3-XJB-I/25 MCA Cast Iron Box Assembly and Pressure Seal Assembly

Summary:

Test was performed by Franklin Institute (Philadelphia, PA) under MCA (or LOCA), Steam-Air-Chemical-Spray conditions. Initial test conditions were 300°F at 60 lbf/in^2 with an NaOH/boric acid chemical spray for two hours. (See also T3-1013 Supplement).

The E11GM and E11GH outputs shifted -8% and -13%, respectively, at 300F, 60 lbf/in^2. Of the above shifts, -6% and -3%, respecitively, are attributable to the 60 lbf/in^2 change in reference pressure of the E11GM and E11GH.

The E13DM and E13DH outputs shifted +1.5% and [illegible] transiently, then settled to -2% and 0% respectively, at 300F.

On return to reference conditions, all transmitters were within less than 1% of pre-MCA calibrations.

T3-1013-MCA Supplement

This test preceded T3-1013 above, with identical transmitters from the same batch. Test was performed inhouse to the same steam-pressure program but without chemical spray. Test results were similar to those with chemical spray.

T3-1030 - Radiation Test

Devices Tested:

M/17R-MK31, Style B, Pneumatic Repeater

Summary:

Test was to determine effects of 10^5 rads of GAMMA radiation on subject device. Instrument performance was documented as determined before and after exposure to radiation, but was not monitored during the test.

No effect from irradiation was detectable.

T3-1068 - Radiation Test (See Also T3-1097)

Devices Tested: The following units of MCA/RR design with cast iron bases and covers were tested.

Three E13DM-ISAM2 Electronic d/p Transmitters with N0148ND and -NL Amplifiers

Three E13DH-ISAM2 Electronic d/p Transmitters with N0148NL Amplifiers, one remotely mounted.

Two E13DM-HSAM2 Electronic d/p Transmitters with N0148PD Amplifiers.

Note: The Part No. N0148NL designates the 4-20 mA radiation-Resistant amplifier and Part No. N0148PW designates the 10-50 mA radiation-resistant amplifier.

Summary:

Test was to subject E10 Series Electronic Transmitters to a total dosage of 2.2 x 10^8 rads from a GAMMA radiation source.

All transmitters continued to function at 7.6 x 10^7 rads.

Two transmitters, 4-20 mA, with N0148ND Amplifiers, survived the total dosage of 2.2 x 10^8 rads.

Two transmitters 4-20 mA, with N0148NL, survived total dosage while one failed at 8.6 x10^7 rads.

Of the two 10-50 mA transmitters with N0148PD Amplifiers, one failed at 7.6 x 107 rads and one survived 9 x 10^7 rads.

As a result of this test, further modification was implemented in the N0148NL and N0148PW designs to achieve longer life under GAMMA irradiation. Performance of the modified amplifiers is documented in Test Report T3-1097.

PERS 75-113 - Seismic, Sine-Beat (From T3-1077)

Devices Tested:

Twenty (20) different SPEC 200 instruments, including nests, converters, controllers, integrators, alarms, isolators, signal selectors, etc., (two of each, 40 total).

Summary:

Test was to determine whether the subject devices would perform without loss of function when subjected to 3.5, 5.0 and 10g's peak, 1 to 35 Hz sine-beat vibration.

In general, all of the input/output and computing cards performed well, even at 10g's.

There were a few mechanical hardware problems, as well as some chattering of mercury-wetted relays at various frequencies.

Test was severe in that all equipment tested was subjected to the three levels above plus resonance search.

Output spikes which occurred on some devices were due to a test-setup phenomenon as explained in the transmittal letter attached to subject report.

T3-1086 - Seismic Vibration

Devices Tested:

M/122FE Pneumatic Consotrol Recorder
M/130M-N4 Pneumatic Consotrol Indicating Controller
M/130ZY-N4 Pneumatic Consotrol Ratio Controller
M/135T Pneumatic Consotrol Manual Loading Station
M/101-5-NO-30-RI-BO Shelf for above units

Above items were modified as described in the report to assure retention within the shelf during seismic vibration.

Summary:

Test was a resonance search at 0.9g, 1 to 35 Hz and sine-beat tests at 2g's, 2 to 35 Hz.

All devices repeated pre-seismic references to better than 1% after all tests.

Recorders and Indicators produced wide bandwidth indications at certain frequencies but retained static calibration accuracies.

T3-1091 - Seismic Vibration

Devices Tested:

E11GM-ISAE2 Electronic Pressure Transmitter
E11GH-IINN2 Electronic Pressure Transmitter
E13DH-ISAM5 Electronic d/p Transmitter
E13DM-ISAMX Electronic d/p Transmitter

All above with cast iron bodies and covers, MCA/RR modifications and cast iron "XJB" external junction box assemblies.

Summary:

Test of E10 Series MCA/RRW Transmitters per IEEE Standard 344-1971 for seismic qualification.

Sine-beat testing was performed at 3.5, 5.0 and 10g's.

All transmitters operated without loss of function throughout all tests.

While significant output bandwidths and output shifts occurred at some frequencies during sine beats, the maximum calibration shift found after a single series of tests along a given axis was ≈4% on one unit (E13DH, but see full report). Maximum calibration shift on other three transmitters was 0.6%.

T3-1097 - E10 Series, Radiation

Devices Tested:

Three Standard Amplifiers, N0148TE (4-20 mA)
Three Radiation Resistant Amplifiers, N0148NL (4-20 mA)
Three Radiation Resistant Amplifiers, N0148PW (10-50 mA)

(See Also T3-1068)

Summary:

This test was to determine the susceptibility of E10 Series, 4-20 and 10-50 mA amplifiers to various dosage rates and levels of GAMMA radiation.

All N0148TE Amplifiers functioned without failure to 1 x 10^7 rads. Worst-case zero shift was less than 2.5% and worst-case span shift was less than 0.5%.

All N0148NL Amplifiers functioned to a total dose of 2.2 x 10^8 rads without failure. Worst-case zero shift was 5.7% and worst-case span change was 1%.

Two of the N0148PW Amplifiers survived a total of 2.2 x 10^8 rads. One amplifier failed at 1.4 x 10^8 rads. Zero shifts of the two survivors were 4.2% and less with worst span change 2.2%.

T3-1099 - Seismic Test

Device Tested:

M/66N, Style B, Signal Characterizer

Summary:

This test consisted in a resonance search at 0.5g and a sine-beat test at 1g at 1 Hz and 2g's, 2 Hz to 35 Hz.

The M/66N functioned properly with no damage through the test. Maximum output shift was less than 0.5%.

T4-1025 - Seismic Test

Device Tested:

Seismic design, double-sided SPEC 200 Rack, Model 2ES-N.

Summary:

Test subjected dummy-loaded rack to a resonance search from 1 to 35 Hz at 0.5g and to sine-beats at 1 and 2g's, 1 to 35 Hz.

The rack is satisfactory in all respects at the 1g level. However, some minor modifications are required to make it suitable in a stand-alone installation at the 2g level.

T4-1030 - Seismic Test, Random (See T4-1030, Addendum)

Devices Tested:

M/62H-4E-DJ Style C Controller
M/67HTG-OJ Style C Auxiliary Station
M/610AT-OI Style C Power Supply (Modified)
M/6403HF-OJ Style A Recorder (Modified)
M/66AT-OJ Style E Square Root Converter
M/63U-BT-OJER Style B Alarm
M/66BT-2J Style D Current Repeater
M/EH4-D Shelf

Summary:

Test subjected above devices to simultaneous horizontal and vertical random inputs based upon Bechtel Response Spectrum 6600-C-2102, Fig. 10. Zero period acceleration of required response spectrum was 0.9g.

With the exception of the M/64 Recorder, all devices tested remained within rated accuracy during and after resonance search and random vibration.

While the M/64 Recorder was generally within 0.5%, shifts of up to 2.8% were observed. In addition, the chart drive loosened and became nonoperational. (See T4-1030 ADDENDUM for fix and retest).

T4-1030 ADDENDUM - Seismic Test, Random (See Also T4-1030)

Devices Tested:

M/6430HF-OJ Style A Recorder
M/6420HF-OJ Style A Recorder
M/63U-BT-OJER Style B Alarm

Summary:

Test was to determine whether modifications to the M/64 chart drive assemblies avoided the failure noted in T4-1030. Also, to ascertain that the M/63U Alarm responded properly to input steps during seismic vibration, a function which was not tested in T4-1030 originally.

The chart drive did operate without loosening during the seismic test program and the M/63U Alarm functioned properly.

T4-6040 - Radiation Test

Devices Tested:

Eight (8) E11GM body-cover assemblies, with "E" capsules, four (4) with standard silicone elastomer O-rings and four (4) with ethylene polypropylene O-rings.

Summary:

Test was to determine effect of GAMMA radiation does to 2.2×10^8 rads on ability to withstand pressures to 4000 lbf/in^2 without leakage. Test included a temperature-simulated Design Basis Accident (DBA) of 300°F for two hours and 244°F for twenty-two hours.

There was no leakage detectable after total dosage on the units with silicone elastomer O-rings.

Slight (0.1 cc/min and 1 cc/min) occurred at 3000 and 4000 lbf/in^2 after total dosage on one unit with ethylene propylene O-rings.

No leaks were detectable on any of the eight units with 1×10^8 rads.

No leaks were detectable on any of the eight units, including the one with slight leaks (above) after simulated-temperature DBA.

T4-6045 - Radiation (+ Simulated DBA)

Devices Tested:

Four (4) Connection Assemblies using Teflon Gaskets, Part No. D114RB

Four (4) Connection Assemblies using Chemloy Gaskets, Part No. D120AC

Four (4) Connection Assemblies using Ethylene Propylene Gaskets, from Conover Co., Parker Compound No. E515-80.

These connection assemblies are those used on E13 and similar transmitters.

Summary:

Test was to determine hydrostatic pressure leakage effects on various gasket materials when subjected to levels up to and including 2.2×10^8 rads of GAMMA radiation and a temperature-simulated Design Basis Accident (DBA) of 300F for two hours and 244F for 22 hours.

No leakage occurred with up to 9000 lbf/in^2 on assemblies with Ethylene Propylene gaskets after 2.2×10^8 rad irradiation and the DBA temperature test environment.

Both Chemloy and Teflon gaskets leaked after 1×10^8 rad and DBA temperature test.

Chemloy gaskets were found to be satisfactory after 3×10^7 rad and the DBA temperature test.

T4-6061 - MCA (DBA)

Devices Tested:

Two (2) E13DM-ISAMX, Electronic 4-20 mA d/p Transmitters.

Summary:

Test was to determine effect on operation of subject transmitters when subjected to a specific temperature-time profile simulating a Design Basis Accident (DBA). Temperature sequence was 350F for 10 minutes, 302F for 8 hours and 228F for 42 hours.

Maximum output shift (at 80% input) was -4.2%.

This report covers an extension of temperature conditions simulated in Test Reports T1-1013 and T3-1013 Supplement, and is intended to be used with them.

T5-6066 - Seismic (Random)

Devices Tested:

One (1) E93-AJ20USFD, Style B, Temperature Transmitter
One (1) E93-BJ90USFD, Style A, Temperature Transmitter
One (1) E94-N20SFD, Style B, Temperature Transmitter

Summary:

Test was to determine effects on above devices when subjected to seismic vibration conditions specified in the full report.

The calibration shifts before vs. after each resonance search and random vibration test were less than 0.05% for all three devices. The zero period acceleration of the required response spectrum was 1.0g.

The largest output shift during any test was 0.6%.

T5-6059 - Seismic (Sine-Beat)

Devices Tested (One Each):

2ANU-P, Style A, Nest
2ANU-P, Style A, Nest
2AP+SUM, Style B, Summer
2AO-V3I, Style A, V/I Converter
2AP+AVS, Style A, Voltage Source
2AC+DYC, Style A, Dynamic Compensator
2AI-N2V, Style A, Resistance Converter
2AI-I3V, Style A, I/V Converter
2AO-V2I, Style A, V/I Converter
2AO-IPD-S, Style A, Integrator Power Driver
2AP+DSS, Style A, Solid State Logic
2AX-P39A, Style B, Power Supply (Prototype)
2AX-PS9A, Style A, Power Supply
2ARPS, Style C, Power Supply (Prototype)

Summary:

Test was to determine the ability of the above SPEC 200 devices to perform without loss of function when subjected to sine-beat vibration. Frequency range was 1 to 35 Hz with maximum acceleration of 4g's (2ARPS, Power Supply) and 2.6g's (2ANU-P Nests).

Significant problems encountered involve workmanship on prototype power supplies, retention of cards in nests, and unresolved spikes on outputs of some devices.

Resolution of problems and explanation of anamolies are covered in transmittal letter incorporated into the report.

T6-6015 - Seismic (Sine-Beat, Resonance Search)

Devices Tested:

230SM
226
250PM-M2N
250PM-V-M2N
250PM-V-M2N
230SM
202S-06
250PZ-M2N

Summary:

This test was conducted to determine the ability of the above SPEC 200 devices to function without loss of function when subjected to sine-beat vibration.

T6-6020 - Seismic

Devices:

2ARPS-A Style C
2ARPS-A Style D

Summary:

Test was run to determine the ability of the above devices to operate properly during resonance search and sine-beat tests.

APPENDIX A

TYPE TEST REPORT ORDERING GUIDE

FOR N-E10 SERIES NUCLEAR TRANSMITTERS

MODEL NUMBER	SEISMIC (IEEE 344-1971)	LOCA (IEEE 323-1971)	RADIATION (IEEE 323-1971)
N-E11AM-II N-E11AH-II N-E11DM-II N-E11GM-II N-E11GH-II N-E13DM-II N-E13DH-II	T3-1091	T3-1013	T3-1068 T3-1097
N-E11AM-IA-HI N-E11AH-IA-HI N-E11DM-IA-HI N-E11GM-IA-HI N-E11GH-IA-HI N-E13DM-IA-HI N-E13DH-IA-HI N-E13DL-IA	T1-1059 T3-1091	Q9-6005	T3-1068 T3-1097
N-E11AM-HA N-E11AH-HA N-E11DM-HA N-E11GM-HA N-E11GH-HA N-E13DM-HA N-E13DH-HA	T1-1059	Q9-6005	T3-1068 T3-1097
N-E11AL-II N-E13DL-II	T3-1091	T3-1013	T3-1068 T3-1097
N-E11AL-IA-HI N-E13DL-HI N-E11GH-HI	T1-1059A T3-1091	Q9-6005 T3-1013	T3-1068 T3-1097
N-E11AL-HA N-E13DL-HA	T1-1059A	Q9-6005	T3-1068 T3-1097

Questions concerning validity of test reports for specific customer applications, and which require additional documentation or engineering will require additional charges for engineering time. Please refer to Foxboro.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: AB-244A
DESCRIPTION: Auxiliary Building - Elev. 244'-6" - Ch. Pump Cubicles

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	50-120	11	NA		NA		104 to 130: 0-2 sec 130: 2-100 sec 130-185: 100-2100 sec 185-183: 2100-5400 sec 183-115: 5400 sec-24 hr	12
PRESSURE (psia)	14.7	NR	NA		NA		15.14: 0-10 sec 15.14-15.0: 10-35 sec 15.0-14.7: 35-200 sec	12
RELATIVE HUMIDITY (%)	NC		NA		NA		100	12
CHEMICAL SPRAY	NA		NA		NA		NA	
RADIATION (rads)	2×10^6	14	3.6×10^6	14	<100	26	<100	26
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the list following the References.

Note: Not applicable. No safety related electrical equipment will be affected by the submergence level at the 244'6" elevation of the Auxiliary Building.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Dockets: 50-338 and 50-339

ZONE: AB-244B
DESCRIPTION: Auxiliary Building - Elev. 244'-6" - General Areas

PARAMETER	NORMAL ENVIRONMENT	PAGE	LOCA ENVIRONMENT	PAGE	MSLB ENVIRONMENT	PAGE	HELB ENVIRONMENT	PAGE
TEMPERATURE (°F)	50-120	11	NA		NA		104 to 176: 0-3 sec 176-204: 3-30 sec 204-195: 30-1800 sec 195-192: 1800-5400 sec 192-124: 5400 sec-24 hr	12
PRESSURE (psia)	14.7	NR	NA		NA		15.14: 0-10 sec 15.14-15.0: 10-35 sec 15.0-14.7: 35-200 sec	12
RELATIVE HUMIDITY (%)	NC		NA		NA		100	12
CHEMICAL SPRAY	NA		NA		NA		NA	
RADIATION (rads)	5.30×10^3	15	$<1 \times 10^4$	14	<100	26	<100	26
SUBMERGENCE (elev)	NA		NA		NA		Note	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

NOTE: Not applicable because no safety-related electrical equipment will be effected by the submergence level at the 244'6" elevation of the Auxiliary Building.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: AB-244C
DESCRIPTION: Auxiliary Building - Elev. 244'-6" - Pipe Penetration Area and Nonregen, Hx Cubicles

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	50-120	11	NA		NA		104 to 176: 0-3 sec 176-204: 3-30 sec 204-195: 30-1800 sec 195-192: 1800-5400 sec 192-124: 5400 sec-24 hr	12
PRESSURE (psia)	14.7	NR	NA		NA		15.14: 0-10 sec 15.14-15.0: 10-35 sec 15.0-14.7: 35-200 sec	12
RELATIVE HUMIDITY (%)	NC		NA		NA		100	12
CHEMICAL SPRAY	NA		NA		NA		NA	
RADIATION (rads)	$2 \times 10^{[illegible]}$	14	$3.6 \times 10^{[illegible]}$	14	<100	26	<100	26
SUBMERGENCE (elev)	NA		NA		NA		Note	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

Note: Not applicable. No safety related electrical equipment will be affected by the submergence level at the 244'6" elevation of the Auxiliary Building.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: AB-259A
DESCRIPTION: Auxiliary Building - Elev. 259'-6" - General Areas

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	50-120	11	NA		NA		104 to 176: 0-3 sec 176-204: 3-30 sec 204-195: 30-1800 sec 195-192: 1800-5400 sec 192-124: 5400 sec-24 hr	12
PRESSURE (psia)	14.7	NR	NA		NA		15.14: 0-10 sec 15.14-15.0: 10-35 sec 15.0-14.7: 35-200 sec	12
RELATIVE HUMIDITY (%)	NC		NA		NA		100	12
CHEMICAL SPRAY	NA		NA		NA		NA	
RADIATION (rads)	Note 1 Note 2	15 32	Note 1 Note 2	14 32	<100	26	<100	26
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated. All numbers in Reference Column are referenced in the back of this section.

Note 1) For zone AB-259A, the 40-yr normal operation dose was calculated to be 5.3×10^3, and the 6-month LOCA dose was calculated to be 1×10^6.

Note 2) A point-source calculation was performed for equipment mark No. H [illegible]-HC-100 and -200. The 40-yr normal operation was calculated to be 880, and the 6-month LOCA dose was calculated to be 2.5×10^5.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: AB-259B
DESCRIPTION: Auxiliary Building - Elev. 259'-6" - Electrical Penetration Area

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	70-120	11	NA		NA		NA	
PRESSURE (psia)	14.7	NR	NA		NA		NA	
RELATIVE HUMIDITY (%)	NC		NA		NA		NA	
CHEMICAL SPRAY	NA		NA		NA		NA	
RADIATION (rads)	5.3×10^3	17	3.1×10^4	17	<100	26	<100	26
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: AB-274
DESCRIPTION: Auxiliary Building - Elev. 274'-0" - General Areas

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	50-120	11	NA		NA		104 to 176: 0-3 sec 176-204: 3-30 sec 204-195: 30-1800 sec 195-192: 1800-5400 sec 192-124: 5400 sec-24 hr	12
PRESSURE (psia)	14.7 0-10 sec	NR	NA		NA		15.14 15.14-15.0: 10-35 sec 15.0-14.7: 35-200 sec	12
RELATIVE HUMIDITY (%)	NC		NA		NA		100	12
CHEMICAL SPRAY	NA		NA		NA		NA	
RADIATION (rads)	5.3×10^3	15	$<1 \times 10^4$	14	<100	26	<100	26
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: AB-280
DESCRIPTION: Auxiliary Building - Elev. 280'-MCC General Area

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	50-120	11	NA		NA		NA	
PRESSURE (psia)	14.7	NR	NA		NA		NA	
RELATIVE HUMIDITY (%)	NC		NA		NA		NA	
CHEMICAL SPRAY	NA		NA		NA		NA	
RADIATION (rads)	8.8 x 10[?]	18	Note 1 Note 2 Note 3	22 34 18	<100	26	NA	
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

NOTES: 1) The 6-month LOCA dose for zone AB-280 was calculated to be 5.9x10[?].

2) A point-source calculation was performed for equipment mark no. 2-EE-SS-04. The 6-month LOCA dose was calculated to be 1.7x10[?].

3) Point-source calculations were performed for the following equipment for the 6-month LOCA doses: TS-HV2229 (130 rads), TS-HV-2230 ($9.6x10^3$ rads), and 2-HV-F-68A & B (190 rads).

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: AB-291A
DESCRIPTION: Auxiliary Building - Elev. 291'-10" - General Area

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	50-120	11	NA		NA		104 to 118: 0-300 sec 118-155: 300-1800 sec 155: 1800-16700 sec 155-115: 16700 sec-24 hr	21
PRESSURE (psia)	14.7	NR	NA		NA		15.06: 0-10 sec 15.06-15.0: 10-35 sec 15.0-14.7: 35-200 sec	12
RELATIVE HUMIDITY (%)	NC		NA		NA		100	12
CHEMICAL SPRAY	NA		NA		NA		NA	
RADIATION (rads)	Note 1 Note 2	15 ~~36~~ 35	Note 1 Note 2	14 ~~36~~ 35	<100	26	<100	26
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

NOTES:
1) For zone AB-291A the 40-yr normal operation was calculated to be 5.3×10^3, and the 6-month LOCA dose was calculated to be [illegible]$\times10^6$.
2) A point source calculation was performed for equipment mark no. 1-HV-F-8A,B,C. The 40-yr normal operation was calculated to be 980, and the 6-month LOCA dose was calculated to be 120.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket:

ZONE: AB-291B
DESCRIPTION: Auxiliary Building - Elev. 291'-10" - Charcoal Filter Cubicles

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	50-120	11	NA		NA		104 to 118: 0-300 sec 118-155: 300-1800 sec 155: 1800-16700 sec 155-115: 16700 sec-24 hr	21
PRESSURE (psia)	14.7	NR	NA		NA		15.06: 0-10 sec 15.06-15.0: 10-35 sec 15.0-14.7: 35-200 sec	12
RELATIVE	NC		NA		NA			
RELATIVE HUMIDITY (%)	NC		NA				100	12
CHEMICAL SPRAY	NA		NA		NA		NA	
RADIATION (rads)	$2x10^6$	14	$3.6x10^5$	14	<100	26	<100	26
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

All numbers in Reference Column are referenced in the back of this section.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: RECOM-1
DESCRIPTION: Hydrogen Recombiner Cubicles

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	15-120	11	NA		NA		NA	
PRESSURE (psia)	14.7	NR	NA		NA		NA	
RELATIVE HUMIDITY (%)	NC		NA		NA		NA	
CHEMICAL SPRAY	NA		NA		NA		NA	
RADIATION (rads)	8.8×10^{2}	15	1×10^{6} (120 days)	29	NA		NA	
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: RC-216A
DESCRIPTION: Reactor Containment - Elev. 216'-11" - Inside Crane Wall

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	86-105	1	280 for 0-30 min 280 to 150 for 30-60 min 150 for 120 days	2	430 for 0-2 min 280 for 2 to 60 min 150 for 120 days	3	NA	
PRESSURE (psia)	8.9-14.7	4	59.7 for 0 to 30 min 59.7-14.7 for 30 to 60 min 14.7 for 120 days	2	Use LOCA Parameters	3	NA	
RELATIVE HUMIDITY (%)	NC	5	100	19	100	3	NA	
CHEMICAL SPRAY	NA		Boric acid (2000-2100 ppm boron) buffered to a pH at 8.5 to 11.0 with NaOH for 0 to 4 hrs pH then reduced to 7.8 to 9.0 for 120 days	7	Use LOCA Parameters	7	NA	
RADIATION (rads)	3.0×10^6	16	1.8×10^7	10	1.3×10^4	5	NA	
SUBMERGENCE (elev)	NA		to 226'0" elev.	9	To 225'0"elev.	9	NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Dockets: 50-338 and 50-339

ZONE: RC-216B
DESCRIPTION: Reactor Containment - Elev. 216'-11" - Outside Crane Wall

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	86-105	1	280 for 0-30 min 280 to 150 for 30-60 min 150 for 120 days	2	430 for 0-2 min 280 for 2 to 60 min 150 for 120 days	3	NA	
PRESSURE (psia)	9.9-14.7	4	59.7 for 0 to 30 min 59.7-14.7 for 30 to 60 min 14.7 for 120 days	2	Use LOCA Parameters	3	NA	
RELATIVE HUMIDITY (%)	NC		100	19	100	3	NA	
CHEMICAL SPRAY	NA		Boric acid (2000-2300 ppm boron) burrered to a pH at 8.5 to 11.0 with NaOH for 0 to 4 hrs pH then reduced to 7.8 to 9.0 for 120 days	7	Use LOCA Parameters	7	NA	
RADIATION (rads)	3.5 x 10^4	8	7.5 x 10^6	8	1.3 x 10^6	5	NA	
SUBMERGENCE (elev)	NA		To 226'0" elev.	9	To 226'0" elev.	9	NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: RC-241A
DESCRIPTION: Reactor Containment - Elev. 241'-0" - Inside Crane Wall

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	86-105	1	280 for 0-30 min 280 to 150 for 30-60 min 150 for 120 days	2	430 for 0-2 min 280 for 2 to 60 min 150 for 120 days	3	NA	
PRESSURE (psia)	8.9-14.7	4	59.7 for 0 to 30 min 59.7-14.7 for 30 to 60 min 14.7 for 120 days	2	Use LOCA Parameters	3	NA	
RELATIVE HUMIDITY (%)	NC		100	19	100	3	NA	
CHEMICAL SPRAY	NA		Boric acid (2000-2100 ppm boron) buffered to a pH at 8.5 to 11.0 with NaOH for 0 to 4 hrs pH then reduced to 7.8 to 9.0 for 120 days	7	Use LOCA Parameters	7	NA	
RADIATION (rads)	$3.0x10^7$	16	$1.8x10^7$	10	$1.3x10^6$	5	NA	
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: RC-241B
DESCRIPTION: Reactor Containment - Elev. 241'-0" - Outside Crane Wall

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	86-105	1	280 for 0-30 min 280 to 150 for 30-60 min 150 for 120 days	2	430 for 0-2 min 280 for 2 to 60 min 150 for 120 days	3	NA	
PRESSURE (psia)	8.9-14.7	4	59.7 for 0 to 30 min 59.7-14.7 for 30 to 60 min 14.7 for 120 days	2	Use LOCA Parameters	3	NA	
RELATIVE HUMIDITY (%)	NC		100	19	100	3	NA	
CHEMICAL SPRAY	NA		Boric acid (2000-2100 ppm boron) buffered to a pH at 8.5 to 11.0 with NaOH for 0 to 4 hrs pH then reduced to 7.8 to 9.0 for 120 days	7	Use LOCA Parameters	7	NA	
RADIATION (rads)	3.5×10^{4}	8	6.79×10^{6}	10	1.3×10^{4}	5	NA	
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: RC-262A
DESCRIPTION: Reactor Containment - Elev. 262' -10" - Inside Crane Wall

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	86-105	1	280 for 0-30 min 280 to 150 for 30-60 min 150 for 120 days	2	430 for 0-2 min 280 for 2 to 60 min 150 for 120 days	3	NA	
PRESSURE (psia)	8.9-14.7	4	59.7 for 0 to min 59.7-14.7 for 30 to 60 min 14.7 for 120 days	2	Use LOCA Parameters	3	NA	
RELATIVE HUMIDITY (%)	NC		100	19	100	3	NA	
CHEMICAL SPRAY	NA		Boric acid (2000-2100 ppm boron) buffered to a pH at 8.5 to 11.0 with naOH for 0 to 4 hr pH then reduced to u7.8 to 9.0 for 120 days	7	Use LOCA Parameters	7	NA	
RADIATION (rads)	3.0×10^7	16	1.8×10^7	10	1.3×10^6	5	NA	
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 or 50-339

ZONE: RC-262D
DESCRIPTION: Reactor Containment - Elev. 262'-10" - Outside Crane Wall

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	86-105	1	280 for 0-30 min 280 to 150 for 30-60 min 150 for 120 days	2	430 for 0-2 min 280 for 2 to 60 min 150 for 120 days	3	NA	
PRESSURE (psia)	8.9-14.7	4	59.7 for 0 to 30 min 59.7-14.7 for 30 to 60 min 14.7 for 120 days	2	Use LOCA Parameters	3	NA	
RELATIVE HUMIDITY (%)	NC		100	19	100	3	NA	
CHEMICAL SPRAY	NA		Boric acid (2000-2100 ppm boron) buffered to a pH at 8.5 to 11.0 with NaOH for 0 to 4 hrs pH then reduced to 7.8 to 9.0 for 120 days	7	Use LOCA Parameters	7	NA	
RADIATION (rads)	3.5×10^{4}	8	6.79×10[illegible]	10	1.3×10^{4}	5	NA	
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: RC [illegible]A
DESCRIPTION: Reactor Containment - Elev. 291'-10" - Inside Crane Wall

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	86-105	1	280 for 0-30 min 280 to 150 for 30-60 min 150 for 120 days	2	430 for 0-2 min 280 for 2 to 60 min 150 for 120 days	3	NA	
PRESSURE (psia)	8.9-14.7	4	59.7 for 0 to 30 min 59.7-14.7 for 30 to 60 min 14.7 for 120 days	2	Use LOCA Parameters	3	NA	
RELATIVE HUMIDITY (%)	NC		100	19	100	3	NA	
CHEMICAL SPRAY	NA		Boric acid (2000-2100 ppm boron) buffered to a pH at 8.5 to 11.0 with NaOH for 0 to 4 hrs pH then reduced to 7.8 to 9.0 for 120 days	7	Use LOCA Parameters	7	NA	
RADIATION (rads)	3.0×10^7	16	1.8×10^7	10	1.3×10^4	5	NA	
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the Reference List following this Section.

ENVIRONMENTAL ZONE DESCRIPTION SHEET

Facility: VEPCO, NORTH ANNA
Units: 1 and 2
Docket: 50-338 and 50-339

ZONE: RC-291a
DESCRIPTION: Reactor Containment - Elev. 291'-10" - Outside Crane Wall

PARAMETER	NORMAL ENVIRONMENT	REFERENCE	LOCA ENVIRONMENT	REFERENCE	MSLB ENVIRONMENT	REFERENCE	HELB ENVIRONMENT	REFERENCE
TEMPERATURE (°F)	86-105	1	280 (0-30 min) 280 -150 (30-60 min) 150-120 days	2	330 (0-2 min) 280 (2-60 min) 150 (120 days)	3	NA	
PRESSURE (psia)	8.9-14.7	4	59.7 for 0 to 30 min 59.7-14.7 for 30 to 60 min 14.7 for 120 days	2	Use LOCA Parameters	3	NA	
RELATIVE HUMIDITY (%)	NC		100	19	100	3	NA	
CHEMICAL SPRAY	NA		Boric acid (2000-2100 ppm boron) buffered to a pH at 8.5 to 11.0 with NaOH for 0 -4 hrs then reduced to 7.8 -9.0 (120 days)	7	Use LOCA Parameters	7	NA	
RADIATION (rads)	3.5×10^4	8	6.79×10^6	10	1.3×10^6	3	NA	
SUBMERGENCE (elev)	NA		NA		NA		NA	

NA = Not applicable. NR = Not required. NC = Not calculated.

Numbers in Reference Columns are identified in the list following the References.

1, 1

NS-SS-79287

Nuclear Technology Division
From Safety Standards
W.N. 249-4856
Date November 28, 1979
Subject Qualification of Electrical Equipment for
Near Term OL Plants

W. C. Gangloff, 5
M. A. Siano, 5
To R. S. Howard, 5
J. L. Vota, 5
M. H. Judkis, 5

cc: D. H. Rawlins, 4
R. J. Sero, 4
G. Butterworth, 4

As a result of a meeting with the five (Salem 2, North Anna 2, McGuire 1, Sequoyah 1, Diablo Canyon) near term OL plants on October 31, 1979 commitments were made to provide information on Westinghouse supplied electrical equipment inside containment. The information required along with a sample transmittal letter is attached. Please transmit Attachment A and the appropriate valve table (Attachment B) to your customer. As indicated herein, an additional transmittal on valves operators will be required prior to December 11, 1979.

Since the enclosed information is vital to the near term OL plants, it is essential that you get an advanced copy of this information to your customer after project manager approval.

If you have any questions, please contact the undersigned.

Carlos E. Faust III

C. E. Faust, III
Safety Standards

JJM/keg

Attachment(s)

Discard Date:

Westinghouse
Electric Corporation

Water Reactor
Divisions

PWR Systems Division

Box 355
Pittsburgh Pennsylvania 15230

Qualification of Westinghouse
Supplied Electric Equipment Inside Containment

Dear Sir:

In response to your request at the October 31, 1979 meeting with Westinghouse, information is provided to further support your operating license review and the qualification of Westinghouse supplied electrical equipment inside containment. The enclosed information has been segregated into two attachments as follows:

Attachment A - The information in this Attachment identifies Westinghouse supplied electrical equipment (excluding valve operators) inside containment. This information is presented in the tabular format identified in draft NUREG-0588. This information is generic and, as such, must be reviewed by your staff to identify which equipment is applicable to your plant. Additionally, portions of the information required by draft NUREG-0588 is plant specific and must be completed by your staff.

Attachment B - This Attachment identifies valves and their electircal operators located inside containment required to mitigate the consequences of a postulated accident. The valves listed represent those valves inside containment in Westinghouse supplied systems. However, all the valves and/or the valve operators may not have been supplied by Westinghouse. Currently, the qualification documentation for the valve operators identified in this Attachment is being reviewed. This effort will be completed by December 11, 1979 and a table in the format of draft NUREG-0588 will be provided.

In regard to valve operators, there have been a number of NRC I&E Bulletins and Circulars over the past several years which may have necessitated field modifications to valve operators. Based on these NRC instructions and other circumstances it is recommended that you verify the information in Attachment B based upon as-installed conditions.

The post-accident radiation dose used in the calculation of the narrow range RTD qualified life sent to you in a previous letter ( ) dated ( ) was too large. The calculations of attachment C are a corrected version of those transmitted previously. [The revised calculation does not affect the qualified life.] (The sentence in brackets should be deleted for McGuire and Sequoyah.)

If you have any questions on the enclosed information, please contact Mr. G. Butterworth, (412-373-4761) or Mr. C. Faust,III, (412-373-4176).

PROJECT MANAGER

/keg

W PROPRIETARY CLASS 2

WESTINGHOUSE SU[illegible]D SAFETY-RELATED ELECTRICAL EQUIPM[illegible] INSIDE CONTAINMENT

				Abnormal or Accident Environment			Qualified Environment							
Equipment function	Location	Manufacturer	Model Number or Identification Number	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of Span)	Accuracy Demonstrated (% of Span)	Qualification Reference and Method
Pressurizer Pressure Transmitter		Barton	763 (Lot 1				LOCA 280°F 78 psia 100% RH Fig. 3-1 SLB 380°F 75 psig 100% RH Fig. 3-19 thru 3-22	1.14 wt. % Boric Acid and 0.17 wt. % NaOH dissolved in water	LOCA 5×10^7 GAMMA SLB 1.13 x 10^5 GAMMA	4 months Post-DBE	4 months Post-DBE	±10% for ≤5 min. 5 min. to 4 mo. ±25%	≤5% for 5 min. Max. Error 5 min. to 4 mo. 17%	NS-TMA-1950 Anderson to Stolz NS-TMA-2120 Anderson to Stolz (Test)
		Barton	763 (Lot 2)				380°F 75 psig 100% RH	1.14 wt. % Boric Acid and 0.17 wt. % NaOH dissolved in water	5×10^7 GAMMA	4 months Post-DBE	4 months Post-DBE	±10% for ≤5 min. 5 min. to 4 mo. ±25%	(1)	(1)
		Foxboro	E11 GM (MCA) (4-20 ma)				>300 °F see App. B >[illegible] psig 100% RH	1.5% Boric Acid by weight + NaOH to adjust the pH to 9.25-10	2.2 x 10^8 GAMMA	30 min. Post-DBE	40 hr. Post-DBE	±10% for ≤5 min.	Max. Error 0 to 5 min. -7% >5 min. -9%	WCAP-8541 (Test)
		Foxboro	E11 GM (MCA) (10-50 ma)				>318 °F see App. A >90 psig 100% RH	None	2.2 x 10^8 GAMMA	30 min. Post-DBE	25 hr. Post-DBE	±10% for ≤5 min.	Max. Error -14%	WCAP-8541 (Test)

WESTINGHOUSE SU[illegible]ED SAFETY-RELATED ELECTRICAL EQUIPMENT INSIDE CONTAINMENT

Equipment Function	Location	Manufacturer	Model Number or Identification Number	Abnormal or Accident Environment: Peak Temperature Pressure Humidity	Abnormal or Accident Environment: Chemistry Condition	Abnormal or Accident Environment: Integrated Dose Radiation Type	Qualified Environment: Peak Temperature Pressure Humidity	Qualified Environment: Chemistry Condition	Qualified Environment: Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of Span)	Accuracy Demonstrated (% of Span)	Qualification Reference and Method
Pressurizer Level Transmitter		Barton	764 (Prototype)				>320 °F 75 psig 100% RH see Figure	1.14 wt. % Boric Acid and 0.17 wt. % NaOH dissolve in water	1.0×10^7 GAMMA	4 months Post-DBE	4 months Post-DBE	+10% −∞ for ≤5 min.	0 to 5 min. <3% 5 min. to 4 mo. −19%	NS-CE-1384 Eicheldinger to Stolz (Test)
		Barton	764 (Lot 1)				LOCA 280°F 73 psia 100% RH Fig. 3-1 SLB 380°F 75 psig 100% RH Fig. 3-19 thru 3-22	1.14 wt. % Boric Acid and 0.17 wt. % NaOH dissolve in water	LOCA 5×10^7 GAMMA SLB 1.13×10^5 GAMMA	4 months Post-DBE	4 months Post-DBE	+10% −∞ for ≤5 min.	0 to 5 min. ±5% Max. Error 5 min. to 4 mo. 17%	NS-TMA-195[illegible] Anderson to Stolz NS-TMA-2120 Anderson to Stolz (Test)
		Barton	764 (Lot 2)				380°F 75 psig 100% RH	1.14 wt. % Boric Acid and 0.17 wt. % NaOH dissolve in water	5×10^7 GAMMA	4 months Post-DBE	4 months Post-DBE	+10% −∞ for ≤5 min. 5 min. to 4 mo. ±25%	(1)	(1)

WESTINGHOUSE SUPP[illegible] SAFETY-RELATED ELECTRICAL
EQUIPMEN. .SIDE CONTAINMENT

Equipment Function	Location	Manufacturer	Model Number or Identification Number	Abnormal or Accident Environment: Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Qualified Environment: Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of Span)	Accuracy Demonstrated (% of Span)	Qualification Reference and Method
RCS Wide Range Pressure		Barton	763 (Prototype)				>320 °F 75 psig 100% RH see Figure	1.14 wt. % Boric Acid and 0.17 wt. % NaOH dissolved in water	1.8 x 10^7 GAMMA	4 months Post-DBE	4 months Post-DBE	±10%	<±10%	NS-CE-1304 Eicheldinger to Stolz (Test)
		Barton	763 (Lot 1)				LOCA 280°F 70 psia 100% RH, Fig. 3-1 SLB 380°F 75 psig 100% RH Fig. 3-19 thru 3-22	1.14 wt. % Boric Acid and 0.17 wt. % NaOH dissolved in water	LOCA 5x10^7 GAMMA SLB 1.13 x 10^7 GAMMA	4 months Post-DBE	4 months Post-DBE	±10%	<±10%	NS-TMA-1950 Anderson to Stolz NS-TMA- Anderson to Stolz (Test)
		Barton	763 (Lot 2)				300°F 75 psig 100% RH	1.14 wt. % Boric Acid and 0.17 wt. % NaOH dissolved in water	5x10^7 GAMMA	4 months Post-DBE	4 months Post-DBE	±10%	(1)	(1)
		Veritrak	59 PH				130°F Atmospheric N/A	None	None	N/A	N/A	0.5%	<0.5%	Instruction Manual (Test) (2)

WESTINGHOUSE SU[illegible]D SAFETY-RELATED ELECTRICAL EQUIPMENT INSIDE CONTAINMENT

Equipment Function	Location	Manufacturer	Model Number or Identification Number	Abnormal or Accident Environment: Peak Temperature Pressure Humidity	Abnormal or Accident Environment: Chemistry Condition	Abnormal or Accident Environment: Integrated Dose Radiation Type	Qualified Environment: Peak Temperature Pressure Humidity	Qualified Environment: Chemistry Condition	Qualified Environment: Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of Span)	Accuracy Demonstrated (% of Span)	Qualification Reference and Method
Steam Generator Level Transmitter (Narrow Range)		Barton	764 (Lot 1)				LOCA 280°F 78 psia 100% RH Fig. 3-1 SLB 300°F 75 psig 100% RH Fig. 3-19 thru 3-22	1.14 wt. % Boric Acid and 0.17 wt. % NaOH dissolved in water	LOCA 5×10^7 GAMMA SLB 1.13×10^5 GAMMA	4 months Post-DBE	4 months Post-DBE	[illegible].0% ≤5 min.	0 to 5 min. <5% Max. Error 5 min. to 4 mo. 1/%	NS-TMA-1950 Anderson to Stolz (Test)
		Barton	764 (Lot 2)				300°F 75 psig 100% RH	1.14 wt. % Boric Acid and 0.17 wt. % NaOH dissolved in water	5×10^7 GAMMA	4 months Post-DBE	4 months Post-DBE	<10% ≤5 min.	(1)	(1)

WESTINGHOUSE SUPP[illegible] SAFETY-RELATED ELECTRICAL
EQUIPMENT INSIDE CONTAINMENT

Equipment Function	Location	Manufacturer	Model Number or Identification Number	Abnormal or Accident Environment: Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Qualified Environment: Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of Span)	Accuracy Demonstrated (% of Span)	Qualification Reference and Method
Steam Flow Transmitter		Fischer and Porter	10B2496				>350 °F see Fig. 5-2 to 6-4 66 psig 100% RH	1.14 wt. % Boric Acid and 0.17 wt. % NaOH dissolved in H_2O	4×10^4 GAMMA	Initiate SI on steamline break	Failed at 6 min.	±10% until containment pressure initiates SI	Max. Error [illegible]2.1% [illegible]1.9%	WCAP-9157 Rev. -0 (Test)
		Barton	764 (Lot 2)				300°F 75 psig 100% RH	1.14 wt. % Boric Acid and 0.17 wt. % NaOH dissolved in water	5×10^7 GAMMA	4 months Post-DBE	4 months Post-DBE	-10% +[illegible] for ≤5 min.	(1)	(1)
		Veritrak	590P				130°F Atmospheric N/A	None	None	N/A	N/A	0.5%	<0.5%	Instruction Manual (Test) (2)

WESTINGHOUSE SUPPLIED SAFETY-RELATED ELECTRICAL
EQUIPMENT INSIDE CONTAINMENT

Equipment Function	Location	Manufacturer	Model Number or Identification Number	Abnormal or Accident Environment: Peak Temperature Pressure Humidity	Abnormal or Accident Environment: Chemistry Condition	Abnormal or Accident Environment: Integrated Dose Radiation Type	Qualified Environment: Peak Temperature Pressure Humidity	Qualified Environment: Chemistry Condition	Qualified Environment: Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of Span)	Accuracy Demonstrated (% of Span)	Qualification Reference and Method
RCS Temperature Narrow Range RTDs		Rosemount	176KF				>320 °F see Fig. 5-3 and 6.3 66 psig 100% RH	1.146 wt. % Boric Acid and 0.17 wt. % NaOH dissolved in H_2O	$1x10^8$ GAMMA	30 sec. Post-SLB	40 yr. Life over 30 sec. Post-SLB	+.2%	+.2%	WCAP-9157 (Test)
		Sostman	110348-1				>320 °F see Fig. 5-3 and 6.3 66 psig 100% RH	1.146 wt. % Boric Acid and 0.17 wt. % NaOH dissolved in H_2O	$1x10^8$ GAMMA	30 sec. Post-SLB	40 yr. Life over 30 sec. Post-SLB	+.2%	+.2%	WCAP-9157 (Test)
RCS Temperature Wide Range RTDs		Rosemount	176KS				>320 °F see Fig. 5-3 and 6-3 66 psig 100% RH	1.146 wt. % Boric Acid and 0.17 wt. % NaOH dissolved in H_2O	$1x10^8$ GAMMA	2 weeks Post-SLB	12 yr. Life 2 weeks Post-SLB	+.2%	+.2%	WCAP-9157 (by comparison)
		Sostman	11901B				>320 °F see Fig. 5-3 and 6-3 66 psig 100% RH	1.146 wt. % Boric Acid and 0.17 wt. % NaOH dissolved in H_2O	$1x10^8$ GAMMA	2 weeks Post-SLB	12 yr. Life 2 weeks Post-SLB	+.2%	+.2%	WCAP-9157 (by comparison)
Excore Neutron Detectors (Power Range)		WIGTD	WL-23686				300°F Atmospheric N/A	N/A	(5)	8 hr. at 175°F	16 hr. at 300°F	N/A	Detector Functional	W Test 7/69

WESTINGHOUSE SUPPLI[illegible] [illegible]AFETY-RELATED ELECTRICAL
EQUIPMENT [illegible]SIDE CONTAINMENT

				Abnormal or Accident Environment			Qualified Environment							
Equipment Function	Location	Manufacturer	Model Number or Identification Number	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Peak Temperature Pressure Humidity	Chemistry Condition	Integrated Dose Radiation Type	Operability Requirements	Operability Demonstrated	Accuracy Requirements (% of Span)	Accuracy Demonstrated (% of Span)	Qualification Reference and Method
Electric Hydrogen Recombined		W Sturtevant	A				300°F 77 psia 100% RH see Supp. 2 Sect. 3.4.3	2500 ppm Boron as Boric Acid with N_AOH to give a pH of 10	$2x10^8$ GAMMA	<1 yr. Post-DBE	1 yr. Post-DBE	N/A	N/A	WCAP-7820 and Supp. 1-4 WCAP-7709-L and Supp. 1-4 (Test)
Electric Hydrogen Recombiner		W Sturtevant	B				302°F (4) 69 psia 100% RH	2500 ppm Boron as Boric Acid with N_AOH to give a pH of 10	$2x10^8$ GAMMA 2x10[illegible] BETA	<1 yr. Post-DBE	1 yr. Post-DBE	N/A	N/A	WCAP-7820 and Supp. 1-7 WCAP-7709-L and Supp. 1-7 (Test)

NOTES:

(1) The tests have been completed and the report is being developed for submittal to the NRC.

(2) The test is a calibration preformed on each instrument by the manufacturer per the instruction manual.

(3) The recombiners are qualified to 420°F per the NRC acceptance letter dated 6/22/78.

(4) Designed to 5 x 10" n/cm^2s thermal, 5 x 10" n/cm^2s fast and 5 x 10^5 R/Hr gamma up to 2 x 10^{18} n/cm^2 and/or 0.7 x 10^{10} R.

NORTH CATEGORY I VALVES

Description	System	Valve No.	Location	Function	Type	Valve Operator	Manufacturer	Model No. or ID No.
Pressurizer SV	RCS	551 ABC	IRC	AM/RCPB	Relief	N/A		
Letdown LCV	CVCS	+LCV-460A	IRC	RCPB/AM	AOV			
Letdown LCV	CVCS	+LCV-460B	IRC	RCPB/AM	AOV			
Letdown	CVCS	+200 ABC	[illegible]	CIS	AOV			
Ex Letdown	CVCS	201	IRC	RCPB	AOV	LS	NAMCO	D-2400X
						S	ASCO	LB-831654
RCP Seal Ret	CVCS	+380	IRC	CIS	MOV			
ACC. TO GAS SYST.	SIS	HCV-936	IRC	CIS	AOV	LS	NAMCO	D-2400X
						S	ASCO	LB-832654
ACC. TO TEST LINE	SIS	842	IRC	CIS	AOV	LS	NAMCO	D-2400X
						S	ASCO	LB-832654

\+ Information on operator not available at Westinghouse. Please check as-installed records.

IRC - inside reactor containment

AM - accident mitigation

RCPB - reactor coolant pressure boundary

CIS - containment isolation

AOV - air operated valve

LS - limit switch

S - solenoid

ATTACHMENT C

Radiation Dose Calculations for RTD's

The object of the following calculations is to estimate the plant specific in-service life that, when taken in conjunction with assuming the RTD's operate for 100 days in a post-LOCA environment, yields a total dose equal to 1 x 10^8 Rads as employed by Westinghouse for the testing reported in WCAP-9157.

External Environment

WCAP-8587, Figure 6-4, indicates a containment atmosphere dose of 1 x 10^8 Rads for 100 days post-LOCA. This value is based on a TID calculation for a 4100 MW reactor and a containment volume of 1.1 x 10^6 ft^3. The Westinghouse calculated dose can be approximately scaled for your plant application by the formulae:

$$D = 1.0 \times 10^8 \quad \frac{P}{4100} \quad \frac{1.1 \times 10^6}{V} \quad \text{Rads}$$

Inserting a value of 2900 MW (P) and 2.4 x 10^6 (V) as applicable to your plant yields a post-LOCA 100 day integrated dose of 3.2 x 10^7 Rads for the RTD external connection. Since the narrow range RTD is only required for a short time after the event this calculation only applies to the wide range measurement. The external dose for the narrow range is on the order of 10^6 Rads and is insignificant compared to the test condition.

The remaining dose available to cover in-service effects is the difference between the total dose employed in the Westinghouse test reported in WCAP-9157 (i.e., 1 x 10^8 Rads) and the above calculated post-LOCA dose (i.e., 3.2 x 10^7 Rads), which is 6.8 x 10^7 Rads. The dose rate during normal operation appropriate to the external connection is taken as 165 R/hr (Table 6-2, WCAP-8587). Thus, assuming an 80 percent load factor, the time required to attain this remaining dose is:

Wide Range $\frac{6.8 \times 10^7}{165 x 24 x 365 x 0.8}$ = 59 years

Narrow Range $\frac{1.0 \times 10^8}{165 x 24 x 355 x 0.8}$ = 86 years

The Westinghouse calculated dose post-LOCA employed for this calculation is conservative with respect to those recommended by the Staff in Appendix D in NUREG-0588.

Internal Environment

WCAP-8587, Figure 6-8, indicates a RCS internal pipe dose of 1.8×10^7 Rads for 100 days post-LOCA. Without considering any reduction in this value by scaling for your plant, the remaining dose available to cover in-service radiation effects on the RTD is 8.2×10^7 Rads. The dose rate during normal operation for wide range RTD's installed directly in the reactor coolant system is conservatively taken as 820 R/hr as defined for the RCL pipe center in Table 6-2, WCAP-8587. For the bypass line, narrow range RTD's, the dose rate is conservatively taken as 165 R/hr as defined for the RCL outside surface. Thus, assuming an 80 percent load factor the time required for the internal part of the RTD to attain the remaining dose is:

Narrow Range $\frac{8.2 \times 10^7}{165 x 24 x 365 x 0.8}$ = 70.9 years

Wide Range $\frac{8.2 \times 10^7}{820 x 24 x 365 x 0.8}$ = 14.3 years

Summary

Using Westinghouse dose estimates from WCAP-8587 scaled for your plant, the shortest demonstrated life for the wide range RTD is 14.3 years and greater than 40 years for the narrow range RTD.

ITEM 5

(67)

DELAVAL

GEMS
SENSORS DIVISION

FARMINGTON
CONNECTICUT 0603?
PHONE 203 677-1311
TELEX 93306

May 7, 1974

Mr. Art Murphy
Stone & Webster Engineering Corp.
P.O. Box 2325
Boston, Massachusetts 02107

Dear Mr. Murphy:

Per our telephone conversation of today, this is to confirm that the units that we have type tested for radiation and steam exposure acceptance are completely made of a corrosion resistant metal that is compatible for usage with boric acid and sodium hydroxide sprays.

Both the 29400 type units and the 36495 type units are of this category.

Very truly yours,

Milton Aron

Milton Aron
Chief Engineer

MA:cm

cc: M. Brown
M. Wright

ITEM 6 (1)

Technical

Report

Final Report
F-C3834

TEST OF A LIQUID LEVEL SENSOR
UNDER CONDITIONS SIMULATING A LOSS-OF-COOLANT ACCIDENT
WITHIN THE CONTAINMENT OF A NUCLEAR POWER GENERATING STATION

Prepared for

DeLaval
GEMS Sensors Division
Farmington, Connecticut

March 1974

FRANKLIN INSTITUTE RESEARCH LABORATORIES

CONTENTS

FIGURES

1. INTRODUCTION

This report describes the radiation and steam exposures of a liquid level sensor conducted as part of a program to qualify the unit for use inside the containment of a nuclear power generating station. The test program consisted of exposure to gamma radiation to a total dose of 200 megarads followed by a fourteen-day environmental exposure that started with a one-hour exposure to steam at 60 psia/280°F.

Operation of the unit was simulated by fixing the float assembly to the stem and recording the indicated position.

The unit performed satisfactorily during the radiation and fourteen-day environmental exposure periods.

2. SAMPLE DESCRIPTION

The unit tested consisted of a probe assembly, manufactured by DeLaval/GEMS Sensors Division; the unit had a stem two feet long and was designated as P/N XM 36495. A P/N 31320 controller unit was used to power the sensor and record its output.

Figure 1 is a photograph showing both the probe assembly and the controller unit.

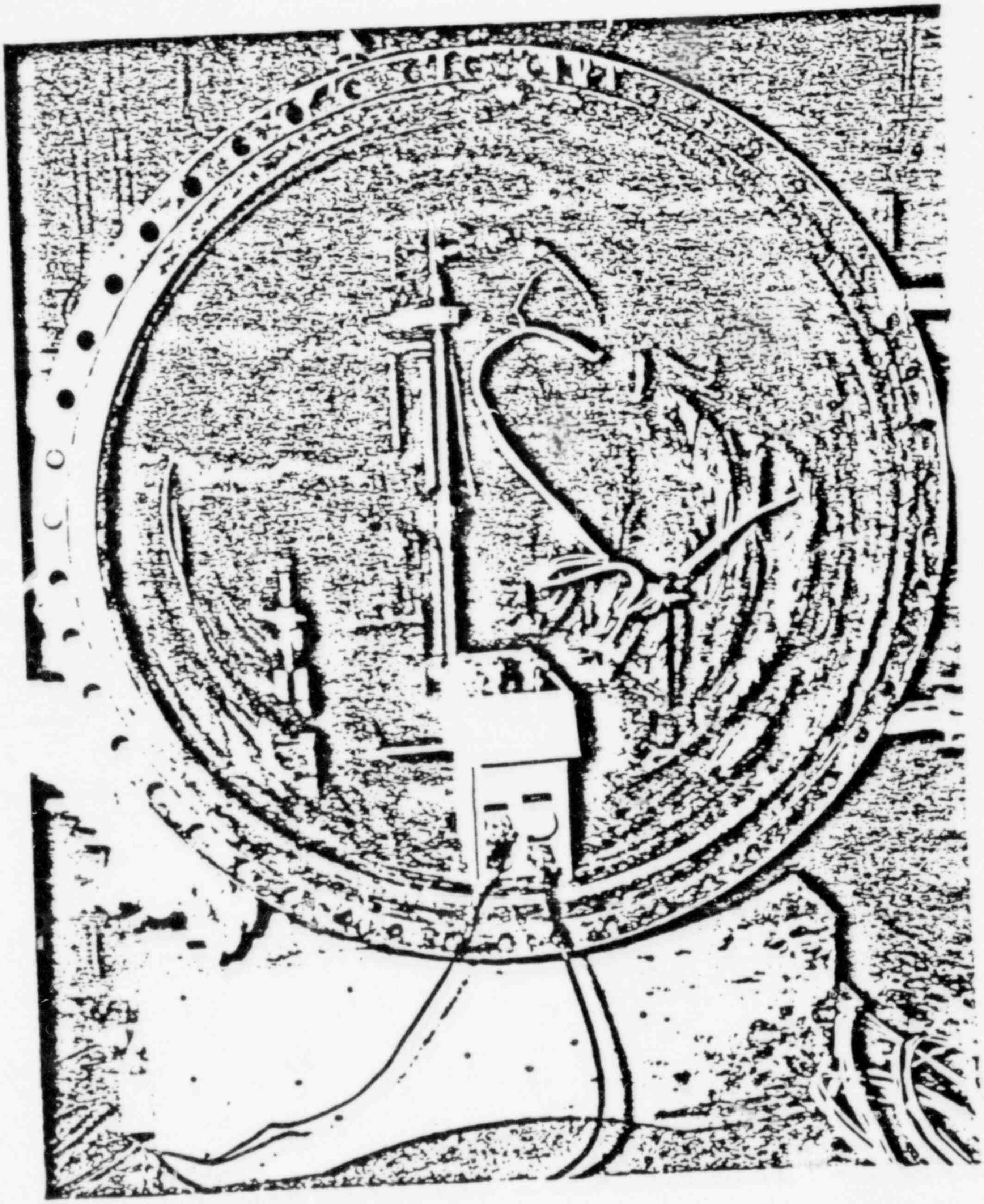


Figure 1. Liquid level sensor mounted in test chamber prior to being tested. (Controller in foreground was outside the chamber during the test.)

3. TEST PROGRAM

3.1 RADIATION EXPOSURE

The sensor assembly was electrically connected to the controller by three 1/C-18 AWG copper conductors insulated with silicone rubber and fiberglass braid.

The spherical float assembly was fixed at the midpoint of the stem by securing it with stainless-steel music wire to the snap rings at the top and bottom of the stem. Prior to securing the float, the unit was operated to insure the electrical connections had been made properly. Immediately before the unit was placed in a radiation hot-cell, approximately one quart of silicone fluid supplied by GEMS was poured into the unit through the junction box.

With the probe assembly installed inside the radiation hot-cell and connections made for remote readout of the position indicator, the assembly was subjected to gamma radiation from a cobalt-60 source to a total, equivalent air, dose of 200 megarads. This exposure includes installed life aging simulation of 50 megarads with the balance attributable to the dose resulting from a loss-of-coolant accident (LOCA).

Appendix A contains the certification of radiation exposure as performed by Isomedix, Inc. of Parsippany, New Jersey.

3.2 ENVIRONMENTAL EXPOSURE

After the radiation exposure, the electrical output leads were secured at the junction box to avoid any movement of the wires during handling. The leads were passed through a short piece of 1-inch pipe that was attached to the junction box fitting with a hose clamp, and the pipe was filled with potting compound.* The sensor unit was then

*General Electric RTV 60.

installed inside a pressure vessel with the mounting flange connected to a pipe stand to keep the unit in a vertical position. The lead wires were brought outside of the chamber through rubber-grommeted feedthrough fittings that sealed on each individual conductor.

The probe assembly was subjected to an environmental exposure in accordance with the pressure/temperature profile given in Figure 2, which included steam injection during the first hour of the 14-day exposure.

3.3 POSITION MEASUREMENTS AND INSPECTIONS

Visual inspections were performed before and after each phase of the environmental exposure periods to determine any obvious signs of degradation resulting the exposure environment.

Measurements of position were made periodically to indicate performance. Prior to each measurement, a calibration check was made by adjusting a variable resistor in the controller to set the voltage across the sensor circuit at 10 Vac, as indicated by a circular dial meter. Prior to the test, the dial reading corresponding to the fixed position of the float was marked, and this was subsequently regarded as being the zero reading. Position readings made during the test consisted of measuring the deviation of the dial reading (in degrees) from the pre-test zero reading.

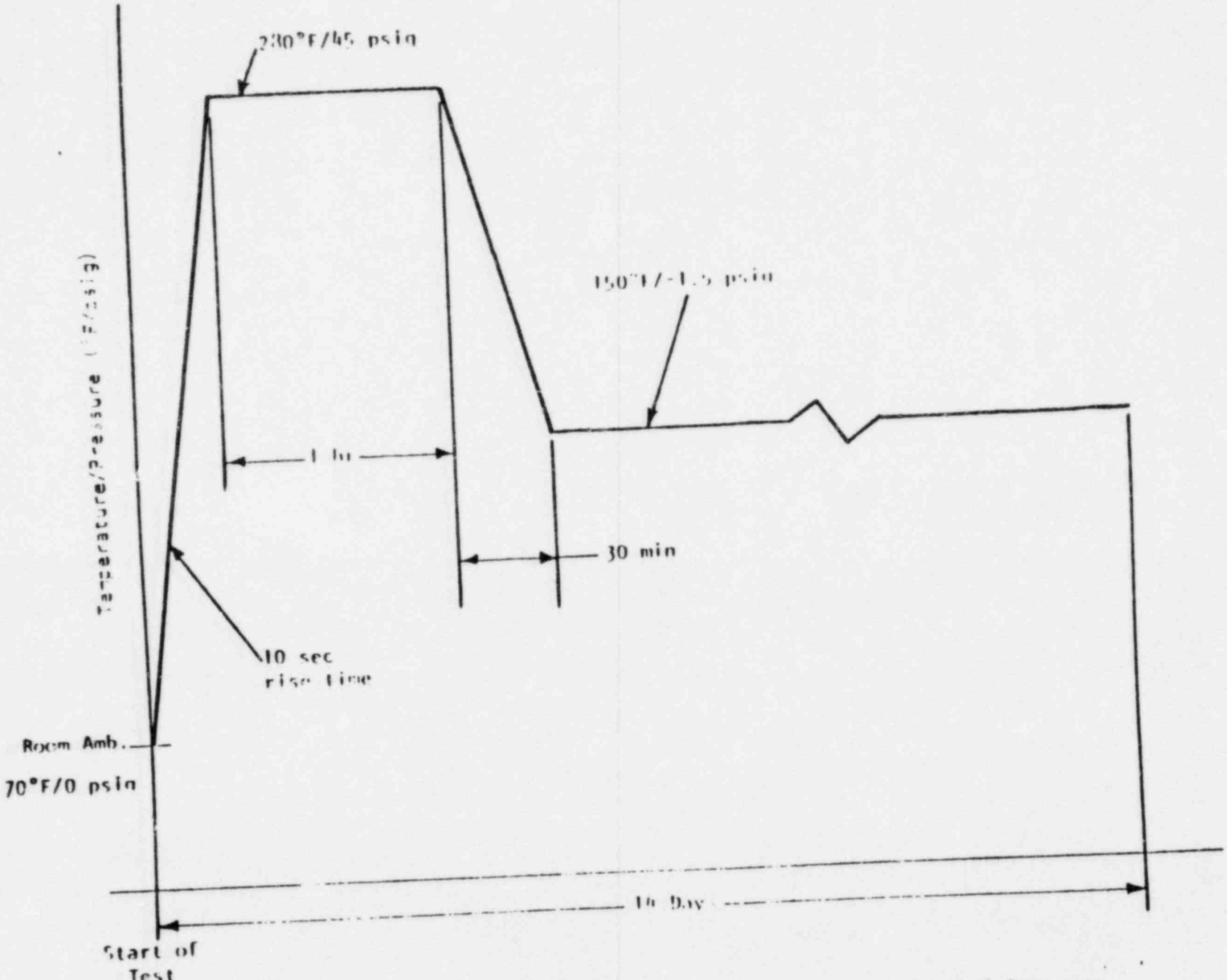


Figure 2. Temperature/Pressure Profile Specified for Environmental Exposure

4. TEST RESULTS

4.1 RADIATION EXPOSURE

No change in output was observed during the initial exposure period while the Cobalt-60 source was being raised into position to initiate the irradiation. The total deviation recorded during the remainder of the exposure period was less than 5 degrees to the left of the initial zero position.

At the conclusion of the exposure period the sensor assembly was removed from the hot cell and inspected for any visible degradation due to radiation. No damage was apparent. Some expansion of the solidified silicone fluid had taken place, as evidenced by 2 to 3 ounces of the solid material on the sensor mounting flange that had apparently leaked out along the gasket of the junction box cover.

4.2 FOURTEEN DAY EXPOSURE

The chamber was at room ambient temperature of 70°F prior to starting the exposure. Steam was admitted rapidly causing the conditions to increase from room ambient to 280°F at 63 psia. The conditions were maintained at 28[illegible] ± 1°F and [illegible] ± 2 psia for one hour followed by a drop to 150°F at 13.5 psia that required 1 hour 24 minutes to achieve. Conditions were maintained at 150 ± 1°F and 13.5 ± 0.5 psia for the balance of the fourteen-day exposure period with the following exceptions.

At an elapsed time of approximately six hours from the initiation of steam exposure, a vacuum control valve stuck in an open position causing the vacuum pump to operate continuously overnight, thereby causing the pressure to decrease to 3 psia. The valve was replaced the next morning and the pressure returned to its correct value.

At an elapsed time of 296 hours, a heater failure caused the temperature to drop from 150°F to 95°F during the next 16 hours. The heater was replaced and the temperature brought back to 150°F during the next two hours.

The exposure ended at an elapsed time of 336 hours (14 days) without further incident. Figure 3 shows the exposure profile, including a history of these events.

The maximum deviation of the position indication was less than 5 degrees counterclockwise from the zero position reading during the entire 14-day exposure period.

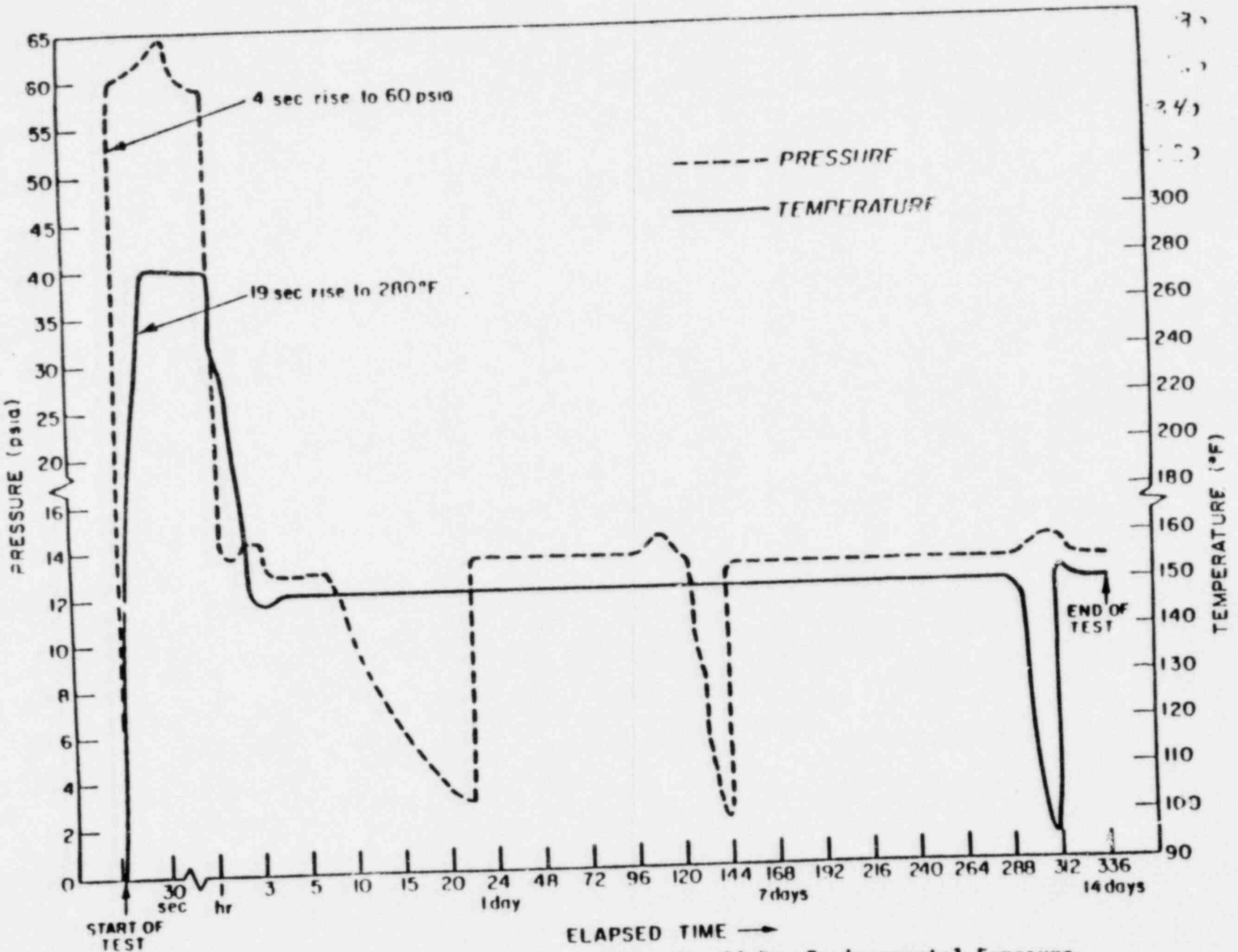


Figure 3. Temperature and Pressure Profiles for 14-Day Environmental Exposure

F-C3834

5. SUMMARY AND CONCLUSIONS

A liquid level sensor designed for use inside the containment of a nuclear power generating station was subjected to environmental testing consisting of radiation and steam exposures.

The unit was subjected to gamma radiation from a cobalt-60 source to a total, equivalent air, dose of 200 megarads. This was followed by exposure to steam at 280°F/60 psia for the first hour and 150°F/13.5 psia for the balance of fourteen days. The unit functioned satisfactorily throughout the entire test program.

6. CERTIFICATION

The undersigned certify that this report presents a true account of the tests conducted and results obtained.

Nissen M. Burstein
Project Leader

Leroy E. Witcher
Test Engineer

APPROVED

Zenons Zudans, Director,
Mechanical and Nuclear
Engineering Department

S. P. Carfagno, Manager,
Performance Qualification
Laboratory

ISOMEDIX

ENVIRONMENTAL EXPOSURE OF LIQUID LEVEL SENSOR

Performed by

Component Testing Division

Isomedix, Inc.

Parsippany, New Jersey

for

DeLaval

GEMS Sensor Division

Farmington, Connecticut

November 1975

Isomedix Inc. • 25 Eastmans Road, Parsippany, New Jersey (201) 887-4700
Mailing Address: Post Office Box 177, Parsippany, New Jersey 07054

CHICAGO DIVISION • 7825 Nagle Ave., Morton Grove, Illinois 60053 (312) 966-1160

CONTENTS

List of Figures

Page

List of Tables

1. Introduction

This report describes the steam and chemical-spray environmental exposure of a liquid level sensor. The environmental test was in accordance with Bechtel Specification 6600-M-2218 paragraph 4.3. The test program consisted of an exposure to environments of steam and chemical-spray for a four hour period at nominal conditions of 59 psig/300°F.

The float assembly, used as an indication of fluid level, was fixed to the stem of the unit by stainless steel music wire, while a constant input voltage was applied. The input and output voltages were recorded throughout the test period.

The unit performed satisfactorily during the four hour environmental exposure period.

This program was performed at the test facilities of Isomedix, Inc. of Parsippany, New Jersey, during October 1975.

2. Sample Description

The unit tested was a Model XM-36495 Level Sensor, manufactured by the GEMS Sensor Division/DeLaval Co.

3. Test Program

3.1 Environmental Exposure

The sensor was supported by an aluminum tripod secured at the bolt holes of the support flange of the head assembly. A 3/c lead wire was connected to the three electrical output leads of the sensor. Both ends of the lead wire were potted in aluminum tubes. One end was fitted in the sensor, while the other end was fitted through an opening in the top of the pressure vessel and secured by a tube fitting. Figure 1 is a photograph of the unit installed inside the pressure vessel prior to the exposure.

The sensor assembly was filled with approximately one quart of silicone fluid, supplied by GEMS.

The probe assembly was subjected to an environmental exposure in accordance with the pressure/temperature profile given in Figure 2.

A chemical-spray solution was sprayed into the test chamber at a rate corresponding to 0.15 gmp per square ft. of the chamber cross-section area during the steam exposure period. The solution consisted of 15,000 ppm boric acid in solution with sodium hydroxide to obtain a pH of 10.5 at room temperature.

3.2 Test Measurements

A d.c. power supply provided an input voltage measured as 10.725 volts d.c. across terminal leads 1 and 2. The sensor float was positioned in the middle of the stem to provide an output signal simulating a fluid level.

The output voltage was recorded as 4.787 volts d.c. and was read across sensor terminals 1 and 3. Throughout the test, both input and output voltages were monitored in order to detect changes in the voltage levels.

A record of the readings taken during the exposure period is presented in Table 1.

TABLE 1

MEASUREMENTS OF SENSOR PERFORMANCE

Elapsed Time (Min.)	Input (Volts d.c.)	Output (Volts d.c.)
0	10.725	4.787
5	10.725	4.787
10	10.725	4.787
20	10.725	4.786
30	10.725	4.787
50	10.725	4.788
60	10.725	4.788
90	10.725	4.788
120	10.725	4.788
150	10.725	4.788
180	10.725	4.788
210	10.725	4.788
240	10.725	4.788
270	10.725	4.788

4. Test Results

The vessel was at room ambient temperature of 75°F prior to starting the exposure. Steam was rapidly admitted causing the conditions to increase from room ambient to 300°F at 56 psig within 8 minutes. The conditions were maintained at 298°F ± 2°F and 55 ± 5 psig for the four hour exposure period, as shown in Figure 2.

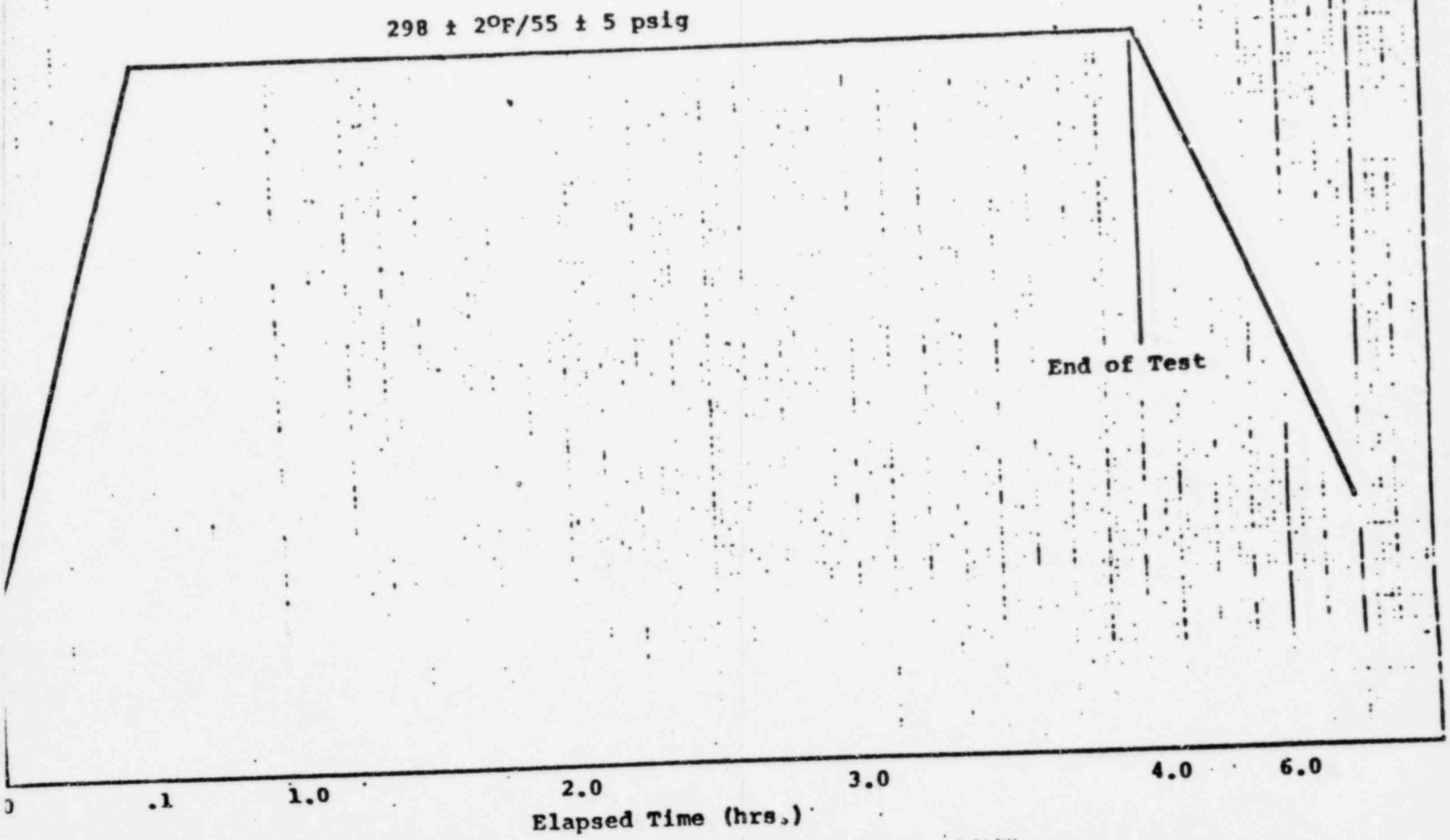
The input voltage remained constant at 10.725 volts d.c. throughout the test. The output voltage was maintained at a value of 4.787 ± .001 volts d.c.

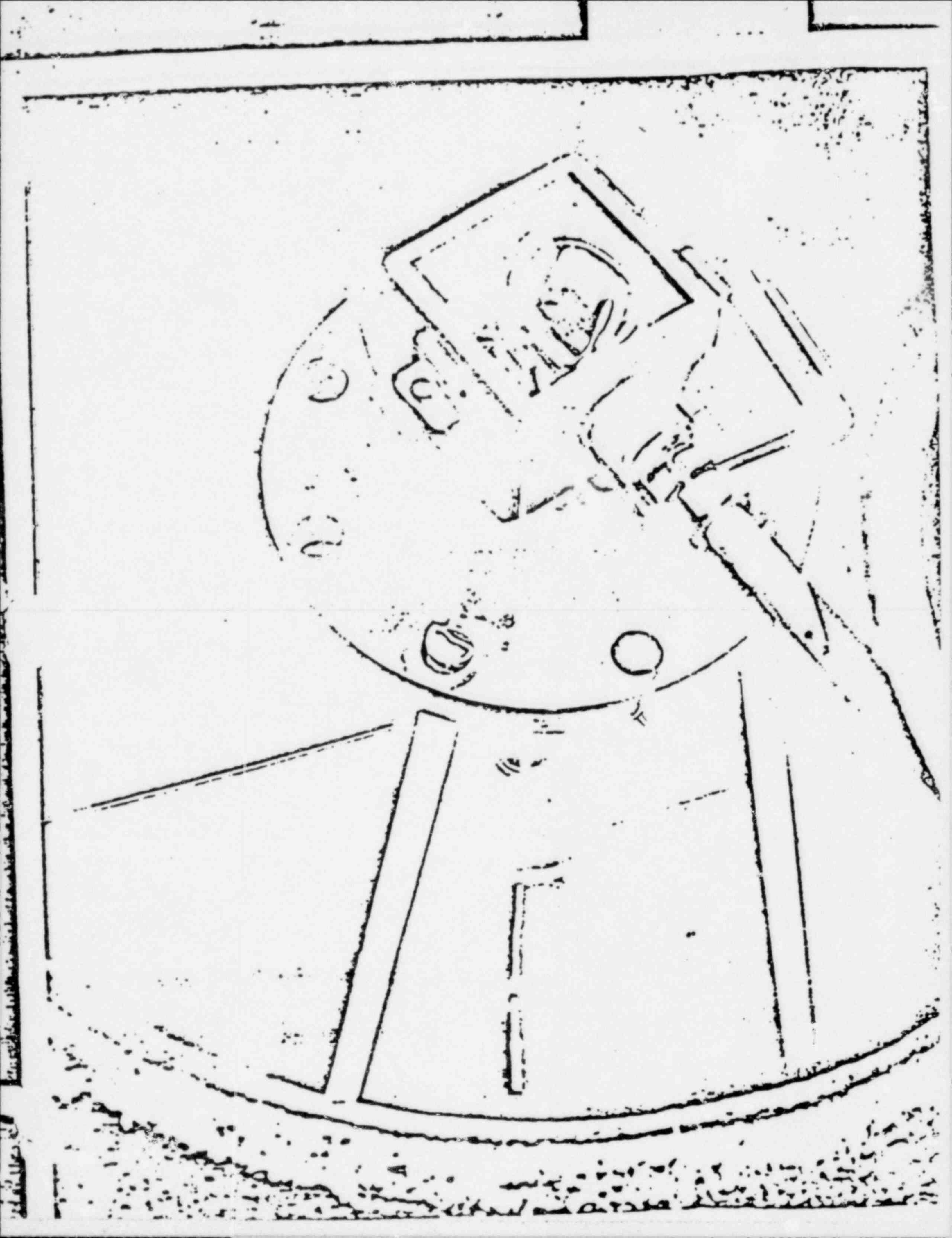
The silicone fluid in the sensor leaked through the insulation of the three conductors of the lead wire. At the end of the test, it was found that the level of silicone fluid dropped 1 inch from its original level before the exposure. Figure 3 shows the unit after the exposure period.

5. Summary and Conclusions

A liquid level sensor was exposed to environments of steam and chemical-spray at 300°F/59 psig for a period of four hours. The unit functioned satisfactorily throughout the entire test.

Figure 2 TEMPERATURE PROFILE OBTAINED DURING THE ENVIRONMENTAL EXPOSURE PERIOD





Client: Virginia Electric and Power Company Address: Mineral, Va J.O. No.:

Period Ending Weekly: Monthly:

Stone & Webster Engineering Corporation
W.C. Transportation Insurance Co. - Marsh & McLennan
C.G.L. Continental Casualty Co. - Marsh & McLennan

7-11-80	W.C. Policy # 5397239	Payroll	W.C. Rates	Premium
5183	Plumbing			
5213	Concrete Construction N.O.C.			
5606	Contractor's Exec. Super.			
8810	Clerical Office			
	Rate Increase			
	Exp. Mod.			
	Total W.C. Premium			
Until Cancelled				

C.G.L. Policy No. CCP-746-7750	Payroll	C.G.L. Rate	Premium
Bodily Injury/Property Damage		.90	
		TOTAL PREMIUM:	
Sent to Marsh & McLennan			

6. Certification

The undersigned certifies that this report presents a true account of the test program and results obtained. Any questions relating thereto should be addressed to same.

Nissen M. Burstein
Manager, Component Testing

ITEM 6(2)

WYLE LABORATORIES
SCIENTIFIC SERVICES AND SYSTEMS GROUP
P. O. BOX 1008 • HUNTSVILLE, ALABAMA 35807
TWX (810) 726-2225 • TELEPHONE (205) 837-4411

QUALIFICATION PLAN

QUALIFICATION PLAN 45102-1

DATE November 7, 1980

FINAL QUALIFICATION PLAN

FOR

LEVEL TRANSMITTERS, LEVEL SWITCHES
AND MODULAR RECEIVER

FOR

TRANSAMERICA DELAVAL, INC.
GEMS SENSOR DIVISION

FOR USE IN THE

STANDARDIZED NUCLEAR UNIT POWER PLANT SYSTEM
(SNUPPS)

APPROVED BY: Bobby L. Quinn
FOR: Seismic Qualification

APPROVED BY: David Stinson
FOR: Qual Plan Review

APPROVED BY: James W. Foreman
FOR: Seismic Analysis

APPROVED BY PROJECT MANAGER: Robert A. Hall
Robert A. Hall

APPROVED BY QUALITY ASSURANCE: M. C. Kimbrell
M. C. Kimbrell

PREPARED BY PROJECT ENGINEER: Frank E. Hancock
Frank E. Hancock

REVISIONS

FORM 1109-1 12-5-77

REV. NO.	DATE	PAGES AFFECTED	BY	APP'L.	DESCRIPTION OF CHANGES

2.0 QUALIFICATION REQUIREMENTS (CONTINUED)

2.1 Definition of Service Conditions (Continued)

2.1.1 Normal Conditions (Continued)

Item 8 - Modular Receiver Unit RE-36562

o	Temperature:	60°F to 104°F
o	Pressure:	0 psig (atmospheric) to 1/4" W.G. above atmospheric
o	Voltage:	115 VAC ± 8% (105.8 to 124.2 VAC)
o	Relative Humidity:	30% to 95%
o	Radiation:	1 x 10^3 rads 40-year total integrated dose (0.0005 rads/hour maximum dose rate)

2.1.2 Design Basis Event (DBE) Conditions

2.1.2.1 Seismic

The Required Response Spectra (RRS) specified by Bechtel Power Corporation are as shown in Figures 4, 5, and 6.

2.1.2.2 Accident

2.1.2.2.1 Loss-of-Coolant (LOCA) and Main Steam Line Break (MSLB) As Specified in Bechtel Specification No 10446-J-830(Q)

Items 1 through 5, 9, and 10 - Level Transmitters

o	Radiation:	1 x 10^8 rads gamma (air equivalent)

The time, temperature, and pressure parameters are as shown in Figure [illegible].

2.1.3 Extreme Service Conditions

The Level Switch, Transmitter, and Receiver Module will be subjected to the following extreme service conditions, as specified in Bechtel Specification No. 10446-J-830(Q):

2.0 QUALIFICATION REQUIREMENTS (CONTINUED)

2.1 Definition of Service Conditions (Continued)

2.1.3 Extreme Service Conditions (Continued)

2.1.3.1 Items 6 and 7 - Level Switches LS-57761 and LS-57763

- o Temperature: 160°F maximum
- o Pressure: Atmospheric
- o Relative Humidity: 5% to 100%
- o Gamma Radiation: 1×10^7 rads (integrated 40-year dose)

2.1.3.2 Item 8 - Modular Receiver RE-36562

- o Temperature: 60°F to 104°F
- o Pressure: 0 psig (atmospheric) to 1/4" W.G. above atmospheric
- o Relative Humidity: 30% to 95%
- o Radiation: .25 rad

2.1.3.3 Reactor Building Integrity Test

The level transmitters (Items 1 through 5, 9, and 10) will be subjected to the following conditions:

- o Temperature: Up to 120°F
- o Pressure: 69 psig
- o Relative Humidity: Up to 100%

2.1.4 Other Service Conditions

The following cycle requirements for the level transmitter/receiver module and level switch are as specified by Bechtel Power Corporation.

- o Cycle Requirements: 200

2.0 QUALIFICATION REQUIREMENTS (CONTINUED)

2.2 Safety-Related Functions

The safety classification of this equipment is Class IE. The subject equipment provides essential services in support of emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or is otherwise essential in providing support to prevent significant release of radioactive material to the environment. The safety related functions are described in the following paragraphs.

2.2.1 Description

The transmitter/receiver system senses and indicates liquid levels over a specified range. The level switch senses and indicates the presence or absence of liquid at a particular level (i.e., as a maximum or minimum level).

2.2.2 Acceptance Criteria

The acceptance criteria for the level transmitter and receiver module are as follow:

1) The meter readings at the five (5) float positions shall not vary from the calibration readings by more than ± 3% of full scale (± 6 microamperes).

2) The receiver module output at the five (5) float positions may not vary from the calibration reading by more than ± 3% of full scale (± .6 milliamperes)

3) No structural failure shall occur, e.g., broken or loosened parts or deformation resulting in device failure.

4) No loss of pressure-boundary integrity, e.g., leakage, shall occur.

The acceptance criteria for the level switch are as follow:

1) The switch contacts must change state upon increasing or decreasing float position.

2) No structural failure shall occur, e.g., broken or loosened parts or deformation resulting in device failure.

3) No loss of pressure-boundary integrity, e.g., leakage, shall occur.

2.2.3 Safety-Related Components

All components in the subject equipment are assumed to be safety related.

3.0 QUALIFICATION PROGRAM

3.1 Baseline Functional Tests

3.1.1 Pretest Visual Inspection

A visual inspection of the equipment will be performed upon arrival at Wyle Laboratories. This inspection will assure that the equipment is received with no obvious visible damage. Equipment identification will also be verified. Caution: The level transmitter and level switch must be transported and tested in the vertical orientation.

3.1.2 System Level Tests

All subject equipment will be functionally tested on a system level. The Level Transmitter Unit, XM-54852, and the Receiver Module, RE-36562, are considered to be one (1) system. The Level Switch Unit, LS-57763C, is considered to be one (1) system.

3.1.2.1 Baseline Functional Test for RE-36562 and XM-54852A

The subject equipment will be calibrated during the Baseline Functional Test only. Calibration will be performed as follows:

1) Connect all electrical plugs and cables to the receiver and transmitter. Twenty (20) feet of Bechtel (SNUPPS)-supplied interconnect cables will be utilized for equipment interface. Two (2) sections of 5-ft long, Delaval-supplied flex conduit (hydraulic hose) are to be used on the transmitter to protect the wiring. After the wiring has been connected, the conduit box is to be filled with Dow 710 silicone fluid and a flex conduit installed.

2) With the "ON-OFF-FULL REF" (Reference) toggle switch in the "OFF" position, zero the meters utilizing the pointer set screw adjustment.

3) Adjust receiver voltage input to 115 VAC (± 5%).

4) Hold the "ON-OFF-FULL REF" toggle switch on the receiver module to "FULL REF" while performing Step 5.

5) Adjust the "Calibrate" pot on the receiver module until the meter reads full scale.

6) Position the "ON-OFF-FULL REF" toggle switch on the receiver module to "ON".

7) On the level transmitter, position the float at the "empty" position (the float should rest on the bottom stop) and mark the meter face on the receiver module at the "pointer" position. Record the receiver module converter output (4 to 20 milliamperes DC into a 100 to 800 ohm load).

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.1 Baseline Functional Tests (Continued)

3.1.2 System Level Tests (Continued)

3.1.2.1 Baseline Functional Tests for RE-36562 and XM-54852A

8) Fix the float at the "1/4" position and mark the receiver module meter face at the "pointer" position. Record the receiver module converter output (4 to 20 milliamperes DC into a 100 to 800 ohm load). Repeat for the "1/2", "3/4", and "full" positions. The float positions, "empty", "1/4", "1/2", "3/4" and "full" are based on the inches of indication. For the XM-54852A this is 90 inches. Therefore, the "empty" position is 0 inch of indication,"1/4" is 22 1/2 inches, "1/2" is 45 inches, "3/4" is 67 1/2 inches, and "full" is 90 inches.

NOTE: Spacer bars must be manufactured and utilized to assure duplication of float position for subsequent Functional Tests. The allowable tolerance for the spacer bars is ± 1/8 inch, i.e. for the "1/2" position, the spacer bar must be 45 ± 1/8 inch in length.

3.1.2.2 Functional Tests for RE-36562 and XM-54852A

The subject equipment will be evaluated utilizing the following system level Functional Tests:

1) Connect all electrical plugs and cables on the receiver and transmitter.

2) With the "ON-OFF-FULL REF" toggle switch in the "OFF" position, zero the meter, utilizing the pointer set screw adjustment. If not required, this step may be omitted. Document if zeroing is or is not performed.

3) Adjust the receiver voltage input to 115 VAC (± 5%).

4) Hold the "ON-OFF-FULL REF" toggle switch on the receiver module to "FULL REF" while performing Step 5.

5) Adjust the "Calibrate" pot on the receiver module until the meter reads full scale. If not required, this step may be omitted. Document if calibration is or is not performed.

6) Position the float on the level transmitter to the "empty" position.

7) Record the meter reading. Record the receiver module converter output. The output will be 4 to 20 milliamperes into a 100 to 800-ohm load.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.1 Baseline Functional Tests (Continued)

3.1.2 System Level Tests (Continued)

3.1.2.2 Functional Tests for RE-36562 and XM-54852A (Continued)

8) Repeat Steps 4) and 5) for the "1/4", "1/2", "3/4", and "full" positions, utilizing the spacer bars manufactured for the baseline functional calibration.

9) Repeat Steps 3) through 6) for each voltage variation extreme. The low voltage will be 105.8 VAC (-5, +0). The high voltage will be 124.2 VAC (-0, +6).

3.1.2.3 Baseline Functional Tests for LS-57763C

The subject equipment will be evaluated utilizing the following system level Functional Tests:

1) Twenty (20) feet of Bechtel (SNUPPS)-supplied interconnect cables will be utilized for equipment interface. After the wiring has been connected, the conduit box is to be filled with Dow 710 silicon fluid. Two (2) sections of 5-ft long Delaval-supplied flex conduit (hydraulic hose) are to be used on the level switch to protect the wiring.

2) Input 12 $\pm$ 1 VDC, utilizing a maximum of 0.5 ampere resistive load.

3) Position both floats at the bottom stops.

4) Record output voltage readings. Normally open (NO) contacts shall read 0 VDC. Normally closed (NC) contacts shall approximate the input voltage.

5) Position both floats at the top stops. The NO contacts shall approximate the input voltage. The NC contacts shall read 0 VDC.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.2 Radiation (Continued)

3.2.1 Radiation Exposure (Continued)

3.2.1.3 Receiver RE-36562

The radiation requirement for the receiver module is the normal dose of 1×10^3 rads plus the accident dose of .275 rad (a 10% conservatism margin was added), for a total of 1000.275 rads total integrated dose. Table I defines the nonmetallic materials of the receiver module.

The materials for all components, except the Westinghouse meter, have radiation damage threshold levels above 1×10^4 rads. The nonmetallic materials in the Westinghouse meter have not been defined by the manufacturer. Therefore, a minimum radiation exposure of 1000 rads gamma (air equivalent) is warranted. The receiver will be connected to the transmitter and both units exposed to a minimum total integrated dose of 1×10^3 rads gamma, air equivalent, using a Cobalt 60 source. The float shall be in the "1/2" position; 115 VAC ($\pm$ 5%), 60 Hz, shall be applied to the receiver. The converter output will be observed during the radiation exposure and the input voltage and output current (approximately 12 mA) will be recorded before, at least once during, and after irradiation.

3.2.2 Functional Test

Following irradiation, remove one (1) of the two (1) 5-ft sections of flex conduit (reference Paragraph 3.1.2.1) and then the Functional Test of Paragraphs 3.1.2.2 and 3.1.2.3 will be performed as applicable.

3.3 Aging

The desired qualified life of the subject equipment is 40 years. The desired qualified life for components is also 40 years. Where 40-year qualified life for components is not demonstrated during the test program, a shorter qualified life will be established and the component assigned a maximum maintenance/-replacement interval no greater than its qualified life.

Each component in the subject equipment has been reviewed for function and age-related failure mechanisms which could affect its function. A matrix, Table I, has been prepared which defines the components, manufacturer ratings, materials, service conditions, aging mechanisms, and qualified life. A literature search of Wyle's Aging Library has been utilized to obtain auditable aging data. This data has been used to exempt aging, as well as to define artificial aging procedures. When no applicable data existed, engineering judgment was utilized for the definition of artificial aging procedures. These are noted as assumptions. The aging mechanisms to be addressed for this equipment are operational cycling, time/temperature effects, and humidity.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.2 Radiation

3.2.1 Radiation Exposure

Each component in the equipment has been reviewed in order to ascertain all materials. Evaluation has been made of the function of the component materials. This information has been compared to auditable data to determine the susceptibility of the material, in its application, to the radiation exposure level specified.

3.2.1.1 Transmitter XM-54852A

The radiation requirement for the level transmitters is the normal dose of 6×10^6 rads plus the accident dose of 1.1×10^8 rads (a 10% conservatism margin was added) for a total dose of 1.16×10^8 rads total integrated dose.

Table I, Items 1.0, 2.0, 3.0, 4.0, 5.0, 9.0, and 10.0, defines the nonmetallic materials of the level transmitters.

Radiation damage threshold levels for neoprene, polyolefin, and polyvinyl chloride are lower than the predicted radiation requirement of 1.16×10^8 rads. Because of the threshold damage levels, a minimum radiation exposure of 1.16×10^8 rads gamma (air equivalent) is warranted to confirm the capability of the switches to perform their safety-related function.

The first 1,000 rads of exposure will be performed with the receiver in the chamber, per Paragraph 3.2.1.3. The remaining exposure is to be performed with the transmitter only in the chamber, while powered to the receiver. As a minimum, the receiver module input voltage and output current, as well as the "pointer" position, shall be recorded once per day after the first 1,000 rads.

3.2.1.2 Level Switches Type LS-57763C

The radiation requirement for the level switches is the 40-year total integrated dose, normal plus accident, of 1×10^7 rads (a 10% conservatism margin was added) for a total of 1.1×10^7 rads total integrated dose.

Table I, Items 6.0 and 7.0, defines the nonmetallic materials of the level switches.

The radiation damage threshold level for neoprene is lower than the predicted radiation requirement of 1.1×10^7 rads. Because of the threshold damage level, radiation exposure of 1.1×10^7 rads gamma (air equivalent) is warranted to confirm the capability of the switches to perform their safety-related function.

The level switch will be powered using 12 ($\pm$ 1 VDC), 0.5 ampere resistive load, maximum, during radiation exposure and electrical inputs and outputs will be recorded once per day minimum and before and after irradiation..

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.3 Aging (Continued)

3.3.1 Operational Cycling

Operational cycling will be performed on the system level. The level switch and the level transmitter/receiver module will be cycled for 220 cycles each, as specified by Bechtel Power Corporation (a 10% conservatism margin has been added). A cycle is defined as manually moving the float(s) from the bottom stop to the top stop and back to the bottom stop. The receiver module/level transmitter will be electrically connected and powered with 115 (± 5%) VAC, 60 Hz. The level switch will be electrically powered with 12 (± 1) VDC, 0.5 A, resistive load maximum.

3.3.2 Time/Temperature Effects

The present state-of-the-art will allow acceleration of the time/temperature aging effects artificially by increasing the temperature. Most components of the subject equipment contain metallic as well as nonmetallic materials. The deterioration due to these effects is judged to be insignificant for metallic materials. Therefore, the aging of these components will be based on their nonmetallic materials.

For many nonmetallic materials, it is known that the degradation process can be defined by a single temperature-dependent reaction that follows the Arrhenius equation:

$$k = A \exp(-(Ea/k_B T)) \qquad (1)$$

where,

k	=	reaction rate
A	=	frequency factor
exp	-	exponent to base e
Ea	=	activation energy
k_B	=	Boltzmann's Constant
T	=	absolute temperature

It is further noted that, for many reactions, the activation energy can be considered to be constant over the applicable temperature range. Equation (1) can be transformed into a form which yields an acceleration factor.

The acceleration factor is defined as t_2/t_1.

The equation is:

$$t_2/t_1 = \exp(-(Ea/k_B)(1/T_1 - 1/T_2)) \qquad (2)$$

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.3 Aging (Continued)

3.3.2 Time/Temperature Effects (Continued)

where,

t_1	=	accelerated aging time at temperature T_1
t_2	=	normal service time at temperature T_2
exp	=	exponent to base e
Ea	=	activation energy (eV)
k_B	=	Boltzmann's Constant (8.617×10^{-5} eV/°K)
T_1	=	accelerated aging temperature (°K)
T_2	=	normal service temperature (°K)

The transformation of the reaction rate form of the Arrhenius equation to an acceleration form is accomplished as follows:

Life is assumed to be inversely proportional to the chemical reaction rate (References 5 and 6). In terms of life, and after converting to Napierian base logarithms, Equation (1) becomes:

$$\ln(\text{life}) = (Ea/k_B)(1/T) + \text{Constant} \quad (3)$$

Equation (3) has the algebraic form:

$$y = mx + b \quad (4)$$

where,

y	=	ln (life)
x	=	1/T
m	=	Ea/k_B, constant for single dominant reactions
b	=	constant

The constants, m and b, can be estimated by fitting the experimental data in the form of ln (life) versus 1/T to the above simple linear relationship.

The derivation of an acceleration factor is accomplished by taking the difference between any two points of the linear relationship.

Thus, if we substitute t for life into Equation (3), we obtain:

$$\ln t = (Ea/k_B)(1/T) + \text{Constant} \quad (5)$$

For the set of points (t_1, T_1), Equation (5) becomes:

$$\ln t_1 = (Ea/k_B)(1/T_1) + \text{Constant} \quad (6)$$

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.3 Aging (Continued)

3.3.2 Time/Temperature Effects (Continued)

For the set of points (t_2, T_2), Equation (5) becomes:

$$\ln t_2 = (Ea/k_B)(1/T_2) + \text{Constant} \quad (7)$$

Subtracting Equation (6) from Equation (7) yields:

$$\ln t_2 - \ln t_1 = (Ea/k_B)(1/T_2) + \text{Constant} - (Ea/k_B)(1/T_1) - \text{Constant} \quad (8)$$

Simplifying and rearranging of Equation (8) yields:

$$\ln (t_2/t_1) = -(Ea/k_B)(1/T_1 - 1/T_2) \quad (9)$$

Taking antilogarithms yields:

$$t_2/t_1 = \exp (-(Ea/k_B)(1/T_1 - 1/T_2)) \quad (10)$$

Equation (10) is the same as Equation (2).

The acceleration factor, (t_2/t_1), is the reciprocal of the time compression factor, (t_1/t_2). Taking the reciprocal of Equation (10) yields:

$$t_1/t_2 = \exp ((Ea/k_B)(1/T_1 - 1/T_2)) \quad (11)$$

Solving Equation (11) for t_1 yields:

$$t_1 = t_2 \exp ((Ea/k_B)(1/T_1 - 1/T_2)) \quad (12)$$

Equation (12) can be used to derive the accelerated aging times for materials with known activation energies. In many cases, it is not practical to independently accelerate the time/temperature effects of each nonmetallic material. In this case, a determination is made as to which material has the lowest activation energy. The time/temperature effects are accelerated based upon the lowest activation energy for conservatism. This assures that the degradation of each age-sensitive material is accelerated to at least the equivalent degradation as that to be encountered during the qualified life.

The conservatism of basing accelerated aging on the lowest activation energy is demonstrated as follows:

The acceleration factor (t_2/t_1) of Equation (10) is greater than 1, for a constant activation energy, when the accelerated aging temperature T_1 is greater than the normal service temperature T_2.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.3 Agi: g (Continued)

3.3.2 Time/Temperature Effects (Continued)

With T_1 greater than T_2, the term $(1/T_1 - 1/T_2)$ is negative. This negative, multiplied by the negative in the exponent, results in a positive exponent. A positive exponent, in turn, results in an acceleration factor greater than 1.

The acceleration factor versus (1/T) for various activation energies is plotted in Figure 1. Since the slope of each plot is proportional to the activation energy, per Equation (4), it is shown that a lower activation energy causes a lower slope. Thus, for a given accelerated aging temperature, different activation energies cause different acceleration factors, assuming that the normal service temperature is the same. This is demonstrated in the following example.

EXAMPLE: Assume that a system consists of four (4) materials which have activation energies of 0.4, 0.8, 1.0, and 2.0 eV. It is assumed that each material is normally at a service temperature of 30°C for a qualified life of 40 years. It is further assumed that accelerated thermal aging will be performed at 50°C.

If the accelerated aging program is based upon the material with an activation energy of 1.0 eV, the following results:

The relationship for the curves of Figure 1 is generated from Equation (10) and is defined as:

$$t_2/t_1 = \exp(-(Ea/k_B)(1/T_1 - 1/T_2)) \qquad (13)$$

Substituting Ea = 1.0 eV, T_1 = 323°K, T_2 = 303°K, into Equation (13) yields an acceleration factor of approximately:

$$t_2/t_1 = 11 \qquad (14)$$

Thus, for a normal service time of 40 years (t_2 = 40), the accelerated aging time from Equation (14) is:

$$t_1 = 40/11 = 3.64 \text{ years} \qquad (15)$$

Therefore, using the accelerated thermal aging program of 50°C for 3.64 years, the equivalent demonstrated normal service times at 30°C for the other materials with activation energies of 0.4, 0.8, and 2.0 eV can be calculated using Equation (13).

Thus, for Ea = 2.0 eV,

$$t_2 = 3.64 \exp(-(2.0/8.617 \times 10^{-5})(1/323 - 1/303)) \qquad (16)$$

$$t_2 = 418 \text{ years} \qquad (17)$$

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.3 Aging (Continued)

3.3.2 Time/Temperature Effects (Continued)

For Ea = 0.8 eV,

$$t_2 = 3.64 \exp(-(0.8/8.617 \times 10^{-5})(1/323 - 1/303)) \quad (18)$$

$$t_2 = 24.3 \text{ years} \quad (19)$$

For Ea = 0.4 eV,

$$t_2 = 3.64 \exp(-(0.4/8.617 \times 10^{-5})(1/323 - 1/303)) \quad (20)$$

$$t_2 = 9.4 \text{ years} \quad (21)$$

Thus, it is seen that materials with activation energies less than 1.0, upon which the aging program was based, are underaged by the accelerated aging of 50°C for 3.64 years.

In order to assure the demonstration of a 40-year service time for all materials, the lowest activation energy should be chosen.

Basing the accelerated aging program on the lowest activation energy of 0.4 eV results in the following:

Substituting Ea = 0.4 eV, T_1 = 323°K, T_2 = 303°K, into Equation (13) yields an acceleration factor of approximately

$$t_2/t_1 = 2.6 \quad (22)$$

Thus, the aging time is:

$$t_1 = 40/2.6 = 15.4 \text{ years} \quad (23)$$

Rechecking the other materials for adequate aging results in the following for an accelerated aging program of t_1 = 15.4 years, T_1 = 323°K, T_2 = 303°K.

For Ea = 0.8 eV,

$$t_2 = 103 \text{ years} \quad (24)$$

For Ea = 1.0 eV,

$$t_2 = 165 \text{ years} \quad (25)$$

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.3 Aging (Continued)

3.3.2 Time/Temperature Effects (Continued)

For $Ea = 2.0$ eV,

$$t_2 = 1{,}768 \text{ years} \quad (26)$$

Thus, it has been demonstrated that basing an accelerated thermal aging program on the lowest activation energy, when the baseline temperatures are common, provides the conservatism desired.

END OF EXAMPLE

For components with time/temperature-related aging mechanisms, the aging was based upon available auditable aging data. Where this data was unavailable, careful extrapolation and/or selective engineering judgment was employed and identified in the Aging Analysis section applicable to the specific equipment being qualified.

Where adequate information was available, a determination of age sensitivity will be performed to determine the qualified life goal. Those items found to be age insensitive are noted in the column entitled "Aging Mechanisms, Time/Temperature Effects," Table I. A reference was made for the conclusion of age insensitivity. These references are to paragraphs in this document which justify the conclusion, reference documents, or other basis, such as metallic materials.

Age sensitivity is addressed for electronic components in Paragraph 3.4.1. Metals are judged to be age insensitive for time/temperature effects.

For nonmetallic materials, a determination was made as to whether the material can be qualified for a 40-year life. This was done by using the worst-case normal service temperature for the baseline temperature.

The applicable Arrhenius equation will be evaluated using the baseline temperature as follows:

EXAMPLE: The Arrhenius equation, Equation (3), is repeated:

$$\ln(\text{life}) = (Ea/k_B)(1/T) + \text{Constant} \quad (27)$$

A substitution will be made for the applicable slope and constant and the equation evaluated, e.g., for glass-filled nylon (Zytel 70G33L), for mechanical properties, the Arrhenius curve is:

$$\ln(\text{life}) = 9969.197026\,(1/T) - 14.71269763 \quad (28)$$

For an assumed baseline temperature of 37.8°C:

$$T = 37.8^{\circ}C + 273^{\circ}C = 310.8^{\circ}K \quad (29)$$

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.3 Aging (Continued)

3.3.2 Time/Temperature Effects (Continued)

$$\ln(\text{life}) = 9969.197026\,(1/310.8) - 14.71269763 \qquad (30)$$

$$\ln(\text{life}) = 17.26 \qquad (31)$$

$$\text{life} = \text{greater than } 3{,}900 \text{ years} \qquad (32)$$

It is concluded that this glass-filled nylon can be qualified for 40 years at a baseline temperature of 37.8°C. END OF EXAMPLE

The applicable Arrhenius equation refers to the equation which is most appropriate to the material application when more than one equation is known.

For components with time/temperature-related aging mechanisms, the aging will be based upon available auditable aging data, as noted in Table I . Where this data was unavailable, engineering judgment has been employed and an activation energy assumed.

The baseline operating temperature has been defined by Bechtel Power Corporation to be:

Item		Temperature
1.0	Level Transmitter	120°F continuous
7.0	Level Switch	120°F continuous
8.0	Receiver Module	104°F + 12.6°F heat rise = 116.6°F

3.4 Aging Analysis

Each subassembly, component, and material has been reviewed for aging mechanisms which could affect the safety-related function.

3.4.1 Determination of Age Sensitivity to Time/Temperature Effects (Electronic Components)

The following demonstrates the rationale behind the conclusion that aging is not a significant failure mechanism for certain electronic components in controlled environments in Nuclear Power Generating Stations. This is because the aging of certain electronic components, applied within their design rating, occurs at such

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4 Aging Analysis (Continued)

3.4.1 Determination of Age Sensitivity to Time/Temperature Effects (Electronic Components) (Continued)

a low rate that its effect on the failure rate is undetectable for durations in excess of the maximum desired qualified life of 40 years.

To illustrate the failure rate history of these electronic components, refer to Figure 2, Failure Rate Curve. The failure rate curve is typical for many components. The curve is divided into three parts. The first part is characterized by a decreasing failure rate and represents the period commonly referred to as the "infant mortality period." It is common in the electronics industry to "burn in" components prior to actual use in order to eliminate early failures. The second part of the curve, which is often characterized by a constant failure rate, is normally regarded as the period of useful life. During this period, only chance, or random, failures occur. The third part of the curve is characterized by an increasing failure rate and is the period during which components fail primarily because they are worn out (Reference 7).

During the time when the failure rate is constant, there is no statistically significant difference in failure rate as a function of time. Thus, there can be no significant age-related failure mechanisms. Another way of stating this is that the change in failure rate over time is zero. A constant failure rate is characteristic of an exponential distribution of failures. If a component with an exponential failure distribution has survived to a point in time, the probability of survival for the next increment of time is the same as if it had just been placed into service (Reference 8). A decreasing failure rate is characteristic of the Weibull Distribution with Beta less than 1. If a component with a Weibull Distribution (Beta less than 1) has survived to a point in time, the probability of survival for the next increment is greater than if it had just been placed into service (Reference 8).

A constant or decreasing failure rate of a component during the life of the plant is equivalent to its exemption from aging. This is true since, in its unaged condition, it has the same, or higher, probability of failure for constant or decreasing failure rates, respectively.

Many sources contain failure rate information for electronic components. MIL-HDBK-217C, "Reliability Prediction of Electronic Equipment," and individual manufacturers' test data are the most common sources. It will be shown that many electronic components have constant or decreasing failure rates for the time period under consideration—40 years.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4 Aging Analysis (Continued)

3.4.1 Determination of Age Sensitivity to Time/Temperature Effects (Electronic Components) (Continued)

The following define some studies which have been made of the potential failure mechanisms for electronic components. A common element is that the time/-temperature-dependent mechanisms have been characterized and activation energies determined for the mechanisms. Consequently, reliability testing has been performed on the component as well as the assembly level. A portion of this testing consisted of accelerated thermal aging of the components. This is done using Arrhenius techniques. This testing of electronic components to greatly accelerated conditions, as defined by the most conservative acceleration factor (i.e., the smallest applicable activation energy, typically 0.4 to 0.5 eV), has resulted in the conclusion that no evidence of wearout was experienced. Wearout failures, as the name implies, occur when wearout takes place, both physically and electrically, at the end of a device's useful life. Statistically, this will not happen until hundreds of years have elapsed for electronic components, semiconductors, and whole printed circuit assemblies, as is evident from the following studies.

3.4.1.1 Integrated Circuits

The conclusion that aging is insignificant to integrated circuits is justified as follows:

A study (Reference 9) sponsored by the U. S. Army Missile Command to determine the storage reliability of missile material, focused on monolithic, bipolar, small-scale integration (SSI), and medium-scale integration (MSI) digital integrated circuits.

Fifteen (15) billion hours of storage or nonoperating data was gathered, together with an additional 170 million hours of high-temperature storage test data. Individual devices experienced the degradation equivalent of over 17,500 years at 40°C, calculated using Arrhenius techniques.

One of the conclusions of the report was a failure rate model which assumed a constant failure rate over the device storage period. This assumption was investigated.

Analyses were performed for differences of device complexity, packaging, aging, quality level, logic type, use temperature, die-attach method, and glassivation.

Existing operational failure rate data sources were reviewed. Average operating to nonoperating failure rate ratios were calculated and range from 0.5 to 14.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4 Aging Analysis (Continued)

3.4.1 Determination of Age Sensitivity to Time/Temperature Effects (Electronic Components) (Continued)

3.4.1.1 Integrated Circuits (Continued)

High-temperature storage data included durations of 1,000 hours to 2 1/3 years.

Dormancy and cycling effects were investigated. One thousand (1,000) IC's had been tested for 18 months, with the following test profile:

Group	Profile
1	160 units, 2 days off, 1 hour on
2	160 units, 4 days off, 1 hour on
3	160 units, 7 days off, 1 hour on
4	160 units, 9 days off, 1 hour on
5	160 units, 12 days off, 1 hour on
6	200 units, control group, continuously operating

No failures were noted.

The conclusion of the report was that no significant trend was apparent from the data to indicate that the failure rate was not constant.

Another study (Reference 10) reports on the results of high-temperature operating life tests and high-temperature storage life tests. The results of these tests show that the constant failure rates of integrated circuits, even large-scale integrated (LSI) devices, are valid in excess of 40 years.

This report concerns the Signetics Field Programmable Read Only Memories (PROM's). A quantity of 653 PROM's amassed a total of 1.006×10^8 equivalent device hours (approximately 11,500 years) based upon an activation energy of 0.41 eV at 25°C, with zero failures. Of the 653, 47 had each been subjected to 370,000 equivalent device hours (approximately 42 years) at 25°C.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.7 Seismic Analysis (Continued)

3.7.3 Supportive Calculations and/or Conclusions (Continued)

3.7.3.4 The Effect of Flange Versus Bracket Mounting (Continued)

Level Transmitter Application

$$f_1 = \frac{\sqrt{\frac{K_v}{W}}}{2\pi}$$

where K_v = 1.547×10^5 lb/in.
g = 386.4 in./sec^2
W = 35

$f_1 = 1.60 \times 10^6 \times 386.4/24/2\pi$ = 807 Hz

Natural Frequency of Bracket Mount

Level Switch

$f_1 = \sqrt{Kg/W}/(2\pi)$

where K_v = 1.547×10^5 lb/in.
g = 386.4 in./sec^2
W = 35 lb

f_1 = 208 Hz

Level Transmitter

$f_1 = \sqrt{Kg/W}/(2\pi)$

where K_v = 1.547×10^5 lb/in.
g = 386.4 in./sec^2
W = 24 lb

f_1 = 251 Hz

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.7 Seismic Analysis (Continued)

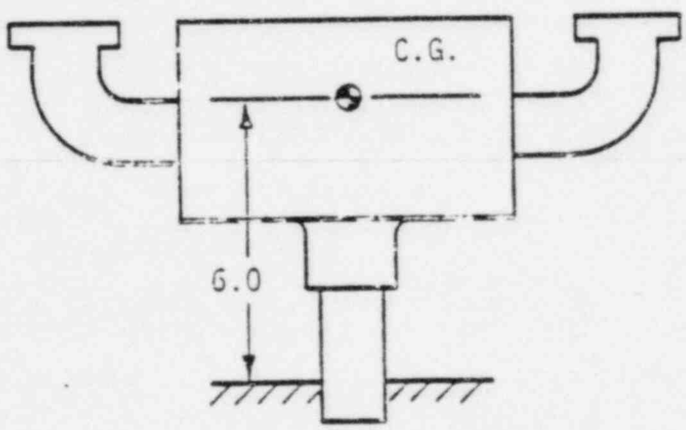
3.7.3 Supportive Calculations and/or Conclusions (Continued)

3.7.3.5 The Effect of a Single Versus a Double-Elbow Configuration of the J-Box

The worst case for the J-box is considered, i.e., the double-elbow configuration, as shown in Drawing B 57784.

Conservative weights and assumptions are used in the analysis.

Weight of J-box weldment	1.5 lb
Weight of silicone fluid	2.3 lb
Consider 5 ft of cable	20.0 lb
	23.8 lb



For 1 g horizontal load applied at C.G. of J-box

$M = 23.8 \times 6 = 142.8$ in.-lb

1.0 SCOPE

This document is prepared by Wyle Laboratories for Transamerica Delaval, Inc., Gems Sensors Division, hereinafter referred to as the equipment supplier, for its customer, Bechtel Power Corporation, Inc., hereinafter referred to as the A-E, for use in the Standardized Nuclear Unit Power Plant System (SNUPPS).

1.1 Objectives

The purpose of this Qualification Plan is to present the approach, methods, philosophies, and procedures for qualifying a Class IE Level Transmitter, Level Switch, and Modular Receiver Unit, assembled and/or manufactured by Transamerica Delaval, Inc., Gems Sensors Division, for use in Nuclear Power Generating Stations.

Nuclear environmental qualification of any safety-related device to meet the intent of IEEE 323-1974 is usually a three-step process, i.e., 1) radiation exposure; 2) aging; and 3) Design Basis Event Qualification (seismic, and for equipment inside containment, LOCA). The purpose of the first two steps is to put the sample equipment to be used for qualification into a condition that represents the worst state of deterioration that a plant operator will permit prior to taking corrective action, i.e., its end-of-qualified-life condition. The next step demonstrates that it still has adequate capability remaining to withstand the added environmental stresses of the specified design basis events and still perform its safety-related functions.

It is incumbent on the equipment supplier to assure that the components and materials contained in the equipment actually placed into service are the same as those qualified.

The specific details of the qualification are defined herein.

1.2 Applicable Qualification Standards, Specifications, and Documents

IEEE 323-1974, "IEEE Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations"

IEEE 344-1975, "IEEE Recommended Practices for Seismic Qualification of Class IE Equipment for Nuclear Generating Stations"

Bechtel Specification No. 10466-J-820(Q), Revision 1, dated May 27, 1975, "Technical Specification for Seismic Qualification Requirements for Class IE Control and Instrumentation Devices for the Standardized Nuclear Units Power Plant System (SNUPPS)"

Bechtel Specification No. 10466-J-830(Q), Revision 2, dated November 23, 1977, "Environmental Qualification Requirements for Safety-Related Control and Instrument Devices for the Standardized Nuclear Unit Power Plant System (SNUPPS)"

TRANSMITTERS TO BE QUALIFIED

Matrix Item No.	Model Type	Delaval Gems Part No.	Resistance Ohms		Approximate Dimensions			Weight
			per inch	Total	Inches of Indication	Float Travel	Overall Length	
	Bracket Mounted							
1.	XM-54852A	57734D	15	1335	90"	96-1/2"	108-1/2"	24 lbs.
9.	XM-54852	60077	15	975	66"	72-1/2"	79-1/2"	21 lbs.
	Transfer Bracket Mounted							
2.	XM-54853	57737E	10	650	66"	72-1/2"	84-1/2"	21 lbs.
10.	XM-54853	60076	15	1335	90"	96-1/2"	103-3/4"	24 lbs.
	Bracket and Flange Mounted							
3.	XM-54854A	57745E	10	650	66"	73-1/4"	85"	33 lbs.
4.	XM-54854A	57753E	43	1247	30"	37-1/4"	49"	28.5 lbs.
5.	XM-54854A	57755E	20	1300	66"	73-1/4"	85"	33 lbs.

1.0 SCOPE (CONTINUED)

1.4 Qualification Sequence

The qualification program will be performed in the following sequence:

- o Basline Functional Test
- o Radiation
- o Functional Test
- o Aging
- o Functional Test
- o Pressurization Test*
- o Functional Test*
- o Abnormal Operations
- o Functional Test
- o Seismic Qualification
- o Functional Tests
- o Accident Qualification (LOCA/MSLB)*
- o Functional Tests*
- o Post-Test Inspection

* Only the level transmitter will require these tests due to its plant location.

2.0 QUALIFICATION REQUIREMENTS

2.1 Definition of Service Conditions

As directed by Bechtel Power Corporation, the following margins, as specified in Paragraph 6.3.1.5, IEEE Standard 323-1974, will be added to the normal conditions.

o	Pressure:	+ 10% of gauge
o	Radiation:	+ 10% of accident dose
o	Cycle Requirements:	+ 10% of normal requirement

2.1.1 Normal Conditions

The following normal service conditions are as specified in Bechtel Specification No. 10466-J-830(Q):

Items 1,through 5, 9, and 10 - Level Transmitters

o	Temperature:	50°F to 150°F (120°F average)
o	Pressure:	± 2 psig
o	Relative Humidity:	0% to 100%
o	Gamma Radiation:	6 x 10^6 rads 40-year total integrated dose; 20 rads/hour maximum dose rate

Items 6 and 7 - Level Switches

o	Temperature:	60°F to 160°F (120°F average)
o	Pressure:	± 3 psig
o	Voltage:	11 ± 1 VDC (10 to 12 VDC)
o	Relative Humidity:	5% to 95%
o	Gamma Radiation:	2 x 10^6 rads 40-year total integrated dose; 4 rads/hour maximum dose rate

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4 Aging Analysis (Continued)

3.4.1 Determination of Age Sensitivity to Time/Temperature Effects (Electronic Components) (Continued)

3.4.1.1 Integrated Circuits (Continued)

Another report (Reference 11) describes reliability tests and field results. For the reliability tests, a quantity of 2,016 of Intel's 8080 Microcomputer (a microprocessor type of integrated circuit) amassed a total of 7.84 x 10^7 equivalent hours (approximatey 9,000 years) based upon an activation energy of 0.5 eV at 25°C, with three failures. Two of the failures occurred during a 48-hour burn-in at 125°C prior to life testing. The other failure occurred during the first 168 hours of life test at 125°C. Of the 2,016, 74 had each been subjected to 400,000 equivalent hours (approximately 46 years) at 25°C, with zero failures. From the field results, the total devices reported on was 100,000 devices which had accumulated 1.3 x 10^3 hours, with eight failures.

In addition, Intel reports on the Intel 2107A/2107B N-Channel Silicon Gate MOS 4K RAMS (Reference 12) reports on the results of high-temperature bias tests, dynamic burn-in tests, high-voltage cell stress tests, and system life tests, which consisted of dynamic life tests at 125°C, continuous life tests at 70°C, and rotating life tests at 70°C, while mounted in P.C. boards which were exercising the devices with selected data patterns. The number of 2107B units tested was 2,699. The equivalent cumulative test time at 25°C, using an activation energy of 0.3, is 5.7 x 10^7 hours, with five failures. The number of 2107A units tested was 1,827. The equivalent cumulative test time at 25°C, using an activation energy of 0.3, is 1.8 x 10^7 hours, with four failures.

Intel also reports on its Polysilicon Fuse Bipolar PROM's (Reference 13), which have undergone 85°C rotating system life tests, 85°C dynamic system life tests, 160°C high-temperature bias tests, and 125°C and 160°C dynamic life tests. The number of units tested as of August, 1975, was 12,576. The equivalent cumulative test time at 25°C, using an activation energy of 0.4, was 1.4 x 10^8 hours, with three failures. Of the 12,576 devices, 32 have each accumulated 3.95 x 10^5 hours (45 years), with no failures.

Integrated circuit manufacturers typically have reliability programs which continually assess the reliability of their products, both commercial as well as military. If they are supplying devices which meet military specifications, then they are required to be qualified to MIL-M-38510, "Military Specification for Microcircuits" (Reference 14). MIL-M-38510 is a rigorous program designed to assure high quality and reliability. To become qualified, a manufacturer must demonstrate that the device can withstand rigid mechanical (including variable frequency testing), environmental, and life tests. The life tests assure failure rate compliance.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4 Aging Analysis (Continued)

3.4.1 Determination of Age Sensitivity to Time/Temperature Effects (Electronic Components) (Continued)

3.4.1.1 Integrated Circuits (Continued)

MIL-HDBK-217C, Military Standardization Handbook, "Reliability Prediction of Electronic Equipment," dated April 9, 1979 (Reference 3), states in Paragraph 2.0.d, pp. 2-5, in the discussion on the part failure rate models used in MIL-HDBK-217C, "All the part models include both catastrophic and drift failures and are based upon a constant failure rate, except for some rotary devices that show an increasing failure rate." The part failure rate model for devices meeting MIL-M-38510 are given in MIL-HDBK-217C.

An example of integrated circuit manufacturer reliability programs which apply to commercial devices, i.e., not MIL-M-38510 qualified, is exemplified by Signetics' SURE II/883B Qualification Program (Reference 15). The Signetics SURE (Systematic and Uniform Reliability Evaluation) program has been in existence since 1963. Signetics states on page 2 of Reference 15, "The SURE program is designed to monitor the continuing uniformity of all Signetics products and to demonstrate via periodic qualifications that Signetics products meet or exceed the stringent long-term reliability requirements of their intended applications."

The Signetics product line includes TTL, Schottky, Low Power Schottky, IIL, ECL, NMOS, DMOS, and Linear Devices, packaged in plastic, ceramic, metal-can, and flat-pack devices. The qualification test results for the period 1975 through 1977 were reported by Signetics in August, 1978 (Reference 16). Signetics reports from Reference 16, "The results show that out of over 24,000 devices that were tested, less than 1% failed to meet the SURE II acceptance criteria at the conclusion of the accelerated stress tests. The devices that are used in the SURE II stress program are Signetics standard off-the-shelf products that have not received any special screening tests. As a result, these tests are indicative of the high quality and reliability of Signetics products."

Another typical program is the Texas Instruments SNC/MACH-IV 883 Class B Vendor Equivalent Program (Reference 17). The 1977 results of this program (Reference 18) for TTL devices are: A sample of 4,020 SSI/MSI integrated circuits accumulated 2.01 x 10^8 equivalent device hours based upon an activation energy of 0.4 eV at 25°C, with only 19 failures, for a 0.47 failure percentage.

Another report (Reference 9) describes a recently conducted program which compares accelerated aging tests and real-time aging performed on approximately 6,800 parts and subassemblies. The items in this study included integrated circuits, as well as transistors, diodes, capacitors (ceramic, mica, plastic, and tantalum), and resistors (carbon-composition, wire-wound, fusible,

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4 Aging Analysis (Continued)

3.4.1 Determination of Age Sensitivity to Time/Temperature Effects (Electronic Components) (Continued)

3.4.1.1 Integrated Circuits (Continued)

and metal/cermet.) Failure analyses were performed on failed devices. The failure analysis states, "All components which failed during accelerated and real-time aging were submitted to the failure analysis laboratory to identify the exact mechanism of failure. Twelve (12) failure modes occurred as a result of accelerated aging and, in all cases, the mechanisms were identical to those observed on samples which were subjected to real-time aging. Six of the mechanisms resulted from inadequate design. The remaining six were directly attributable to that small percent of anomalies which are manufactured into mass-produced electronic parts and are commonly classified under the broad category of poor workmanship."

The conclusion of this report states, "A statistically significant sample of Copperhead projectile components has been subjected to accelerated aging using the Arrhenius relationship to determine test duration. The 12 failure mechanisms from accelerated aging were also observed after real-time aging so the methodology employed did not overstress the devices. Corrective action consisting of redesign and improved process control resulted in elimination of 10 of the anomalies identified. Integrated circuit lead corrosion was judged not to be a problem at the printed circuit card level and the small degradation in plastic material ductility was not significant to the application."

3.4.1.2 Transistors

Transistors share the following reports, previously identified and discussed in the justification of age insensitivity for integrated circuits: References 3 and 19. In addition, the following are presented.

A General Electric report (Reference 20) reports on the experience obtained at the General Electric Semiconductor Products Department, Syracuse, New York. This paper reports on the results of long-term tests and several product line reliability monitoring tests on devices manufactured during 1967 and 1968. The report states, "Accelerated stresses have been utilized on a number of reliability improvement programs. The chief advantage of using these tests is that it is possible to determine, in a short period of time, the probability of successful application of electronic components in long-life systems. A review of the normal failure pattern expected for electronic components is shown in Figure 8 (not included). This pattern includes the early failure period of workmanship type failures, the useful life or constant failure rate period, and the wearout period,

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4 Aging Analysis (Continued)

3.4.1 Determination of Age Sensitivity to Time/Temperature Effects (Electronic Components) (Continued)

3.4.1.2 Transistors (Continued)

which has not been established for semiconductors. The assumption of constant failure rate during useful life is normally quite conservative since semiconductors under test and in most applications have demonstrated a decreasing failure rate."

In addition, the report contains the conclusion, based upon a Weibull plot of accelerated power stress, "As seen in the graph, a Beta of less than 1 was obtained, which demonstrated that these devices had a decreasing failure rate."

Another General Electric Report (Reference 21) discusses plastic-encapsulated signal and power transistors. The abstract is included: "Results from accelerated and long-term programs demonstrate the capability of both epoxy and silicone transistors to operate successfully under a wide range of environmental, electrical, and thermal stress as required in consumer, industrial, and military applications. The selection of the stresses used was based on demonstrating long-term resistance to moisture, stability on long-term operating life, and thermally matched assembly materials.

"Excellent performance is demonstrated for the monoplastic epoxy-encapsulated signal transistors after 12,000 cumulative hours of exposure to high levels of temperature/humidity at 85°C and 85% R.H. A very low failure rate for signal transistors was obtained on operating life for over 2 years duration. Results show the capability of these devices to withstand stresses such as 300 temperature cycles and hundreds of hours of exposure to salt atmosphere.

"Similarly, excellent performance was obtained for silicone-encapsulated power transistors on 10,000 hours of operating life, 100,000 cycles of power cycling, 2,000 cycles of temperature cycling, and 8,000 hours of humidity life at 85°C, 85% R.H.

"Reliability prediction models have been developed for signal transistors and for power transistors. The gain in reliability by derating power dissipation or operating junction temperature is shown quantitatively for both signal and power devices."

3.4.1.3 Diodes

Diodes share the following reports previously identified and discussed in the justification of age insensitivity for integrated circuits: References 3 and 19.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4 Aging Analysis (Continued)

3.4.1 Determination of Age Sensitivity to Time/Temperature Effects (Electronic Components) (Continued)

3.4.1.4 Resistors, Potentiometers

Carbon-composition, wire-wound, and film resistors share the following reports previously identified and discussed in the justification of age insensitivity for integrated circuits: References 3 and 19.

In addition, the following are presented:

CTS states, with reference to cermet resistors (Reference 22), "In 1 billion, 42 million element hours of extended load life testing, CTS resistors have exhibited an established failure rate of only 0.00047%/1,000 hours at a 95% confidence level."

TRW/IRC states, with reference to molded wire-wound resistors (Reference 23), that, based on unit hour accumulation over the past 17 years, BWH failure rate/1,000 hours is 0.0080%/10^3 hours. This is based upon 19.7 x 10^6 unit hours with zero failures.

"Failure rate documentation is per MIL-R-39017. This test consists of continuous sampling of product and placing on 70°C, 10,000-hour load life, preceded by a 24-hour burn-in at 1.5 times power.

"The documented failure rate on the RLR Metal Glaze product line is:

- o 0.0012%/1,000 hours at 60% confidence
- o 0.0030%1,000 hours at 90% confidence"

Bourns Trimpot Division states, with reference to wire-wound and nonwire-wound potentiometers (Reference 25), "Bourns does not design special parts for the military specifications. The standard catalog designs are used." Bourns Hi-Rel nonwire-wound potentiometers are qualified to failure rates from 1.0%/10^3 to 0.01%/10^3 hours.

3.4.1.5 Capacitors

Tantalum, ceramic, and mylar capacitors share the following reports previously identified and discussed in the justification of age insensitivity for integrated circuits: References 3 and 19.

In addition, Centralab (Reference 26) has tested ceramic capacitors for a total of 2.8 x 10^6 equivalent unit hours at 85°C with only two failures.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4 Aging Analysis (Continued)

3.4.2 Relative Humidity

Relative humidity is not considered an aging mechanism for the Level Switch and Receiver Module. For insulation systems, its effect is usually not the primary failure mechanism, as noted in Reference 27, with respect to motor insulations: "However, in most cases, moisture plays only a secondary role in the failure. It does not produce the damage in the insulation—the insulation wears away or cracks for other reasons. Moisture merely provides a direct electrical pathway between these matured devices and ground."

For hermetically sealed electronic devices, moisture is assumed to be of no consequence. The effects of moisture were included in References 15, 16, 20, and 21, Paragraphs 3.4.1.1 and 3.4.1.2, and did not change the conclusion of constant failure rates for the non-hermetic devices.

Therefore, the ability of the level switch and receiver module to perform within their relative humidity environment will be demonstrated during functional testing before and after aging when the safety-related characteristics are tested under the extreme service conditions (temperature, humidity, power supply, etc.).

The effect of relative humidity for equipment located inside containment and/or where specifications call for up to 100% relative humidity is not known. In order to attempt to account for possible effects, the ability of the level transmitter to perform within its relative humidity environment will be demonstrated during aging and again during the extreme service conditions (temperature, humidity, power supply, etc.).

3.4.3 Aging Analysis Summary

The Level Transmitter, Item 1.0, will be thermally aged for 1,089 hours at 115°C under saturated steam conditions.

The Level Switch, Item 7.0, will be thermally aged for 1,089 hours at 110°C with uncontrolled relative humidity.

The Receiver Module, Item 8.0, will be thermally aged for 2,965 hours at 110°C with uncontrolled relative humidity.

The aging durations and temperatures equate to an equivalent 40-year qualified life. The aging durations were determined by utilizing the lowest activation energy for the item, as defined in Table I. For the level transmitter and level switch, this was 0.94 eV for G-10 epoxy. For the receiver module, this was based on 0.8 eV, this being a value for several materials. The temperatures utilized were based on the highest temperature allowed by the materials..

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.4.3 Aging Analysis Summary (Continued)

3.4.3.1 Functional Test

The Functional Test of Paragraph 3.1 will be repeated.

3.5 Reactor Building Integrity Test

The Level Transmitter, Item 1.0, will be subjected to the following conditions:

- Temperature: Room ambient
- Pressure: 77 psig (a 10% conservatism margin has been added)
- Relative Humidity: Uncontrolled
- Duration: 3 minutes
- Cycles: 44 (a 10% conservatism margin has been added)

The temperature and relative humidity parameters of up to 120°F and 100% R.H., respectively, are assumed to be adequately accounted for in the LOCA/MSLB simulation. Therefore, the Reactor Building Integrity Test will be performed at room ambient temperatures and uncontrolled relative humidity. For purposes of this test, a cycle is defined as pressurizing the environmental chamber from 0 psig to 77 psig, holding for 3 minutes, and then bleeding off the pressure until 0 psig is reached.

Following completion of the Building Integrity Test, the test specimen will be subjected to a chemical spray, as defined in Paragraph 3.9, except with a pH of 4.0 for 5 minutes.

3.5.1 Functional Test

The Functional Test of Paragraph 3.1.2.2 will be repeated.

3.6 Abnormal Operations

The level switch and receiver module will be subjected to the following abnormal conditions.

3.6.1 Receiver Module

Eight (8) hours at 104°F (-0, +5), 95 ± 5% relative humidity, and eight (8) hours at 60°F (+0, -5) uncontrolled relative humidity. The input voltage will be 105.8 VAC (-5, +0) for the first 4 hours and 124.2 VAC (-0, +6) for the second 4 hours of each temperature extreme. The level transmitter will be electrically connected to the receiver module, but located in a room ambient environment. The input voltage to the receiver module and output current from the receiver module will be recorded at the beginning and end of each voltage extreme.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.6.3 Level Switch

The level switch will be subjected to the following conditions: Eight (8) hours at 160°F (-0, +5), 95 ± 5% relative humidity, and eight (8) hours at 60°F (+0, -5) uncontrolled relative humidity. The input voltage will be 10 VDC (-1, +0) for the first 4 hours and 12 VDC (-0, +1) for the second 4 hours of each temperature extreme. The current must not exceed 0.5 ampere resistive load. The input voltage and current will be recorded at the beginning and end of each voltage extreme.

3.6.4 Functional Test

The Functional Test of Paragraph 3.1 will be repeated.

3.7 Seismic Analysis

An analysis of the transmitter was performed to determine the following:

- o The possibility of seismically qualifying the transmitter by similarity to a previously tested unit and, if not, define a worst-case transmitter for testing.
- o The effect of a loss-of-coolant accident (LOCA) or Main Steam Line Break (MSLB) on the float clearance.
- o The effect of submerging the transmitter during the Seismic Test.
- o The effect of flange versus bracket mounting.
- o The effect of single- versus double-elbow configuration of the J-box.

An analysis of the level switch was performed to define the worst-case level switch for testing.

3.7.1 Summary of Results

The following results were obtained:

- o The Level Transmitter, Type XM-54852A, is the worst case, and the remaining units can be seismically qualified by testing this unit.
- o Proper float clearance is maintained during a LOCA/MSLB to allow free movement.
- o Seismically testing the level transmitter unsubmerged while accounting for the uniform mass of the displaced water is most conservative.
- o The bracket mount is the worst-case mounting method.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.7 Seismic Analysis (Continued)

3.7.1 Summary of Results (Continued)

- o The single-elbow configuration of the J-box may be used as the test item since the double-elbow configuration was shown to be rigid and does not influence the response of the stem assembly.
- o The Level Switch, Type LS-57763C, is the worst case, and the remaining unit can be seismically qualified by similarity.

3.7.2 Limitations

The analysis covers structural items only and does not include the qualification of electrical or control devices. The functional operation will be based on tests.

The results do not apply for structural changes or alterations not identified in this report.

3.7.3 Supportive Calculations and/or Conclusions

3.7.3 1 Definition of Transmitter Worst Case for Test Specimen Selection

A Transmitter XM-39496, was previously tested (ETL Report 5386, Reference 39), and was found to have no resonances below 33 Hz when the overall length is 89 inches or less. Transmitters with supportive lengths less than 89 inches, with stems identical to the tested unit, can be considered to have their lowest resonance above 33 Hz. These are as follow:

Item	Type	Gems Part Number
2.0	XM-54853	57737E
3.0	XM-54854A	57745E
4.0	XM-54854A	57753E
5.0	XM-54854A	57755E
9.0	XM-54852	60077

The remaining transmitters are as follow:

Item	Type	Gems Part Number
1.0	XM-54852A	57734D
10.0	XM-54853	60076

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.7 Seismic Analysis (Continued)

3.7.3 Supportive Calculations and/or Conclusions (Continued)

3.7.3.1 Definition of Transmitter Worst Case for Test Specimen Selection (Continued)

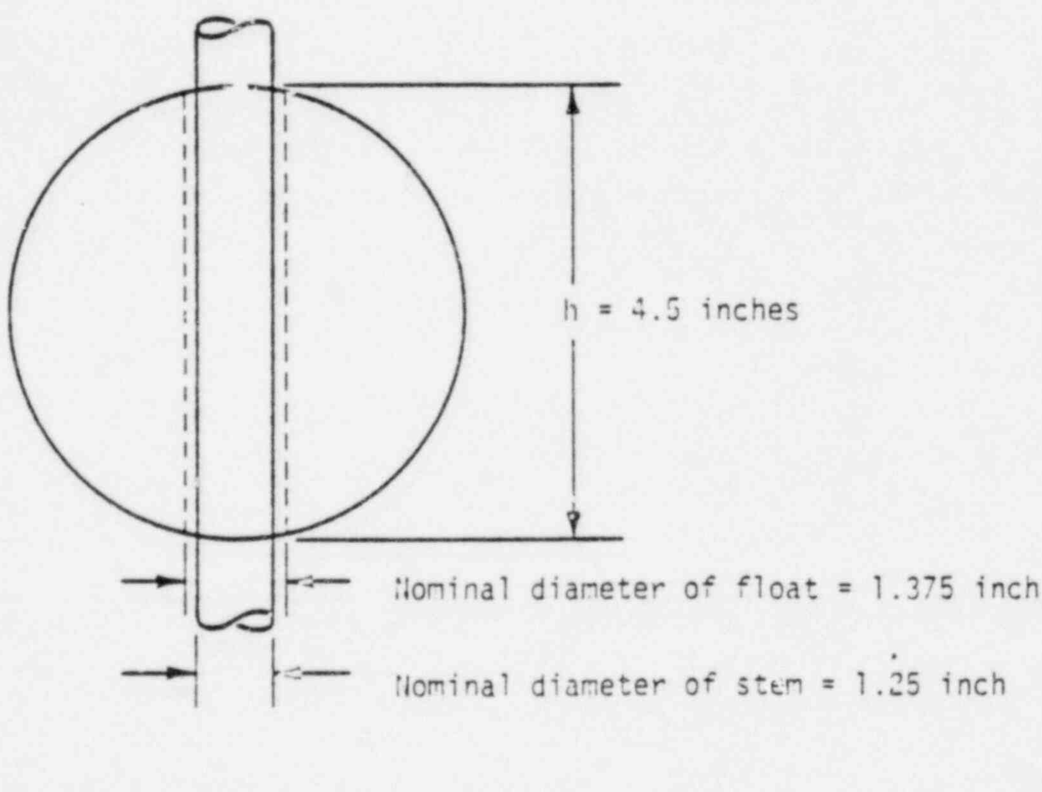
Item 1.0, Level Transmitter Type XM-54852A, has the longest overall length and highest mass. Therefore, it will have a lower natural frequency and higher response than the remaining transmitter and must be considered worst case. Item 10.0 can, therefore, be qualified by testing Item 1.0, Transmitter XM-54852A.

3.7.3.2 Effect of LOCA/MSLB on Float Clearance

These calculations consider the LOCA/MSLB conditions to determine if there is adequate clearance between the stem and float during this event. Since the temperature occurring during a postulated MSLB are more severe, it will be utilized.

1) Consider 381°F differential temperature.

2) Consider internal pressure of 60 psig.



3.0 QUALIFICATION PROGRAM (CONTINUED)

3.7 Seismic Analysis (Continued)

3.7.3 Supportive Calculations and/or Conclusions (Continued)

3.7.3.2 Effect of LOCA/MSLB on Float Clearance (Continued)

Condition 1-381 Degrees F

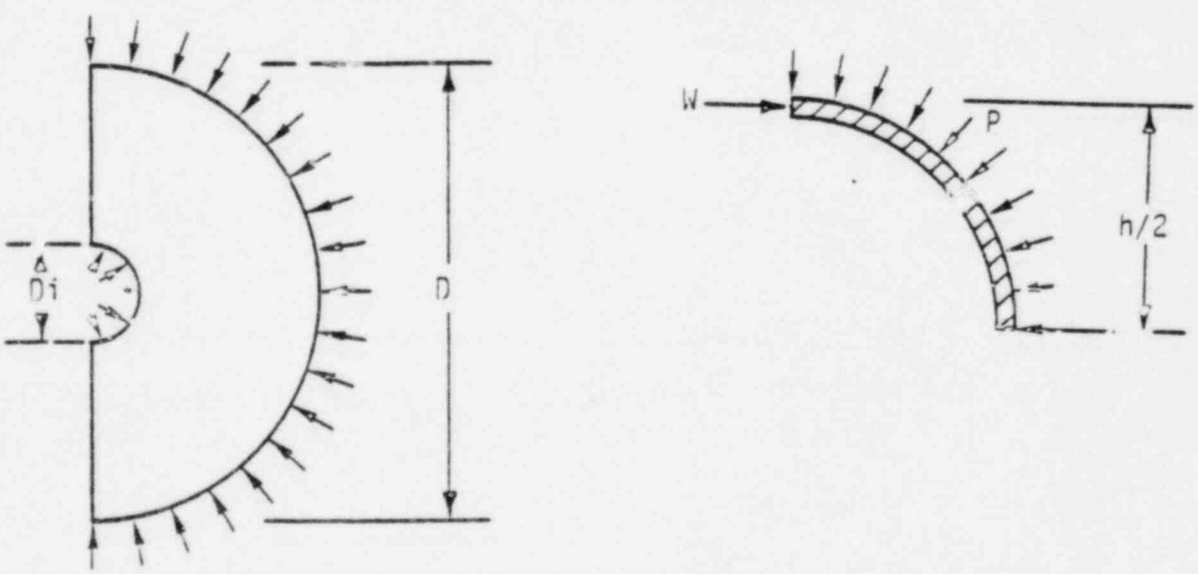
Consider an extreme condition where the stem is 381°F and the float is 0°F. Then the change in diameter (ΔD) of the stem becomes

$$\Delta D = \Delta T \alpha D$$

where,

ΔT	=	change in temperature in degrees F = 381°F
	=	coefficient of thermal expansion in inches/inch/°F = 9.2×10^{-6} for 316 or 304 stainless steel
D	=	diameter of stem = 1.25 inch
ΔD	=	$381 \times 9.2 \times 10^{-6} \times 1.25$
ΔD	=	.00438 inch

Condition 2 Internal Pressure of 60 psig



Uniform pressure of p=60 psig

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.7 Seismic Analysis (Continued)

3.7.3 Supportive Calculations and/or Conclusions (Continued)

3.7.3.2 Effect of LOCA/MSLB on Float Clearance (Continued)

One Four Section of Float

Effective horizontal area of 1/4 of float = $h/2 \times D_o$

where,

$h = 4.5$ inches

$D_o = 4.5$ inches

then,

$WD_i = h/2 \times D_o \times P$

$W = h/2\ D_o \times P/D_i$

$W = 4.5 \times 4.5 \times 60/(2 \times 1.375)$

$W = 443$ lb/inch

Where W is load imposed on the tube of the float due to external pressure on the shell.

Pressure Load

Consider load W reacted over 1/4" length of tube of float.

$D = \sigma D/E$

where,

$\sigma = Pr/t$

$t = .065$ inch

$P = 443/.25 = 1{,}772$ psi

$\sigma = 1{,}772 \times 1.37/2 \times .065 = 18{,}674$ psi

$\Delta D = 18{,}674 \times 1.37/29 \times 10^6$

$\Delta D = .0008$ inch

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.7 Seismic Analysis (Continued)

3.7.3 Supportive Calculations and/or Conclusions (Continued)

3.7.3.2 Effect of LOCA/MSLB on Float Clearance (Continued)

Total change in diameter due to LOCA or MSLB is:

$$\Delta D_{total} = \Delta D_{temperature} + \Delta D_{pressure} =$$

$$\Delta D_{total} = .00438 + .0008 \approx .0052 \text{ inch}$$

The total change in diameter due to a LOCA/MSLB worst-case condition is within design tolerance and float travel will not be affected. Therefore, during the LOCA/MSLB, the float travel does not require testing. The float will be fixed at the "1/2" position.

3.7.3.3 Definition of Submerged Versus Unsubmerged Test as Worst Case

A transmitter with a similar tube assembly was found to have a resonance of 33 Hz when the support distance was 89 inches. This finding, documented by Testing Laboratories, Inc., in their "Report of Seismic Test on XM-36490 Transmitter" was on an unsubmerged transmitter. The anticipated first mode frequency for an unsubmerged transmitter is approximated as follows:

$$f_1 = \sqrt{(L_1/L_2)^3} \times 33$$

where,

L_1 = 89

L_2 = 96.875

then,

$$f_1 = \sqrt{(89/96.875)^3} \times 33 = 29 \text{ Hz}$$

Conservatively consider a virtual mass of water equal to the water displaced by tube.

For 1 1/4-inch diameter tube, weight of water per unit length (W_w).

$$W_w = \frac{\pi D^2 \gamma}{4}$$

where γ = 0.0361 lb/in.^{3}

W_w = .0443 lb/in.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.7 Seismic Analysis (Continued)

3.7.3 Supportive Calculations and/or Conclusions (Continued)

3.7.3.3 Definition of Submerged Versus Unsubmerged Test as Worst-Case (Continued)

Weight of tube W_T = .117 lb/in.

Total Weight = W

$W = W_T + W_W$

$W = .117 + .0443 = .1613$ lb/in.

If the proposed test specimen is tested under water, the first mode frequency would be approximately

$$f_1 = \sqrt{W_T/W} \times 29$$

where W = total effective mass, i.e., weight of tube assembly plus virtual mass of water.

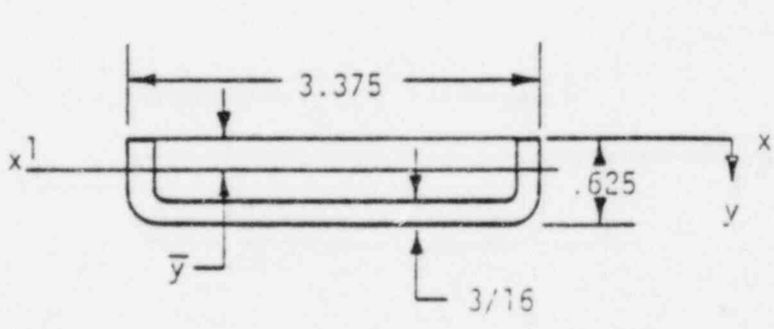
Then $f_1 = \sqrt{.117/.1613} \times 29 = 25$ Hz

Since the required response spectrum shows a higher response at 25 Hz than at 29 Hz, and to take into account the effective mass of the surrounding water, it is recommended that a uniform mass equal to the weight of the water displaced by the tube be added to the test unit. The uniform mass of 0.0443 pounds per inch conservatively simulates the effective weight of the water and should be used on both the transmitter and level switch which are to be tested simulating worst case for either submerged or unsubmerged conditions.

3.7.3.4 The Effect of Flange Versus Bracket Mounting

The vertical stiffness of the bracket mounting is compared with the vertical stiffness of the flange mounting.

Bracket Stiffness



3.0 QUALIFICATION PROGRAM (CONTINUED)

3.7 Seismic Analysis (Continued)

3.7.3 Supportive Calculations and/or Conclusions (Continued)

3.7.3.4 The Effect of Flange Versus Bracket Mounting (Continued)

Bracket Stiffness (Continued)

$A = 3.375 \times .625 - 3.00 \times .4375 = .797 \text{ in}^2$

$\overline{y} = (3.375 \times (.625)^2 - 3.00 \times (.4375)^2)/(2 \times .797) = .467$

$I_{xx} - (3.375 \times (.625)^3 - 3.00 (.4375)^3 - 3 \times .797 \times (.467)^2)/3$

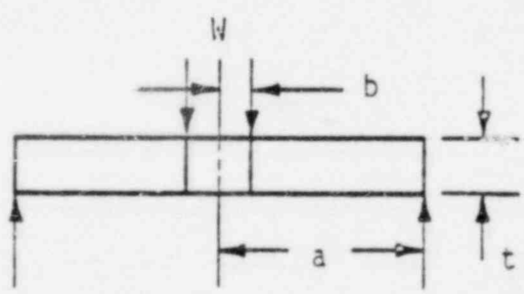
$I_{xx} = .0171 \text{ in.}^4$ (.1098)

Vertical Stiffness for bracket (K_V)

$K_V = 12 \; EI/L^3 =$

$K_V = 12 \times 29 \times 10^6 \times .0171/(3.375)^3 = 1.547 \times 10^5$ lb/in.
(9.9394×10^5)

Flange Stiffness



a = 4.75
b = .625
t = .9375

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.7 Seismic Analysis (Continued)

3.7.3 Supportive Calculations and/or Conclusions (Continued)

3.7.3.4 The Effect of Flange Versus Bracket Mounting (Continued)

Flange Stiffness (Continued)

Case 14, R. J. Roark, "Formulas for Stress and Strain," 3rd Edition, p. 198

For W = 1

$$= \frac{3(m^2-1)}{4\ Em^2t^3}\left[\frac{(a^2-b^2)(3m+1)}{(m+1)} + \frac{(4a^2b^2)(m+1)}{(m-1)(a^2-b^2)} \quad (\log_e \frac{a}{b})^2\right]$$

where,

m	=	reciprocal of poissons ratio = 1/v = 1/0.3 = 3.33
m^2	=	$(1/.3)^2 = 11.11$
$(\log_e a/b)^2$	=	$(\log_e 4.75/.625)^2 = (2.0281)^2 = 4.113$
a^2	=	$(4.75)^2 = 22.56$
b^2	=	$(.625)^2 = .3906$
t^3	=	$(.9375)^3 = .8240$
Δ	=	6.236×10^{-7}
K_v	=	$1/\Delta = 1/6.236 \times 10^{-7} = 1.60 \times 10^6$

Natural Frequency

Where the estimated weight of the level transmitter is 24 pounds and the estimated weight of the level switch 35 pounds, the natural frequency of the flange mount is as follows:

Level Switch Application:

$f_1 = \sqrt{Kg/W}/(2\pi)$

where $K_v = 1.60 \times 10^6$ lb/in.
$g = 386.4$ in./sec^2
$W = 35$ lb

$f_1 = \ = 669$ Hz

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.7 Seismic Analysis (Continued)

3.7.3 Supportive Calculations and/or Conclusions (Continued)

3.7.3.5 The Effect of a Single Versus a Double-Elbow Configuration of the J-Box (Continued)

For 1" Schedule 10S

Section Modulus (S) = .1150

Bending Stress f_b

$f_b = 142.8/.1150 = 1{,}242$ psi

For 302 or 304 Stainless Steel

use 0.9 yield strength

0.9 x 30,000 = 27,000 psi

Then allowable horizontal acceleration (g_H) becomes

$g_H = 27{,}000/1{,}242 = 21.73$

Natural Frequency

Conservatively consider 6 inches effective length of 1 inch Schedule 10 pipe.

Then bending stiffness (K) becomes

$K = 3EI/L^3$

For I = 0.0765

$K = 3 \times 29 \times 10^6 \times 0.0765/(6)^3 =$

$K = 3.08 \times 10^4$ lb/in.

$f_1 = \sqrt{Kg/W}/(2\pi)$

$f_1 = \sqrt{3.08 \times 10^4 \times 386.4/23.8}/(2\pi) = 112$ Hz

Since the natural frequency is above 33 Hz, the J-box may be treated as a rigid body with no amplification transmitted to the stem assembly. This allows the J-box to be qualified by static analysis. It then becomes necessary to test a stem assembly for structural integrity and functional operation. Therefore, a J-box with a single elbow maybe used for the test unit for seismic qualification.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.7 Seismic Analysis (Continued)

3.7.3 Supportive Calculations and/or Conclusions (Continued)

3.7.3.6 Definition of Worst-Case Level Switch for Test Specimen Selection

Level Switches LS-57761C and LS-57763C are structurally similar and have identical components. The LS-57763C differs from the LS-57761C only in the number of floats. The LS-57763C, with two (2) floats, has a larger mass and would, therefore, be a worst case for seismic testing. LS-57761C can, therefore, be qualified by testing LS-57763C.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.8 Design Basis Events

3.8.1 Seismic

3.8.1.1 Mounting

3.8.1.1.1 Test Item Mounting and Orientation

A Level Transmitter (Type XM-54852A), 108 1/2 inches high x 4 1/2 inches in diameter; a Level Switch (Type LS-57763C), 55 inches high x 4 1/2 inches in diameter; and a Modular Receiver (Type 36562), approximately 5 inches wide x 9 1/2 inches deep x 9 1/4 inches high, hereinafter called the test items, will be attached to Wyle-fabricated test fixtures, as shown in Figure 3. The test items will then be placed on the Wyle Multiaxis Seismic Simulator Table such that the bases of the fixtures will be flush with the top of the test table. The test items will be initially oriented with one horizontal axis colinear with the longitudinal axis of the table. For the second orientation, the test items will be rotated 90 degrees in the horizontal plane. The fixtures will be welded to the test table in each orientation. The mounting of the test items will simulate their in-service mounting configurations as closely as practical. The effect of the uniform mass of the displaced water on a submerged level transmitter or level switch must be accounted for. A uniform mass of 0.0443 pounds/inch will be added to the unsubmerged level transmitter and level switch to simulate the effect of the displaced water.

3.8.1.2 Excitation

3.8.1.2.1 Simultaneous Biaxial Excitation

Each horizontal axis will be excited separately, but each one will be excited simultaneously with the vertical axis (longitudinal simultaneously with vertical, then lateral simultaneously with vertical).

3.8.1.2.2 Resonance Search

A low-level (approximately 0.2 g) biaxial sine sweep from 1 to 40 Hz will be performed in each test orientation to determine major resonances. The sweep rate will be 2 octaves per minute. Transmissibility plots from the resonance search tests will be included in the test report.

3.8.1.2.3 Random Multifrequency Tests

The test items will be subjected to 30-second duration biaxial multifrequency random motion which will be amplitude controlled in 1/3-octave bandwidths spaced 1/3 octave apart over the frequency range of 1 to 40 Hz. Two (2) simultaneous, but independent, random signals will be used as the excitation to

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.8 Design Basis Events (Continued)

3.8.1 Seismic (Continued)

3.8.1.2 Excitation (Continued)

3.8.1.2.3 Random Multifrequency Tests (Continued)

produce phase-incoherent horizontal and vertical motions. The amplitude of each 1/3-octave bandwidth will be independently adjusted in each axis until the Test Response Spectra (TRS) envelop the Required Response Spectra (RRS). The resulting table motion will be analyzed by a response spectrum analyzer at 5% damping and plotted at 1/3-octave intervals over the frequency range of 1 to 250 Hz.

Five (5) Operating Basis Earthquake (OBE) tests, followed by one (1) Safe Shutdown Earthquake (SSE) test, will be performed in both the front-to-back/vertical and the side-to-side/vertical orientations. The SSE RRS is shown in Figure 4. The OBE RRS will be one-half the SSE RRS. It should be noted that the SSE RRS exceeds the test machine limitations at the 1/3-octave frequencies below 5 Hz (see Figure 5). The SSE tests shall be performed to the machine limitations at those frequencies.

3.8.1.2.4 Sine Beat Tests - Optional

In lieu of the random multifrequency tests described in Paragraph 3.8.1.2.3, the test items may be subjected to biaxial sine beat tests at each 1/3 frequency from 1 to 33 Hz. The sine beat tests would consist of 10 oscillations per beat, 5 beats per test frequency, with a 2-second pause between beats. The input acceleration would be as shown in Figure 6. The sine beat tests would be performed both in phase and out of phase.

3.8.1.3 Instrumentation

3.8.1.3.1 Excitation Control

Horizontal and vertical control accelerometers will be mounted on the table at a location near the base of the test items.

3.8.1.3.2 Specimen Response

Six (6) uniaxial piezo-electric accelerometers will be mounted on the test items to monitor response to the seismic excitation. Placement of these accelerometers will be as directed by the Transamerica Delaval, Inc., Technical Representative or the Wyle Project Engineer. FM tape and oscillograph recorders will provide a record of each accelerometer's response. TRS plots from the SSE tests will be included in the test report.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.8 Design Basis Events (Continued)

3.8.1 Seismic (Continued)

3.8.1.3 Instrumentation (Continued)

3.8.1.3.3 Electrical Powering

Electrical power of 115 VAC (± 5%), 60 Hz., single-phase, and 11 VDC (± 1), 0.5 ampere resistive load, maximum, will be provided for operation of the test item during the Seismic Test Program.

3.8.1.3.4 Electrical Monitoring

One (1) channel of electrical monitoring will be recorded on an oscillograph recorder to monitor the electrical operation of the test items. This channel will be used to monitor the 4-20 milliampere output of the receiver.

3.8.1.4 Functional Tests

The Baseline Functional Tests of Paragraphs 3.1.2.2 and 3.1.2.3 will be repeated.

3.9 Accident (LOCA/MSLB)

The level transmitter will be subjected for a period of 30 days to the LOCA/MSLB accident conditions of Figure 6 on a best-effort basis. The 1-year accident duration has been shortened to 30 days by increasing the temperature. The requirement of 125°F from the second day to 1 year is equivalent to 30 days at 173°F, using Arrhenius theory and an activation energy of 0.94. The composition of the chemical spray is as follows:

- Boric Acid (.28 molar)
- Sodium Thiosulfate (.064 molar)
- Sodium Hydroxide (as required to make a pH of 11.0 maximum for the first 2 hours of the test and 8.5 to 9.0 thereafter)

The chemical spray will be sprayed vertically downward at a rate of 0.15 (gal/min)/ft^2 of area of the test chamber projected onto a horizontal plane. Spray initiation will begin 120 seconds into the second ramp and continue for the duration of the test.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.9 Accident (LOCA/MSLB) (Continued)

3.9.1 Test Item Mounting and Orientation

A Level Transmitter (Type XM-54852A) shall be attached to a Wyle-fabricated test fixture, utilizing mounting hardware supplied by the equipment supplier. The transmitter shall be inserted into a Wyle LOCA chamber. Penetrations will be utilized along the LOCA chamber wall to allow for passage of the Transamerica Delaval-supplied cable to the test specimen. The wiring shall be such that the flex conduit end will be exposed to the LOCA conditions. All penetrations shall be potted with Scotchcast 9 epoxy. The transmitter float position shall be fixed throughout the duration of the LOCA Test at the "1/2" position. The Level Transmitter shall be electrically connected to the Receiver (Type RE-36562) during the test. The Receiver shall be at room ambient conditions.

3.9.2 Instrumentation

The chamber pressure shall be measured with a pressure transducer in combination with a pressure gauge. The temperature of the chamber shall be measured through the use of three (3) thermocouples connected in parallel located inside the LOCA chamber. The thermocouples will be positioned along the centerline of the chamber in such a way as to be within 2 inches of the test specimen. Paralleling means taking an average of three (3) thermocouples so that a single chamber temperature can be utilized for recording purposes. The pH of the chemical spray will be recorded prior to each ramp and on a daily basis thereafter. The flow rate of the chemical spray will be recorded daily from a flow meter. The chamber temperature and pressure will be recorded on a datalogger at 30-minute inte[illegible]xcept during ramps, when it will be operated at its peak rate. The ch[illegible] temperature will be continuously recorded utilizing a pen chart recorder.

3.9.3 Electrical Powering

Electrical power of 115 VAC (± 5%), 60 Hz, will be provided for operation of the receiver module. The receiver module will be electrically connected to the level transmitter for the duration of the test.

3.0 QUALIFICATION PROGRAM (CONTINUED)

3.9.3 Functional Test

The Functional Test of Paragraph 3.1.2.2 will be repeated.

3.10 Post-Test Inspection

Upon completion of the qualification program, the equipment will be visually inspected. The equipment will be disassembled to the extent necessary to perform the inspection. The condition of the equipment will be recorded.

3.11 In-Process Inspection

The records shall be checked for quality of performance after each test.

The test items shall be examined for possible damage following all severe tests, such as at structural resonance. All important test effects shall be logged.

Photographs shall be taken of any noticeable physical damage that may occur.

All instrumentation to be used in the performance of this test program will be calibrated in accordance with Wyle Laboratories' Quality Assurance Policies and Procedures Manual, which conforms to the applicable portions of ANSI N-45.2, 10 CFR 50 Appendix B, and Military Specification MIL-C-45662A. Standards used in performing all calibrations are traceable to the National Bureau of Standards.

4.0 REFERENCES

The references which form the basis for development and/or conclusion of sections of this document are provided.

1) NEMA Pub. L15-1969, "Temperature Indices of Industrial Thermosetting Laminates," March 19, 1969, Library Code 001-78

2) "DuPont Arrhenius Curves of Zytel 101," U.L. File Number 41938, Library Code 032-78

3) MIL-HDBK-217C, Military Standardization Handbook, "Reliability Prediction of Electronic Equipment," dated April 9, 1979, Library Code 228-79

4) Elements of Polymer Degradation, Leo Reich, et. al., McGraw-Hill Book Company, New York, 1971, Library Code 256-80

5) IEEE 101-1972, "IEEE Guide for the Statistical Analysis of Thermal Life Test Data," Library Code 265-80

6) Handbook of Engineering Fundamentals, Wiley, 1975, Library Code 247-80

7) Probability and Statistics for Engineers, I. Miller and John E. Freund, Prentice-Hall, Inc., 1965, Library Code 248-80

8) "Application of Mathematics and Statistics to Reliability and Life Studies," Reliability Handbook, O. B. Moan, McGraw-Hill, 1966, Library Code 266-80

9) Storage Reliability of Missile Material Program, Monolithic, Bipolar, SSI/MSI Digital Integrated Circuit Analysis, LC-76, ICI, Raytheon Company, 1976, Library Code 267-80

10) Generic Reliability Data for Signetics PROM's, February, 1976, Signetics Corporation, Library Code 268-80

11) Reliability Report on 8080/8080A Microcomputer, Intel No. RR-10, March, 1976, Library Code 249-80

12) Intel Reliability Report on 2107A/2107B N-Channel Silicon Gate MOS 4K RAMS, No. RR7, September, 1975, Library Code 250-80

13) Intel Reliability Report on Polysilicon Fuse Bipolar PROM's, Intel Report No. RR8, October, 1975, Library Code 258-80

14) "Military Specification for Microcircuits," MIL-M-38510A, July 3, 1972, Library Code 257-80

4.0 REFERENCES (CONTINUED)

15) Signetics SURE II 1978 Schedule, Signetics Corporation Report No. R676, dated May, 1978, Library Code 259-80

16) "Signetics SURE II Qualification Test Results", Signetics Corporation Report No. R-692, August, 1978, Library Code 260-80

17) "High Reliability Linear Integrated Circuits from Texas Instruments", Texas Instruments Bulletin CL425, 1979, Library Code 262-80

18) "Quality Conformance Inspection Summary, Texas Instruments, Inc., TTL Integrated Circuits SNC/MACH IV-SNJ Programs," Texas Instruments, 1977, Library Code 261-80

19) "Accelerated Versus Real Time Aging Tests," E. W. Kimball, 1980 Proceedings, Annual Reliability and Maintainability Symposium, 1980, Library Code 263-80

20) "Reliability of Epoxy Transistors," Erwin A. Herr and Albert Fox, General Electric Company Report No. 95.41, dated March, 1969, Library Code 264-80

21) "Plastic Encapsulated Signal and Power Transistor Reliability," Erwin A. Herr, et. al., General Electric Report No. 95.45, Presented at the 1973 Annual IEEE Chicago Fall Conference, Library Code 244-80

22) "Cermet Resistor Networks," Catalog 3755A, CTS Corporation, Library Code 251-80

23) TRW/IRC BSH Molded Wire-Wound Resistor Reliability Data, April 9, 1979, Library Code 253-80

24) "TRW/IRC Resistors," Handbook 770, 1977, Library Code 254-80

25) "Trimmers," Catalog No. TR-1, Bourns Trimpot Division, 1979, Library Code 252-80

26) Centralab's Estimated Failure Rate for Ultra Kaps, Centralab Letter, October 12, 1979, Library Code 246-80

27) Industrial Motor Users' Handbook of Insulation for Rewinds, L. J. Rejda and Kris Neville, Elsevier, 1977, Library Code 255-80

28) "How Radiation Affects Engineering Materials," R. E. Bowman, Library Code 155-78

4.0 REFERENCES (CONTINUED)

29) General Electric Company Wire and Cord Life Test Data, Library Code 185-79

30) "Raychem Corporation WCSF Thermal Aging Data," EDR-2001, Library Code 360-80, and "Raychem Engineering Data on WCSF," Raychem Corporation Final Report F-C4033-3, Library Code 328-80

31) "Loctite Product Data Sheets 49 through 92, Letter Grades and JILS," Loctite Corporation, April 1979, and Loctite Radiation Test Data, Library Code 303-80

32) International Journal of Polymeric Materials, Volume 2, No. 1, October, 1972, p. 181, Library Code 040-78

33) G. E. General Purpose Phenolic Data Letter, dated October 1, 1980, Library Code 359-80

34) "Circuit Protection devices/Relays/Switches/Flashers," Littelfuse Catalog 19, Library Code 245-80

35) "Degradation of Polymers," Comprehensive Chemical Kinetics, C. H. Bamford and C. F. M. Tipper, Vol. 14, Library Codes 021-78 and 022-78

36) "Information About Silicone Fluids; Dow Corning 710 Fluid," Dow Corning (Form No. 22-281a-76), Library Code 241-79

37) MIL-W-16878, "Wire, Electrical, Insulated, High-Temperature", Library Code 218-79

38) U.L. Life Data on Noryl, Library Code 274-80

39) "Report of Seismic Test on XM-36490 Transmitter," Testing Laboratories, Inc., January 29, 1974, ETL Report No. 5386, TIISO 701-403A (Subsidiary of Telecomunications Industries, Inc.)

40) Thermal Degradation of Organic Polymers, Samuel L. Madorsky, Interscience Publishers (John Wiley and Sons), p. 252, Library Codes 063-78 and 079-78 through 086-78

41) Belden Wire, Life Data on Polyurethane, Library Code 225-79

42) Franklin Institute Test Report #F-C3834, March, 1974, (Raychem Specification 44/0111-22 General Purpose Hook-Up Wire), Library Code 314-80

43) "Thermal Degradation of Polymers at High Temperature," Samuel L. Madorsky and Sidney Straus, Journal of Research of the National Bureau of Standards, Library Codes 086-78, 134-78, and 153-78

4.0 REFERENCES (CONTINUED)

44) "Radiation Effects on Microelectronic Components and Circuits," L. W. Ricketts, Solid State Electronics, April, 1972, pp. 50-55, Library Code 236-79

45) General Electric Company, "Engineering Properties of Lexan (and Aging Properties of Lexan)," Library Code 149-78

46) Arrhenius Plots of Beldsol (U.L.), Belden Wire Company, Library Code 225-79

47) "78XX Reliability Data," Fairchild Industries, (Letter to David Johnson, June 12, 1980, from Doris Weber, Fairchild Reliability Supervisor, LIC Division, and Contact Report by F. Hancock from Sheenu and Shah, Fairchild)

48) "Life Test Data on Diallyl Phthalate," John Jessup, FMC, Princeton, New Jersey, Library Code 243-80

49) "Heat Resistance of Epon Resin Systems," Shell Development Company, Houston, Texas, Technical Abstract T-9, September 1, 1976, Library Code 162-78

50) International Journal of Polymeric Materials, Volume 2, No. 1, October, 1972, p. 181, Library Code 042-78

51) DuPont, U.L. File No. E-66288, Library Code 163-78

52) Haveg Test Report No. LWR-2093, Revision D, March 14, 1979, Library Code 366-80

53) "The Effect of Nuclear Radiation on Elastomeric and Plastic Materials," Battelle Radiation Effects Center, REIC Report No. 21, September 1, 1961, R. W. King, et. al., Library Code 286-80

54) General Electric Advertisement, January, 1978, Issue of Insulation Circuits, Library Code 031-78

55) Sprague Failure Rate Curves on Various Series Capacitors, dated November, 1978, Library Code 273-80

56) "What Happens to Semiconductors in a Nuclear Environment?", David K. Myers, Library Code 227-79

57) "Radiation Information on Noryl," General Electric Company, Noryl Division, Library Code 319-80

4.0 REFERENCES (CONTINUED)

58) "The Effects of Radiation on Electrical Insulating Materials," REIC Report No. 46, Library Code 299-80

59) "Wire and Cable Insulation," Raychem Specification No. 44, H50142, April, 1977, Library Code 341-80

60) "The Effect of Nuclear Radiation on Capacitors, Electrolytic Capacitors (Tantalum and Aluminum)," Extracted from Radiation Effects Information Center Report No. 15, dated February 15, 1961, Battelle Memorial Institute, Library Code 301-80

Item No.	TABLE I. AGING MATRIX Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms NAS = . Age Sensitive Time/Temperature	Radiation	Qualified Life Goal
.0	323 Transmitter, P/N XM-54852, Revision A, Bottoming Type, J-Box Output, Bracket-Mounted Part List 57734, Rev. C, Transmitter, Radiation, Type XM-54852	Indication =90" ohms/inch = 15 Total resistance = 1,335 ohms							40 years
.1	Stem Assembly, P/N 43510, 'A' Dim. = 97 1/4"			Stainless Steel		Mechanical	NAS-Metal		
.1.1	Stem Assembly, P/N 43511 Length = 97 1/8"			"		"	"		
.1.2	Tubing, Basic, P/N 26696			"		"	"		
.1.3	Bracket, P/N 35750			"		"	"		
.1.4	Adapter, P/N 43512			"		"	"		
.1.5	End Plug, P/N 26693			"		"	"		
.2	Float Assembly, P/N 35560								
.2.1	Hemisphere, P/N 35561			"		"	"		
.2.1.1	Hemisphere, P/N 17826			"		"	"		
.2.2	Tube, Center, P/N 35562			"		"	"		
.2.2.1	Tubing, Basic, P/N 35564			"		"	"		
.2.3	Ring, Magnet, P/N 35563			Aluminum		"	"		
.2.4	Magnet, P/N 14395			Alnico V		"	"		
.2.5	Eyelet, P/N 30223			Brass		"	"		

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
1.3	Switch Assembly, P/N 59141			Various, as follows:		Electronic Component			40 Yrs.
1.3.1	P.C. Board, 97 1/2", /N 26082	130°C (U.L.)		G10 Epoxy/ Glass	0.94 (Ref 1)	"		2.5×10^9 (Ref 53)	
1.3.2	Resistor (Qty: 89), P/N 32971C, 15 Ohms, 1/4W (TD-35337)	150°C Storage		TRW/IRC RG-1/4 (Meets MIL-R-10509)		"	NAS (Ref 3 & 24)	1×10^9 (Ref 28)	
1.3.3	Ductorseal, P/N 58954, Douglas Engineering #7759	121°C Operation 177°C intermittent				"			
1.3.3.1	Wire, #18, P/N 46825 Haveg #721816, Legend 2	150°C (U.L.)		EXAR-500 Cross-Linked Polymer (Polyole...)	1.09 (Ref 29)	"		2×10^7 (Ref 52)	
1.3.3.2	Potting Compound	205°C		Epoxy (A...me Epon 828)	1.09 (Ref 49)	Insulation		9.5×10^8 (Ref 28)	
1.3.4	Resistor (Qty: 3), p/N 32981 330 Ohms, 1/4W (TD-35337)	150°C Storage		TRW/IRC RG-1/4 (Meets MIL-R-10509)		Electronic Component	NAS (Ref 3 & 24)	"	
1.3.5	Switch (Qty: 92), P/N 28425 Gorcos MR 708-2	-55°C to 125°C 10 million cycles at 1A		Glass, Rhodium-Plated Contacts		"	NAS-Metal, Glass		
1.3.6	Jumper Wire, #24, P/N 41721 Yellow, Raychem Spec. 44/0111-24	150°C		Polyalkene Kynar Coated	2.08 (Kynar) (Ref 43)	"		Useful to 5×10^8 (Ref 59)	
1.3.7	O-Ring, 2-016, P/N 59159	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/Temperature	Aging Mechanisms Radiation	Qualified Life Goal
1.3.8	Wire, 22AWG, P/N 41719, Red, Black, and White, Raychem Spec. 44/0111-22	150°C		Polyalkene Kynar Coated	2.08 (Kynar) (Ref 43)	Insulation		Useful to 5 x [illegible] (Ref 59)	
1.4	J-Box Weldment, P/N 57688			Stainless Steel		Mechanical	NAS-Metal		
1.4.1	J-Box (Rework), P/N 54843			"		"	"		
1.4.1.1	J-Box (Basic), P/N 29884			"		"	"		
1.4.2	Adapter, P/N 57689			"		"	"		
1.4.3	Elbow (Rework), P/N 57691			"		"	"		
1.4.3.1	Elbow (Basic), P/N 57690			"		"	"		
1.4.4	Adapter, P/N 29888			"			"		
1.4.5	Ground Lug, P/N 57758			"		"	"		
1.5	Retaining Ring, P/N 58959			"		"	"		
1.6	Adapter Assembly, P/N 39558			"		"	"		
1.6.1	Adapter, P/N 36764			"		"	"		
1.6.2	Conduit Connector, P/N 39557			"		"	"		
1.7	Nut, Hex, P/N 17308			"		"	"		
1.8	Nameplate, P/N 27337			"		"	"		
1.9	Lockwire, P/N 12009			"		"	"		
1.10	Shock, Tubing, P/N 26543	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	"	"	2×10^6 (Ref 53)	

Item No.	TABLE I. AGING MATRIX (CONTINUED) Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/Temperature	Aging Mechanisms Radiation	Qualified Life Goal
1.11	Butt Connector, P/N 51716	175°C						2×10^7 (Ref 28)	
1.11.1	Barrel			Tin-Plated Copper		Connection	NAS-Metal		
1.11.2	Insulation			Polyvinyl Chloride	1.39 (Ref 50)	Insulation		2×10^7 (Ref 28)	
1.12	Bracket, P/N 57681			Stainless Steel		Mechanical	NAS-Metal		
1.13	Silicone Fluid, P/N 58956	260°C		Dow #710	1.82 (Ref.35)	"		2×10^8 (Ref 36)	
1.14	Loctite, P/N 40049, Pipe Sealant HVV Cat. #71	149°C		Methacrylate	2.09 (Ref 31)	"		2×10^8 (Ref 31)	
1.15	O-Ring, #3-916, P/N 39157	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	"		2×10^6 (Ref 53)	
1.16	Screw, Hex-Head Cap, P/N 32309			Stainless Steel		"	NAS-Metal		
1.17	Flat Washer, P/N 32313			"			"		
1.18	Locknut, Hex, P/N 57686			"		"	"		
1.19	Shrinkable Tubing, P/N 58957	150°C Intermittent; 90°C continuous		Raychem WCSF-N	1.29 (Ref 29)	Insulation		2×10^8 (Ref 30)	
1.20	Lockwasher, 1/4", P/N 46701			Stainless Steel		Mechanical	NAS-Metal		
1.21	Terminal Lug, P/N 33285			Tin-Plated Copper/PVC	1.39(Ref 50)	Connection/ Insulation		2×10^7 (Ref 28)	

TABLE 1. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms		Qualified Life Goal
							Time/Temperature	Radiation	
1.22	Insulating Tube, P/N 59142	140°C (UL)		G11 Epoxy/ Glass	0.95 (Ref 1)	Insulation		8.3×10^9 (Ref 28)	
1.23	Tubing (Basic), P/N 39571	140°C (UL)		G11 Epoxy/ Glass	0.95 (Ref 1)	"		8.3×10^9 (Ref 28)	

Item No.	TABLE 1. AGING MATRIX (CONTINUED) Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/Temperature	Radiation	Qualified Life Goal
2.0	323 Transmitter, XM-54853, XM-57737, Rev. E, Bottoming/XFR Typg, Bracket Mtd., J-Box Output P/L 57737, Rev. D, Transmitter, Radiation	Inches of indication = 66" ohms/inch = 10 ohms. Total resistance = 650 ohms.							40 Yr
2.1	Stem Assembly, P/N 43510 'A' Dim. = 72 1/2"			Stainless Steel		Mechanical	NAS-Metal		
2.1.1	Stem (Length 73 1/8"), P/N 43511			"		"	"		
2.1.1.1	Tubing (Basic), 6', P/N 26696			"		"	"		
2.1.2	Bracket, P/N 35750			"		"	"		
2.1.3	Adapter, P/N 43512			"		"	"		
2.1.4	End Plug, P/N 26693			"		"	"		
2.2	Float Assembly, P/N 35560								
2.2.1	Hemisphere, P/N 35561			"		"	"		
2.2.2	Tube, Center, P/N 35562			"		"	"		
2.2.2.1	Tubing (Basic), P/N 35564			"		"	"		
2.2.3	Ring, Magnet, P/N 35563			Aluminum		"	"		
2.2.4	Magnet, P/N 14395			Alnico V		"	"		
2.2.5	Eyelet, P/N 30223			Brass		"	"		

Item No.	TABLE I. AGING MATRIX (CONTINUED) Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
2.3	Switch Assembly, P/N 59143					Electronic			
2.3.1	P.C. Board, P/N 26082 Length 73 1/2"	130°C		G10	0.94 (Ref 1)	Mechanical/ Insulation		9.5×10^8 (Ref 28)	
2.3.2	Switch (Qty: 69), P/N 28425 Reed Switch, Gordos MR708-2	125°C 10 million cycles at 1A		Glass, Rhodium-Plated Contacts		Electronic	NAS-Glass/Metal		
2.3.3	Resistor (Qty: 65), P/N 37240, 10 Ohms, 1/4W (TD-35337)	150°C		TRW/IRC RG-1/4 (Meets MIL-R-10509)		"	NAS (Ref 3)	1×10^5 (Ref 28)	
2.3.4	Ductorseal, P/N 58954 Douglas Engineering Co. #7759					Connection			
2.3.4.1	Wire, #18, P/N 46825 Haveg #721816, Legend 2	150°C (UL)		EXAR-500 Cross-Linked Polyolefin	1.09 (Ref 29)	"		2×10^7 (Ref 52)	
2.3.4.2	Potting Compound	177°C		Epoxy, Equiv. to Epon 828	1.09 (Ref 49)	Mechanical		9.5×10^8 (Ref 28)	
2.3.5	Resistor (Qty: 3), P/N 32981 330 Ohms, 1/4W (TD-35337)	150°C		TRW/IRC RG-1/4 (Meets MIL-R-10509)		Electronic	NAS (Ref 3)	1×10^9 (Ref 28)	
2.3.6	Jumper Wire #24 AWG, P/N 41721 Raychem Spec. 44/0111-24	150°C (Ref 59)		Polyalkene W/Kynar Coating	2.08 (Kynar) (Ref 43)	Connection		2×10^8 (Ref 42)	
2.3.7	O-Ring #2-016, P/N 59159 (TD-39159)	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	
2.3.8	Wire, #22AWG, P/N 41719 Red, White, Black, Green Raychem Spec. 44/0111-22	150°C		Polyalkene, Kynar Coated	2.08 (Ref 43)	Connection		2×10^8 (Ref 42)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
2.4	J-Box Weldment, P/N 57784			Stainless Steel		Mechanical	NAS-Metal		
2.4.1	J-Box (Rework) P/N 54846			"		"	"		
2.4.1.1	J-Box (Basic) P/N 29884			"		"	"		
2.4.2	Adapter, P/N 57689			"		"	"		
2.4.3	Elbow (Rework) P/N 57691			"		"	"		
2.4.3.1	Elbow (Basic) P/N 57690			"		"	"		
2.4.4	Adapter, P/N 29888			"		"	"		
2.4.5	Ground Lug, P/N 57758			"		"	"		
2.5	Retaining Ring, P/N 58959			"		"	"		
2.6	Adapter Assembly, P/N 39558			"		"	"		
2.6.1	Adapter, P/N 36764			"		"	"		
2.6.2	Conduit Connector, P/N 39557			"		"	"		
2.7	Nut, Hex, P/N 17308			"		"	"		
2.8	Nameplate, P/N 27337			"		"	"		
2.9	Lockwire, P/N 12009			"		"	"		
2.10	Shock Tubing, P/N 26534	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	"		2×10^6 (Ref 53)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
2.11	Butt Connector, P/N 51716 Hollingsworth Fit No. 64070	175°C							
2.11.1	Barrel			Tin-Plated Copper		Connection			
2.11.2	Insulation			Polyvinyl Chloride	1.39 (Ref 50)	Insulation		2×10^7 (Ref 28)	
2.12	Bracket, P/N 57681			Stainless Steel		Mechanical	NAS-Metal		
2.13	Silicone Fluid, P/N 58956	260°C		DOW #710	1.82 (Ref 35)	"	NAS Below 250°C (Ref 36)	2×10^8 (Ref 36)	
2.14	Loctite, P/N 40049 Pipe Sealant, HVV Cat. #71	149°C		Methacrylate	2.09 (Ref 31)	"		2×10^8 (Ref 31)	
2.15	O-Ring #3-916, P/N 39157	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	"		2×10^6 (Ref 53)	
2.16	Screw, Hex-Head Cap, P/N 32309			Stainless Steel		"	NAS-Metal		
2.17	Washer, Flat, P/N 32313			"		"	"		
2.18	Locknut, Hex, P/N 57686			"		"	"		
2.19	Shrinkable Tubing, P/N 58957 Raychem WCSF-N	150°C Intermittent; 90°C continuous		Polyolefin	1.29 (Ref 30)	Insulation		2×10^8 (Ref 30)	
2.20	Lockwasher, 1/4, P/N 46701			Stainless Steel		Mechanical	"		

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms		Qualified Life Goal
							Time/Temperature	Radiation	
2.21	Ductorseal, P/N 58954, Douglas Engineering Co. #7759								
2.21.1	Wire, #18, P/N 46825 Haveg 721816, Legend 2	150°C		EXAR-500 Cross-Linked Polymeric (Polyolefin)	1.09 (Ref 29)	Mechanical/ Insulation		2×10^7 (Ref 52)	
2.21.2	Potting Compound	177°C		Epoxy (Equiv. to Epon 828)	1.09 (Ref 49)	"		9.5×10^8 (Ref 28)	
2.22	Terminal Lug, 1/4, P/N 33285 Hollingsworth, R4150F	175°C		Tin-Plated Vinyl Insul.	1.39 (Ref 50)	Connection		2×10^7	
2.23	Insulating Tubing, P/N 59142	140°C (UL)		G11 Epoxy/ Glass	0.95 (Ref 1)	Insulation		8.3×10^9 (Ref 28)	
2.23.1	Tubing (Basic) P/N 39571	140°C (UL)		"	0.95 (Ref 1)	"		8.3×10^9 (Ref 28)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
3.0	XM-54854 Rev. A 323 Transmitter, Bottoming Type, J-Box Output, Bracket and Flange Mounted, Parts List 57745, Rev. D. Transmitter Radiation, Type XM-54854 (Also Drawing No. XM-57745, Rev E).	Indication = 66' Ohms/inch = 10 Total resistance = 650 ohms							
3.1	Stem Assembly, P/N 57757, 'A' Dim. = 73 1/4"			Stainless Steel		Mechanical	NAS-Metal		
3.1.1	Stem, P/N 45113, Length 73 7/16" 'B' = 3/4"			"		"	"		
3.1.1.1	Tubing, Basic P/N 26696			"		"	"		
3.1.2	Flange, P/N 42067			"		"	"		
3.1.2.1	Flange (Basic), P/N 44071			"		"	"		
3.1.3	End Plug, P/N 26693			"		"	"		
3.2	Float Assembly, P/N 35560			"		"	"		
3.2.1	Hemisphere, P/N 35561			"		"	"		
3.2.1.1	Hemisphere, P/N 17826			"		"	"		
3.2.2	Tube, Center, P/N 35562			"		"	"		
3.2.2.1	Tubing (Basic), P/N 35564			"		"	"		
3.2.3	Ring, Magnet, P/N 35563			Aluminum		"	"		
3.2.4	Magnet, P/N 14395			Alinco V		"	"		
3.2.5	Eyelet, P/N 30223			Brass		"	"		

TABLE 1. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
3.3	Switch Assembly, P/N 59141					Electronic			
3.3.1	P.C. Board (74"), P/N 26082	130°C		G10 Epoxy/ Glass	0.94 (Ref 1)	"		2×10^9 (Ref 53)	
3.3.2	Resistor, (Qty: 65), P/N 37240 10 Ohms, 1/4W (TD-35337)	150°C		TRW/IRC RG-1/4 (Meets MIL-R-10509)		"	NAS (Ref 3 & 24)	1×10^9 (Ref 28)	
3.3.3	Ductorseal, P/N 58954	MATERIALS SAME AS ITEM 1.3.3							
3.3.4	Resistor (Qty: 3), P/N 32961 330 Ohms, 1/4W (TD-35337)	150°C		"		"	"		
3.3.5	Switch (Qty: 68), P/N 28425 Gordos MR708-2	125°C 10 million cy. at 1A		Glass, Rhodium-Plated Contacts		"	NAS-Glass/ Metal		
3.3.6	Jumper Wire, P/N 41721 Raychem Spec. 44/0111-24	150°C		Polyalkene Kynar-Coated	2.09 (Kynar) (Ref 43)	Connection		Useful to 5×10^8 (Ref 59)	
3.3.7	O-Ring 2-016, P/N 59159	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	
3.3.8	Wire #22 AWG, P/N 41719 Raychem Spec. 44/0111-22	150°C		Polyalkene Kynar-Coated	2.08 (Kynar) (Ref 43)	Connection		Useful to 5×10^8 (Ref 59)	
3.4	J-Box Weldment, P/N 57688			Stainless Steel		Mechanical	NAS-Metal		
3.4.1	J-Box, Rework, P/N 54843			"		"	"		
3.4.1.1	J-Box (Basic), P/N 29884			"		"	"		
3.4.2	Adapter, P/N 57689			"		"	"		
3.4.3	Elbow (Rework), P/N 57691			"		"	"		

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
3.4.3.1	Elbow (Basic), P/N 57690			Stainless Steel		Mechanical	NAS-Metal		
3.4.4	Adapter, P/N 29888			"		"	"		
3.4.5	Ground Lug, P/N 57758			"		"	"		
3.5	Shrinkable Tubing, P/N 58957	90°C		Raychem WCSF-N Cross-Linked Polyethylene	1.29 (Ref 29)	Insulation		2×10^8 (Ref 30)	
3.6	Adapter Assembly, P/N 39558			Stainless Steel		Mechanical	"		
3.6.1	Adapter, P/N 36764			"		"	"		
3.6.2	Conduit Connector, P/N 39557			"		"	"		
3.7	Nut, Hex, P/N 17308			"		"	"		
3.8	Nameplate, P/N 27337			"		"	"		
3.9	Lockwire, P/N 12009			"		"	"		
3.10	Shock Tubing, P/N 26534	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	"		2×10^6 (Ref 53)	
3.11	Butt Connector, P/N 51716	175°C							
3.11.1	Terminal			Tin-Plated Copper		Connection	NAS-Metal		
3.11.2	Insulation			Polyvinyl Chloride	1.39 (Ref 50)	Insulation		2×10^7 (Ref 28)	

TABLE 1. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/Temperature	Aging Mechanisms Radiation	Qualified Life Goal
3.12	Bracket, P/N 57681			Stainless Steel		Mechanical	NAS/Metallic		
3.13	Silicone Fluid, P/N 58956	260°C		Dow Corning #710	1.82 (Ref 35)	"		2×10^8 (Ref 36)	
3.14	Loctite, P/N 40049, Pipe Sealant, HVV, Cat. #7i	149°C		Methacrylate	2.09 (Ref 31)	"		2×10^8 (Ref 31)	
3.15	O-Ring, #3-916, P/N 39157	90°C Continuous; 120°C Intermittent		Neoprene	1.04 (Ref 29)	"		2×10^6 (Ref 53)	
3.16	Screw, Hex-Head Cap, P/N 51877			Stainless Steel		"	NAS/Metallic		
3.17	Flat Washer, P/N 32313			"		"	"		
3.18	Locknut, Hex, P/N 57686			"		"	"		
3.19	Bracket Assembly, P/N 26685			"		"	"		
3.19.1	Bracket, P/N 26686			"		"	"		
3.19.2	Clamp, P/N 26686			"		"	"		
3.19.3	Lockwasher, P/N 14911			"		"	"		
3.19.4	Bolt, P/N 14986			"		"	"		
3.20	Retaining Ring, P/N 36422			"		"	"		
3.21	Lockwasher, 1/4, P/N 46701			"		"	"		
3.22	Terminal Lug, P/N 33285, Hollingsworth R4150F	175°C		Tin Copper/PVC	1.39 (Ref 50)	"	"	2×10^7 (Ref 28)	
3.23	Retaining Ring, P/N 58959, Waldes Kohinoor Truarc #5005-75			Stainless Steel		"	"		

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
3.24	Insulating Tube, P/N 59142	140°C		G11 Epoxy/ Glass	0.95 (Ref 1)	Mechanical		9.5×10^8 (Ref 28)	
3.24.1	Tube (Basic), P/N 39571	140°C		"	0.95 (Ref 1)	"		"	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Racing Environmental and Operational	Service Environ-mental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
4.0	XM-57753 Rev. D 323 Transmitter, XM54854 Bottoming Type, J-Box Output, Bracket and Flange Mounted, P/L 57753, Rev. D., Transmitter, Radiation, Type No. XM-54854	Indication=30" Ohms/Inch=43							
4.1	Stem Assembly, P/N 57757 'A' Dim. = 37 1/4"			Stainless Steel		Mechanical	NAS-Metal		
4.1.1	Stem , P/N 45113, Length = 37 7/16", 'B' = 3/4"			"		"	"		
4.1.2	Tubing (Basic) P/N 26696			"		"	"		
4.1.3	Flange, P/N 42067			"		"	"		
4.1.3.1	Flange (Basic), P/N 44071			"		"	"		
4.1.4	End Plug, P/N 26693			"		"	"		
4.2	Float Assembly, P/N 35560								
4.2.1	Hemisphere, P/N 35561			"		"	"		
4.2.2	Hemisphere, P/N 17826			"		"	"		
4.2.3	Tube, Center, P/N 35562			"		"	"		
4.2.4	Tubing (Basic), P/N 35564			"		"	"		
4.2.5	Ring, Magnet, P/N 35563			Aluminum		"	"		
4.2.6	Magnet, P/N 14395			Alnico V		"	"		
4.2.7	Eyelet, P/N 30223			Brass		"	"		

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time-Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
4.3	Switch Assembly, P/N 59141					Electronic			
4.3.1	P.C. Board (38"), P/N 26082	130°C		G10 Epoxy/ Glass	0.94 (Ref 1)	Mechanical/ Insulation		2.5×10^9 (Ref 28)	
4.3.2	Resistor, (Qty: 29), P/N 39168 43 Ohms, 1/4W (TD-35337)	150°C		TRW/IRC RG-1/4		Electronic	NAS (Ref 3 & 24)	1×10^9 (Ref 28)	
4.3.3	Ductorseal, P/N 58954	MATERIALS SAME AS ITEM 1.3.3							
4.3.4	Resistor (Qty: 3), P/N 32981, 330 Ohms, 1/4W (TD-35337)	150°C		"		"	"	"	
4.3.5	Switch (Qty: 32), P/N 28425 Gordos MR 708-2	125°C 10 million cycles at 1A		Glass, Rhodium-Plated Contacts		"	NAS-Glass/Metal		
4.3.6	Jumper Wire, P/N 41721, Raychem Spec. 44/0111-24	150°C		Polyalkene Kynar-Coated	2.08 (Kynar) (Ref 43)	Connection		Useful to 5×10^8 (Ref 42)	
4.3.7	O-Ring 2-016, P/N 59159	90°C Continuous 120°C intermittent		Neoprene		Mechanical	1.04 (Ref 29)	2×10^6 (Ref 53)	
4.3.8	Wire, #22 AWG, P/N 41719 Raychem Spec. 44/0111-22	150°C		Polyalkene Kynar-Coated	2.08 (Kynar) (Ref 43)	Connection		Useful to 5×10^8 (Ref 42)	
4.4	J-Box Weldment, P/N 57688			Stainless Steel		Mechanical	NAS-Metal		
4.4.1	J-Box, Rework, P/N 54843			"		"	"		
4.4.2	J-Box (Basic), P/N 29884			"		"	"		
4.4.3	Adapter, P/N 576[illegible]			"		"	"		
4.4.4	Elbow (Rework) P/N 57691			"		"	"		

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
4.4.5	Elbow (Basic), P/N 57690			Stainless Steel		Mechanical	NAS-Metal		
4.4.6	Adapter, P/N 29888			"		"	"		
4.4.7	Ground Lug, P/N 57758			"		"	"		
4.5	Shrinkable Tubing, P/N 58957	SAME AS ITEM 1.9				Insulation			
4.6	Adapter Assembly, P/N 39558			"		Mechanical	"		
4.6.1	Adapter, P/N 36764			"		"	"		
4.6.2	Conduit Connector, P/N 39557			"		"	"		
4.7	Nut, Hex, P/N 17308			"		"	"		
4.8	Nameplate, P/N 27337			"		"	"		
4.9	Lockwire, P/N 12009			"		"	"		
4.10	Shock Tubing, P/N 26534	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	"		2×10^6 (Ref 53)	
4.11	Butt Connector, P/N 51716	175°C							
4.11.1	Barrel			Tin-Plated Copper		Connection	"		
4.11.2	Insulation			Polyvinyl Chloride	1.39 (Ref 50)	Insulation		2×10^7 (Ref 28)	
4.12	Bracket, P/N 57681			Stainless Steel		Mechanical	"		
4.13	Silicone Fluid, P/N 58956	260°C		Dow #710	1.82 (Ref 35)	"		[illegible] $\times 10^8$ (Ref 36)	
4.14	Loctite, P/N 40049	149°C		Methacrylate	2.09 (Ref 31)	"		2×10^8 (Ref 31)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
4.15	O-Ring #3-916, P/N 39157	149°C		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	
4.16	Screw, Hex-Head Cap, P/N 51877			Stainless Steel		"	NAS-Metal		
4.17	Flat Washer, P/N 32313			"		"	"		
4.18	Locknut, Hex, P/N 57686			"		"	"		
4.19	Bracket Assembly, P/N 26685			"		"	"		
4.19.1	Bracket, P/N 26686			"		"	"		
4.19.2	Clamp, P/N 26686			"		"	"		
4.19.3	Lockwasher, P/N 14911			"		"	"		
4.19.4	Bolt, P/N 14986			"		"	"		
4.20	Retaining Ring, P/N 36422			"		"	"		
4.21	Lockwasher, 1/4, P/N 46701			"		"	"		
4.22	Terminal Lug, P/N 33285 Hollingsworth R4150F	175°C		Tin Copper/PVC	1.39 (Ref 50)	Connection	"	2×10^7 (Ref 28)	
4.23	Retaining Ring, P/N 58959 Waldes Kohinoor Truarc #5005-75			Stainless Steel		Mechanical	"		
4.24	Insulating Tube, P/N 59142	140°C		G11 Epoxy/ Glass	0.95 (Ref 1)	Insulation		9.5×10^8 (Ref 28)	
4.24.1	Tube (Basic), P/N 39571	140°C		"	0.95 (Ref 1)	"		9.5×10^8 (Ref 28)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms		Qualified Life Goal
							Time/ Temperature	Radiation	
5.0	XM-54854 Rev. A, 323 Transmitter, Bottoming Type, J-Box Output, Bracket and Flange Mounted, Parts List 57755, Rev. D, Transmitter, Radiation, Type XM-54854	Indication=66" Ohms/inch=20 Total Resistance = 1,300 ohms.							
5.1	Stem Assembly, P/N 57757 'A' Dim. = 73 1/4"			Stainless Steel		Mechanical	NAS-Metal		
5.1.1	Stem, P/N 45113, Length = 73 7/16", 'B' = 3/4"			"		"	"		
5.1.2	Tubing, Basic, P/N 26696			"		"	"		
5.1.3	Flange, P/N 42067			"		"	"		
5.1.3.1	Flange (Basic), P/N 44071			"		"	"		
5.1.4	End Plug, P/N 26693			"		"	"		
5.2	Float Assembly, P/N 35560								
5.2.1	Hemisphere, P/N 35561			"		"	"		
5.2.1.1	Hemisphere, P/N 17826			"		"	"		
5.2.2	Tube, Center, P/N 35562			"		"	"		
5.2.3	Tubing (Basic), P/N 35564			"		"	"		
5.2.4	Ring, Magnet, P/N 35563			Aluminum		"	"		
5.2.5	Magnet, P/N 14395			Alnico V		"	"		
5.2.6	Eyelet, P/N 30223			Brass		"	"		

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
5.3	Switch Assembly, P/N 59141								
5.3.1	P.C. Board (74"), P/N 26082	130°C		G10 Epoxy/ Glass	0.94 (Ref 1)	Mechanical/ Insulation		2.5×10^9 (Ref 28)	
5.3.2	Resistor (Qty: 65), P/N 44195 20 Ohms, 1/4W (TD-35337)	150°C Storage		T.[illegible] RG-1/4		Electronic	NAS (Ref 3 & 24)	1×10^9 (Ref 28)	
5.3.3	Ductorseal	SAME AS ITEM 1.3.3							
5.3.4	Resistor (Qty: 3), P/N 32981 330 Ohms, 1/rW (TD-35337)	150°C Storage		"		"	"	1×10^9 (Ref 28)	
5.3.5	Switch (Qty: 68), P/N 28425 Gordos MR708-2	125°C 10 million cycles at 1A		Glass, Rhodium-Plated Contacts		"	NAS-Glass/ Metal		
5.3.6	Jumper Wire, #24 AWG, P/N 41721 Yellow, Raychem Spec. 44/0111-24	150°C		Polyalkene Kynar-Coated	2.08 (Kynar) (Ref 43)	Connection		Useful to 5×10^8 (Ref 42)	
5.3.7	O-Ring 2-016, P/N 59159	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	
5.3.8	Wire, #22 AWG, P/N 41719 Raychem Spec. 44/0111-22	150°C		Polyalkene Kynar-Coated	2.08 (Kynar) (Ref 43)	Connection		Useful to 5×10^8 (Ref 42)	
5.4	J-Box Weldment, P/N 57688			Stainless Steel		Mechanical	NAS-Metal		
5.4.1	J-Box, Rework, P/N 54843			"		"	"		
5.4.2	J-Box (Basic), P/N 29884			"		"	"		
5.4.3	Adapter, P/N 57689			"		"	"		
5.4.4	Elbow (Rework), P/N 57691			"		"	"		

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
5.4.5	Elbow (Basic), P/N 57690			Stainless Steel		Mechanical	NAS-Metal		
5.4.6	Adapter, P/N 29888			"		"	"		
5.4.7	Ground Lug, P/N 57758			"		"	"		
5.5	Shrinkable Tubing, P/N 58957 Raychem WCSF-N	90°C		Cross-Linked Polyolefin	1.29 (Ref 30)	Insulation		2×10^8 (Ref 30)	
5.6	Adapter Assembly, P/N 39558			Stainless Steel		Mechanical	"		
5.6.1	Adapter, P/N 36764			"		"	"		
5.6.2	Conduit Connector, P/N 39557			"		"	"		
5.7	Nut, Hex, P/N 17308			"		"	"		
5.8	Nameplate, P/N 27337			"		"	"		
5.9	Lockwire, P/N 12009			"		"	"		
5.10	Shock Tubing, P/N 26534	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	"		2×10^6 (Ref 53)	
5.11	Butt Connector, P/N 51716	175°C							
5.11.1	Barrel			Tin-Plated Copper		Connection	"		
5.11.2	Insulation			Polyvinyl Chloride	1.39 (Ref 50)	Insulation		2×10^7 (Ref 28)	
5.12	Bracket, P/N 57681			Stainless Steel			"		
5.13	Silicone Fluid, P/N 58956	260°C		Dow #710	1.82 (Ref 35)	Mechanical		2×10^8 (Ref 36)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
5.14	Loctite, P/N 40049, Pipe Sealant HVV Cat. #71	82°C Continuous 149°C Intermittent		Methacrylate	2.09 (Ref 31	Mechanical		2×10^8 (Ref 31)	
5.15	O-Ring #3-916, P/N 39157	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29	"		2×10^6 (Ref 53)	
5.16	Screw, Hex-Head Cap, P/N 51877			Stainless Steel		"	NAS-Metal		
5.17	Flat Washer, P/N 32313			"		"	"		
5.18	Locknut, P/N 57686			"		"	"		
5.19	Bracket Assembly, P/N 26685			"		"	"		
5.19.1	Bracket, P/N 26685			"		"	"		
5.19.2	Clamp, P/N 26686			"		"	"		
5.19.3	Lockwasher, P/N 14911			"		"	"		
5.19.4	Bolt, P/N 14986			"		"	"		
5.20	Retaining Ring, P/N 36422			"		"	"		
5.21	Lockwasher, 1/4, P/N 46701			"		"	"		
5.22	Terminal Lug, P/N 23285	175°C		Tin-Plated Copper/PVC	1.39 (Ref 50)	Insulation	X	2×10^7 (Ref 28)	
5.23	Retaining Ring, P/N 58959			Stainless Steel		Mechanical	NAS-Metal		
5.24	Insulating Tube, P/N 59142	140°C		G11 Epoxy/ Glass	0.95 (Ref 1)	Electronic Component		9.5×10^8 (Ref 1)	
5.24.1	Tubing (Basic), P/N 39571	140°C		"	0.95 (Ref 1)	"		9.5×10^8 (Ref 1)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
6.0	LS-57761B Level Switch Bracket Mtd. J/Box Output S.S. Round Float								
6.1	Stem Assembly 43771 A = 47-7/8", B = 0, C = 41-3/4"			Stainless Steel		Mechanical	Metal, NAS		
6.1.1	Stem 47406 A = 48-1/4", B = 0, C = 42-3/16"			"		"	"		
6.1.2	Tubing (Basic) 26696			"		"	"		
6.1.3	End Plug 26693			"		"	"		
6.1.4	Bracket 35750			"		"	"		
6.1.5	Adapter 43512			"		"	"		
6.1.6	Retaining Ring 36427			"		"	"		
6.2	Float Assembly 35560			"		"	"		
6.2.1	Hemisphere 35561			"		"	"		
6.2.2	Hemisphere 17826			"		"	"		
6.2.3	Tube, Center 35562			"		"	"		
6.2.4	Tubing (Basic) 35564			"		"	"		
6.2.5	Ring, Magnet 35563			Aluminum		"	"		
6.2.6	Magnet 14395			Alnico V		"	"		
6.2.7	Eyelet 30223			Brass		"	"		

Item No.	TABLE I. AGING MATRIX (CONTINUED) Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/Temperature	Aging Mechanisms Radiation	Qualified Life Goal
6.3	Switch Assembly, P/N 59359								
6.3.1	P.C. Board, P/N 26082	130°C		G10 Epoxy/ Glass Laminate	0.94 (Ref 1)	Mechanical/ Insulation		2.5×10^9 (Ref 28)	
6.3.2	Switch, P/N 28243 Hamlin, Inc., DRT-DTH (Mod.)	50 million cycles 125°C		Glass-Sealed Reed Switch SPDT			NAS		
6.3.3	O-Ring, 2-016, P/N 59159 (T939159)	149°C		Neoprene	1.04 (Ref 29)	Mechanical		14.5×10^7 (Ref 23)	
6.3.4	Ductorseal, P/N 58954	SAME AS ITEM 1.3.3				"			
6.3.5	Wire, #22AWG, P/N 41719	SAME AS ITEM 1.3.8							
6.4	J-Box Weldment, P/N 57688			Stainless Steel		Insulation Mechanical	NAS-Metal		
6.4.1	J-Box (Rework), P/N 54843			"		"	"		
6.4.2	J-Box (Basic), P/N 29884			"		"	"		
6.4.3	Adapter, P/N 57689			"		"	"		
6.4.4	Elbow (Rework), P/N 57691			"		"	"		
6.4.5	Elbow (Basic), P/N 57690			"		"	"		
6.4.6	Adapter, P/N 29888			"		"	"		
6.4.7	Ground Lug, P/N 57758			"		"	"		
6.5	Shrinkable Tubing, P/N58957 Raychem WCFS-N	90°C		Cross-Linked Polyolefin	1.29 (Ref 30)	Insulation		2×10^8 (Ref 30)	

Item No.	TABLE I. AGING MATRIX (CONTINUED) Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/Temperature	Radiation	Qualified Life Goal
6.6	Adapter Assembly, P/N 39558			Stainless Steel		Mechanical	NAS-Metal		
6.6.1	Adapter, P/N 36754			"		"	"		
6.6.2	Conduit Connector, P/N 39557			"		"	"		
6.7	Nut, Hex, P/N 17308			"		"	"		
6.8	Nameplate, P/N 27337			"		"	"		
6.9	Lock Wire, P/N 12009			"		"	"		
6.10	Shock Tubing, P/N 26534	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Insulation		2×10^6 (Ref 53)	
6.11	Butt Connector, P/N 51716 Hollingsworth FIT No. B4070	175°C				Insulation			
6.11.1	Barrel			Tin-Plated Copper		Connection			
6.11.2	Insulation			Polyvinyl Chloride	1.39 (Ref 50)	Insulation		2×10^7 (Ref 28)	
6.12	Bracket, P/N 57681			Stainless Steel		Mechanical	NAS-Metal		
6.13	Silicone Fluid, P/N 58956	260°C		Silicone Fluid Dow Corning #710	1.82 (Ref 35)	"		2×10^8 (Ref 36)	
6.14	Loctite, P/N 40049, Pipe Sealant, HVV Cat. #71	149°C		Methacrylate	2.09 (Ref 31)	Mechanical		2×10^8 (Ref 31)	
6.15	O-Ring, P/N 39517 #3-916 (TD-39159)	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 28)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
6.16	Screw, Hex-Head Cap, P/N 51877			Stainless Steel		Mechanical	NAS-Metal		
6.17	Flat Washer, P/N 32313			"		"	"		
6.18	Locknut, Hex, P/N 57686			"		"	"		
6.19	Retaining Ring, P/N 36422			"		"	"		
6.20	Lockwasher, 1/4", P/N 46701			"		"	"		
6.21	Terminal Lug, 1/4", P/N 33285	175°C		Tin-Plated Copper/PVC	1.39 (Ref 50)	Connection		2×10^7 (Ref 28)	
6.22	Retaining Ring, P/N 58959			Stainless Steel		Mechanical	NAS-Metal		
6.23	Insulating Tube, P/N 59393	140°C		G11 Epoxy/Glass	0.95(Ref 1)	Insulation		8.3×10^9 (Ref 28)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
7.0	Level Switch, LS-57763B, Bracket Mounted, J-Box Output								
7.1	Stem Assembly, P/N 43771 A = 47 7/8"; B = 0; C = 41 3/4"; D = 8 3/4"			Stainless Steel		Mechanical	NAS-Metal		
7.1.1	Stem, P/N 47406, A = 48 1/4"; B = 0; C = 42 3/16"; D = 9 3/16"			"		"	"		
7.1.2	Tubing (Basic), P/N 26696			"		"	"		
7.1.3	End Plug, P/N 26693			"		"	"		
7.1.4	Bracket, P/N 35750			"		"	"		
7.1.5	Adapter, P/N 43512			"		"	"		
7.1.6	Retaining Ring, P/N 36427			"		"	"		
7.2	Float Assembly, P/N 35560								
7.2.1	Hemisphere, P/N 35561			"		"	"		
7.2.2	Hemisphere, P/N 17826			"		"	"		
7.2.3	Tube, Center, P/N 35562			"		"	"		
7.2.4	Tubing (Basic), P/N 35564			"		"	"		
7.2.5	Ring, Magnet, P/N 35563			Aluminum		"	"		
7.2.6	Magnet, P/N 14395			Alnico V		"	"		
7.2.7	Eyelet, P/N 30223			Brass		"	"		

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
7.3	Switch Assembly, P/N 59395								
7.3.1	P.C. Board, P/N 26082	130°C		G10 Epoxy/ Glass Laminate	0.94 (Ref 1)	Mechanical/ Insulation		2.5×10^9 (Ref 53)	
7.3.2	Switch, P/N 28243, Hamlin, Inc., DRT-DTH (Mod.)	50 million cycles, 125°C		Glass-Sealed Reed Switch		"	NAS		
7.3.3	O-Ring, 2-016, P/N 59159 (TD-39159)	120°C Continuous 90°C Intermittent		Neoprene	1.04(Ref 29)	Mechanical		2×10^6 (Ref 53)	
7.3.4	Ductorseal, P/N 58954	SAME AS ITEM 1.3.3							
7.3.5	Wire, #22AWG, P/N 41719	150°C		Irradiated Cross-Linked Polyolefin Kynar-Coated	2.08 (Kynar) (Ref 43)	Connector		Useful to 5×10^8 (Ref 59)	
7.4	J-Box Weldment, P/N 57688			Stainless Steel		Mechanical	NAS-Metal		
7.4.1	J-Box (Rework), P/N 54843			"		"	"		
7.4.2	J-Box (Basic), P/N 29884			"		"	"		
7.4.3	Adapter, P/N 57689			"		"	"		
7.4.4	Elbow (Rework), P/N 57691			"		"	"		
7.4.5	Elbow (Basic), P/N 57690			"		"	"		
7.4.6	Adapter, P/N 29888			"		"	"		
7.4.7	Ground Lug, P/N 57758			"		"	"		
7.5	Shrinkable Tubing, P/N 58957 Raychem WCSF-N	90°C		Cross-Linked Polyolefin	1.29(Ref 29)	Insulation		2×10^8 (Ref 30)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
7.6	Adapter Assembly, P/N 39558			Stainless Steel		Mechanical	NAS-Metal		
7.6.1	Adapter, P/N 36764			"		"	"		
7.6.2	Conduit Connector, P/N 39557			"		"	"		
7.7	Nut, Hex, P/N 17308			"		"	"		
7.8	Nameplate, P/N 27337			"		"	"		
7.9	Lockwire, P/N 12009			"		"	"		
7.10	Shock Tubing, P/N 26534	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	"		2×10^6 (Ref 53)	
7.11	Butt Connector, P/N 51716	175°C							
7.11.1	Barrel			Tin-Plated Copper		Connector	NAS -Metal		
7.11.2	Insulation			Polyvinyl Chloride	1.39 (Ref 50)	Insulation		2×10^7 (Ref 28)	
7.12	Bracket, P/N 57681			Stainless Steel			NAS-Metal		
7.13	Silicone Fluid, P/N 58956	260°C		Silicone Fluid Dow Corning #710	1.82 (Ref35)	Mechanical		2×10^8 (Ref 36)	
7.14	Loctite, P/N 40049	149°C		Methacrylate	2.09 (Ref 31)	"		2×10^8 (Ref 31)	
7.15	O-Ring #3-916, P/N 39157 (TD-39159)	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	"		2×10^6 (Ref 53)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
7.16	Screw, Hex-Head Cap, P/N 51877			Stainless Steel		Mechanical	NAS-Metal		
7.17	Flat Washer, P/N 32313			"		"	"		
7.18	Locknut, Hex, P/N 57686			"		"	"		
7.19	Retaining Ring, P/N 36422			"		"	"		
7.20	Lockwasher, 1/4", P/N 46701			"		"	"		
7.21	Terminal Lug, 1/4", P/N 33285 Hollingsworth R4150F	175°C		Tin-Plated Copper/PVC	1.39 (Ref. 50)	Insulation		2×10^7 (Ref 28)	
7.22	Retaining Ring, P/N 58959			Stainless Steel		Mechanical	NAS-Metal		
7.23	Insulating Tube, P/N 59393	140°C		G11 Epoxy/ Glass	0.95 (Ref 1)	Electronic Component		8.3×10^9 (Ref 28)	

NAS = NOT AGE SENSITIVE

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
8.0	Modular Receiver with 4 to 20 mA Converter and KX-241 Meter, Type RE-36462, Drawing No. RE-57759B with Parts List 57759B, Transamerica Delaval, Inc., Gems Sensors Division	Operation 0 to 50°C							
8.1	Box, P/N 40830			Steel		Mechanical	NAS-Metal		
8.2	Cover Assembly, P/N 40927								
8.2.1	Cover, P/N 31406			Steel			NAS-Metal		
8.2.2	Shock Cushion, P/N 40827	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	
8.2.3	Adhesive, P/N 33729, USM Corp., Bostik #1142	82°C (93°C light load)		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	
8.2.4	Gasket, Cover, P/N 31407	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	
8.2.5	Gasket, Cover, P/N 40828	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	
8.3	Meter, P/N 15032, Westinghouse, KX-241, 250°C Scale	-40°C to 70°C 0-200 microamp DC		Unknown	Assume 0.8	Electronic Component			
8.3.1	Meter, Face, Blank, P/N 16038			Aluminum		Mechanical	NAS-Metal		

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
8.4	Gasket, Meter, P/N 28736	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	
8.5	Power Light, P/N 37075, Littlefuse #930-434R-794CN								
8.5.1	Body	150°C (UL)		Phenolic	1.81 (Ref.63)	Insulation		2.7×10^6 (Ref 53)	
8.5.2	Lens	115°C (UL)		Lexan 141	1.17 (Ref 45)	Mechanical		4.3×10^6 (Ref 53)	
8.6	Lamp, P/N 36843, Sylvania Type 120MB	110°C		Glass/Metal		Electronic Component	NAS-Glass/Metal		
8.7	Fuse Holder, [illegible] Amperes, P/N15483								
8.7.1	Parts, Molded	130°C (UL)		Diallyl Phthalate	2.17 (Ref 48)	Insulation		1×10^8 (Ref 58)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms		Qualified Life Goal
							Time/ Temperature	Radiation	
8.7.2	Terminal, Side			Brass, Electro Tin-Plated		Connection	NAS-Metal		
8.7.3	Terminal, End			Brass, Electro Tinned		Connection	NAS-Metal		
8.7.4	Seal, O-Ring	105°C (UL)		Silicone Rubber Per ZZ-R-765	1.73 (Ref 29)	Mechanical		1.3×10^6 (Ref 53)	
8.8	Fuse, 1 Ampere, P/N 15483 Bussman, MBO-250V, 1 Ampere								
8.8.1	Tube			Melamine	Unknown Assume 0.8	Insulation		7.4×10^6 (Ref 53)	
8.8.2	End Caps			Brass		Connection	NAS-Metal		
8.9	Harness Assembly, P/N 40926								
8.9.1	Toggle Switch 3PDT, P/N 15709 Cutler-Hammer #7670K6	85°C 10,000 Cycles Electrical							
8.9.1.1	Housing	150°C (UL)		GP Phenolic	1.81 (Ref.63)	Electrical/ Mechanical		3×10^6 (Ref 53)	
8.9.1.2	Seal	105°C (UL)		Silicone Rubber	1.73 (Ref 29)	Mechanical		1.3×10^6 (Ref 53)	
8.9.1.3	Contacts			Silver to Silver		Connection	NAS-Metal		
8.9.1.4	Terminals			Tin-Dipped Metal Alloy		Connection	NAS-Metal		

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
8.9.2	Transformer, P/N 37031 Douglas Randall, MIL-T-27C/R	115V Primary 26V Secondary 105°C Operaing							
8.9.2.1	Magnet Wire	105°C		Polyurethane	Unknown Assume 0.8	Insulation		8.7×10^6 (Ref 53)	
8.9.2.2	Leads, #22AWG	105°C		Polyvinyl Chloride	1.39 (Ref 24)	Insulation		2×10^7 (Ref 28)	
8.9.2.3	Spacer	115°C (UL)		Phenolic-Linen	0.84 (Ref 1)	Insulation		3×10^6 (Ref 53)	
8.9.2.4	Laminate, National Lamination Company, EI-75, 266a M19			Steel			NAS-Metal		
8.9.2.5	Paper	105°C (UL)		Kraft Paper	2.04 (Ref 40)	Insulation		2.7×10^6 (Ref 53)	
8.9.2.6	Tape, 3M #75	130°C (3M)		Mylar	1.53 (Ref 40)	Insulation		4.4×10^6 (Ref 53)	
8.9.2.7	Varnish, Acme #150	150°C		Phenolic	Unknown Assume 0.8	Insulation		3×10^6 (Ref 53)	
8.9.2.8	Glass Cloth, 3M #27	130°C (3M)		Glass Cloth		Insulation	NAS-Glass		
8.9.3	Transformer, P/N 409038 Triad Type F-94X	105°C (Triad)							
8.9.3.1	Outer Cover	105°C (Per Triad)		Cellulose Acetate	2.17 (Ref 40)	Insulation		2.7×10^6 (Ref 53)	
8.9.3.2	Outer Cover	105°C (UL)		Kraft Paper	2.04 (Ref 40)	Insulation		2.7×10^6 (Ref 53)	
8.9.3.3	Insulation from Primary	105°C (Per Triad)		Cellulose Acetate	2.17 (Ref 40)	Insulation		2.7×10^6 (Ref 53)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
8.9.3.4	Insulation, Primary to Secondary	105°C (Per Triad)		Cellulose Acetate	2.17 (Ref 40)	Insulation		2.7×10^6 (Ref 53)	
				Glassine	2.04 (Ref 40)	Insulation		2.7×10^6 (Ref 53)	
8.9.3.5	Coil Wire	150°C (Per Triad)		Copper Varnish; Polyester	1.53 (Ref 54)	Conductor Insulation		5×10^5 (Ref 53)	
8.9.4	Potentiometer, 2.5K, P/N 25945 TD-33910, Rev. C	120°C (Derated)		Meets MIL-R-94					
	ALTERNATE SOURCES:								
8.9.4.1	Allen Bradley JAIE040S252μA	100,000 Cycles W/O Load		Conductive Plastic-Carbon		Electronic	NAS (Ref 3)	1×10 (Ref 28)	
8.9.4.2	Clarostat Series 380	"		"		"	"	"	
8.9.5	Wire, #22AWG, P/N 11117 MIL-W-16878, Type E	200°C		Teflon Jacket	1.69 (Ref 37)	"		1.7×10^4 (Ref 58)	
8.10	Bracket Assembly, P/N 40911			Various as follows:					
8.10.1	Bracket, P/N 40825			Steel		Mechanical	NAS-Metal		
8.10.2	Socket, 11-Pin, P/N 31431 Amphenol #77-MIP11			Various					
8.10.2.1	Contacts			Luballoy		Electronic	NAS-Metal		
8.10.2.2	Housing	150°C (UL)		Phenolic (Assume GP)	1.81 (Ref.63	Insulation		3×10^6 (Ref 53)	

Item No.	TABLE I. AGING MATRIX (CONTINUED) Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/Temperature	Aging Mechanisms Radiation	Qualified Life Goal
8.10.3	Socket, Power Supply, P/N 31417 Amphenol #77-MIP-8			Various					
8.10.3.1	Housing	150°C (UL)		Phenolic (Assume GP)	1.81 (Ref.33)	Insulation		3×10^6 (Ref 53)	
8.10.3.2	Contacts			Luballoy			NAS-Metal		
8.10.4	Screw, Pan-Head, P/N 30801 #6-32			Stainless Steel		Mechanical	NAS-Metal		
8.10.5	Lock Washer, P/N 28681			"		"	"		
8.10.6	Nut, Hex-Head, P/N 30803 #6-32			"		"	"		
8.10.7	Grommet, P/N 40826	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	"		2×10^6 (Ref 53)	
8.10.8	Label, Parts, P/N 36832			Aluminum		"	NAS-Metal		
8.10.9	Wire, #22AWG, P/N 11117 MIL-W-16878, Type E	200°C		Teflon Jacket	1.69 (Ref 37)	Insulation		1.7×10^4 (Ref 58)	
8.10.10	Cable Tie, P/N 31097	85°C (UL W/O Impact)		Nylon	0.85 (Ref 2)	Mechanical		8.6×10^5 (Ref 53)	
8.10.11	Insulating Tubing, P/N 40012 Varglas F-C-1, Size 9	155°C		Acrylic/Glass	2.84 (Ref 35)	Insulation		8.2×10^5 (Ref 53)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
8.11	Terminal Strip Assembly P/N 34266			Various					
8.11.1	Terminal Strip, 9-Pin, P/N 19563, TRW-Cinch "Jones", Type 2009								
8.11.1.1	Insulator	130°C (UL)		Phenolic, XPC	1.06 (Ref 1)	Insulation		2.7×10^5 (Ref 53)	
8.11.1.2	Terminal			Pre-Tinned Brass		Connection	NAS-Metal		
8.11.2	Resistor, 22.1K, P/N 31843 TRW CCB	60°C Operation 170°C Derated		Metal Film (Meets MIL-R-10509)		Electronic	NAS (Ref 3)	1×10^9 (Ref 28)	
8.11.3	Resistor, 330 Ohm, P/N 91331 Hot Molded, Fixed, Composition Allen Bradley Style RC07	70°C Full Power 150°C Derated		Carbon Composition (Meets MIL-R-11)		Electronic	NAS (Ref 3)	1×10^9 (Ref 28)	
8.11.4	Capacitor, 60 mf, P/N 22791 Sprague, CL65BJ600MPE	85°C, 50W VDC		TFE Seal Porous Sintered Tantalum		Electronic	NAS (Ref 3)	8.2×10^8 (Ref 60 - Table VI)	
8.11.5	Wire, #22AWG	SAME AS ITEM 9.5				Connection			
8.12	Screw, Flat-Head, P/N 32463 #6-32 x 1/2"			Stainless Steel		Mechanical	NAS-Metal		
8.13	Nameplate, Gems P/N 36826			Aluminum		Nameplate	NAS-Metal		
8.14	Insulating Tubing, P/N 39427 Syntholvar, Varflex Corp. MIL-I-7444 or MIL-I-631, Grade A	80°C		Polyvinyl Chloride	1.39 (Ref 50)	Insulation		2×10^7 (Ref 28)	

Item No.	TABLE I. AGING MATRIX (CONTINUED) Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/Temperature	Radiation	Qualified Life Goal
8.15	Sealing Boot, P/N 36805 APM Corporation			Hexseal N-1030B As Follows:					
8.15.1	Boot, G.E., SE5553U	105°C (UL)		Silicone Rubber	1.73 (Ref 29)	Mechanical		3×10^6 (Ref 53)	
8.15.2	Nut			Nickel-Plated Brass		"	NAS-Metal		
8.16	Potentiometer, P/N 25954	SAME AS ITEM 8.9.4				Electronic Component			
8.17	Locking Nut, P/N 33914 Allen Bradley M-3236			Nickel-Plated Brass		Mechanical	NAS-Metal		
8.18	Nut, Hex, #6-32, P/N 30803	SAME AS ITEM 8.10.6				"			
8.19	Lock Washer, #6, P/N 28681	SAME AS ITEM 8.10.5				"			
8.20	Cable Tie, P/N 31097	SAME AS ITEM 8.10.10				"			
8.21	Wire, #22AWG, P/N 11117	SAME AS ITEM 9.5				"			
8.22	Terminal Lug, #10, P/N 14476 Hollingsworth R 4149F	176°C		Various, as follows:					
8.22.1	Terminal			Tin-Plated Copper		Connection	NAS-Metal		
8.22.2	Insulation			Polyvinyl Chloride	1.39 (Ref 50)	Insulation			
8.23	Power Supply, P/N 41415								
8.23.1	Housing, P/N 31421	115°C		Lexan (Assume 41)	1.41 (Ref 62)	Mechanical		4.3 × [illegible] (Ref 5[illegible]	

TABLE 1. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
8.23.2	P.C. Board Assembly, P/N 40977			Various, as follows:					
8.23.2.1	P.C. Board, P/N 38445	130°C (UL)		G10 Epoxy-Glass	0.94 (Ref 1)	Insulation/ Mechanical		9.5×10^8 (Ref 28)	
8.23.2.2	Resistor, TRW/IRC, P/N 42567 AS-1 20 Ohms, [illegible]W, Wire Wound	125°C Full Power; 275°C Derated		Ceramic		Electronic	NAS (Ref 3 & 24)	1×10^9 (Ref 28)	
8.23.2.3	Diode, 1N457A, P/N 22786 Meets MIL-S-19500	200°C Storage 150°C Operating		Silicon		Electronic	NAS (Ref 3)	1×10^4 (Ref 56)	
8.23.2.4	Capacitor, P/N 22791	SAME AS ITEM 8.11.4				"			
8.23.2.5	Resistor, 600 Ohms, P/N 31257 TRW/IRC, Type AS, 1/2 W Meets MIL-R-26	125°C		Wire Wound		"	NAS (Ref 3)	1×10^9 (Ref 28)	
8.23.2.6	Voltage Regulator, P/N 38196 Fairchild #7818KC	18 V Nominal Output 70°C Operation 125°C Junction		Metal Can, IC	1.0 (Ref 47)	"		1×10^4 (Ref 28)	
8.23.2.7	Housing Base, 8-Pin, P/N 31421	70°C		Styrene	2.3[illegible] (Ref 32)	Mechanical		1×10^8 (Ref 28)	
8.23.2.8	Insulating Tubing, P/N 25673, Raychem RNF-100-1/8 (Clear)	135°C		XL Polyolefin	1.12 (Ref 29)	Insulation		2×10^7 (Ref 28)	

Item No.	TABLE I. AGING MATRIX (CONTINUED) Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/ Temperature	Radiation	Qualified Life Goal
8.23.2.9	Screw, Round Head, #6-32, P/N 23591			Brass		Mechanical	NAS-Metal		
8.23.2.10	Nut, Hex, #6-32, P/N 11223			Brass		Mechanical	NAS-Metal		
8.23.2.11	Wire, #22AWG, P/N 11117	SAME AS ITEM 9.5							
8.23.2.12	Lock Washer, P/N 16115			Brass		Mechanical	NAS-Metal		
8.23.3	Potting Compound, P/N 17888	105°C (UL Generic for Silicone Rubber)				Insulation			
	Alternate Materials:								
8.23.3.1	G.E. RTV-11/Thermolite #12	204°C (Per G.E.)		Silicone Rubber	0.80 (Ref 61)	Insulation		1.3×10^6 (Ref 53)	
8.23.3.2	Stauffer, V-54/CC Catalyst	250°C		"	"	Insulation		1.3×10^6 (Ref 53)	
8.23.3.3	Stauffer, RTV-128/KR	250°C		"	"	Insulation		1.3×10^6 (Ref 53)	
8.24	Jumper Wire, #22AWG, P/N 29566	200°C		Teflon Jacket	1.69 (Ref 37)	"		1.7×10^4 (Ref 58)	
8.25	Converter, P/N 40900H	4 to 20 mA		Various, as follows:					
8.25.1	Header Assembly, P/N 41530	65°C							
8.25.1.1	Header, P/N 41523	150°C (UL)		Phenolic	1.81 (Ref 33)	Insulation		2.7×10^6 (Ref 53)	
8.25.1.1.1	Header (Basic) P/N 41522	150°C (UL)		Phenolic	1.81 (Ref 33)	Insulation			

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms		Qualified Life Goal
							Time/Temperature	Radiation	
8.25.2	P.C. Board Assembly, 4-20 mA Converter, P/N 41485							2.5×10^9 (Ref 53)	
8.25.2.1	P.C. Board, P/N 40901	130°C (UL)		G10 Epoxy Glass	0.94 (Ref 1)	Mechanical/ Electrical			
8.25.2.2	Pushbutton Switch, P/N 37049 Cutler Hammer, Type B8500	70°C 500,000 cycles							
8.25.2.2.1	Plunger/Actuator	85°C (UL)		Nylon	0.85 (Ref 2)	"		9×10^5 (Ref 53)	
8.25.2.2.2	Body	115°C (UL)		Flock-Filled Polyester	1.51 (Ref 54)	Mechanical		5×10^5 (Ref 53)	
8.25.2.2.3	Contacts			Silver W/Gold Over Nickel		"	NAS-Metal		
8.25.2.3	Resistor, 56K Ohms, 1/2W, P/N 41460, Corning Mil Type RL07, ± 2%	70°C 150°C Derated		Metal Film (Meets MIL-R-22684)		Electronic	NAS (Ref 3)	1×10^9 (Ref 28)	
8.25.2.4	Resistor, 470K Ohms, 1/4W, P/N 91474, Hot Molded Fixed Composition, Style RC07, Allen Bradley "B", MIL-R-11	70°C 150°C Derated		Mixture of Carbon & Binders		"	"	"	
8.25.2.5	Resistor, 6K Ohms, 1/2W, P/N 38712, Wire Wound, TRW/IRC Type AS	125°C 275°C Derated		Wire Wound (Meets MIL-R-26)		"	"	1×10^9 (Ref 28)	
8.25.2.6	Resistor, 390 Ohms, 1W, P/N 46941, Wire Wound, TRW/IRC Type AS	125°C 275°C Derated		"		"	"	"	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
8.25.2.7	Potentiometer, 200K Ohms, P/N 40812, Spectrol P/N 70Y-204	1W @ 85°C 150°C Derated		Cermet		Electronic	NAS-Cermet	1×10^9 (Ref 28)	
8.25.2.8	Potentiometer, 200 Ohms, P/N 44049 Spectrol P/N 70Y-201	1W @ 85°C 150°C Derated		"		"	"	"	
8.25.2.9	Capacitor, 0.01 mf, 80V, P/N 38703, Sprague P/N 192P1039R8	85°C 80W VDC 125°C Derated 50%		Metal Film, Mylar Sleeve (Similar to MIL-C-555[illegible])		"	NAS (Ref 3)	4.4×10^6 (Ref 53)	
8.25.2.10	Capacitor, 0.47 mf, 35V, P/N 33608, MIL-C-39003, Sprague P/N CS13BF474M	85°C Without Derating 125°C Derated 35W VDC		Tantalum (Meets MIL-C-39003)		"	"	3×10^8	
8.25.2.11	Capacitor, 0.47 pf, P/N 44047, Sprague P/N 5GA-Q47	1,000W VDC 85°C Operation 125°C Storage		Ceramic		"	NAS-Cermet	1×10^9 (Ref 28)	
8.25.2.12	Transistor, NPN, P/N 25268, Fairchild Type 2N697	200°C		Silicon (Meets MIL-S-19500)		"	NAS (Ref 3)	1×10^4 (Ref 56)	
8.25.2.13	Diode, 1N457A, P/N 22786 Type JAN 1N457a	200°C Storage		Silicon (Meets MIL-S-19500)		"	"	"	
8.25.2.14	Integrated Circuit, P/N 44048 RCA CA3130T TO-5 Style (COS/MOS & Bipolar)	125°C Operating 150°C Storage		Monolithic Silicon, Epoxy Case, 8-Lead Metal Can	1.0 (Ref 47)	"		"	
8.25.2.15	Jumper Wire, P/N 19383			Copper		Connection	NAS-Metal		
8.25.2.16	Nameplate, P/N 41484			Aluminum		Nameplate	"		

Item No.	TABLE I. AGING MATRIX (CONTINUED) Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/Temperature	Radiation	Qualified Life Goal
8.25.3	P.C. Board Assembly, P/N 41490 Power Supply			Various, as follows:					
8.25.3.1	P.C. Board, P/N 40902	130°C (UL)		G10 Epoxy Glass	0.94 (Ref 1)	Electronic Component		2.5×10^9 (Ref 53)	
8.25.3.2	Screw, Round-Head, P/N 23591 #6-32 x 7/16"			Brass		Mechanical	NAS-Metal		
8.25.3.3	Lock Washer #6, P/N 16115			Brass		"	"		
8.25.3.4	Nut, Hex #6-32, P/N 11223			"		"	"		
8.25.3.5	Resistor, 470 Ohms, P/N 38786 1W, Wire Wound, IRC Type AS	125°C Operation 275°C Derated		Wire Wound (Meets MIL-R-26)		Electronic Component	NAS (Ref 3)	1×10^9 (Ref 28)	
8.25.3.6	Resistor, 390 Ohms, 1W, P/N 46941 Wire Wound, TRW/IRC Type AS	"		"		"	"	"	
8.25.3.7	Diode, 1N4245, P/N 38194 G.E. 1N4245	200V, 1A, Junct. Temp. 160°C 200°C Storage		Silicon (Meets MIL-S-19500)		"	"	1×10^4 (Ref 56)	
8.25.3.8	Capacitor, P/N 46403, 80 mf, 60W VDC @ 85°C, Sprague 600D806G060D.4	85°C 125°C Derated		Aluminum		Electronic Component		5.7×10^6 (Ref 60)	
8.25.3.9	Diode, Zener, P/N 41464, 1N5231B Case, Style DO-7	5.1V ± 5% 500 mv		MOS	Assume 0.8	"		1×10^4 (Ref 56)	
8.25.3.10	Voltage Regulator, P/N 44072 Fairchild #7815KC TO-3 Package	70°C Operation		Metal Can, IC	1.0 (Ref 47)	"	NAS (Ref 47 and Paragraph 3.4.2.4)	1×10^4 (Ref 56)	
8.25.3.11	Nameplate, P/N 41486			Aluminum		Nameplate	NAS-Metal		
8.25.3.12	Resistor, 330 Ohms, 2W, Wire Wound, P/N 46402, Ward Leonard Type 2X AX 1 OHM	25°C Full Power 350°C Derated		Wire Wound		Electronic Component	NAS-Metal, Glass	1×10^9 (Ref 28)	

Item No.	TABLE I. AGING MATRIX (CONTINUED) Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/Temperature	Radiation	Qualified Life Goal
8.25.4	Wire, #22 AWG P/N11117 Type E, MIL-W-16878	200°C		Teflon	1.69 Ref. 37	Insulation Mechanical		1.7×10^6 (Ref. 28)	
8.25.5	Bracket P/N41521			Steel		"	Metal, NAS		
8.25.6	Screw. Fl. Hd #6-32 P/N16093			Cadmium-plated Steel		"	"		
8.25.7	Lockwasher #6 P/N14631			Steel		"	"		
8.25.8	Nut, Hex 6-32 P/N39275			Steel		"	"		
8.25.9	Housing P/N41525	70°C		Polystyrene	2.34 Ref. 32	"		1×10^8 Ref. 28	
8.25.10	Housing (Basic) P/N41524	"		"	"	"		"	

Item No.	TABLE I. AGING MATRIX (CONTINUED) Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/Temperature	Aging Mechanisms Radiation	Qualified Life Goal
8.26	Insulating Tubing, P/N 40012 Varglas F-C-1, Size 9 MIL-I-3190B	155°C		Acrylic/Glass	2.84 (Ref 35)	Insulation		8.2×10^5 (Ref 53)	
8.27	Label, P/N 40898			Aluminum		Reference	NAS-Metal		
8.28	Label, P/N 36827			Aluminum		"	NAS-Metal		
8.29	Label, P/N 40897			Aluminum		"	NAS-Metal		
8.30	Nameplate, P/N 36835			Aluminum		"	NAS-Metal		
8.31	Label, Slave, P/N 36828			Aluminum		"	NAS-Metal		
8.32	Label, Probe, P/N 36829			Aluminum		"	NAS-Metal		
8.33	Receptacle, 2-Pin, P/N 28106 Cannon MS3102E14S-9B			MIL-C-5015		Connection			
8.33.1	Shell			Aluminum, Cadmium-Plated		Mechanical	NAS-Metal		
8.33.2	Insulator	90°C Continuous 120°C Intermittent		Polychloroprene	1.04 (Ref 29)	Insulation		2×10^6 (Ref 53)	
8.33.3	Contacts			Brass or Copper Alloy		Connection	NAS-Metal		
8.34	Plug, 2-Socket, P/N 28107 Cannon MS3106E14S-9S	MATERIALS SAME AS ITEM 8.33				Connection			
8.35	Receptacle, 2-Socket, P/N 28108 Cannon MS3102E14S-9S	MATERIALS SAME AS ITEM 8.33				Connection			
8.36	Plug, 2-Pin, P/N 28109 Cannon MS3106E14S-9P	MATERIALS SAME AS ITEM 8.33				Connection			

Item No.	TABLE I. AGING MATRIX (CONTINUED) Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
8.37	Cover Plate, P/N 57772			Steel		Mechanical	NAS-Metal		
8.38	Gasket, P/N 27452	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	
8.39	Receptacle, 3-Socket, P/N 10426 Cannon MS3102E14S-7S	MATERIALS SAME AS ITEM 8.33				Connection			
8.40	Plug, 3-Pin, P/N 10626 Cannon MS3106E14S-7P	MATERIALS SAME AS ITEM 8.33				Connection			
8.41	Gasket, Size #14, P/N 16600	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	
8.42	Receptacle, 2-Socket, P/N 28111 Rotated, Cannon MS3102E14S-9SW	MATERIALS SAME AS ITEM 8.33				Connection			
8.43	Insulating Tubing, P/N 26657 Syntholvar 302	80°C		Polyvinyl Chloride	1.39 (Ref 50)	Insulation		2×10^7 (Ref 28)	
8.44	Receptacle, Protective Cap, P/N 28113, Bendix 10-37398-14	125°C							
8.44.1	Cap			Aluminum		Mechanical	NAS-Metal		
8.44.2	Gasket	125°C (this application)		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	
8.45	Lock Washer, #4, P/N 22405			Stainless Steel		Mechanical	NAS-Metal		
8.46	Screw, Flat Head, P/N 29148, #4-40 x 7/16			Stainless Steel		Mechanical	NAS-Metal		

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/Temperature	Aging Mechanisms Radiation	Qualified Life Goal
8.47	Toggle Switch, SPDT, P/N 11612, Cutler Hammer MS35058-23								
8.47.1	Seal	105°C (UL)		Silicone Rubber	1.73 (Ref 29)	Mechanical		1.3×10^6 (Ref 53)	
8.47.2	Housing	150°C (UL)		GP Phenolic	1.81 (Ref 33)	Insulation/ Mechanical		3×10^6 (Ref 53)	
8.47.3	Contacts			Silver to Silver		Electronic Component	NAS-Metal		
8.47.4	Terminals			Tin-Dipped Metal Alloy		"	NAS-Metal		
8.48	Nameplate, P/N 57773			Aluminum		Reference	NAS-Metal		
8.49	Plug, 2-Pin, P/N 28112, Rotated, Cannon MS3106E14S-9PW	SAME MATERIALS AS ITEM 8.33							

TABLE 1. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: NAS = Not Age Sensitive — Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
9.0	323 Transmitter, P/N XM-54852, Revision A, Bottoming Type, J-Box Output, Bracket Parts List 57734, Revision C, Transmitter, Radiation, Type XM-54852	Indication =90" ohms/inch = 15 Total resistance = 975 ohms							
9.1	Stem Assembly, P/N 43510, 'A' Dim. = 75 1/2"			Stainless Steel		Mechanical	NAS-Metal		
9.1.1	Stem Assembly, P/N 43511 Length = 73 1/8"			"		"	"		
9.1.2	Tubing, Basic, P/N 26696			"		"	"		
9.1.3	Bracket, P/N 35750			"		"	"		
9.1.4	Adapter, P/N 43512			"		"	"		
9.1.5	End Plug, P/N 26693			"		"	"		
9.2	Float Assembly, P/N 35560								
9.2.1	Hemisphere, P/N 35561			"		"	"		
9.2.1.1	Hemisphere, P/N 17826			"		"	"		
9.2.2	Tube, Center, P/N 35562			"		"	"		
9.2.2.1	Tubing, Basic, P/N 35564			"		"	"		
9.2.3	Ring, Magnet, P/N 35563			Aluminum		"	"		
9.2.4	Magnet, P/N 14395			Alnico V		"	"		
9.2.5	Eyelet, P/N 30223			Brass		"	"		

TABLE I. AGING MATRIX (CONTINUED

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
9.3	Switch Assembly, P/N 59141			Various, as follows:		Electronic Component			40 Yrs.
9.3.1	P.C. Board, 73 1/2", P/N 26082	130°C		G10 Epoxy/ Glass	0.94 (Ref 1)			2.5×10^9 (Ref 53)	
9.3.2	Resistor (Qty: 65), P/N 32971C, 15 Ohms, 1/4W (TD-35337)	150°C Storage		TRW/IRC RG-1/4 (Meets MIL-R-10509)		"	NAS (Ref 3 & 24)	1×10^9 (Ref 28)	
9.3.3	Ductorseal, P/N 58954, Douglas Engineering #7759	121°C Operation 177°C Intermittent				Mechanical			
9.3.3.1	Wire, #18, P/N 46825 Haveg #721816, Legend 2	150°C		EXAR-500 Cross-Linked Polymer (Polyolefin)	1.09 (Ref 29)	Insulation		2×10^7 (Ref 52)	
9.3.3.2	Potting Compound	205°C		Epoxy (Assume Epon 828)	1.09 (Ref 49)	"		9.5×10^8 (Ref 28)	
9.3.4	Resistor (Qty: 3), P/N 32981 330 Ohms, 1/4W (TD-35337)	150°C Storage		TRW/IRC RG-1/4 (Meets MIL-R-10509)		Electronic Component	NAS (Ref 3 & 24)	"	
9.3.5	Switch (Qty: 68), P/N 28425 Gordos MR 708-2	-55°C to 125°C 10 million cycles at 1A		Glass, Rhodium-Plated Contacts		"	NAS-Metal, Glass		
9.3.6	Jumper Wire, #24, P/N 41721 Yellow, Raychem Spec. 44/0111-24	150°C		Polyalkene Kynar Coated	2.08 (Kynar) (Ref 43)	Insulation		Useful to 5×10^8 (Ref 59)	
9.3.7	O-Ring, 2-016, P/N 59159	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
9.3.8	Wire, #22AWG, P/N 41719, Red, Black, and White, Raychem Spec. 44/0111-22	150°C		Polyalkene Kynar Coated	2.08 (Kynar) (Ref 43)	Insulation		Useful 5×10^8 (Ref 59)	
9.4	J-Box Weldment, P/N 57688			Stainless Steel		Mechanical	NAS-Metal		
9.4.1	J-Box (Rework), P/N 54843			"		"	"		
9.4.1.1	J-Box (Basic), P/N 29884			"		"	"		
9.4.2	Adapter, P/N 57689			"			"		
9.4.3	Elbow (Rework), P/N 57691			"		"	"		
9.4.3.1	Elbow (Basic), P/N 57690			"		"	"		
9.4.4	Adapter, P/N 29888			"		"	"		
9.4.5	Ground Lug, P/N 57758			"		"	"		
9.5	Retaining Ring, P/N 58959			"		"	"		
9.6	Adapter Assembly, P/N 39558			"		"	"		
9.6.1	Adapter, P/N 36764			"		"	"		
9.6.2	Conduit Connector, P/N 39557			"		"	"		
9.7	Nut, Hex, P/N 17308			"		"	"		
9.8	Nameplate, P/N 27337			"		"	"		
9.9	Lockwire, P/N 12009			"		"	"		
9.10	Shock, Tubing, P/N 26543	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Insulation		2×10^6 (Ref 53)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
9.11	Butt Connector, P/N 51716	175°C						2×10^7 (Ref 28)	
9.11.1	Terminal			Tin-Plated Copper		Connection	NAS-Metal		
9.11.2	Insulation			Polyvinyl Chloride	1.39 (Ref 50)	Insulation		2×10^7 (Ref 28)	
9.12	Bracket, P/N 57681			Stainless Steel		Mechanical	NAS-Metal		
9.13	Silicone Fluid, P/N 58956	260°C		Dow #710	0.88 (Ref 36)	"		2×10^8 (Ref 36)	
9.14	Loctite, P/N 40049, Pipe Sealant HVV Cat. #71	149°C		Methacrylate	2.09 (Ref 31)	"		2×10^8 (Ref 31)	
9.15	O-Ring, #3-916, P/N 39157	90°C Continuous 120°C Intermittent		Neoprene	1.0[illegible] (Ref 29)	"		2×10^6 (Ref 53)	
9.16	Screw, Hex-Head Cap, P/N 32309			Stainless Steel		"	NAS-Metal		
9.17	Flat Washer, P/N 32313			"		"	"		
9.18	Locknut, Hex, P/N 57686			"		"	"		
9.19	Shrinkable Tubing, P/N 58957	150°C Intermittent; 90°C continuous		Raychem WCSF-N	1.29 (Ref 29)	Insulation		2×10^8 (Ref 30)	
9.20	Lockwasher, 1/4", P/N 46701			Stainless Steel		Mechanical	NAS-Metal		
9.21	Terminal Lug, P/N 33285			Tin-Plated Copper/PVC	1.39 (Ref 50)	Connection/ Insulation		[illegible] $\times 10^7$ (Ref 28)	

QUALIFICATION PLAN NO. 45102-1

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
9.22	Insulating Tube, P/N 53142	140°C (UL)		G11 Epoxy/ Glass	0.95 (Ref 1)	Insulation		8.3×10^9 (Ref 28)	
9.23	Tubing (Basic), P/N 39571	140°C (UL)		G11 Epoxy/ Glass	0.95 (Ref 1)	"		8.2×10^9 (Ref 28)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
.0	323 Transmitter, XM-54853, Bottoming/XFR Type, Bracket-Mounted, J-Box Output, Drawing No. XM-60076, P/N 60076	Inches of indication = 90" ohms/inch = 15 ohms. Total resistance = 1,335 ohms,							40 Yr
.1	Stem Assembly, P/N 43510 'A' Dim. = 72 1/2"			Stainless Steel		Mechanical	NAS-Metal		
.1.1	Stem (Length 73 1/8"), P/N 43511			"		"	"		
.1.1.1	Tubing (Basic), 6', P/N 26696			"		"	"		
.1.2	Bracket, P/N 35750			"		"	"		
.1.3	Adapter, P/N 43512			"		"	"		
.1.4	End Plug, P/N 26693			"		"	"		
.2	Float Assembly, P/N 35560								
.2.1	Hemisphere, P/N 35561			"		"	"		
.2.2	Tube, Center, P/N 35562			"		"	"		
.2.2.1	Tubing (Basic), P/N 35564			"		"	"		
.2.3	Ring, Magnet, P/N 35563			Aluminum		"	"		
.2.4	Magnet, P/N 14395			Alnico V		"	"		
.2.5	Eyelet, P/N 30223			Brass		"	"		

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms Time/Temperature	Aging Mechanisms Radiation	Qualified Life Goal
10.3	Switch Assembly, P/N 59143	(INCLUDES ITEMS 2.3.1 THROUGH 2.3.8)				Electronic			
10.3.1	P.C. Board, P/N 26082 Length 97 1/2"	130°C		G10	0.94 (Ref 1)	Mechanical/ Insulation		5.5×10^8 (Ref 28)	
10.3.2	Switch (Qty: 93), P/N 28425 Reed Switch, Gordos MR/08-2	125°C 10 million cycles at 1A		Glass, Rhodium-Plated Contacts		Electronic	NAS-Glass/Metal		
10.3.3	Resistor (Qty: 65), P/N 32971, 15 Ohms, 1/4W (TD-35337)	150°C		TRW/IRC RG-1/4(Meets MIL-R-10509)		"	NAS (Ref 3)	1×10^9 (Ref 28)	
10.3.4	Ductorseal, P/N 58954 Douglas Engineering Co. #7759					Connection			
10.3.4.1	Wire, #18, P/N 46825 Havey #721816, Legend 2	150°C (UL)		EXAR-500 Cross-Linked Polyolefin	1.09 (Ref 29)	"		2×10^7 (Ref 52)	
10.3.4.2	Potting Compound	177°C		Epoxy, Equiv. to Epon 828	1.09 (Ref 49)	Mechanical		9.5×10^8 (Ref 28)	
10.3.5	Resistor (Qty: 3), P/N 32981 330 Ohms, 1/4W (TD-35337)	150°C		TRW/IRC RG-1/4(Meets MIL-R-10509)		Electronic	NAS (Ref 3)	1×10^9 (Ref 28)	
10.3.6	Jumper Wire #24 AWG,P/N 41721 Raychem Spec. 44/0111-24	150°C (Ref 59)		Polyalkene W/Kynar Coating	2.08(Kynar) (Ref 43)	Connection		2×10^8 (Ref 42)	
10.3.7	O-Ring #2-016, P/N 59159 (TD-39159)	90°C Continuous 120°C Intermittent		Neoprene	1.04 (Ref 29)	Mechanical		2×10^6 (Ref 53)	
10.3.8	Wire, #22AWG, P/N 41719 Red, White, Black, Green Raychem Spec. 44/0111-22	150°C		Polyalkene, Kynar Coated	2.08 (Ref 43)	Connection		2×10^8 (Ref 42)	

Item No.	TABLE I. AGING MATRIX (CONTINUED) Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms		Qualified Life Goal
							Time/ Temperature	Radiation	
0.4	J-Box Weldment, P/N 57784			Stainless Steel		Mechanical	NAS-Metal		
0.4.1	J-Box (Rework) P/N 54846			"		"	"		
0.4.1.1	J-Box (Basic) P/N 29884			"		"	"		
0.4.2	Adapter, P/N 57689			"		"	"		
0.4.3	Elbow (Rework) P/N 57691			"		"	"		
0.4.3.1	Elbow (Basic) P/N 57690			"		"	"		
0.4.4	Adapter, P/N 29888			"		"	"		
0.4.5	Ground Lug, P/N 57758			"		"	"		
0.5	Retaining Ring, P/N 58959			"		"	"		
0.6	Adapter Assembly, P/N 39558			"		"	"		
0.6.1	Adapter, P/N 36764			"		"	"		
0.6.2	Conduit Connector, P/N 39557			"		"	"		
0.7	Nut, Hex, P/N 17308			"		"	"		
0.8	Nameplate, P/N 27337			"		"	"		
0.9	Lockwire, P/N 12009			"		"	"		
0.10	Shock Tubing, P/N 26534	90°C Continuous 120°C Intermittant		Neoprene	1.04 (Ref 29)	"		2×10^6 (Ref 55)	

TABLE I. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
0.11	Butt Connector, P/N 51716 Hollingsworth Fit No. B4070	175°C							
0.11.1	Barrel			Tin-Plated Copper		Connection			
0.11.2	Insulation			Polyvinyl Chloride	1.3[illegible] (Ref 50)	Insulation		2×10^7 (Ref 28)	
0.12	Bracket, P/N 57681			Stainless Steel		Mechanical	NAS-Metal		
0.13	Silicone Fluid, P/N 58956	260°C		DOW #710	0.88 (Ref 36)	"	NAS Below 250°C (Ref 36)	2×10^8 (Ref 36)	
0.14	Loctite, P/N 40049 Pipe Sealant, HVV Cat. #71	149°C		Methacrylate	2.09 (Ref 31)			2×10^8 (Ref 31)	
0.15	O-Ring #3 316, P/N 39157	90°C Continuous 1[illegible]0°C Intermittent		Neoprene	1.04 (Ref 29)	"		2×10^6 (Ref 53)	
0.16	Screw, Hex-Head Cap, P/N 32309			Stainless Steel		"	NAS-Metal		
0.17	Washer, Flat, P/N 32313			"		"	"		
0.18	Locknut, Hex, P/N 57686			"		"	"		
0.19	Shrinkable Tubing, P/N 58957 Raychem WCSF-N	150°C Intermittent; 90°C continuous		Polyolefin	1.29 (Ref 30)	Insulation		2×10^8 (Ref 30)	
0.20	Lockwasher, 1/4, P/N 46701			Stainless Steel		Mechanical	"		

TABLE 1. AGING MATRIX (CONTINUED)

Item No.	Item and Manufacturer	Manufacturer's Rating Environmental and Operational	Service Environmental Conditions	Materials	Activation Energy (eV)	Application	Aging Mechanisms: Time/Temperature	Aging Mechanisms: Radiation	Qualified Life Goal
10.21	Ductorseal, P/N 58954, Douglas Engineering Co. #7759								
10.21.1	Wire, #18, P/N 46825 Haveg 721816, Legend 2	150°C		EXAR-500 Cross-Linked Polymeric (Polyolefin)	1.09 (Ref 29)	Mechanical/ Insulation		2×10^7 (Ref 52)	
10.21.2	Potting Compound	177°C		Epoxy (Equiv. to Epon 828)	1.09 (Ref 49)	"	X	9.5×10^8 (Ref 28)	
10.22	Terminal Lug, 1/4, P/N 33285 Hollingsworth, R4150F	175°C		Tin-Plated Vinyl Insul.	1.39 (Ref 50)	Connection		2×10^7	
10.23	Insulating Tubing, P/N 59142	140°C (UL)		G11 Epoxy/ Glass	0.95 (Ref 1)	Insulation		8.3×10^9 (Ref 28)	
10.23.1	Tubing (Basic) P/N 39571	140°C (UL)		"	0.95 (Ref 1)	"		8.3×10^9 (Ref 28)	

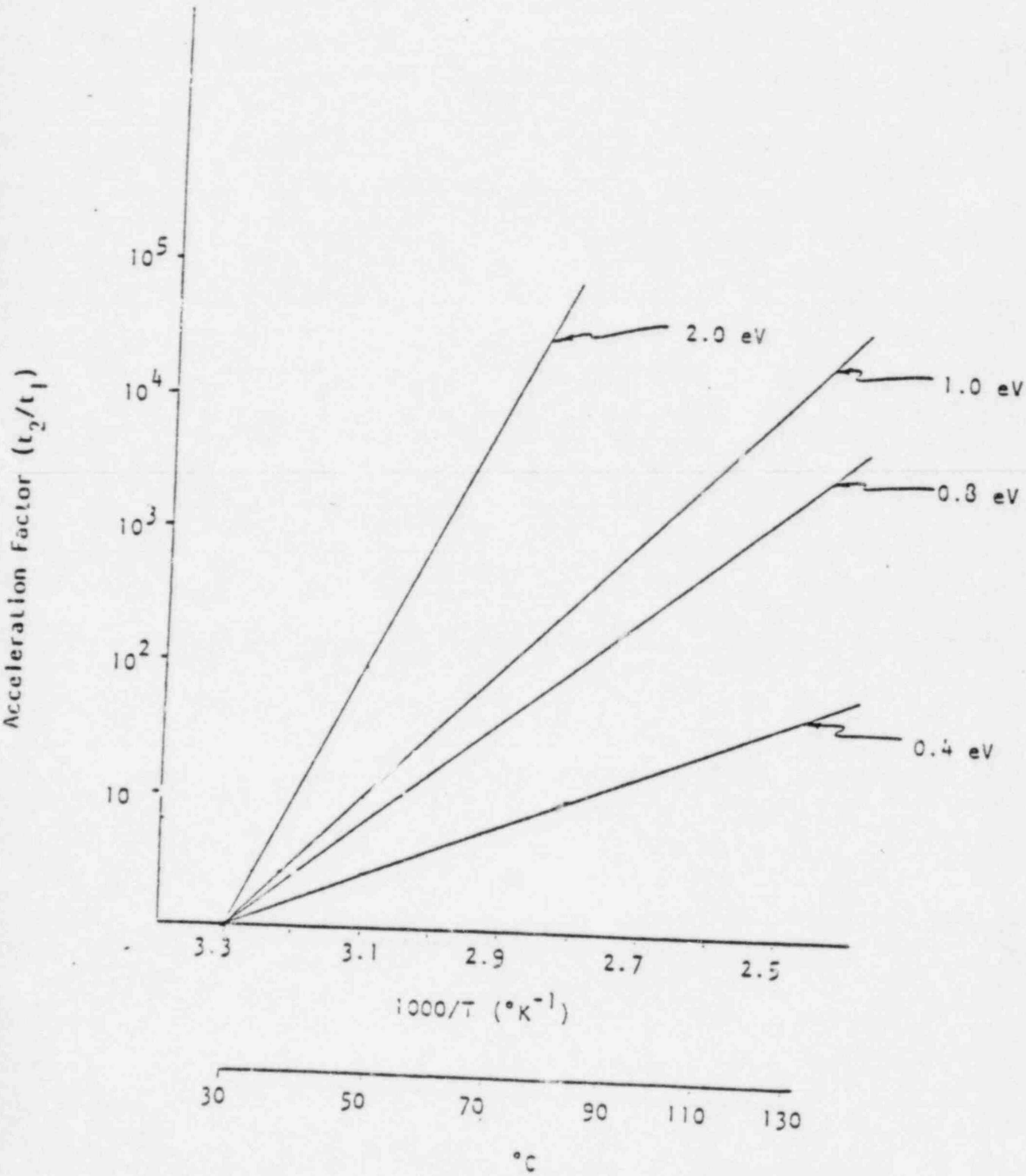


FIGURE 1. Acceleration Factor Versus (1/T) for Activation Energies of [illegible]

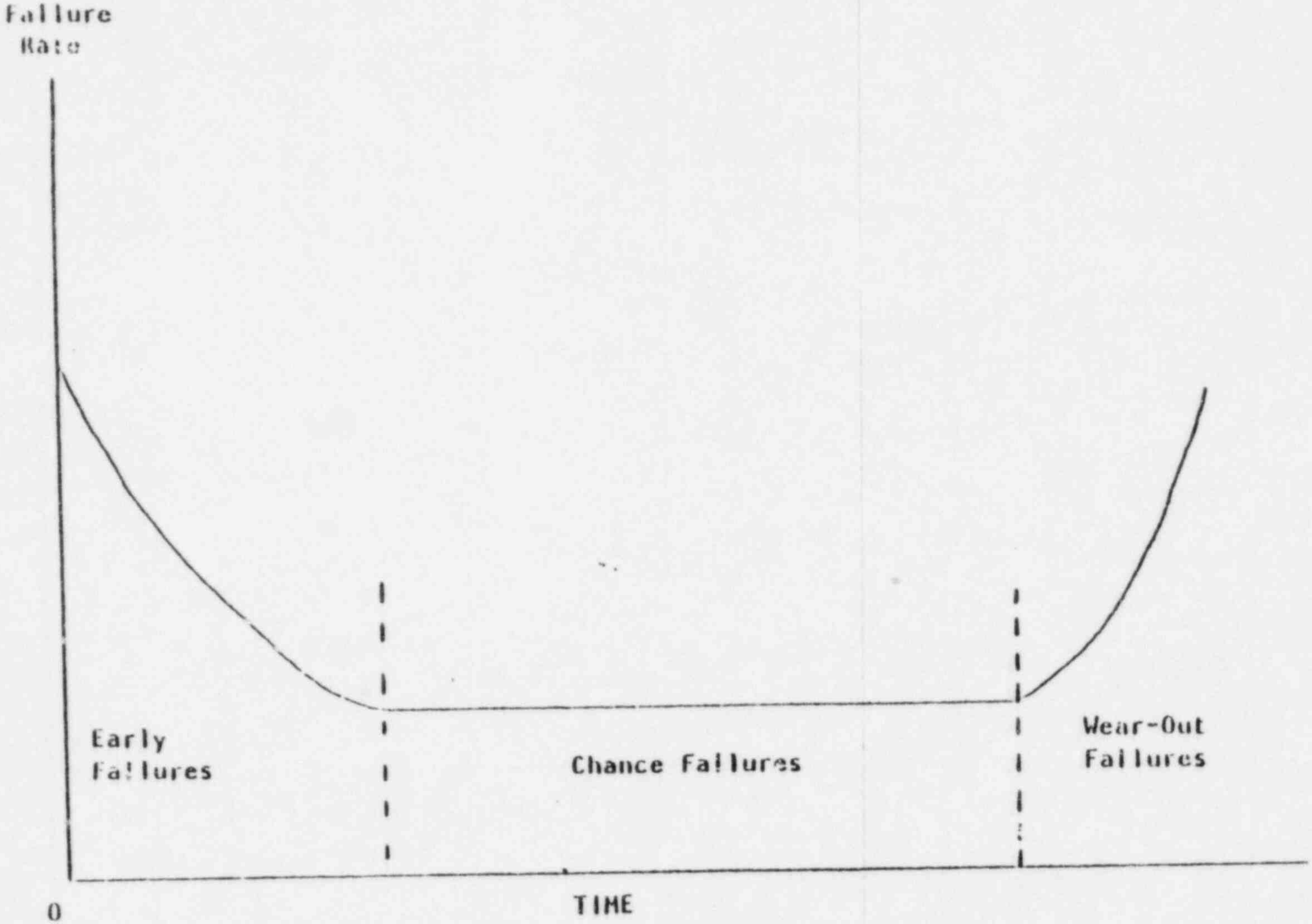


FIGURE 2. Failure Rate Curve

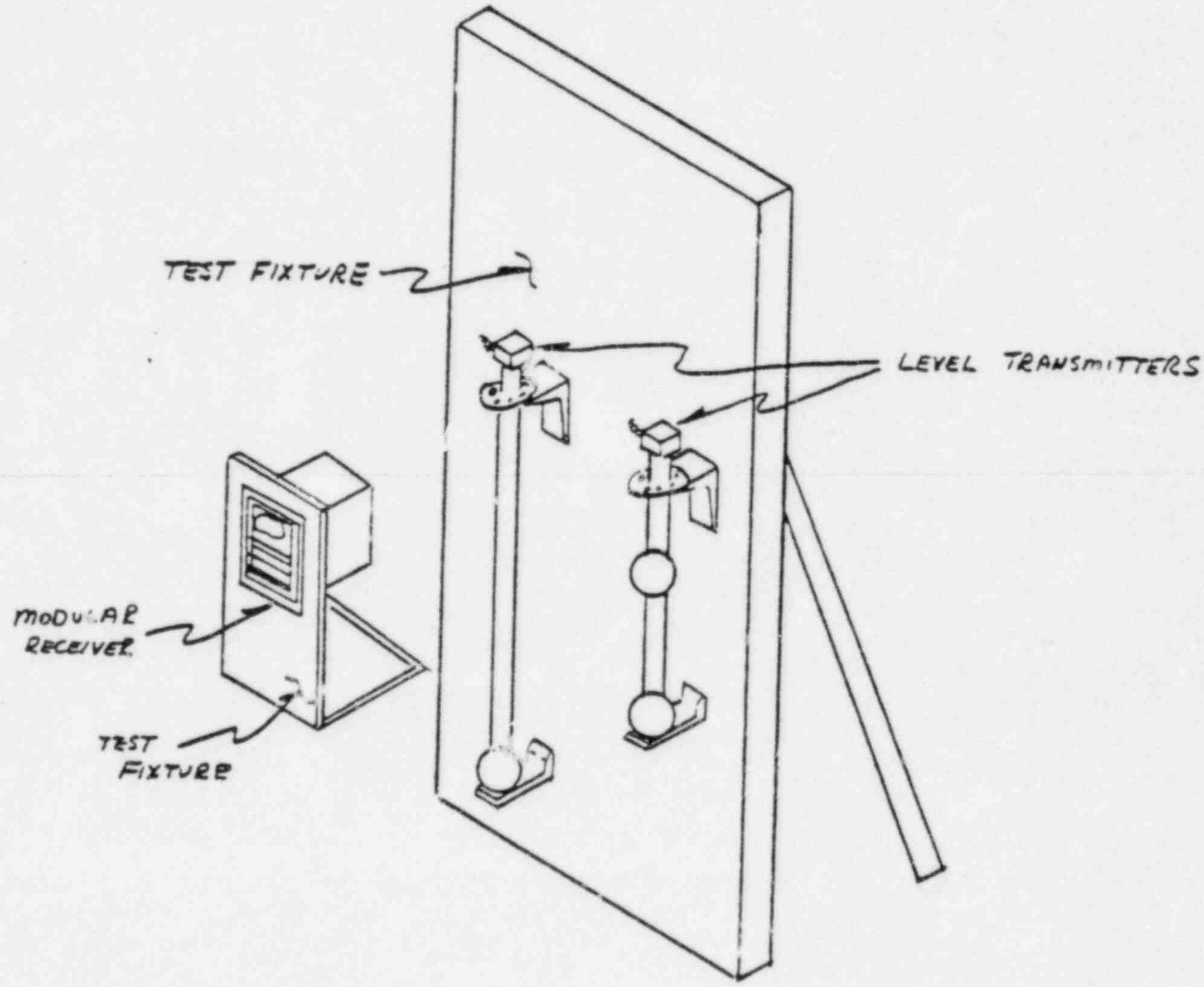
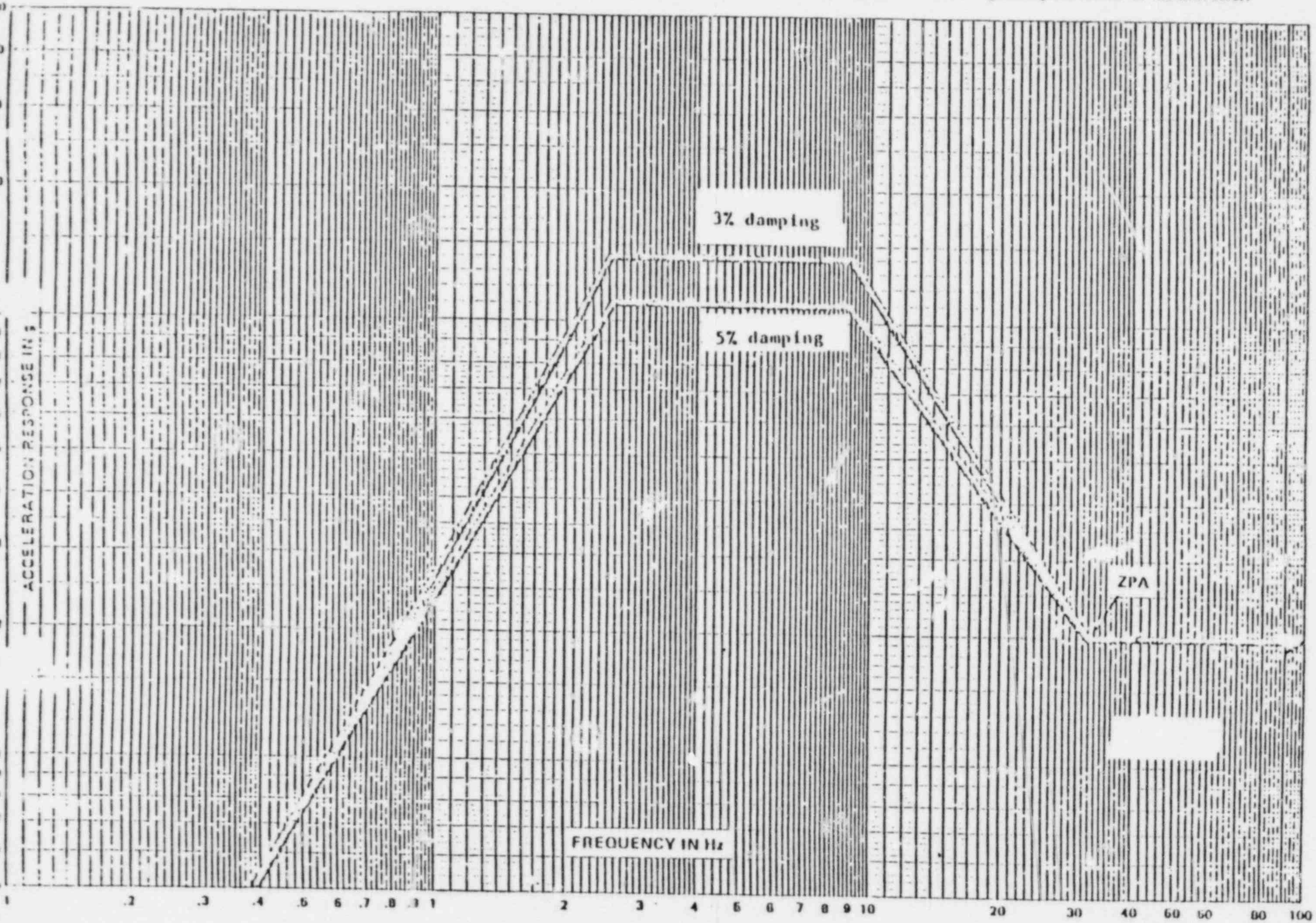

TEST FIXTURE
LEVEL TRANSMITTERS
MODULAR RECEIVER
TEST FIXTURE

FIGURE 3



SPECIFICATION 10466-J820

FIGURE 4. Required Response Spectrum (?RS) for Control Systems Purposes for the Majority of Nuclear Power Plant Locations in the Continental United States.

FULL SCALE SHOCK SPECTRUM (g Peak)

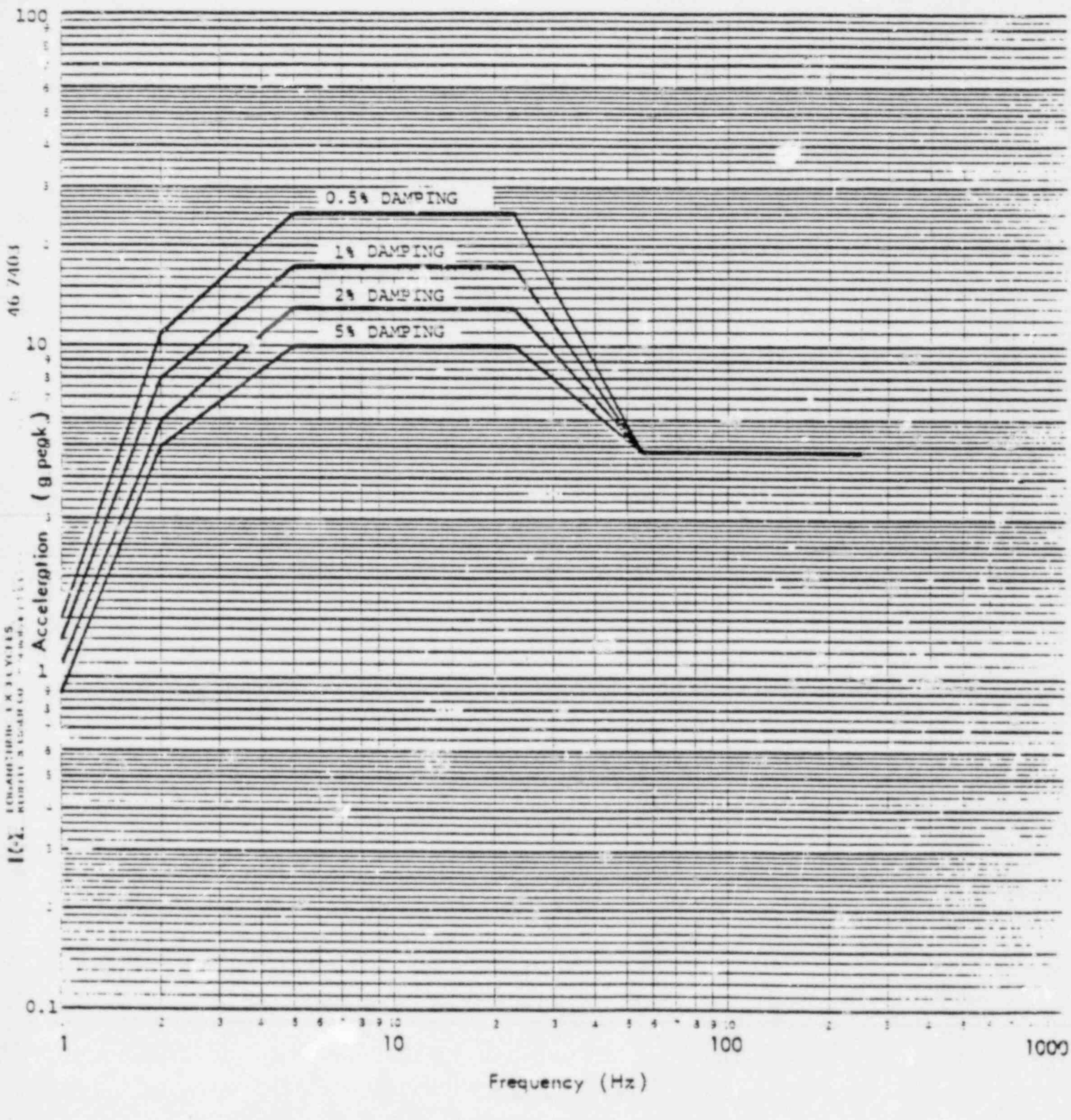


FIGURE 5. APPROXIMATE HORIZONTAL AND VERTICAL BROADBAND LIMITATIONS OF THE WYLE MULTIAXIS (MACHINE "D") SEISMIC SIMULATOR. RESPONSE ANALYZED AT THE DAMPING SHOWN.

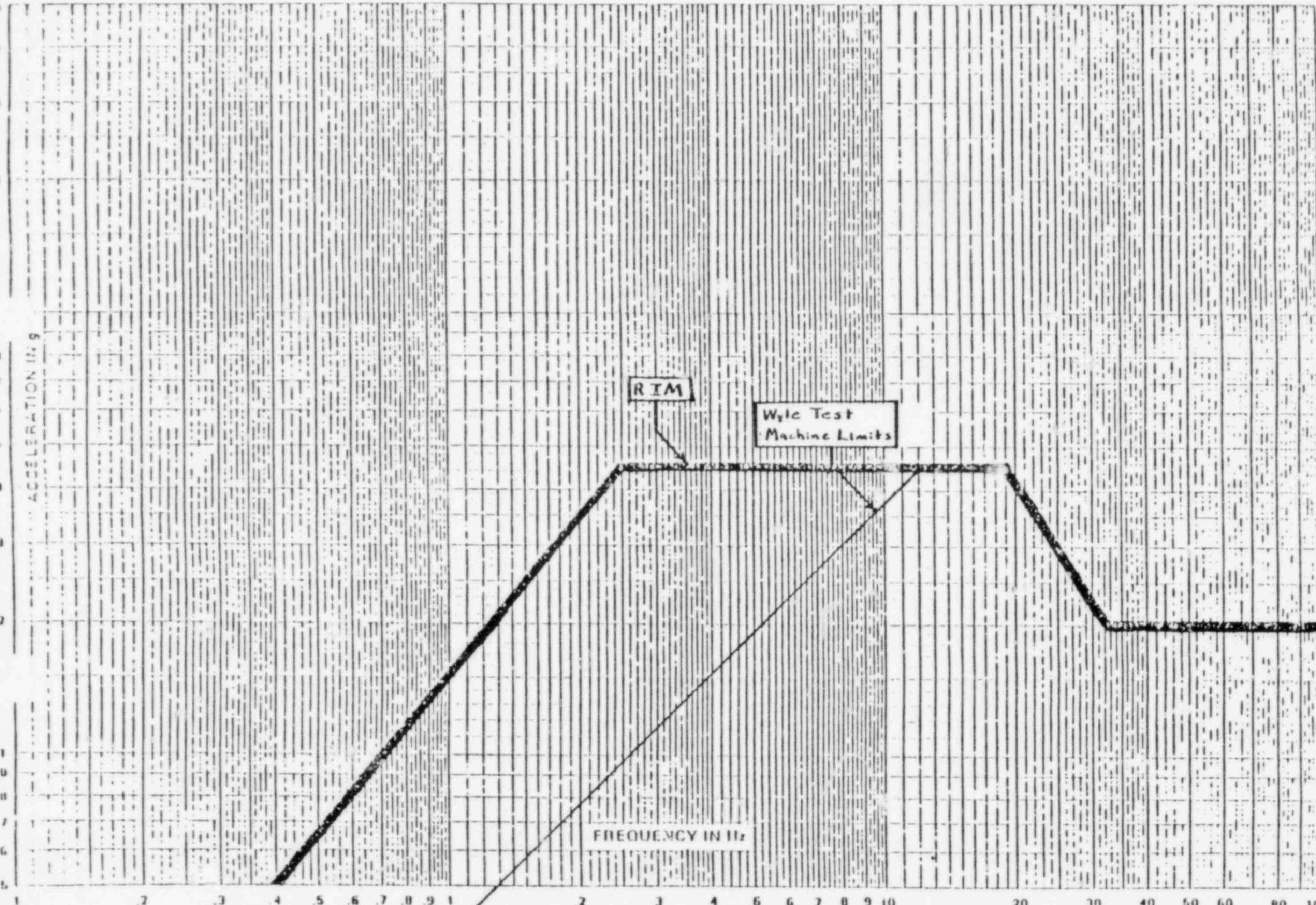


FIGURE 6. Required Input Motion (RIM) for Control Systems Purposes for Line Mounted Devices for the Majority of Nuclear Power Plant Locations in the Continental United States.

SPECIFICATION 10466 J820

FIGURE 2
REVISION 0

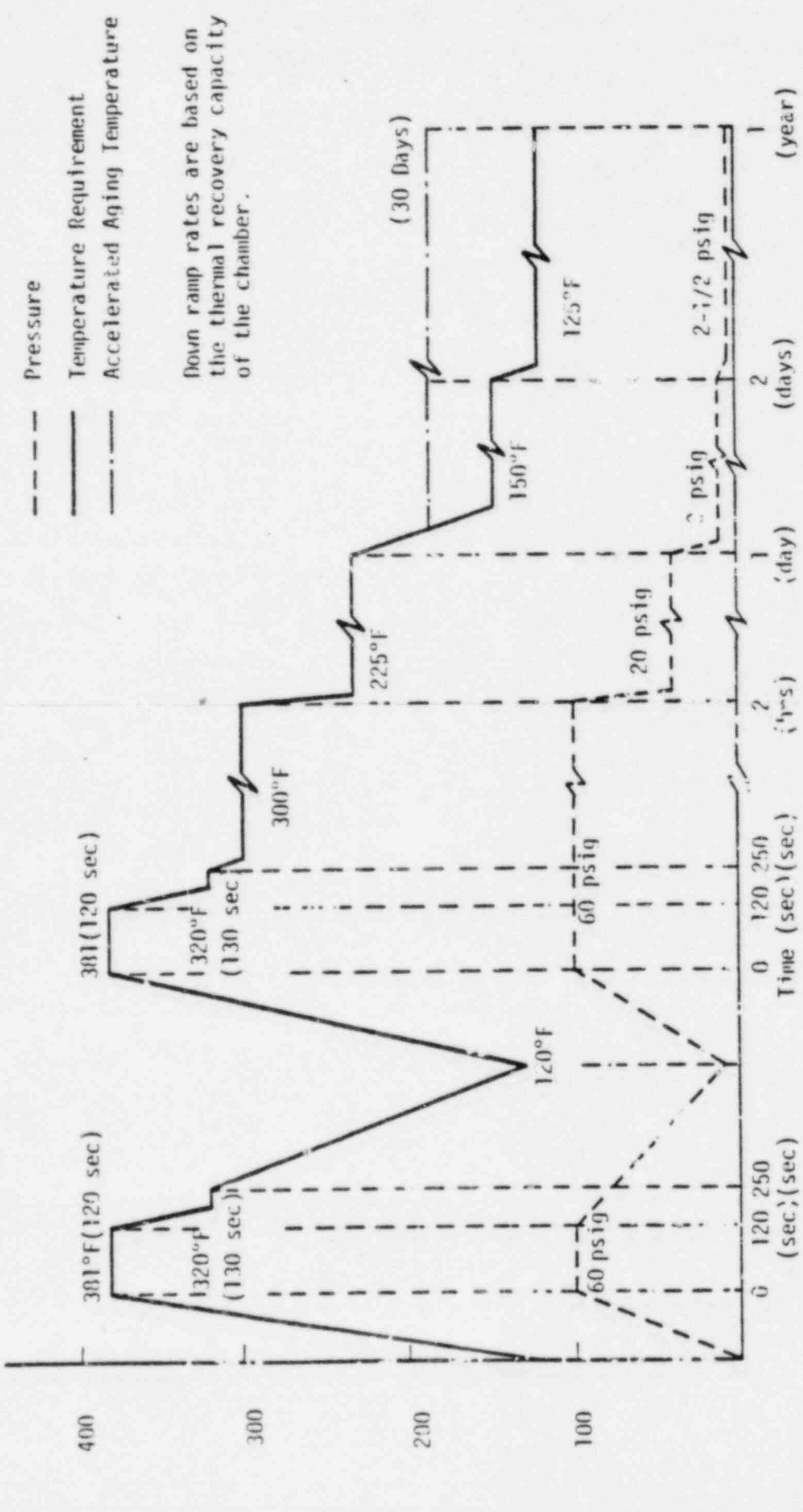


FIGURE 7. LOCA/MSLB Simulated Profile