APPENDIX B

1R10-001B FACILITY TEST PLAN - QUALIFICATION OF PRIMARY CONTAINMENT HYDROGEN/OXYGEN ANALYZERS

GENERAL ELECTRIC
SPACE DIVISION
PHILADELPHIA

PROGRAM INFORMATION REQUEST / RELEASE

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	U	— 1R10 —		— 001	B

*USE "C" FOR CLASSIFIED AND "U" FOR UNCLASSIFIED

FROM	TO
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DATE SENT	DATE INFO. REQUIRED	PROJECT AND REQ. NO.	REFERENCE DIR. NO.
9/16/74			

SUBJECT

FACILITIES TEST PLAN - QUALIFICATION OF PRIMARY CONTAINMENT HYDROGEN/OXYGEN ANALYZERS

INFORMATION REQUESTED/RELEASED

1 INTRODUCTION

The objective of this test is to subject the primary containment hydrogen and oxygen analyzers to a temperature/pressure profile that will meet the environmental requirements described in GE-APED Specifications #21A1375, 21A1918, 21A1915 and 21A1796. This will be accomplished by placing the sensor assemblies in a chamber and running a temperature/pressure profile with saturated steam and known concentrations of hydrogen and oxygen for 90 days. Sensor calibration will be checked periodically to verify sensor stability and to verify integrity of the calibration mechanism.

Prior to the temperature/pressure testing, the sensors and/or sensing electrode diffusion barriers under test will be subjected to an integrated dose of 1×10^7 Rad.

Following completion of the 90 day test, the sensor (s) will be subjected to additional radiation at a dose rate of 1×10^5 rad/hr. for a period of 160 hours to complete the prescribed 2.6×10^7 Rad. integrated dose.

Abbreviated performance tests will then be conducted as required to insure that the integrity of the system is maintained.

GENERAL ELECTRIC
Atomic Power Equipment Department
☐ Disapproved per comments
Revise and resubmit for approval
☐ Approved with Comments
Revise and resubmit IN FINAL FORM
☐ Refer to EDS No. ____
☒ Approved No further action required
☐ Approved Submit certified Copy
☐ Certified by Seller and Approved by Buyer
Reviewed by [illegible]
Date 11-25-74
VPF No. 23-1-5-3

11. OVERALL TEST SEQUENCE

1. Abbreviated performance test (if applicable)*
2. 1×10^7 Rad exposure profile.
3. 90 day environmental profile
4. Abbreviated performance Test.
5. 1.6×10^7 Rad exposure on all sensors.
6. Abbreviated performance Test.
7. High H_2 concentration exposure test (H_2 sensor only).

*To be performed only if the complete sensor(s) is exposed to 1×10^7 Rad dose.

111. TEST FACILITIES

1. Radiation Testing - Radiation facilities shall be provided that have the capability of providing a gamma dose rate of 1.0×10^5 Rad per hour.

RETENTION REQUIREMENTS

COPIES FOR	MASTERS FOR
☐ 1 MO.	☐ 3 MOS.
☐ 3 MOS.	☐ 6 MOS.
☐ 6 MOS.	☐ 12 MOS.
☐ MOS.	☐ MOS.
☐	☐ DO NOT

III. TEST FACILITIES

The initial exposure shall be for an integrated dose of 1×10^7 Rad. The final exposure shall be for a total integrated dose of 2.6×10^7 Rad per sens

2. Abbreviated Performance Test - A chamber shall be provided that can maintain $185^{\circ} \pm 5^{\circ}$F and $95 \pm 5\%$ RH for 24 hours. Refer to Figure 1 for a schematic diagram of the required equipment.

3. 90 Day Environmental Test - Chambers will be used as depicted in Figure 2. Adequate bulk head connections shall be provided to permit the necessary interconnections including:

a. Low voltage instrument lines as required by sensor installation.

b. 1/4" copper lines for sensor calibration.

c. Thermocouples as required for monitoring sensor body and chamber environmental temperatures.

The chamber shall also have the following interfaces:

a. Water line: Controlled supply of water for providing the required high humidity conditions for the test.

b. Pressure gauge (calibrated: 0-100 psia $\pm 1.0\%$ full scale).

IV. Test Procedures

1. Radiation Exposure (Initial)

This test will be conducted with the sensor non-operating and is intended for determination of radiation exposure capability only. The sensor(s) will be placed in a radiation exposure facility exposed to a radiation dose rate of 1×10^5 rad/hr. for a period of 100 hours. (Total Integrated Dose 1×10^7 Rad)

As an alternate to irradiating the complete sensor, membrane material which has been irradiated to the 1×10^7 Rad level at the 1×10^5 rad/hour dose rate may be used as the permeation barrier in the sensor assembly to satisy the pre-environmental test radiation exposure.

2. Abbreviated Performance Test - (24hours). Place the sensor in the test chamber and conduct the initial calibration of the sensor utilizing the calibration and zero gas mixes listed in Table 1A or 1B as is applicable. The pressure input signal shall be adjusted to the chamber total pressure input value on the pressure signal simulating test box. The following calibration sequence shall be used to calibrate the sensor. All output readings shall be measured with a D.V.M. connected to the remote indicating meter output terminals. Data also shall indicate the readout of the recorder, panel meter and remote meter where applicable.

NOTE: If temperature compensation is not provided on the sensor a decade box will be employed to simulate the compensation network.

a. Select Span 2 on the sensor electronics panel. Actuate the sensor calibration mechanism using the high calibration gas mix. Adjust the span control for an equivalent indication of the high calibration concentration readout on the instruments. Record the output in the high calibrate block on the data sheet after allowing the sensor output to stabilize. Vary the simulated total pressure signal to 30 PSIG and 60 PSIG input levels and verify that analyzer outputs decrease by a factor corresponding to the percentage increase of the input signal. Record these outputs on the data sheet. Terminate the high calibration and turn off the gas bottles, then return the simulated pressure signal to the 0 PSIG level.

b. Actuate the sensor calibration mechanism with 100% N_2 and maintain until the instruments indicate 0% on the Span 1 scale and less than 0.1 VDC on the D.V.M.. Record the output in the zero block on the data sheet. Turn off the gas mix at the bottle.

c. Actuate the sensor calibration mechanism using the low calibration gas mix after insuring that Span 1 has been selected on the electronics. When stabilized outputs are obtained, the instruments shall indicate 2% for the H_2 sensor and 4% for the O_2 sensor. Record the output in the low calibrate block on the data sheet. Terminate the low calibration cycle and turn off the gas mixture at the bottle.

After completion of the initial calibration, raise the chamber temperature and RH to 185 $\pm$ 5% and 95 $\pm$ 5%. Maintain these conditions for the balance of the 24 hour period. Calibration per steps 2a through c above shall be conducted upon stabilization of the sensor output. Calibration checks shall be performed at 5 hour intervals per step 2a through c above except that no further calibration adjustments shall be allowed.

TABLE 1A

O_2 ANALYZER

Normal Environment	-	Chamber Environment
Low Calibration	-	4% O_2/N_2 Balance
High Calibration	-	Compressed air
Zero Calibration	-	100% N_2

TABLE 1B

H_2 ANALYZER

Normal Environment	Chamber Environment
Low Calibration	2% H_2/N_2 Balance
High Calibration	4% H_2-7N_2 Balance

3. 90 Day Qualification Test

3.1 Environmental Profile: (Refer to Figure 2)

Initial Stabilization *(Days 1 & 2) - 24 hours at 135° (+5°) followed by 24 hours at 200 ± 5°F with a simulated pressure input of 14.7 PSIA. During the 24 hour period, an initial calibration per section IV-2 may be performed if required, however after the first calibration, no further calibration adjustments are allowed. Data shall be recorded on the data sheets as follows:

1. Temperature
2. Span Adjust knob setting.
3. Meter and/or recorder reading.
4. Sensor output.
5. Simulated pressure signal level.
6. Atmosphere being sampled
7. Chamber pressure.
8. Decade box setting where applicable.**
9. Time

* Stabilization for the purpose of this plan shall mean a change in sensor output of less than 0.1% of full scale in 5 minutes.

** NOTE: If temperature compensation is not provided on the sensor a decade box will be employed to simulate the compensation network.

3.2 Simulated LOCA (Day 3) - Increase the chamber temperature to 340 ± 10°F and pressure to approximately 62 PSIG using steam. Maintain this condition for 15 minutes, and then vent the test chamber until the pressure reaches 35 PSIG. Maintain this condition (340°F ± 10° and 35 PSIG) for three hours. Record test data as per paragraph 3.1 then decrease the temperature according to the next paragraph.

Decrease the chamber temperature to 200 ± 10°F and allow the system to stabilize. If a decade box is used to simulate the temperature compensation network, adjust to the setting used prior to the 340°F excursion and record data as per paragraph 3.1. Maintain these conditions for a minimum of 3 hours after which data should be recorded and the chamber vent valve should be opened to return the chamber to atmospheric pressure (If it is not already there). Close the vent valve and maintain these conditions (200 ± 10°F, 14.7 psia) for a minimum of six hours and then proceed to the long term stabilization portion of the test program.

NOTE: If the performance of either of the sensors appears unusual during or after 340°F exposure the chamber should be cooled and the sensors removed and inspected. Sensors determined to be good (exhibiting no leakage) shall be reinstalled in the test chamber and testing shall continue. Sensors found to be defective shall be removed from the test and a failure analysis shall be conducted.

3.3 Long Term Stabilization (Days 4 through 90) - Chamber conditions shall be established at 200 ± 10°F with a simulated pressure signal of 0 PSIG. These conditions shall then be maintained for the balance of the 90 day test cycle. Calibration checks per IV-2 a through c above shall be performed at a minimum of once per 120 hours. Adjustments required after the initial calibration cycle under these conditions shall be recorded and discussed with cognizant BWRO personnel. Record outputs in the appropiate blocks on the data sheet.

3.4 Radiation Exposure (Final) - This test is conducted on a non operating sensor in a manner similar to that described in Paragraph IV-I except that the time of exposure to the 1×10^5 rad/hour dose rate will be 160 hours.

3.5 High H_2 Concentration Exposure - After completion of the post radiation Abbreviated Performance Test, the H_2 sensor shall be tested in a hydrogen/nitrogen atmosphere at 200°F. This atmosphere shall be a mix greater than 5% H_2. Record the sensor outputs, gas concentration and chamber temperature.

V. DATA & REPORTING

Standing Instructions will be prepared for each test sequence by GE Quality Assurance. Data sheets will be included.

A final qualification test report will be written at completion of all testing.

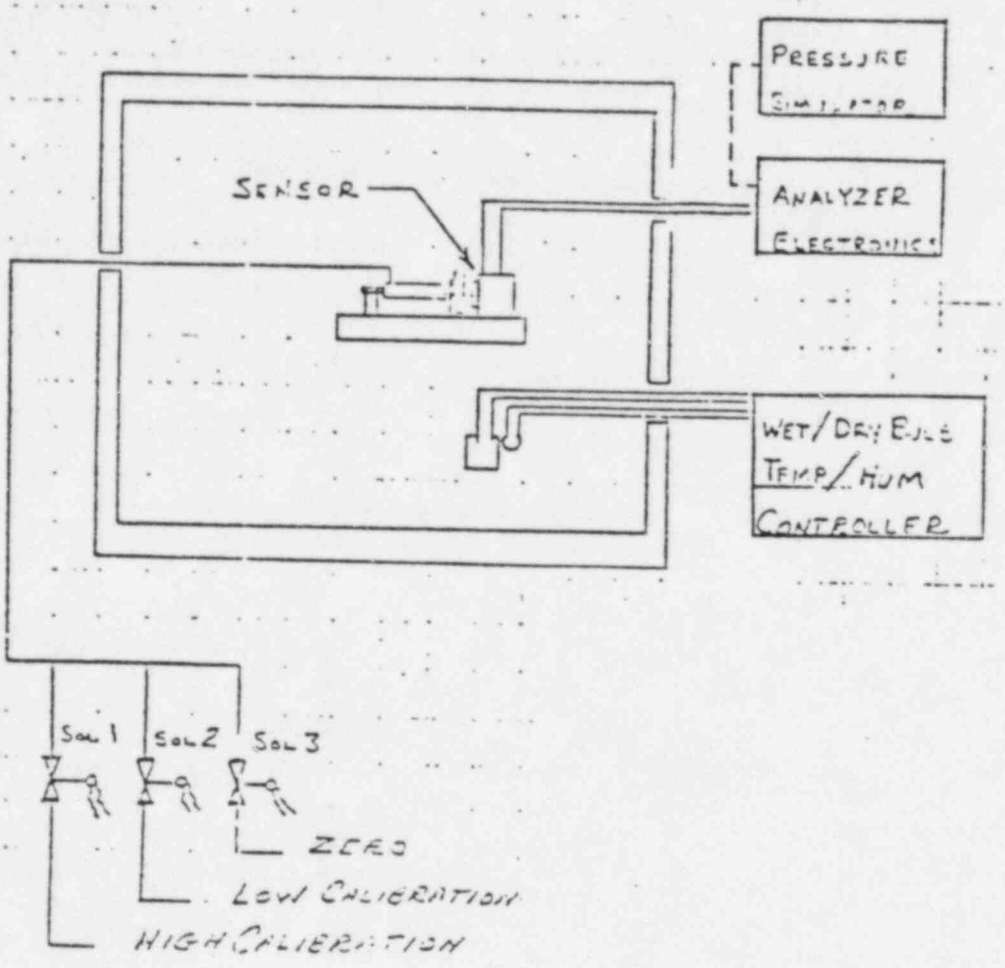

Figure 1. H_2/O_2 Containment Sensor Acceptance Test System Arrangement

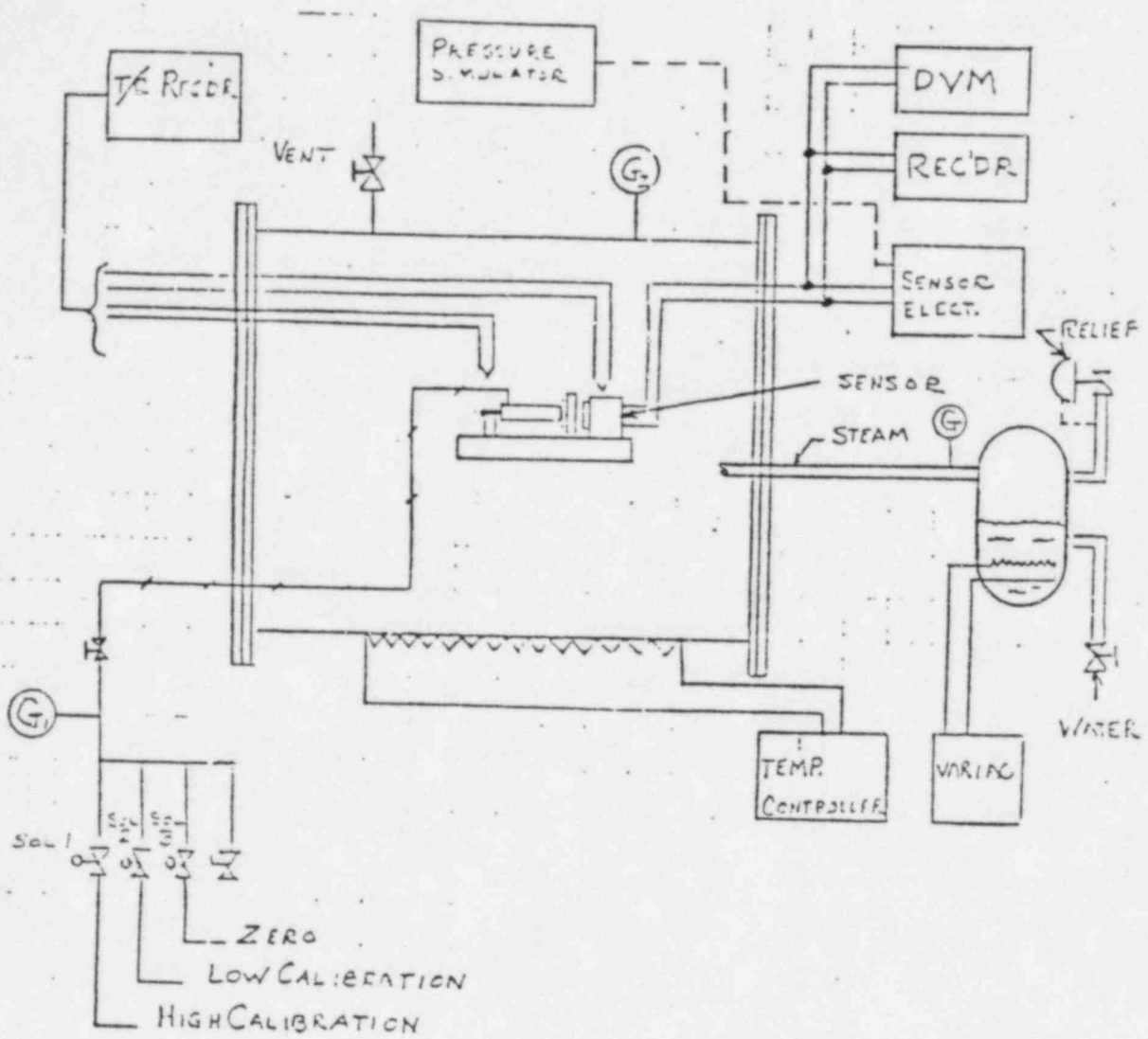

FIGURE 2. H_2/O_2 CONTAINMENT SENSOR TEMP., PRESS., HUM., TEST SYSTEM