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Docket Nos. 50-275
and 50-323

OCT 3 0 1978

MEMORANDUM FOR: John Stolz, Chief, Light Water Reactors Branch No. 1, DPM

FROM: Dennis Allison, Project Manager, Light Water Reactors Branch No. 1, DPM

SUBJECT: DIABLO CANYON INFORMAL INFORMATION

The enclosed draft, informal material was provided by General Electric Company on October 26, 1978. The material responds to questions we asked about the qualification of Diablo Canyon electrical penetrations (manufactured by GE) at a meeting with PG&E and GE on August 30, 1978.

Much of the information contained in the enclosure was previously submitted by PG&E on the Diablo Canyon docket in a letter dated October 11, 1978. Some of the information related to qualification testing of a penetration that had previously leaked in the field is new. We expect that this new information will also be formally submitted in the future on the Diablo Canyon docket.

The purpose of this memorandum is to provide the material to the parties and the Public Document Room.

Original Signed By
Dennis P. Allison
Dennis Allison, Project Manager
Light Water Reactors Branch No. 1
Division of Project Management

Enclosure:
As Stated

ccs w/enclosure:
See next pages

M 4
GD

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DATE➤	10/ /78					

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OCT 30 1978

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OCT 3 0 1978

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ROUGH DRAFT

GENERAL ELECTRIC

NUCLEAR ENERGY

PROJECTS DIVISION

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October 16, 1978

U. S. Nuclear Regulatory Commission
Division of Project Management
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Attention: Mr. D. P. Allison, Project Manager
Light Water Reactors Branch No. 1

Gentlemen:

This letter is in response to questions raised during a meeting August 30, 1978 between the General Electric Company and the NRC's Light Water Reactor Branch No. 1, to discuss the qualification of electrical penetration assemblies supplied for the Diablo Canyon Project. Subsequent to the aforementioned meeting, additional information was requested by Division of Operating Reactors regarding penetration assembly repair and the acceptability of repaired assemblies.

The following summarizes the NRC interests addressed herein:

1. Justification of qualification by similarity of the Diablo Canyon penetration assemblies,

2. Verification that repaired assemblies are qualified for their intended application, and

3. General Electric knowledge of penetration assemblies which have been repaired.

RESPONSE TO QUALIFICATION BY SIMILARITY

Attachment 1 to this letter provides the rationale for qualification by similarity. Diablo Canyon utilizes the canister design assembly, currently in use in a number of operating reactors, e.g., Millstone 1, Oyster Creek, Monticello, Dresden 2 & 3, Quad Cities 1 & 2, etc. The canister design is environmentally qualified due to the similarities in its design to the 100 series electrical penetration assemblies which have successfully completed several simulated LOCA environmental qualification tests. Attachment 1 concludes that the results of the 100

series environmental qualification are directly applicable to the canister assembly due to distinct design similarities, i.e., epoxy, steel and conductors. Also, relative to environmental considerations the canister assembly is a more conservative design than the 100 series. (The 100 series LOCA environment qualification test report was submitted to the Power Systems Branch during the August 30, 1978 meeting.)

ENVIRONMENTAL QUALIFICATION OF ELECTRICAL PENETRATION ASSEMBLIES EXHIBITING GAS LEAKAGE

Attachments 2 and 3 are reports of LOCA and post-LOCA environment qualification tests, performed on two penetration assemblies received from Millstone 2. Both assemblies were found to be deficient, i.e., exhibited gas leakage in excess of specification. The penetrations were returned to General Electric Company and subsequently subjected to the year-long environmental qualification test described by Attachments 2 and 3.[1] The test demonstrates that at temperatures well below ~~that~~ those postulated to occur during a LOCA, post-LOCA ~~temperatures~~, the stresses which created the fissures were alleviated such that a leak tight boundary (per the requirements of IEEE 317-1972) was formed.

Penetration assemblies exhibiting excessive gas leakage in the field are field repaired. The repair consists of pulling, by ~~vacuum~~, a chemically compatible resin into the fissure. The repaired assembly is then gas-leak tested pursuant to IEEE-317. Periodic surveillance of the seals verify the acceptability of the repair.

ADDITIONAL INFORMATION

In no case has General Electric repaired a penetration assembly where both redundant seals exhibited leakage and where the fissure was so large that repair was impossible. Only General Electric Company authorized personnel have made these repairs. No penetration assembly exhibiting gas leaks prior to final release to a customer has ever been shipped.

Both canister and 100 series assemblies employ an epoxy system as the electrical isolator and part of the pressure barrier. In both designs there is a circumference of steel with epoxy embeded therein. Epoxy exhibits one-to-two or more orders of magnitude greater thermal expansion than steel. Any fissure in the epoxy is the result of shrinkage or mechanical fracture.

[1] Evidence indicating that the electrical penetration assemblies were deficient prior to testing is not contained in the test reports. Northeast Utilities and General Electric are currently searching their records to obtain data. In any event, the only data available to General Electric [illegible]

During any postulated incident where containment temperature rises, the epoxy will necessarily expand and soften, causing the small fissures to seal. The aforementioned repair procedure ensures that at any temperature elevation a gas tight seal will be provided.

General Electric's recommendation for periodic monitoring of the seals assures that annoyance leakage will be remedied, and that any remote postulated event will not violate the containment barrier through the assurance that two reliable seals are in place, ~~Although~~ All qualifications have demonstrated that only one seal is necessary to maintain containment integrity.

Each epoxy system currently utilized in General Electric's electrical penetration assemblies has demonstrated sufficient margin to maintain pressure integrity (tested at 102 psig saturated steam conditions). The Millstone 2 qualification test demonstrates the relative mechanical properties of epoxy and steel. Therefore, the Diablo Canyon 1 penetration assemblies will maintain containment integrity in the unlikely event of a LOCA.

Very truly yours,

James W. Cleveland, Sr. Engineer
BWR Product Standards

JWC:bp/1048-50

Attachments

cc: Mr. G. C. Lainas, Chief
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bp/1048-50

ATTACHMENT 1

COMPARISON OF CANNISTER AND 100 SERIES PENETRATION DESIGNS

The 100 Series Electrical Penetration design can be used as the basis for qualification of the cannister design because of the direct correlations between the two penetration designs. The 100 Series modular design was developed by reducing the 12 inch cannister concept to a 2-1/2 inch module. The materials that would be exposed to the LOCA environment are the same in both configurations. These materials included steel, XR5126 epoxy, electrical conductors, and potting boards.

Both the cannister and the modular design used an epoxy system as the electrical isolator and part of the pressure barrier. The cannister design included a steel header plate embedded in the epoxy and the conductors were routed through this plate before being spliced together and held in place by the potting boards. The 100 Series modular design has only the epoxy to provide a barrier between the environment and the pin type connection. The pin connections in the module are less than 1-3/4 inches from the environment as compared with a minimum of 3 inches to the splices in the cannister design.

The spacing between conductors in the 100 Series design is closer than in the cannister design. The conductor center-to-center distance in the modular design is .140 inches as compared to .306 inches in the cannister design for the same sized conductors.

The distortion of the splices during crimping may result in a reduced distance between conductors. However, the reduced distance is still further apart than the spacing between conductors in the 100 Series design.

The following should be noted in summarizing the two penetration designs:

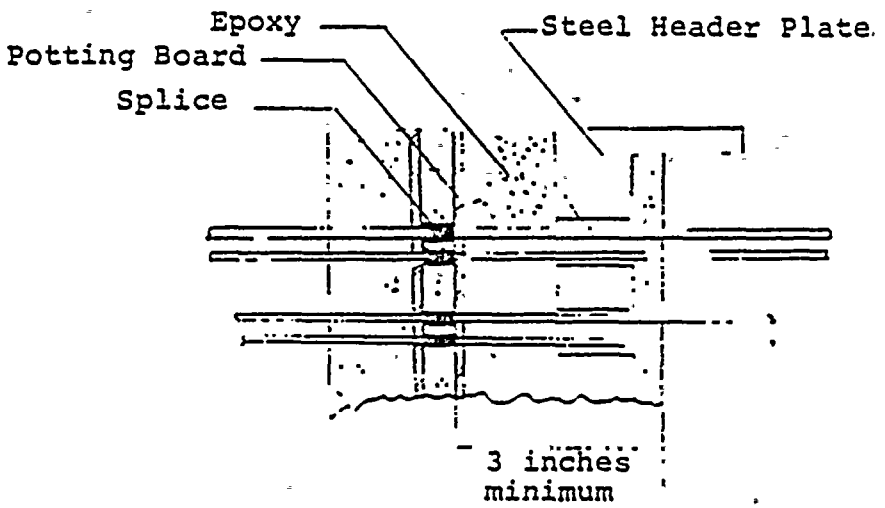
1) Overall design configurations are basically the same
2) Materials subject to the LOCA environment are the same
3) Both designs were built to the same overall quality standards and design parameters

Additional conservative features in the cannister design are: 1) the separation between conductors is greater than in the modular design, 2) the splice connections are a minimum of 3 inches from the exposed surfaces as compared to 1-3/4 inches on the modular design, and 3) the cannister has the additional protection of a steel header plate embedded in the epoxy.

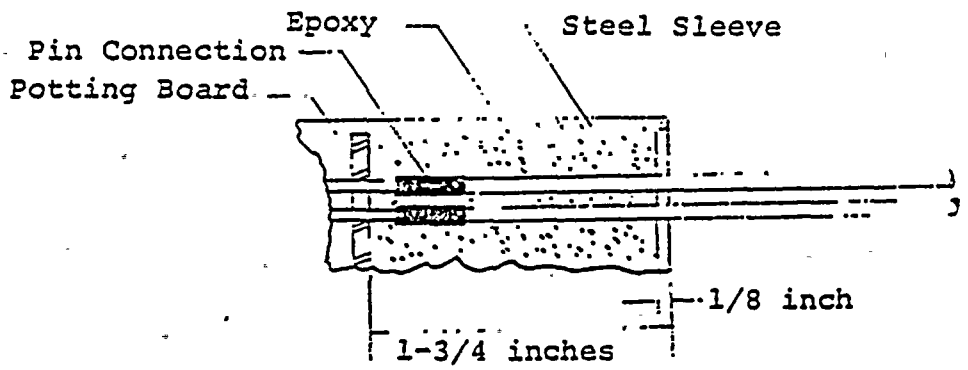
Based on the design similarities and the more conservative features in the cannister design, the qualification testing perfomred on the 100 Series modules demonstrates the acceptability of the cannister design.

CANNISTER AND MODULE CONFIGURATIONS

CANNISTER DESIGN



SERIES 100 MODULAR DESIGN



TITLE: PROTOTYPE TEST REPORT
LOW VOLTAGE ELECTRIC PENETRATIONS
SIMULTANEOUS LOCA, CURRENT & VOLTAGE TEST

FIRST MADE FOR: REFERENCE BECHTEL SPECIFICATION 7604-E34

941-S1610-5

CONT ON SHEET 2 SH NO. 1

REVISIONS

BCK-2713

1.0 INTRODUCTION

This report is applicable to the low voltage electric penetrations which we required to carry a specified current/voltage during the LOCA service environment.

Two generic design penetration modules were selected for this test: #4/0 (4 conductor) and #16 (140 conductor). The 4/0 module was completely aged prior to the test; the #16 module was only irradiated prior to the test. In addition, only low voltage power wire sizes (#8 thru 4/0) have specified current values tested in the specification. For the #16 AWG module, assumed oeprating values for current and voltage were selected by General Electric Company.

2.0 REFERENCES

Bechtel Specification 7604-E-34 para. 12.3.2b7
General Electric Company, Table I, Data Sheet

3.0 TEST REQUIREMENTS

Simultaneously with the below listed LOCA environment, the 4/0 conductors shall carry 148 amps @460 Vac.

Temperature °F	289	260	220
Pressure psig	54	40	20
%RH	100	100	100
Duration	15 min.	45 min.	23 hours

The assumed electrical loading for the #16AWG module is 3 amps @120 Vac.

4.0 TEST HARDWARE

Name	Dwg. No.	Serial No.
4/0	157C4837G001	Y7257-312
#16	157C4836G003	Y7257-259

5.0 TEST SET UP

The two modules were installed in an actual header plate which is mounted to self contained autoclave. The autoclave is partially filled with water containing H_3BO_3/NaOH to make the pH of the solution 10.2. A Calrod™ heater element is used to boil the solution and raise the temperature in the autoclave. In addition, nitrogen gas is added to the vessel (~10 psig) to achieve the specified environment. Figures 1 and 2 define the electrical test set up during the LOCA environment.

PRINTS

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6.0 TEST RESULTS

The two modules were subjected to the environment and electrical loading defined in para. 3.0.Prior to this testing, the modules received the following aging.

#4/0 66 thermal cycles, 50-150-50°F,
3 to 4 cycles per day @100% RH
5×10^7 Rad, gamma exposure

#16 No thermal aging
5×10^7 Rad, gamma exposure

After completion of all testing, both modules were helium leak tight to less than 1×10^{-6} cc/sec @20 psig. An exact value is not provided since the recorders on the helium mass spectrometer showed no sign of change from the calibration of 1×10^{-9} cc/sec.

The effects of irradiation on the epoxy inthe module is to increase the electrical insulation resistance. As the specified value of 1×10^8 Rad is not attained until the end of Post LOCA, a test on the modules which were previously irradiated to this value would not constitute realistic conditions. The value selected (5×10^7 R) increases the hardness of the epoxy but has negligible affect on electrical properties. In addition, 5×10^7 R is the exposure that the secondary seal experiences due to protection from the headerplate. This test, therefore, as conducted, affords the module with the greatest chance of electrical breakdown during LOCA service environments.

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PROTOTYPE TEST REPORT
LOW VOLTAGE ELECTRIC PENETRATIONS
SIMULTANEOUS LOCA, CURRENT & VOLTAGE TEST
REFERENCE BECHTEL SPECIFICATION 7604-E34

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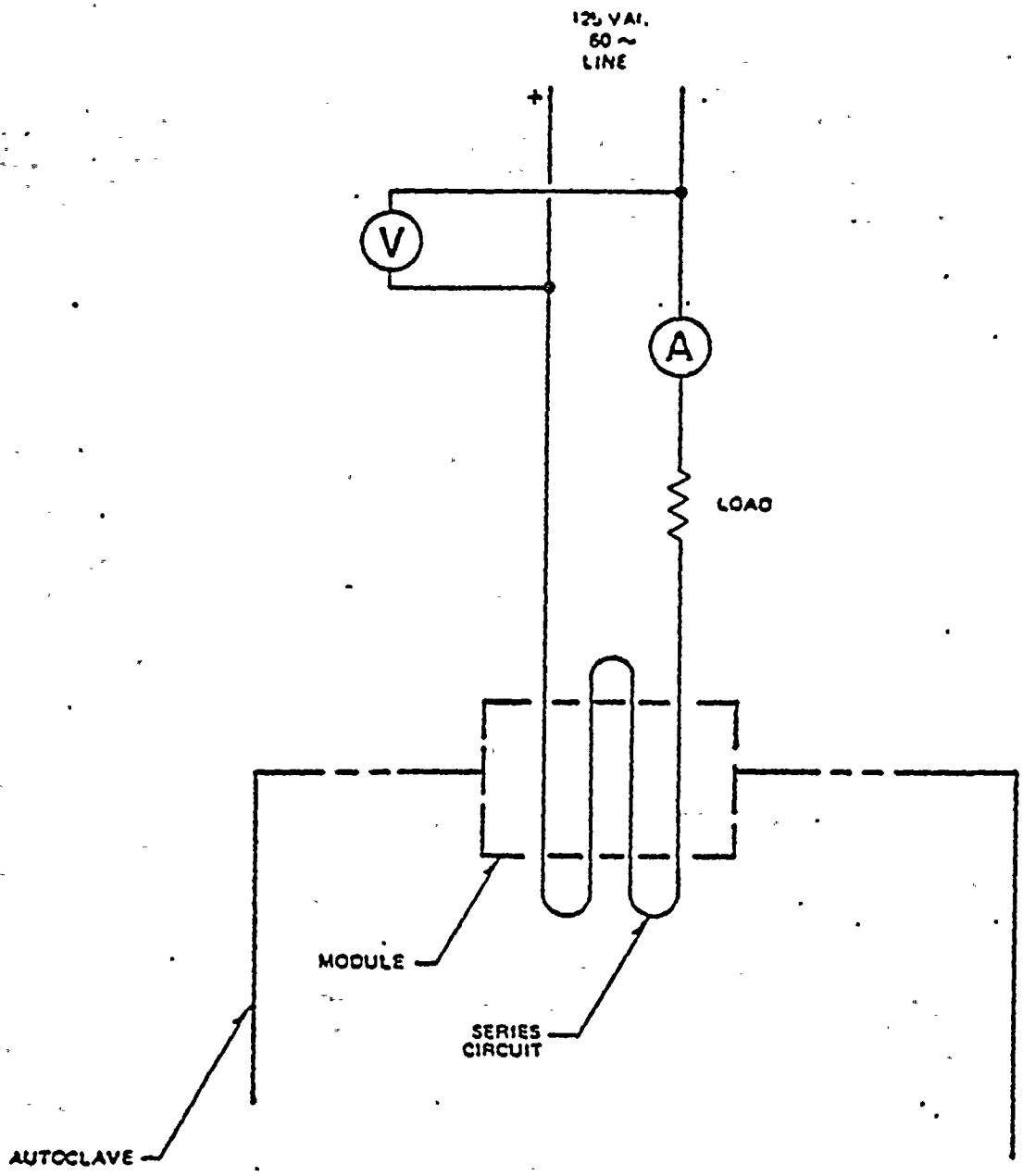

FIGURE 1. ELECTRICAL TEST SET-UP FOR NO. 16AWG CIRCUIT

PROTOTYPE TEST REPORT
LOW VOLTAGE ELECTRIC PENETRATIONS
SIMULTANEOUS LOCA, CURRENT & VOLTAGE TEST
REFERENCE BECHTEL SPECIFICATION 7604-E34

on sheet F sh 04

BC: 2716

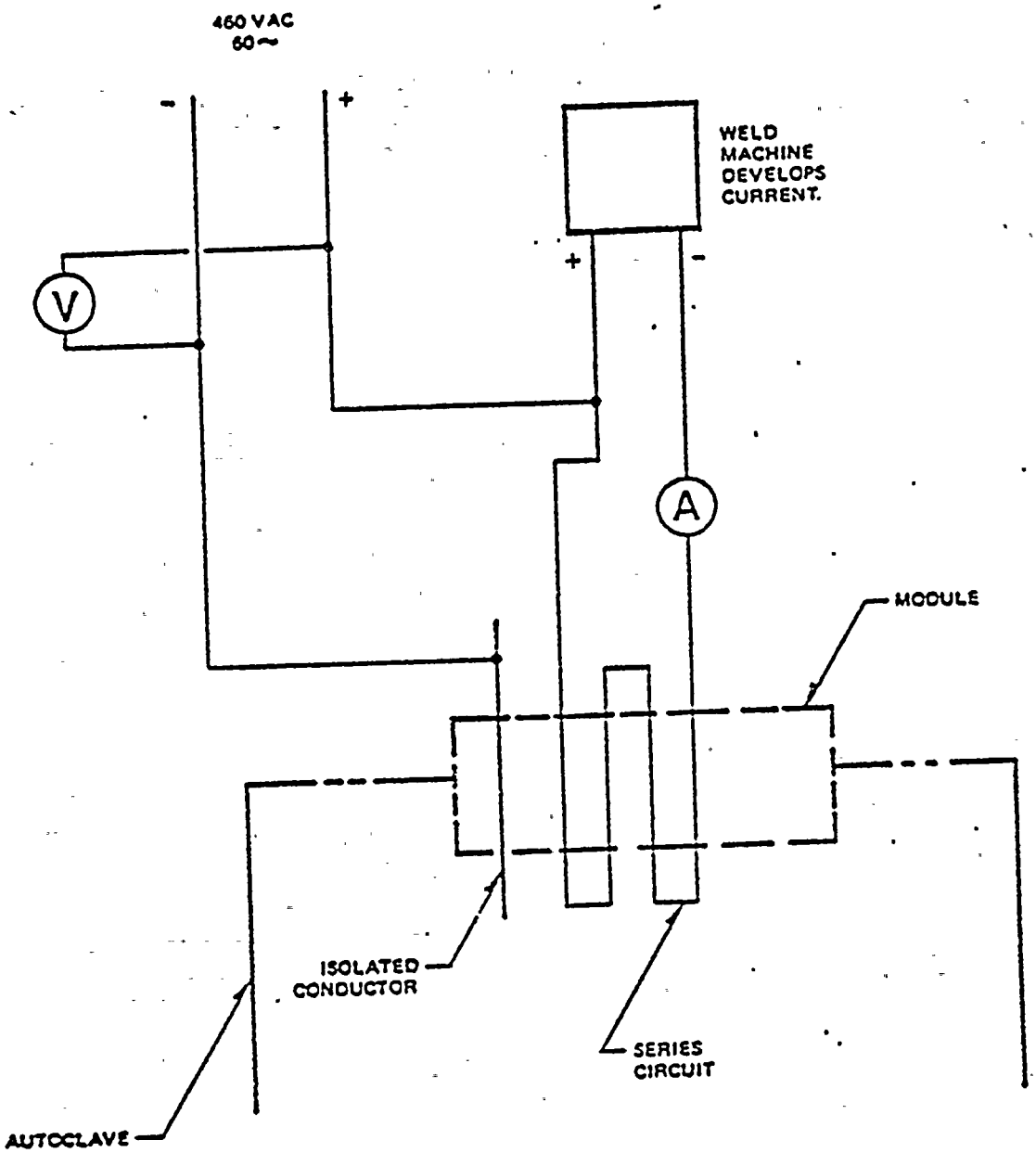

FIGURE 2 ELECTRICAL TEST SET-UP FOR 4/0 CIRCUITS

PROTOTYPE TEST REPORT

MILLSTONE 2 ELECTRIC PENETRATION

POST-LOCA PROTOTYPE TEST

FINAL REPORT

Prepared by: N. G. Luria

Test Conductor: B. J. Nalezinski

TITLE PROTOTYPE TEST REPORT
MILLSTONE 2 ELECTRIC PENETRATION
POST-LOCA PROTOTYPE TEST - FINAL REPORT
FIRST MADE FOR REFERENCE BECHTEL SPECIFICATION 7604-E34

REVISION:

1.0 SUMMARY

For the period from 3 March 1974 thru 10 March 1975, including a one week shutdown, the low voltage power and control modules were subjected to 165°F, 5 psig, 100% RH environment. Upon completion of the test, both units exhibited a leak rate of less than 1×10^{-8} cc He/sec at 1 atm. pressure. The high voltage, over the same period was subjected to 220°F, 20 psig, 100% RH environment and was also helium leak tight to less than 1×10^{-6} cc/sec @ 1 atm pressure.

2.0 Reference

1) Bechtel Specification #7604 E 34

2) GE Test Report - Low Voltage Power #941-S1610-5

3) GE Test Report - High Voltage #74-502-1

3.0 Test Requirement

Bechtel Specification #7604-E-34 para 5.5(2).

"Items B, F, G (low voltage control and power)* shall remain electrically operable under the conditions stated below ..."

pressure, psig	54	40	20	5
temperature, °F	289	260	220	160
duration	15 min	45 min	23 hrs	1 year

see references 2 & 3

(It is assumed that the assembly shall remain helium leak tight to less than 1×10^{-6} cc/sec after completion of the test.)*

*Brackets are GE clarification.

4.0 Hardware Identification

The following hardware was subjected to the required (or greater) environment.

Name	Dwg No.	S/N
High Voltage	17489302G001	6574036
#4/0 Module Asm	157C4837G001	Y7257-312
#16 AWG Module Asm	157C4836G003	Y7257-259

PRINTS TO

5.0 Test Setup

The above hardware was installed in the following autoclaves, in a vertical position to simulate a worst case condition.

Penetration Name	Autoclave
Low Voltage Power	S/N 330
Low Voltage Control	S/N 330
High Voltage	S/N 5641

Tests were conducted at GE, San Jose, Ca. facility, Bldg. W

6.0 Test Results

The tests for Low Voltage were conducted from 3/3/74 to 3/10/75 with a one week shutdown for a periodic test equipment maintenance. The tests for High Voltage were conducted from 3/3/74 to 3/3/75.

The test units were subjected continuously to the following environment:

	Low Voltage Power & Control	High Voltage
temperature, ^{o}F	165	220
pressure, psig	5	20
duration	1 year	1 year
% RH	~100%	~100%

During months 6, 7, 10 & 12, the low voltage units were brought to ambient conditions and the leak rates were measured at less than 1×10^{-8} cc He/sec @ atm pressure. After 1 year, the high voltage was measured to have a leak rate less than 1×10^{-6} cc He/sec @ amb conditions.

6.0 (cont.)

The following electrical measurements were recorded on the test units:

	Date of Test	Insulation Resistance	Hipot	Continuity
Low Voltage Power (#4/0)	3/12/75	@ 50 VDC Ω		No Change
(S/N Y7257-312)		$.5 \times 10^6$ Ω	100 VAC	
	1/15/75	1×10^7 Ω	100 VAC	" "
	10/2/74	2.8×10^5 Ω	700 VAC	" "
	9/3/74	3×10^5 Ω	2.3KVAC	" "
Low Voltage Control (#16)	3/12/75	$.5 \times 10^6$ Ω	100 VAC	No Change
(S/N Y7156-259)	1/15/75	1×10^7 Ω	150 VAC	
	10/2/74	5×10^4 Ω	450 VAC	" "
	9/3/74	1×10^5 Ω	800 VAC	" "