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BECo 85-102

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Operating Reactors Branch #2
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

License DPR-35
Docket 50-293

NUREG 0737, Items II.B.3 and II.F.1.(6)

Dear Sir:

By letters dated June 9, 1983 and August 9, 1984, Boston Edison (BECo) provided design information on Item II.B.3, Post-Accident Sampling, and Item II.F.1.(6), Post-Accident Hydrogen Monitoring.

Attachment A of this submittal provides additional information requested by the NRC via telephone on II.B.3. It supplements our letter of August 9, 1984.

Attachment B revises our June 9, 1983 submittal on II.F.1.(6). This revision stems from design changes implemented during the installation and testing of the hydrogen monitoring system. We have placed change bars in the right hand margin of the original submittal to facilitate your review.

Attachment C is Pilgrim's core damage assessment procedure, a copy of which you requested by telephone.

Attachment D represents a tabulation of times and estimated personnel radiation exposure associated with taking post-accident samples in accordance with procedures. This addresses your telephone request for such information.

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We believe this submittal addresses your request on II.B.3, and provides the latest design information on the implementation of II.F.1.(6) at Pilgrim. Should you wish further information on these items, please contact us.

Very truly yours,

W D Harrington

PMK/kmc

Attachments:

A) Response to telephone request for further information on design criteria of II.B.3

B) Revision to design information concerning post-accident hydrogen monitoring

C) PNPS Procedure No. 5.7.5, "Estimating Core Damage"

D) Table of times and estimated personnel exposure for taking post-accident samples

The following information addresses NRC questions concerning the Post Accident Sampling System of Pilgrim Nuclear Power Station, which were provided to Boston Edison by telephone.

Criterion #1

In our response of August 9, 1984 we provided an approximate time for the collection, transport and analysis of post-LOCA samples. System testing indicates that a sample can be obtained, transported and analyzed in 3 hours or less from the time a decision is made to take a sample.

Criterion #2

The instrument to be used for the back-up analysis of dissolved gases in the primary coolant is a Baseline Industries, Inc. Gas Chromatograph, Model 1030A. This instrument will use a process which provides both a qualitative and quantitative analysis of the gases. The sample to be analyzed is injected into a stream of inert gas which carries the sample through a column. The column is a length of tubing filled or coated internally with a material having a different affinity for the individual components of the gas stream. As a result each component is carried through the column at differing speeds and sequentially exit the column to a detector. The detector converts the volume of gas present to a proportional electronic signal which is amplified and recorded. The qualitative analysis is represented by the time from injection to detection and quantitative analysis is represented by the magnitude of each components' electrical signal, both of which have been determined by appropriate standards.

PNPS Procedure No. 5.7.5, "Estimating Core Damage" is provided as attachment C of this submittal. It is based on "NEDO 22215".

Criterion #3

PASS isolation valves are environmentally qualified.

Criterion #4

The primary means of determining dissolved gas concentration in the primary coolant is performed via the Total Dissolved Gas Measurement Module incorporated in the G.E. Post Accident Sampling System. The determination of the dissolved gas concentration is accomplished by collecting an accurate and known volume of dissolved gas in a chamber. The principle of the method is then based on gas expansion and pressure measurements taken by the built in instrumentation. After the liquid sample is taken into the liquid loop, cooled to ambient conditions and depressurized, the dissolved gases are collected in the chamber. Pressure and temperature measurements are obtained before and after. Henry's Law is applied to calculate the concentration of dissolved hydrogen. If any of the instrumentation is inoperable, a sample may be obtained from the gas chamber via a gas syringe and the analysis preformed on a Gas Chromatograph located in the Chemistry Laboratory, which is described in the response to Criterion #2.

Criterion #5

The sample to be analyzed for chloride is prepared and then analyzed on the Dionex Ion Chromatograph. The sample is pumped through three different ion exchange columns and into a conductivity detector. The first two columns, a precolumn and separator column, are packed with low capacity anion exchange resin. Ions are separated based on their affinity for the exchange sites of the resin. The last column is a suppressor column that contains cation exchange resin in the hydrogen form. The suppressor column reduces the background conductivity of the effluent to a low or negligible level, and converts the anions in the sample into their corresponding acids. The separated anions in their acid form are measured using an electrical-conductivity cell. Anions are identified based on their retention times compared to known standards. Quantification is accomplished by measuring the peak height or area and comparing it to a calibration curve generated from known standards on a Hewlett Packard Integrator.

Criterion #6

The table provided as Attachment D to this submittal gives a summary of times needed to perform certain sampling tasks as described in procedures, as well as the expected post accident personnel radiation exposure. This table contains preliminary estimates which must still be documented and checked in accordance with our procedures.

Criterion #7

Two methods can be used to analyze primary coolant for boron:

1. Plasma Spectrometry utilizing direct aspiration against known standards for which the applicable range is 0.05 to 10PPM with a $\pm$ 10% accuracy.

2. UV/VIS Spectrophotometry, utilizing the carbolic acid technique, for which the applicable range is .01 to 15PPM with a $\pm$ 10% accuracy.

Both methods require sample dilution in order to bring the parameter into the applicable range.

Criterion #8

Questions on this were satisfactorily answered during the telephone conversation.

Criterion #9

Radionuclides can be measured within a factor of two during accident conditions.

Criterion #10

The table below provides the analysis methods detection limits, and range and accuracy for Cl, B, H, and O for a standard post-accident reactor water sample.

CONSTITUENT	ANALYSIS METHOD	DETECTION LIMIT	RANGE & ACCURACY
Cl	Ion Chromatograph	0.01PPM	10PPM ± 10%
B	Plasma Spectrometry	0.05PPM	10PPM ± 10%
B	Spectrophotometry	0.01PPM	15PPM ± 10%
H_2/O_2	Gas Chromatograph	$0cc/K_g$	$2000cc/K_g$ ± 10%
H_2	Gas Chromatograph	$25cc/K_g$	$50cc/K_g$ ± 50%
H_2	Gas Chromatograph	$50cc/K_g$	$2000cc/K_g$ ± 30%

General Information

A training program for PASS is being prepared by Bartlett, Inc., for Boston Edison, and we expect to begin the actual training of personnel in May, 1985. Periodic refamiliarization of cognizant personnel with the system will be accomplished by "rotating" people through operating the equipment during surveillances approximateiy every 6 months, and consistent with shift staffing and plant status.

Attachment B

Revised Description of the H_2/O_2 System

The H_2/O_2 System has been designed to provide the capability for "on-line" monitoring of the hydrogen and oxygen concentrations within the inerted Primary Containment atmosphere (both torus and drywell). The H_2/O_2 System is a safety related system and is designed to monitor potential combustible gas mixtures within the Primary Containment following postulated loss of coolant accidents (LOCA).

Operation of the O_2 portion of the system during plant operation can be used to satisfy the Technical Specification requirements related to the monitoring of containment O_2 concentration during power operation. The H_2/O_2 System consists of two redundant safety trains, each of which can independently fulfill the safety related functions of the system.[1] Each safety train includes an analyzer panel, a Reagent Gas Subsystem and the necessary valves, piping, and tubing to transport the containment atmosphere sample to and from the analyzer panels. Each safety train is capable of taking samples from two locations (approximately EL 80' and 15') within the drywell and one location (EL 14' 3") within the torus. A common Calibration Gas Subsystem to both safety trains is provided for periodic calibration of the analyzers.

The analyzer panels for both trains are located on the 74' 3" elevation in the Reactor Building where local control of the system can be performed. A remote control station for each train is also provided in the Control Room in panels C-174 and C-175.

Each train of the H_2/O_2 System is capable of monitoring oxygen and hydrogen concentrations with a dual range of 0-10% or 0-20% for hydrogen and 0-10% or 0-25% for oxygen concentrations. Readouts are provided locally at the analyzer panels and remotely in the Control Room at panels C-174 and C-175. High hydrogen concentration alarms, high oxygen concentration alarms, and strip chart recorders are also displayed on the Post Accident Monitoring (PAM) panels located in the Control Room (Panel C-170 and C-171).

The analyzer system is accurate to about $\pm 5\%$ of full range.

(1) One drywell and one torus sampling line will not be operational until approximately June 1985.

SYSTEM DESIGN

Detailed Design Description

General

The H_2/O_2 System has been designed to obtain, analyze, and provide indication (locally and in the Control Room) of hydrogen and oxygen concentrations within the Primary Containment following postulated LOCA conditions. The system provides the capability for "on-line" monitoring of H_2/O_2 concentrations through a maximum range of 0 to 20% and 0 to 25%, respectively.

The H_2/O_2 System is comprised of two sample and analyzer trains. Each train consists of an analyzer panel, Calibration Gas and Reagent Gas Subsystems, and associated valves and piping for sample supply and return lines. Each train is independent, and redundant with the exception of a Calibration Gas Subsystem which is common to both trains.[1]

Gas Sample Supply and Return Lines

The H_2/O_2 System is designed to provide the capability for "on-line" analysis of the H_2 and O_2 concentrations in the Primary Containment. In the analyze mode, a Primary Containment atmosphere sample is drawn from the Primary Containment (either drywell or torus) and is returned to containment after passing through the analyzer panel. All sample supply lines are electrically heat traced and insulated to maintain the sample temperatures up to 275°F to prevent condensation of steam in the sample lines. All sample return lines are sloped from the analyzers to allow condensation to drain from the analyzer panels.

The locations of these sample supply and return lines are as follows:

1. Drywell Atmosphere Sample Lines

   Each train of the H_2/O_2 System is capable of obtaining drywell atmosphere samples from two separate locations.

   Train A of the H_2/O_2 System is capable of obtaining drywell atmosphere samples via existing penetrations X-29E and X-106A-b, and the associated containment isolation valves SV-5065-33A and 37A, and SV-5065-14A and 21A, respectively.

   NOTE: Penetration X-29E provides a common drywell atmosphere sample location with the Post Accident Sampling System. The PASS ties in to this sample line outside the H_2/O_2 System containment isolation valves. Penetration X-106A-b provides a common drywell atmosphere sample location with the C-19 Panel. The C-19 Panel ties in to this sample line, downstream of H_2/O_2 System containment isolation valves.

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(1) Sample from torus will not be redundant until about June 1985.

Train B of the H_2/O_2 System will be capable of obtaining drywell samples via penetrations X-15E and X-50A-d and associated containment isolation valves SV-5065-31B and 35B, and SV-5065-13B and 20B, respectively.[1]

NOTE: Penetration X-50A-d will provide a common drywell atmosphere sample location with both the PASS System and C-19 Panel. The PASS and the C-19 sample piping will tie-in to this sample line, downstream of the H_2/O_2 System containment isolation valves.

Torus Atmosphere Sample lines

Each train of the H_2/O_2 System will be capable of obtaining a torus atmosphere sample at one location.

Train A of the H_2/O_2 System is capable of obtaining a torus atmosphere sample via penetration X-228J and containment isolation valves SV-5065-11A and 18A.

NOTE: Penetration X-228J provides a common torus atmosphere sample location with the PASS. The PASS ties in to this sample line downstream of the H_2/O_2 System containment isolation valves.

Train B of the H_2/O_2 System will be capable of obtaining a torus atmosphere sample via penetration X-228C, and containment isolation valves SV-5065-15B and 22B. H_2/O_2 sample lines via penetration X-50-A-d and X-228-C will become available approximately June 1985, PASS and C-19 sample lines from penetration X-50A-d and PASS sample from penetration X-228C are operational (following RFO6).

NOTE: Penetration X-228C will provide a common torus atmosphere sample location with the PASS System. The PASS will tie in to this sample line, downstream of the H_2/O_2 System containment isolation valves.

Sample Return Lines

Sample returns for each train of the H_2O_2 System go to separate locations. Train A returns the samples (either drywell or torus sample) to the drywell, and Train B returns to the torus.

The Train A atmosphere samples are returned to the drywell via penetration X-46F, and containment isolation valves SV-5065-24A and 26A.

NOTE: Penetration X-46F provides a common sample return location with the PASS System. The PASS ties in to this return line, upstream of the H_2O_2 System containment isolation valves.

The Train B atmosphere samples are returned to the torus via penetration X-228K, and containment isolation valves SV-5065--25B and 27B.

(1) H_2/O_2 sample lines via penetration X-50-A-d and X-228-C will become available approximately June 1985, PASS and C-19 sample lines from penetration X-50A-d and PASS sample from penetration X-228C are operational (following RFO6).

NOTE: Penetration X-228K provides a common sample return location with the PASS System. The PASS ties in to this return line piping, upstream of the H_2O_2 System containment isolation valves.

H_2/O_2 Analyzer Panels

1. General

Each train of the H_2/O_2 System is provided with an H_2/O_2 Analyzer Panel located on the 74' 3" elevation in the Reactor Building. The panel receives sample flow from the appropriate sample point. After analysis, the sample is returned to the Primary Containment via the sample return line. The analyzer panels for each train are functionally identical.

2. Analyzer Operation

A. Thermal Conductivity Cell Operation

The H_2O_2 Analyzer takes advantage of the difference in thermal conductivity of various gas species to measure gas concentrations. For example, the thermal conductivity of hydrogen (at the temperatures utilized in the analyzer) is approximately seven times that of nitrogen, oxygen, and water vapor (the only gasses expected to be in the containment atmosphere in significant quantities).

To measure the thermal conductivity of the gas sample, the analyzer uses a self-heating filament within a temperature controlled metal cavity. The temperature of this filament is directly affected by the rate at which heat is conducted from the filament through the sample gas to the cavity wall. Because the cavity wall is maintained at a constant temperature, the filament temperature is a function of the thermal conductivity of the sample gas. The electrical resistance of the self-heating filament is a function of its temperature; therefore, the resistance of the filament is a function of the thermal conductivity of the sample gas yielding an electrical output indicative of the thermal conductivity of the gas.

B Hydrogen Concentration Measurements

Hydrogen concentration measurements are made by two thermal conductivity cells, a reference cell and a measuring cell. Both cells are essentially identical except that the reference cell includes a catalyst which causes the hydrogen in the sample stream to combine with oxygen to form water vapor.

To measure hydrogen concentrations, the sample gas passes through the measuring and reference cells. The lack of hydrogen in the reference cell (caused by the catalytic reaction within the reference cell) causes a mismatch between the electrical resistances of the self-heating filaments (i.e., the difference in thermal conductivity of the gases). The filaments are connected across an electrical bridge which yields an output indicative of the percentage of hydrogen gas present.

The above process assumes that sufficient oxygen is available in the air sample to assure the complete reaction of all hydrogen within the reference cell. This condition may not always exist within the containment atmosphere. Therefore, a reagent gas (essentially 100% O_2; see Reagent Gas Subsystem) is added to the sample stream upstream of the analyzer cells. A sufficient amount of reagent gas is added to assure the complete reaction of hydrogen within the reference cell over the maximum range of the analyzer, assuming no oxygen is present in the containment atmosphere.

C. Oxygen Concentration Measurements

The oxygen analyzer functions essentially the same as the hydrogen analyzer; however in this case, the reagent gas is essentially 100% hydrogen. The lack of oxygen in the reference cell (caused by catalytic reaction) when compared to the presence of oxygen in the measuring cell yields an analyzer output indicative of the percentage of oxygen in the sample gas.

3. Calibration Modes

The analyzer cell operation described above provides an electrical output indicative of the relative difference between the thermal conductivities in the reference and measuring cells.

To relate this relative difference in thermal conductivities to actual concentrations of the sample being analyzed, the output of the analyzer cells must be calibrated. To calibrate the analyzers, two calibration modes are provided, zero mode and span mode. Both modes utilize a calibration gas (see Calibration Gas Subsystem) which supplies a known percentage of gas being analyzed.

A. Zero Mode

The purpose of the zero mode in calibration is to balance the outputs of the measuring cell and reference cell to yield a zero output when no differences in thermal conductivity exists between the cells. In this mode, only the calibration gas passes through the analyzer. Because the reagent gas is not supplied to the analyzer, no catalytic recombination will occur in the reference cell, causing both cells to measure identical thermal conductivities. This is the case when the actual sample stream contains zero percent hydrogen or zero percent oxygen for the hydrogen and oxygen analyzers, respectively. The electrical output of the analyzers are therefore adjusted to indicate a zero percent concentration.

B. Span Mode

The purpose of the span is to adjust the electrical output of the analyzers to be proportional to the percentage of the gas being analyzed. In this mode, both the calibration and reagent gases are allowed to pass through the analyzers. Because the reagent gas is being supplied, catalytic recombination will occur in the reference cell yielding a difference in thermal conductivity. Because the

percentage of hydrogen for the hydrogen analyzer calibration gas and the percentage of oxygen for the oxygen analyzer calibration gas is known, the electrical output of the analyzers can be adjusted to indicate this known percentage.

4. Overall Panel Operation

Train A and Train B are functionally identical.* Train A will be discussed. In the sample mode, the sample gas enters the analyzer panel, passes through an insulated line, through a bellows seal valve, and into a heated sample compartment (hot box). A local pressure indication is provided on this line. In the hot box, the sample flows into a moisture separator. This moisture separator consists of the float operated valve that shuts off flow to the analyzer sections of the panel if the separator is unable to handle the liquid load. This condition could only occur after failure of the heat tracing on the sample supply lines. The condensate from the moisture separator enters the analyzer bypass line and is returned to the containment via PCV-R2-5140A and the analyzer panel sample pump. The analyzer bypass line is provided to allow the analyzer pump to be operated at essentially a constant flow condition. When vacuum in the line is reduced below -11" to -13" Hg, PCV-R2-5140A opens, bypassing sufficient sample flow to allow the pump to operate at maximum total sample flow. Flow indicator FI-1-5127A is located on this line. Normal bypass flow is 9 to 18 scfh. Bypass flow and the return flow from the analyzer section of the panel, combine, and pass through an air cooled heat exchanger. This heat exchanger reduces a sample temperature to 175°F or less to extend the life of the sample pump diaphragms.

The total sample flow from the analyzer exits the sample pump, passes through a bellows seal valve and is returned to the containment via the sample return line.

Sample flow to the analyzer section of the panel is regulated via PCV-R1-5126A. Regulator PCV-R1-5126A operates to maintain a downstream vacuum of 0" to -5" Hg. Downstream of PCV-R1-5126A, sample flow passes through the H_2 and O_2 thermal conductivity cells AE-1-5074A and AE-2-5035A. Some of the flow is bypassed to the sample pump to maintain the proper flow conditions through the analyzers. The bypass flow can be monitored via FI-1-5078A.

The function of both the hydrogen and oxygen analyzer legs and associated calibration and reagent gas legs are identical. The following description is for the hydrogen analyzer but is typical for both analyzers.

The Calibration and Reagent Gas Subsystems tie in to the analyzer leg upstream of the analyzer cell. These gases enter the analyzer panel through solenoid operated valves SV-1-5065A and SV-2-5172A. These solenoid operated valves isolate the calibration and/or reagent gas supply to the analyzer leg depending on the mode of operation of the panel (i.e., sample, zero, or span modes). Pressure switches PS-1-5173A and PS-2-4172A are included on these lines. These pressure switches are set to alarm

* When fully operational (refer to preceding footnotes).

when either gas supply drops below 10 psig. Pressure control valves (PCV-1-5129A and PCV-2-5066A), flow indicating controllers (FIC-1-5310A and FIC-2-5180A), and check valves are located downstream of the solenoid operated valves.

The pressure control valves are factory adjusted and maintain a constant differential pressure of approximately 3 psid across the flow indicating controls.

The flow indicating controllers allow adjustment of the calibration and reagent gas flow rates. Check valves are provided in the lines to separate the calibration and reagent gas lines from the analyzer legs.

The analyzer cell is located downstream of the calibration and reagent gas tie-in points. Analyzer cell flow is regulated by a differential pressure regulator, PCV-R3-5075A, and a fixed orifice, FO-1-5090A. PCV-R3-5075A is factory adjusted to provide approximately 3 psid differential pressure across the fixed orifice.

The fixed orifice is sized to provide a flow of approximately 120 to 200 cc/min through the analyzers. Flow indicator FI-2-5114A is provided downstream to indicate analyzer flow. Vacuum switch PS-2-5412A, is provided to initiate an alarm in the event of fixed orifice blockage, sample pump vacuum loss, or sample exit blockage.

Reagent Gas Subsystems

As described above, the H_2/O_2 analyzers require a reagent gas supply of essentially 100% O_2 and H_2 gas to aid in the analysis for H_2 and O_2 concentrations, respectively. A Reagent Gas Subsystem is provided for each train.

Each Reagent Gas Subsystem consists of two compressed gas cylinders (99.9% H_2 and 99.9% O_2), a compressed gas bottle rack, pressure regulating/relief valves for each bottle, and associated manual valves and tubing to supply the reagent gas to the analyzer panels. The reagent gas bottles and associated bottle racks are located on the 74' 3" elevation within the Reactor Building. The Reagent Gas Subsystems are also provided with auxiliary fill connections located outside the Reactor Building (Secondary Containment). The auxiliary fill connections are provided to allow recharging of the reagent gas bottles during accident conditions when it is assumed that the Reactor Building will be inaccessible.

Calibration Gas Subsystem

The Calibration Gas Subsystem is similar to the Reagent Gas Subsystems, except that only one train is provided common to both analyzer panels. The Calibration Gas Subsystem consists of compressed gas bottles, bottle racks (the calibration gas bottles use the sample bottle racks provided for the Reagent Gas Subsystems), pressure regulator/relief valves for each bottle, and associated valves and tubing to supply calibration gas to the analyzer panels. As in the case of the Reagent Gas Subsystems, the Calibration Gas Subsystem is provided with auxiliary fill connections located outside the Reactor Building to allow recharging of the calibration gas bottles during accident conditions when the Reactor Building may be inaccessible.

Major Component Design

H_2/O_2 Analyzer Panel

The following information is provided.

Panel Dimensions	L x W x H
Analyzer Panel	30" x 30" x 72"
Remote Panel	20 3/8" x 19" x 17 1/2"
Panel Weights:	
Analyzer Panel	1600 pounds
Remote Panel	75 pounds
Panel Design Environmental Limits:	
Temperature	40 to 120°F
Pressure	27.92" Hg to 31.92" Hg
Humidity	0 to 95%
Radiation	0 to 10^6 Rads (total)
Sample Design Environmental Limits at the Analyzer Panel:	
Temperature	60 to 300°F
Pressure	-2 to 60 psig
Humidity	0 to 100%
Radiation	0 to 10^8 Rads (total
System Response Time:	
"Off" to "Analyze" position	6 hours
Power Requirements:	
	120 VAC ± 10%, 60 Hz, ± 10%
	9A 460 VAC, 60 Hz, 3 phase,
	1.70 FLA

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Instrumentation and Control

Parameters to be Controlled and Displayed

1. Main Control Room Panel C-904

- 8 Drywell sample line containment isolation valves
- 4 Suppression Pool sample line containment isolation valves
- 2 Drywell sample return line containment isolation valves |
- 2 Suppression Pool sample return line containment isolation valves
- Valve position indication for the above valves
- Containment isolation signal and containment isolation signal Override for the above valves. |

2. Main Control Room Panels C-170 an C-171

- Isolation Signal Override Alarm
- % H_2 Recorder
- % O_2 Recorder
- Sample Location

(% H_2 Recorder, % O_2 Recorder, Sample Location: one, 3-channel recorder per train) |

- High level Alarm (H_2 or O_2) |

Common Failure Alarm |

3. Main Control Room Panels C-174 and C-175

- Sequence controls and Indication of Sample Line being analyzed. |
- % H_2 and % O_2 Indication
- Alarm lights for High H_2, High O_2, and common failure |
- Analyzer Remote Controls, including Local-Remote selection |
- Status Indication lights for Heater ON, Power ON, Span, Zero, sample, H_2 Range 1, H_2 Range 2, O_2 Range 1, O_2 Range 2 |

4. Local H_2 and O_2 Analyzer Panels C-172 and C-173 |

- Analyzer Local Controls, including local remote selection |

- Alarm lights: High H_2, High O_2, common failure, low pressure, low flow, low temperature, and cell failure
- % H_2 and O_2 Indication
- Status Indication lights: Heater ON, Span, Zero, Sample, H_2 Range 1 or 2, O_2 Range 1 or 2, Power ON, Standby

A 4-20 MA output signal is supplied to the Main Control Room for recording of oxygen and hydrogen concentrations. An indication to identify which of the three samples is being analyzed, is shown locally and in the Control Room. This signal has three signal levels within the span of 4-20 MA.

Analyzer Operating Range

0-10% Hydrogen
0-20% Hydrogen

0-10% Oxygen
0-25% Oxygen

Electrical Power Systems

The H_2/O_2 Systems being installed are two completely redundant H_2/O_2 analyzer instrument racks, identified as C-172 and C-172 and located at elevation 74' - 3" of the Reactor Building (Secondary Containment). The output of each analyzer feeds a 19" insert in the Post Accident Sampling Panels C-174 and C-175 in the Main Control Room. These inserts provide controls necessary for remote control of the analyzers and they also provide tranducers which are required to drive the various devices used to monitor the H_2/O_2 concentration. In addition, alarm lights are located on the analyzers and the C-174/C-175 inserts. Annunciation points (non-safety related) are provided on panels C-170 and C-171.

Each analyzer requires 460 v, 3 phase and 120 v single phase power. The Division I analyzer receives its 460 v supply from safety related MMC B17A and its 120 v power from distribution panelboard Y13. The Division II analyzers receive power from the redundant safety related sources MCC B18A and panelboard Y14.

Each sample and sample return line has two solenoid operated valves piped in series and located as close as possible to the primary containment. Electrically, the solenoids are designed to operate at 120 VAC (outboard) or 125 VDC (inboard). The valves draw 1.5 Amps maximum at rated voltage. The valve position switches are reed type SPST with contacts rated for .5 Amps and 125 VDC. The position switches and coil pigtails are wired to terminal blocks inside a NEMA 4 enclosure where all incoming field cables are terminated.

Except for valves requiring heat tracing, the solenoids are designed to pickup and remain energized between 96 and 132 volts for the AC valves and 90 and 140 volts for the DC valves. Those valves requiring heat tracing have a "control box" in series with the coil of the solenoid. The "control box," which consists of a time delay relay and a voltage dropping resistor, allows the valves to be picked up at rated voltage and "held in" at reduced voltage. The reduced voltage lowers the heat generated in the solenoid housing thus reducing the total temperature around the coil and increasing the life expectancy of the valve. The "control boxes" are located in control panels located in the Main Control Room.

Each series pair of isolation valves is controlled from panel C-904 and receives power (DC inboard and AC outboard) from the same Division of Class IE Electrical Distribution System as its associated analyzer panel. Valves in the redundant sample/return lines receive power from the second independent Class IE Power Distribution System. Power to the DC valves is obtained from panelboards D36 (Div. I) and D37 (Div. II). Power required for the AC solenoid valves is obtained from Class IE panelboards Y31 (Div. 1) and Y41 (Div. II).

Each valve is closed by a containment isolation signal (low reactor water level/high drywell pressure) obtained from multipliers of General Electric containment isolation logics. Division I isolation signals are used for inboard isolation valves and Division II signals are used for outboard valves.

The isolation signals can be overridden by the operator via operation of keylocked switches on panel C-904.

The valve control switches are wired in-series with the isolation logic reset so that the valve control switches must be in the CLOSED position before the logic is reset. This prevents inadvertent opening of the valves when the logic is reset.

The valve control switches and isolation signal override switches were purchased as Class IE. The logic relays are all located on main control panel C-904.

Cables to all containment isolation valves except two are routed in the same conduit system (applies to each of 2 trains). No other circuit is routed through these conduits. Any failure of the conduit system due to high energy pipe break or fire will not prevent closure of the isolation valves. Any open or short circuit in the cables will result in valve closure. A "hot short" between cables (which is extremely unlikely) will not prevent valve closure, since all sources of power in the conduit system, capable of energizing the solenoids, can be deenergized by moving all valve control switches to close.

The cables to the remaining two isolation valves are routed with other control circuits. The conduit for these valves is routed through the reactor building (at elevation 23' East, elevation 51' East to North, and elevation 74' North) in area's not subject to high energy pipe breaks. Any failure of this conduit system due to other causes (fire) resulting in cable opens or short circuits will cause the valves to close. "Hot shorts" between a 120VAC or 125VDC circuit and both valve control cables (extremely unlikely) could result in two

series valves opening. Opening of these valves will extend primary containment into the Category I H_2/O_2 piping system which is designed to withstand the effects of a design basis LOCA within the primary containment.

In general, the power supplies, isolation signals, and override functions are arranged to provide the capability of isolation on a LOCA and the reopening of at least one set of sample lines after a LOCA assuming a single failure. Isolation of the sample lines is assured, in that the series valves receive isolation signals from redundant logics, the valves fail closed on loss of power, and a single failure (high voltage) of either an AC or DC supply will only prevent one valve (inboard's are DC, outboard's are AC) from closing. Reopening of at least one redundant group of isolation valves is possible assuming a single failure because of the complete independence of power supplies to the redundant subsystems and the availability of individual override switches for each group of isolation valves.

The Class IE heat tracing system is divided into redundant subsystems; one serving Division I sample lines and one serving Division II lines. Each subsystem has a control panel (C-176/C-177) located in the electrical equipment room, with a 120/240 volt, 28 circuit distribution panelboard. Each heat trace circuit is supplied via an individual 120 volt breaker. In addition to the power distribution function, the heat trace control panels have temperature control units, high and low temperature alarm units, and current monitoring units for each trace circuit. 100 ohm platinum RTD's monitor the pipe temperature for input to the temperature control units which supply power to the heat trace circuit as required. The power supply (120/240 VAC) to the Division I heat trace subsystem is from Class IE panelboard Y13. The power to the Division II subsystem is from Class IE panelboard Y14. This heat trace system is also used to heat the PASS system atmosphere sample lines.

All electrical equipment has voltage and current ratings exceeding the anticipated operating conditions. Instrumentation, control, and power cables are routed in different raceways as required by "Design Criteria for Electrical Installation."

All safety related components and associated cable/conduit are installed in Seismic Category I buildings. All safety related equipment and Class IE conduit is installed to meet the requirements Seismic Category I installations.

ATTACHMENT C