Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690

Regulatory Docket File

August 2, 1976

DOCKETED USNRC AUG 6 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

RECEIVED AUG 6 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Mr. Dennis L. Ziemann, Chief
Operating Reactors - Branch 2
Division of Operating Reactors
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Dresden Station Units 2 and 3
Quad-Cities Station Units 1 and 2
Containment Atmosphere Monitor/Atmospheric
Containment Atmosphere Dilution (CAM/ACAD)
System, NRC Dockets 50-237/249 and 50-254/265

Dear Mr. Ziemann:

Commonwealth Edison was asked to docket certain information pertinent to the Containment Atmosphere Monitor and Atmospheric Containment Atmosphere Dilution System (CAM/ACAD) presented to members of your staff during a meeting at your offices on April 22, 1976.

The hydrogen detector environmental test report is not available at this time. In lieu of this report, a copy of the test procedure utilized to qualify the H_2/O_2 analyzers is enclosed. The O_2 analyzer included with this procedure has been deleted from the equipment. The hydrogen detector environmental test report will be docketed as soon as it is available.

One (1) signed original and 59 copies of this information is included for your use.

Please direct any additional questions to this office.

Very truly yours,

G. A. Abrell
Nuclear Licensing Administrator
Boiling Water Reactors

Enclosure (1): Responses to Mechanical and Electrical Questions.

(2): Facilities Test Plan - Qualification of Primary Containment Hydrogen Oxygen Analyzers.

(3): Five (5) copies of color photographs of the hydrogen detectors and control cabinets.

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First Set of Questions

A. Question 1: Describe the manner by which the location of the hydrogen sensing points, inside both the drywell and wetwell, were selected.

The hydrogen sensors will be located within the upper half of the containment taking into consideration the accessibility and good gas circulating to the sensors. The redundant sensors will be located 180° apart where possible.

B. Question 2: Discuss the criteria the operator will use to manually activate the CAM System.

The CAM System is actuated automatically following a LOCA.

E. Question 5: Provide typical fan performance curves for both the CAD compressors and the bleed purge fans.

The ACAD compressors have not been purchased at this time, and there are no bleed purge fans in the ACAD System.

F. Question 6: Discuss the logic used to control CAD flow from the compressor to the air receiver and from the air receiver to the drywell and torus.

The air receiver will be loaded continuously, and it shall control the on-off of the compressor via pressure switches. There is also provision for manually overriding these controls in the main control room for on-off operation of the compressors. Dilution air to the drywell and torus is admitted by opening the inlet flow control valve and the isolation valves to the drywell and torus, as shown on the P&ID.

G. Question 7: Indicate the manner by which switch over to a redundant train of either the ACAD or bleed system, should a single failure occur in an operating train.

The switch over is accomplished by closing the flow control valve and the containment isolation valves on the failed train and opening of the same set of valves on the redundant train for either the injection or bleed subsystem.

H. Question 8: Discuss the rationale for manually initiating the bleed system, while the CAD cut off is automatic. Note that an early initiation of the bleed will unnecessarily extend the duration of the purge. Also, indicate whether the lower pressure cut off of the bleed, 41 psia, is manual or automatic.

The ACAD System consists of the air injection subsystem and the pressure bleed subsystem. The on-off operation of either subsystem is accomplished manually by the operator in the main control room. The air injection subsystem will be activated when the hydrogen concentration in the containment reaches 3.5% volume. Dilution will continue until the hydrogen concentration falls below 3.3% or the containment pressure reaches 43 psia. Should the latter occur, the pressure bleed subsystem will be manually initiated while dilution is stopped manually until the containment pressure decreases to 41 psia. As an added feature, pressure switches mounted to the containment will annunciate in the main control panel while automatically closing the air injection inlet flow control valve should the containment pressure reach 44 psia.

ACAD System Proposed
Operating Instructions
Dresden and Quad-Cities Stations
NRC Dockets 50-237/249 and 50-254/265

If the design basis conditions exist in terms of hydrogen concentration, activity concentration in the drywell, and meteorological conditions, the start and stop pressures will be in accordance with the Combustible Gas Control System Design Report. However, in the unlikely event of a loss of coolant accident, the design basis conditions will probably not be met, and it will be possible to avoid high containment pressures and still achieve the needed hydrogen dilution and meet the requirements of 10 CFR Part 100.

Should the ACAD System be needed, it would be operated in accordance with the design report until dose calculations based on actual containment activity and actual meteorological conditions indicate that additional efforts to reduce containment pressure would meet 10 CFR 100 requirements. This would be done to reduce containment pressure, containment leakage, reduce station personnel exposure, and facilitate inspection of long term cooling equipment in the reactor building.

I. <u>Question 9</u>: Provide the calculated durations of vent release by the bleed system and initiation times for a 30 day period.

A computer printout of the injection and bleed durations for a 30 day period was presented at this meeting.

J. <u>Question 10</u>: Discuss the need for, and operation of, the flow control valve on the vent outlet line.

The flow control valves are provided for better control of the bleed flow rate should it be necessary to meet off-site dose limits.

K. <u>Question 11</u>: Provide an analysis which demonstrates that a backup purge flow rate of 25 cfm is sufficient to maintain the hydrogen concentration below 4%.

The backup purge flow rate corresponds actually to the pressure bleed flow rate. The derivation of the 25 scfm is shown on the computer printout and the hydrogen concentration curve is included in Supplement 1 submitted to the NRC.

L. <u>Question 12</u>: Describe the manner by which the pressure equalizing capabilities of the drywell to torus vent system and the vacuum breakers have been factored into the analytical model.

No mixture between the drywell and the torus was assumed.

M. <u>Question 13</u>: Discuss the rationale for inputing the makeup and purge flow fractions to the drywell and wetwell as fixed constants.

The injection fractions to the drywell and torus are based on maintaining equal pressure between the two to ± 1 psi. The purge flow rate was kept as low as possible to reduce gas release to the atmosphere without exceeding the maximum allowable hydrogen concentration in the containment.

H_2 CONTAINMENT ANALYZERS

The following questions asked by NRC were responded to by the General Electric Company, Space Division, at a meeting in the NRC offices in Bethesda, Maryland on April 22, 1976. Handout sheets and photographs used during the presentation are attached.

1. Describe in more detail the design and principle of operation of the hydrogen detectors. Provide a sketch.

The hydrogen partial pressure sensor is galvanic in nature and consists of platinum black sensing electrode and platinum oxide counter electrode within a polysulfone housing. The electrolyte providing the ion conductive path between the two electrodes is separated from the ambient atmosphere by a gas-permeable membrane which is in contact with the sensing electrode. When the ambient atmosphere contains hydrogen, an electrical current is generated by the sensor which is directly proportional to the partial pressure of the hydrogen in the atmosphere.

The transfer relationships for hydrogen diffusion in the cell are summarized in the generalized equations that follow. First, consider that the rate of diffusion of H_2 through a diffusion barrier membrane of a fixed area (A) and thickness (D), is a function of the permeability of the membrane material as expressed by the coefficient, P_r; the ambient temperature, and the partial pressure differential $(P_a - P_i)$ established across the membrane. The generalized rate equation for the diffusion (N) of the hydrogen through the membrane in cc/second is:

$$N = P_r \frac{A}{D} (P_a - P_i) \qquad (1)$$

For a given membrane material and gas, P_r is a constant (at constant temperature) so that for a specific configuration with a fixed membrane area and thickness, the rate equation becomes:

$$N = K (P_a - P_i) \qquad (2)$$

where

$$K = \frac{P_r A}{D}$$

The sensor is designed to electrochemically oxidize hydrogen to the ionically active form immediately upon its adsorption on the sensing electrode. As a result, the effective hydrogen partial pressure (P_i) on the catalyst side of the membrane approaches zero and the rate equation is further reduced to:

$$N = K P_a \qquad (3)$$

1. (Continued)

making the rate of gas diffusion to the electrode a direct function of hydrogen partial pressure in the atmosphere. Conversion to volume percent hydrogen is a simple arithmetical manipulation.

The complete electrochemical oxidation of hydrogen in the two half cell reactions in the sensor results in an electrical current whose magnitude is governed solely by the quantity of hydrogen available for reaction. The magnitude of this current is readily computed utilizing the Faraday relationship which states that 26.59 ampere hours of current will be generated per gram of hydrogen reacted. Having already established the relationship between the hydrogen partial pressure and the rate of hydrogen reacting in the sensor, it is apparent that the current generated is a direct function of the hydrogen partial pressure.

The current thus generated is passed through an external resistance network with a temperature coefficient which is equal in magnitude but negative with respect to the temperature component of P_r. The resulting voltage differential across the compensated load network is the sensor output signal which is now only a function of the partial pressure of hydrogen.

2. What periodic calibration is to be performed to assure a correct reading when needed?

   It is recommended that sensor calibration be checked a minimum of once every 30 days.

3. Are there any possible platinum poisoning mechanisms at the detector locations?

   The only potential contaminant presently identified is Iodine which is estimated to reach a maximum partial pressure 4.36 X 10^{-4} mm Hg. The diffusion barrier over the sensing electrode will protect the sensing electrode by limiting the rate of Iodine flow to the electrode to 1.2 X 10^{-9} cc/hr for the worst case conditions. It is estimated that loss of only 0.03% of catalyst area might result.

4. What are the effects of radiation (expected during a LOCA) on the output of the hydrogen detection system?

   Performance of the sensors was within specification when tested following exposure to radiation to an integrated dose of 3.2 x 10^7 rads.

5. What is the expected life of the detectors in the primary containment environment?

   Sensor operating life is specified as four (4) years or one LOCA (including post LOCA cool down) whichever occurs first.

6. What is the accuracy of the calibration gas?

   Calibration gas is to be provided in appropriate mixtures with analysis certified by the gas supplier.

7. What is the accuracy of the hydrogen detection system with the sensor elevated to the LOCA temperature?

   Analyzer accuracy at LOCA temperatures is the stated system accuracy of $\pm$ 2% FS.

8. Describe the installation details of the hydrogen detector that assures that the calibration gas is not diluted during the calibration.

   The calibration of sensors is accomplished by providing a certified gas mixture to the "Swagelok" connection on the calibration assembly. When calibration gas pressure is applied, the piston is extended so that the cup covers the sensor face bathing the sensing electrode in the calibration gas at the ambient pressure of the environment. When calibration gas pressure is relieved, the piston will return to its normal rest position and the sensor is again monitoring the containment environment.

9. Describe the qualification tests performed on the hydrogen detectors which qualify them for a LOCA environment.

   The analyzer has been tested through a simulated LOCA and a 90 day post LOCA period to verify that performance will remain within specification throughout this period. Testing followed the following general sequence.

   1. Abbreviated performance test.

   2. Exposure to irradiation to 1.6 x 10^7 rads (integrated dose)

   3. Simulated LOCA with steam, temperature to 340°F and pressure to 75 psia.

   4. Post LOCA operation for 90 days.

   5. Exposure to irradiation to 1.0 x 10^7 rads (total integrated dose now to 2.6 x 10^7 rads).

   6. Abbreviated performance test.

   7. Exposure to high H_2 in air (greater than the lower explosive limit).

10. Is it possible for the detectors located in the suppression chamber to be immersed in water at any time during a LOCA and if so what effect does this have on the output?

Location of the sensors are the responsibility of Sargent & Lundy and Commonwealth Edison Company.

Should the sensor inadvertantly become immersed in water, detection of H_2 in the atmosphere will of course cease. When water levels drop, and the sensor face is again exposed, proper performance should begin again as the water runs off the non-wettable face of the sensor. The only precautions required are that sensor orientation be such that run-off of fluid is not prevented.

11. Provide the detailed procedure used to determine the temperature compensation network for the sensor.

This current-partial pressure relationship is constant for a specific electrode configuration and constant temperature. For changes in temperature, however, the absolute permeability of the membrane varies resulting in a change in the electrical current generated by the sensor. This change in permeability (hence current) is a first order change increasing logarithmically with increasing temperature. The increased output of the sensor due to increasing temperature is compensated for by matching the sensor with a thermistor/resistor network having the correct temperature/resistance characteristics. When the thermistor/resistor network is attached across the output leads of the sensor, the calibration of the sensor is maintained within a comparatively close tolerance over the entire operational temperature range.

Each sensor is tested at various temperatures to obtain a specific temperature profile for each unit. The temperature compensation network for each unit is then determined and this network is added to the sensor. Adequacy of the temperature compensation network is later verified during the acceptance tests.

K. Question 11: Provide logic diagrams for the control systems.

It was agreed that a logic diagram is not required since the ACAD System is controlled manually, as explained in our response to Question 8 of the first set of questions.

L. Question 12: The drawings appear to be incorrect for the flow control valves for both the air injection and venting systems. Explain the purpose of the air supply which is applied directly to the solenoid valve and give the controlled valve position for loss of air and loss of electrical power.

The air supply to the solenoid was a drafting error. It should have been the open port and the air supply is actually to the I/P converter.

M. Question 13: Describe the power train assignment to instrumentation, control system, and isolation valve pilot solenoids.

Power for CAM/ACAD instrumentation, controls, and isolation valve pilot solenoids will be from the CAM/ACAD panels. The panels are redundant with the ac power feeds having a source of on-site and off-site emergency power. No single failure of the air or electrical feed will prevent operation of the system because one injection and purge line with components are supplied by a opposite unit.

N. Question 14: Describe the air supply system to the control and isolation valves.

Quad-Cities Station Instrument Air System
NRC Dockets 50-254 and 50-265

(1) There are three instrument air compressors; one compressor is provided for each unit, and one compressor can be tied into either or both units. Each compressor is a Nash Type 1256C rotary type rated at 300 CFM.

(2) The unit air systems consist basically of a compressor (including outlet filter and water separator), pre-filters, intermediate filters, dryer, after-filters, and a receiver. The system common to both units (originally intended as a backup) consists of a compressor, pre-filters, dryer, and after-filters.

(3) The instrument air system piping is cross-connected between the units at three locations. However, the crosstie valves are locked closed. This is to prevent the opposite unit from losing its air supply if one unit experiences an instrument air failure.

(4) Instrument air compressors are fed from Bus 17 (27). The common compressor is fed from Bus 18 and will be available in the event of loss of all off-site power because Bus 18 is supplied by an emergency diesel generator. The service air compressors are fed from non-vital Buses 15 (25).

(5) The unit air systems each have a service air backup which ties into the instrument air piping just upstream of the pre-filters. If air pressure at the receiver reaches 85 psig, a valve will open to admit service air into the system. This valve must be manually reset at a local panel in order to close the valve upon restoration of air pressure.

(6) The instrument air dryers are dual chamber continuous purge type manufactured by Pall-Trinity Micro Corporation. They are equipped with an internal bypass valve which opens when the dryer outlet pressure drops to 80 psig.

(7) Control room alarms exist for low air pressure, compressor water separator low level, compressor trip, dryer bypass open, and dryer switching failure.

Dresden Station Units 2 and 3 Instrument Air System
NRC Dockets 50-237 and 50-249

The instrument air system for each of the Dresden Units consist of two Gardner Denver oil free reciprocating air compressors with their associated dryers and receivers.

The air systems are normally spilt but can be cross-connected at several accessible locations in the turbine building. In addition, Unit 2 has an automatic crosstie to the Unit 1 instrument air system.

Low air pressure automatically opens a crosstie from the service air system on each unit. The service air system consists of a single reciprocating compressor for each unit of 600 CFM capacity.

The Unit 2 service air system has an automatic cross tie to the Unit 1. The electrical feed to the instrument air compressors are from non-vital Buses 26 (36 on Unit 3) and 27 (37). The service air compressors are likewise fed from non-vital Buses 25 (35). These buses are not available immediately on loss of off-site power, but are available in the event of a loss of all off-site power when the emergency diesel generators backfeed Buses 23 (33) and 24 (34) via the 23 to 23-1 (33 to 33-1) or 24 to 24-1 (34 to 34-1) feed breakers in order to provide long term cooling. The use of the ACAD system is not contemplated prior to the need for containment on long term cooling.

All three instrument air compressors on Unit 1 are fed from buses which are normally fed by the Unit 1 emergency diesel generator.

In summary, although the instrument air system is not Class 1, it is possible to isolate damaged and non-vital sections and cross-connect to other systems. Eleven air compressors are available to supply the system, and the compressors are available during the long term cooling phase even in the event of a loss of off-site power.

O. Question 15: Describe the criteria employed in the design, i.e., Codes, Standards, Regulatory Guides, etc., to which those systems are designed.

The Standards used are IEEE-279, 344 and 384 for instrument cables.

P. Question 16: Describe the physical separation for electrical, instrumentation, and control cables for the CAM & ACAD Systems.

The control and power cables will be routed through existing cable pans which are divisionally separated. The instrumentation cables will be routed in conduit and the conduit for each division shall have separation as outlined in IEEE-384.

NRC Dkts. 50-237/249
50-254/265

GENERAL ELECTRIC
SPACE DIVISION
PHILADELPHIA
PROGRAM INFORMATION REQUEST / RELEASE

PIR NO.	*CLASS. LTR.	OPERATION	PROGRAM	SEQUENCE NO.	REV. LTR.
	U	1R10		001	B

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

FROM	TO
E. Glanfield Room M4230 VFSC	F. P. Rudek, Program Manager Off Gas Hydrogen Analyzers Room M4230, VFSC

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 req'd
☐ Approved Submit certified copy
☐ Certified by Seller and Approved by Buyer
Reviewed by
Date 11-12-74
VPF No. 3517-5-3

II. 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.

III. 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.

PAGE NO. 1 OF 5

RETENTION REQUIREMENTS

COPIES FOR	MASTERS FOR
☐ 1 MO.	☐ 3 MOS.
☐ 3 MOS.	☐ 6 MOS.
☐ 6 MOS.	☐ 12 MOS.
☐ MOS.	☐ MOS.
☐	☐ DONT DESTROY

FORM 1020B REV. (9-70)

III. TEST FACILITIES

1. 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 sensor.

2. Abbreviated Performance Test - A chamber shall be provided that can maintain 185° ±5°F and 95±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 ±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

O_2 ANALYZER

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

3. <u>90 Day Qualification Test</u>

3.1 Environmental Profile: (Refer to Figure 2)

<u>Initial Stabilization *(Days 1 & 2)</u> - 24 hours followed by 24 hours at 200 ± 5°F at 135 (+5°) 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.

** <u>NOTE</u>: 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.

<u>NOTE</u>: 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 $\pm$ 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 x 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 CE Quality Assurance. Data sheets will be included.

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

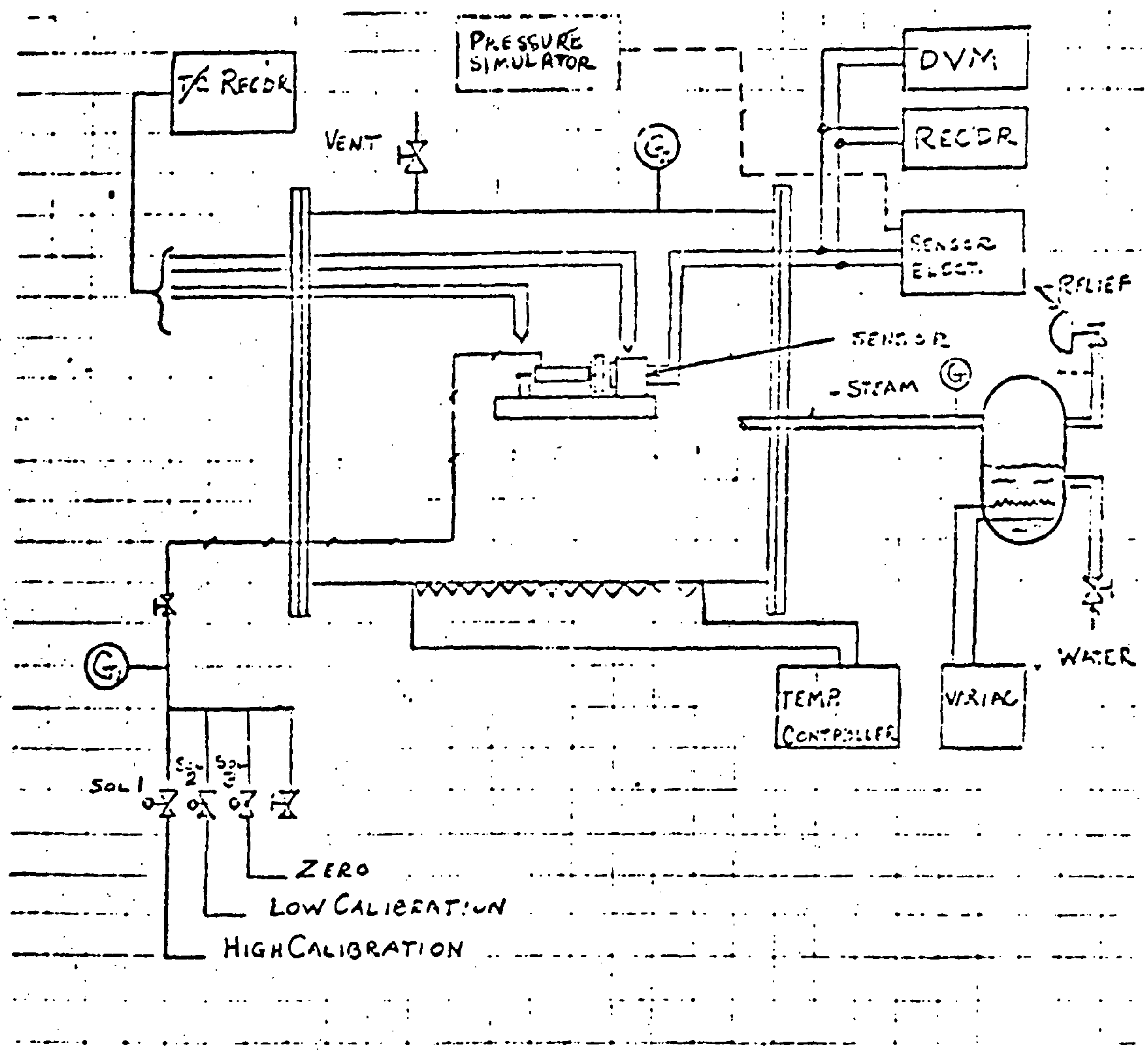


FIGURE 2. H_2/O_2 CONTAINMENT SENSOR TEMP., PRESS., HUM., TEST SYSTEM

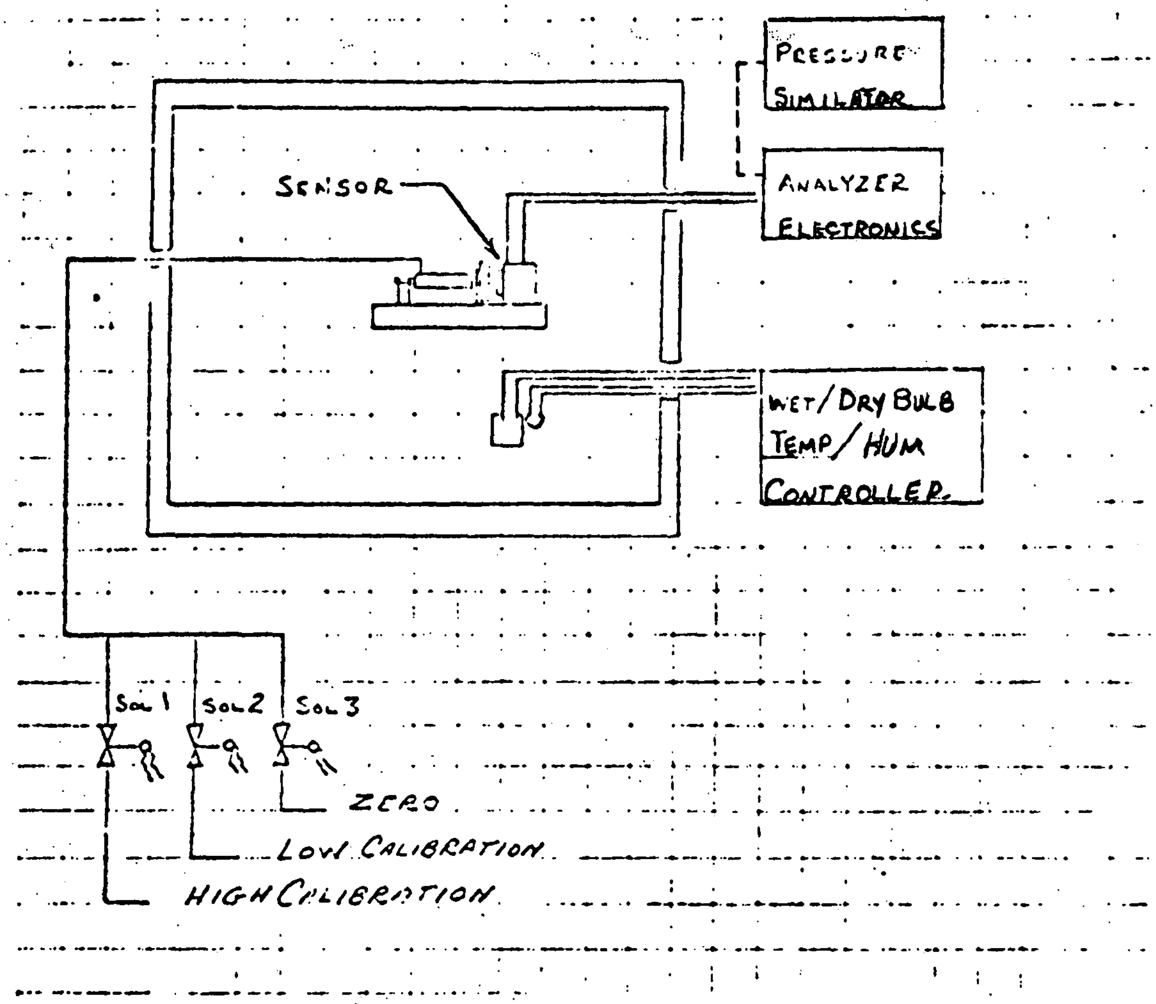
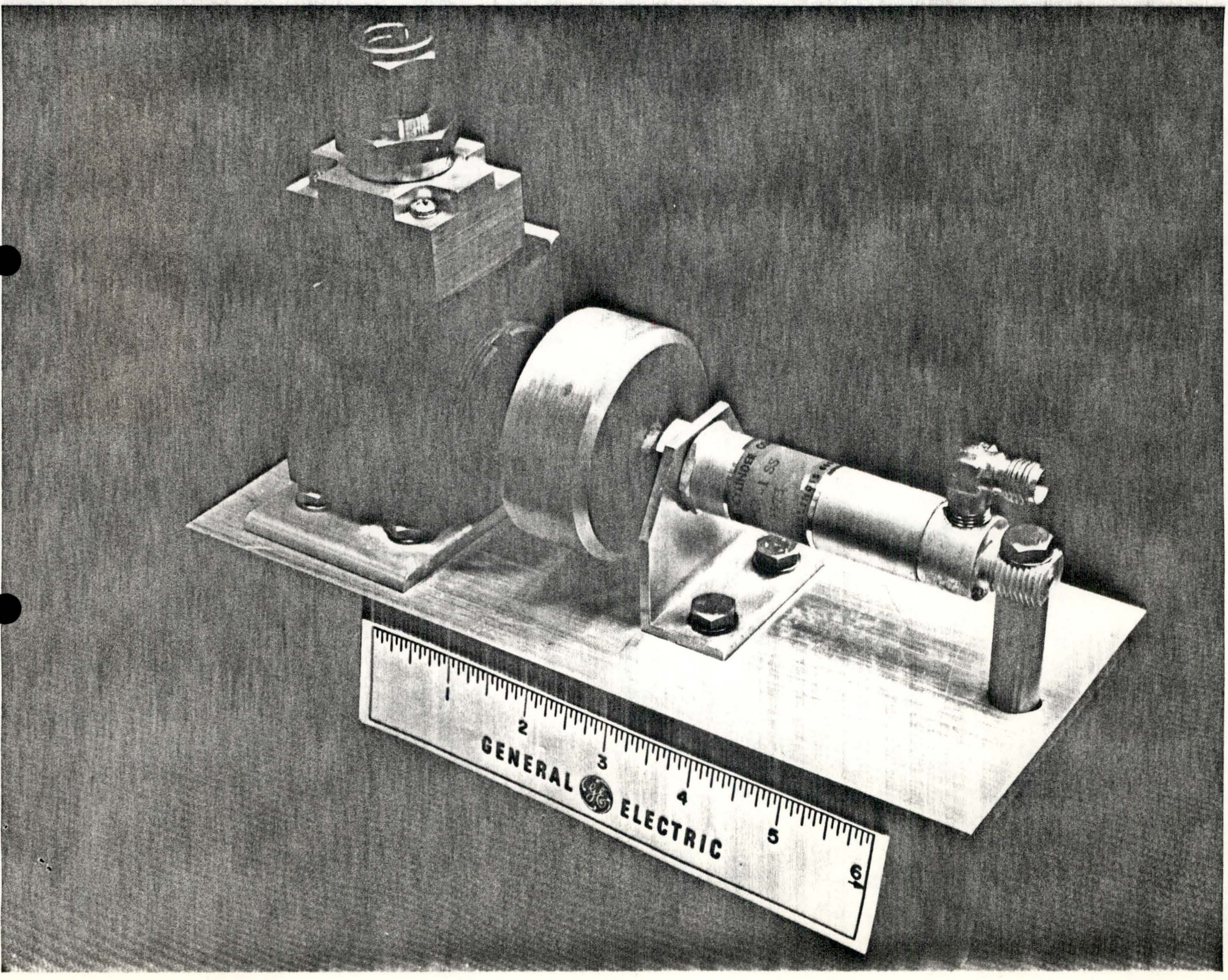


Figure 1. H_2/O_2 Containment Sensor Acceptance Test System Arrangement


GENERAL ELECTRIC
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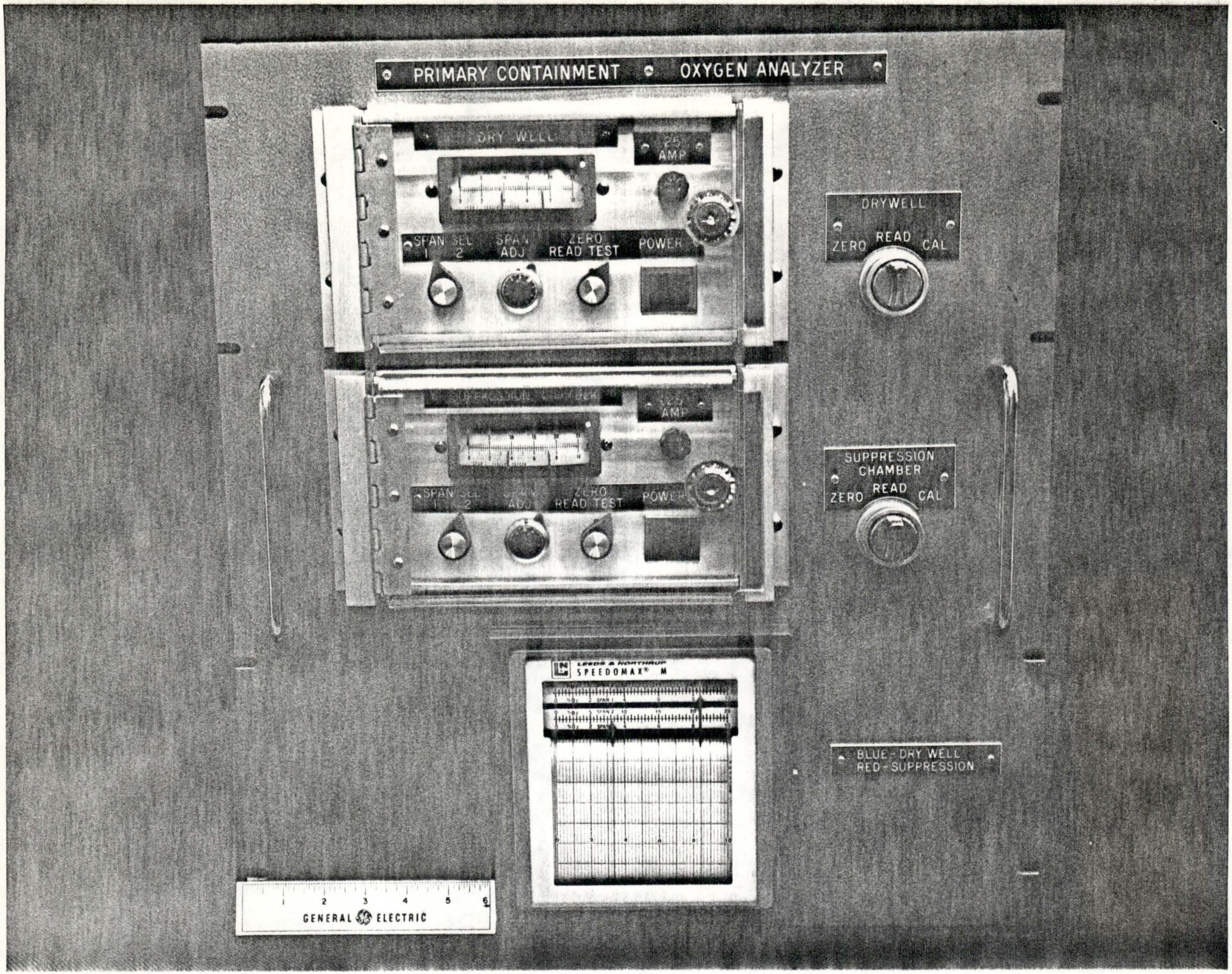
PRIMARY CONTAINMENT OXYGEN ANALYZER
DRY WELL
SPAN SEL
1 2
SPAN ADJ
ZERO READ TEST
POWER
AMP
DRYWELL
ZERO READ CAL
SPAN SEL
1 2
ADJ
ZERO READ TEST
POWER
AMP
SUPPRESSION CHAMBER
ZERO READ CAL
SPEEDOMAX M
BLUE - DRY WELL
RED - SUPPRESSION
GENERAL ELECTRIC