CP&L
Carolina Power & Light Company

SERIAL: NLS-84-111

MAR 09 1984

Director of Nuclear Reactor Regulation
Attention: Mr. D. B. Vassallo, Chief
Operating Reactors Branch No. 2
Division of Licensing
United States Nuclear Regulatory Commission
Washington, DC 20555

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-325 AND 50-324
LICENSE NOS. DPR-71 AND DPR-62
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION - NUREG-0737
ITEM II.F.1.4, CONTAINMENT PRESSURE MONITOR SYSTEM
ITEM II.F.1.5, CONTAINMENT WATER LEVEL MONITOR SYSTEM
ITEM II.F.1.6, CONTAINMENT HYDROGEN MONITOR SYSTEM

Dear Mr. Vassallo:

In your letter dated February 2, 1984, Carolina Power & Light Company (CP&L) was requested to provide information regarding NUREG-0737, Items II.F.1.4, .5 and .6. The two general subject areas were identified as Attachments 2 and 14 to that letter.

Attachment 2 requested identification of any exceptions taken to those NUREG requirements that are within the review scope of the Containment Systems Branch. In response, CP&L considers Brunswick's implementation of the three subject items to be in complete compliance with the requirements stated in NUREG-0737.

Attachment 14 requests presentation of information related to the accuracy and time response characteristics of the equipment installed on the three subject items. In response, Attachment 1 to this letter provides the requested data.

Should you have any questions concerning this letter, please do not hesitate to contact a member of our Licensing Staff.

Yours very truly,

S. R. Zimmerman
Manager
Nuclear Licensing Section

PPC/ccc (9653PPC)

cc: Mr. D. O. Myers (NRC-BSEP)
Mr. J. P. O'Reilly (NRC-RII)
Mr. M. Grotenhuis (NRC)

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ATTACHMENT 1

Response to Attachment 14 of NRC letter dated February 2, 1984, titled:

"Request for Additional Information on three NUREG-0737 Items

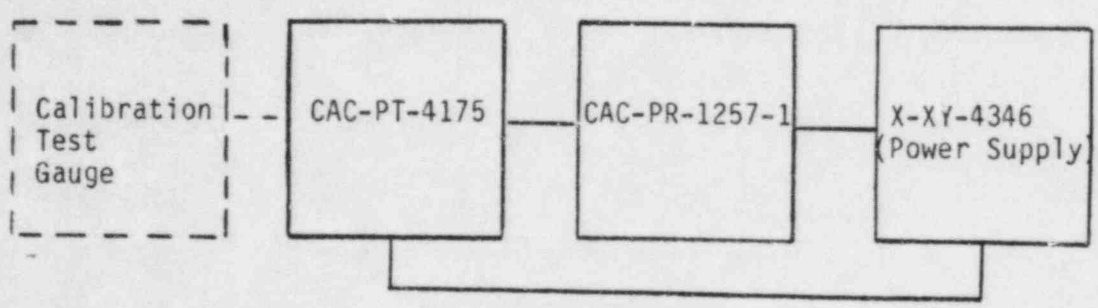
II.F.1.4	Containment Pressure Monitor
II.F.1.5	Containment Water Level Monitor
II.F.1.6	Containment Hydrogen Monitor"

(2) II.F.1.4 - PRESSURE MONITORING SYSTEM (PMS) - ACCURACY AND RESPONSE

The wide range containment pressure monitoring system consists of two independent instrument loops, one driving a recorder and the other providing indication only. Both loops are calibrated over the range of (-)5 to (+)245 PSIG. Since the loop components vary, they are treated separately in the following discussion.

LOOP # 1

(2a1) BLOCK DIAGRAM



(2b1) MODULE UNCERTAINTY PARAMETERS

CALIBRATION TEST GAUGE: HEISE PRESSURE GAUGE (REFERENCE #1)

General Accuracy: ±0.1% of full scale. Two gauges are used - one to cover the vacuum range and the other for the positive pressure range (300 PSIG). Therefore, the greater uncertainty introduced is = ± (.001) (300) = ± 0.3 PSIG
S_{G1} = Standard Deviation = ± (1/3) (0.3) = ± 0.1 PSIG

Temperature Effects: Not significant since the installed instrument location is near the ambient temperature of the lab in which the test gauges are calibrated.

CAC-PT-4175: ROSEMOUNT MODEL 1152 PRESSURE TRANSMITTER (REFERENCE #2)

General Accuracy: ±0.25% of calibrated span (250 PSIG)
=± (.0025) (250) =± .625 PSIG
S_{T1} = Standard Deviation =± (1/3) (0.625)
= ± .208 = ± .21 PSIG

Random Error: Stability = ± 0.25% of upper range limit (300 PSIG)
= (.0025) (300) = ± .750 PSIG
S_{T2} = Standard Deviation = ± (1/3) (0.750)
= ± .250 = ± .25 PSIG

Temperature Effects: Total temperature effect including span and zero errors:
@ min span (0-50) ≈ ± 3.5% span/100^{o}F
@ max span (0-300) ≈ ± 1.0% span/100^{o}F
Interpolating for calibrated span of 250^{o}F, effect ≈ ± 1.5% span/100^{o}F
Post-accident temperature at instrument location peaks at 210^{o}F (140^{o}F above normal ambient); therefore, the maximum temperature effect ≈ ± (.0015) (250) (1.4)
= ± .525 ≈ ± .53 PSIG
S_{T3} = Standard Deviation = ± (1/3) (0.53)
= ± .177 ≈ ± .18 PSIG

Power Supply Voltage: ± 0.005% of span (250 PSIG) per volt
= ± .00005 (250) = ± .0125 PSIG/Volt
Negligible compared to other effects considered

Hysteresis: Included in general accuracy statement

Deadband: None

CAC-PR-1257-1: BAILEY CONTROLS SR-1310 RECORDER (REFERENCE #3)

General Accuracy:
± 0.5 of span (250 PSIG)
= ± (.005) (250) = ± 1.25 PSIG
S_{R1} = Standard Deviation = ± (1/3) (1.25)
= ± .42 PSIG

Random Errors:
Linearity = ± 0.25% of span (250 PSIG)
= ± (.0025) (250) = ± .63 PSIG
S_{R2} = Standard Deviation = ± (1/3) (.63) = ± .21 PSIG

Repeatability = ± 0.1% of span (250 PSIG)
= ± (.001) (250) = ± .25 PSIG
S_{R3} = Standard Deviation = ± (1/3) (.25) = ± .08 PSIG

Power Supply Voltage:
<0.02% of span (250 PSIG) per volt over the normal supply range of 23-29 VDC = ± (.0002) (250) = ± 0.05 PSIG/Volt
Negligible compared to other effects considered

Hysteresis:
0.15% of span (250 PSIG)
= (.0015) (250) = .38 PSIG
Hysteresis Loop Half Width = .19 PSIG

Deadband:
0.1% of span (250 PSIG)
= (.001) (250) = .25 PSIG
Deadband Loop Half Width = .13 PSIG

(2c1) OVERALL SYSTEM UNCERTAINTY

NOTE: The techniques utilized here, and in subsequent sections of this report, for combination of the various module uncertainty parameters are based on the instructions presented on pages 6 and 7 of Attachment 14 of the February 2, 1984 NRC letter.

Under normal plant ambient temperature conditions, the standard deviation of the total measurement error is bounded by:

$$S^2 \text{ (total system)} = S^2(s) = S^2(s,b) + H^2(s) + H(s) * D(s) + D^2(s)/2$$

$$S(s,b) = \sqrt{S_{G1}^2 + S_{T1}^2 + S_{T2}^2 + S_{R1}^2 + S_{R2}^2 + S_{R3}^2}$$

$$= \sqrt{.10^2 + .21^2 + 25^2 + .42^2 + .21^2 + .08^2}$$

$$= \sqrt{.344} = \pm .59 \text{ PSIG}$$

H(s) = .19 PSIG

D(s) = .13 PSIG

Then:

S (total system) $= \sqrt{(.59)^2 + (.19)^2 + (.19)\ (.13) + (.13)^2/2}$

$= \sqrt{.417} \approx \pm .65$ PSIG

Under maximum accident temperature conditions at the transmitter location, the standard deviation of the total measurement error increases as follows:

$$S(s,b) = \sqrt{S_{G1}{}^2 + S_{T1}{}^2 + S_{T2}{}^2 + S_{T3}{}^2 + S_{R1}{}^2 + S_{R2}{}^2 + S_{R3}{}^2}$$

$$= \sqrt{.10^2 + .21^2 + .25^2 + .18^2 + .42^2 + .21^2 + .08^2}$$

$$= \sqrt{.376} = \pm .61 \text{ PSIG}$$

Then:

S (total system) $= \sqrt{(.61)^2 + (.19)^2 + (.19)\ (.13) + (.13)^2/2}$

$= \sqrt{.441} = \pm .66$ PSIG

(2d1) MODULE TIME RESPONSES

CAC-PT-4175: Time constant continuously adjustable between 0.2 and 1.67 seconds. To be left at factory setting of 0.2 seconds.

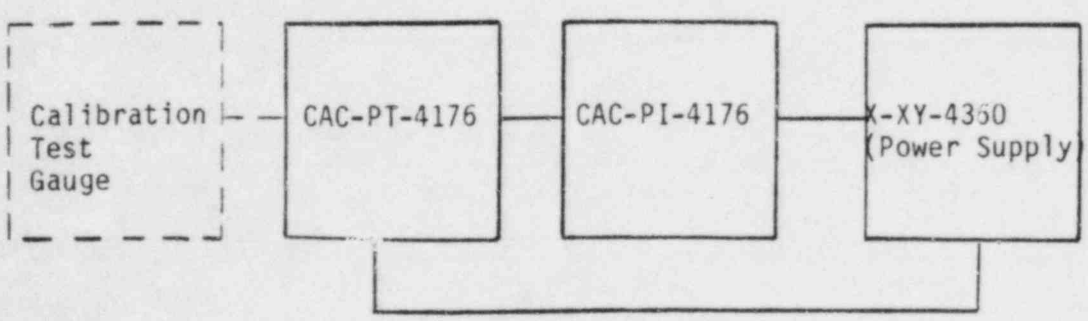
CAC-PR-1257-1: Pen speed adjustable from less than 1 second to greater than 15 seconds for 98% of span. To be left at minimum setting, assume = 1 second for 98% of span.

(2e1) OVERALL SYSTEM TIME RESPONSE

To be completed by NRC.

LOOP # 2

(2a2) BLOCK DIAGRAM



(2b2) UNCERTAINTY PARAMETERS

CALIBRATION TEST GAUGE: HEISE PRESSURE GAUGE (REFERENCE #1)

Same range and uncertainty parameters as stated above for Loop #1. Use:

$S_{G1} = \pm 0.1$ PSIG

CAC-PT-4176: ROSEMOUNT 1152 PRESSURE TRANSMITTER (REFERENCE #2)

Same range and uncertainty parameters as stated above for PT-4175. Use:

$S_{T1} = + .21$ PSIG

$S_{T2} = \pm .25$ PSIG

$S_{T3} = \pm .18$ PSIG

CAC-PT-4176: INTERNATIONAL INSTRUMENTS SERIES 1151 INDICATOR (REFERENCE #4)

General Accuracy:	± 1.5% of span (250 PSIG) = ± (.015) (250) = ± 3.75 PSIG S_{I1} = Standard Deviation = ± (1/3) (3.75) = ± 1.25 PSIG
Random Error:	Repeatability = ± 2.0% full scale (250 PSIG) = ± (.02) (250) = ± 5.0 PSIG S_{I2} = Standard Deviation = ± (1/3) (5.0) = ± 1.7 PSIG
Temperature Effects:	Not stated
Power Supply Voltage:	Not applicable
Hysteresis:	Not stated
Deadband:	Not stated

(2c2) OVERALL SYSTEM UNCERTAINTY

Under normal plant ambient temperature conditions, the standard deviation of the total measurement error is bounded by:

$$S^2 \text{ (total system)} = S^2(s) = S^2(s,b) + H^2(s) + H(s) * D(s) + D^2(s)/2$$

$$S(s,b) = \sqrt{S_{G1}^{\ 2} + S_{T1}^{\ 2} + S_{T2}^{\ 2} + S_{I1}^{\ 2} + S_{I2}^{\ 2}}$$

$$= \sqrt{.10^2 + .21^2 + .25^2 + 1.25^2 + 1.7^2}$$

$$= \sqrt{4.7} = \pm\ 2.14 \text{ PSIG}$$

Since both H(s) and D(s) = 0,

$\underline{S \text{ (total system)}} = S^2(s,b) = \underline{\pm\ 2.14 \text{ PSIG}}$

Under maximum accident temperature conditions at the transmitter location, the standard deviation of the total measurement error is calculated as follows:

$$S(s,b) = \sqrt{S_{G1}^{\ 2} + S_{T1}^{\ 2} + S_{T2}^{\ 2} + S_{T3}^{\ 2} + S_{I1}^{\ 2} + S_{I2}^{\ 2}}$$

$$= \sqrt{.10^2 + .21^2 + .25^2 + .18^2 + 1.25^2 + 1.7^2}$$

$$= \sqrt{4.60} = \pm\ 2.15 \text{ PSIG}$$

Since both H(s) and D(s) = 0,

$\underline{S \text{ (total system)}} = S^2(s,b) = \underline{\pm\ 2.15 \text{ PSIG}}$

Note that due to the relative magnitude of S_{I1}, inclusion of the temperature effect does not significantly increase the system standard deviation.

(2d2). MODULE TIME RESPONSES

CAC-PT-4176: Time constant continuously adjustable between 0.2 and 1.67 seconds. To be left at factory setting of 0.2 seconds.

CAC-PI-4176: Response time: 2.5 seconds maximum (includes response to a 3/4 full scale step change, with settling to within 1.5% full scale of the step target)

Damping factor: 5 minimum (per ANSI C39.1)

(2e2) OVERALL SYSTEM TIME RESPONSE

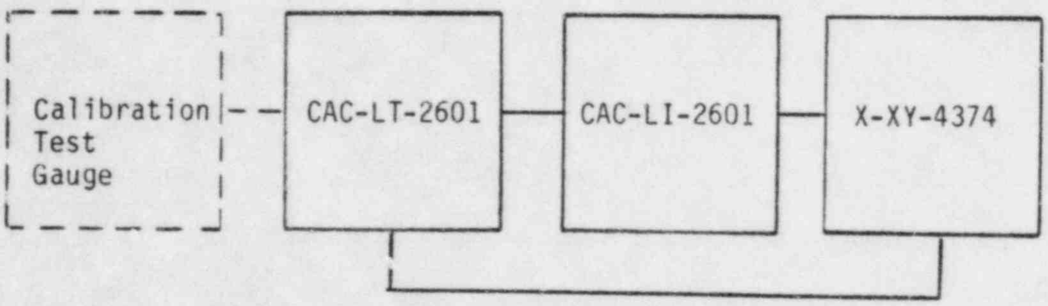
To be computed by NRC.

(3) II.F.1.5 - WATER LEVEL MONITORING SYSTEM (WLMS) - ACCURACY

The wide range suppression pool water level monitoring system features independent instrument loops, each monitoring over a calibrated range of 192 inches. Since the loop components vary, the loops are treated separately in the following discussion.

LOOP # 1

(3a1) BLOCK DIAGRAM



(3b1) UNCERTAINTY PARAMETERS

CALIBRATION TEST GAUGE: WALLACE & TIERNAN SERIES 65-120 PORTABLE PENUMATIC CALIBRATOR (REFERENCE #6), or better

General Accuracy: ±0.1% of full scale (950 inches)
= ± (.001) (950) = ± 0.95 inches
S_{G1} = Standard Deviation = ± (1/3) (.95)
= ± 0.32 inches

Random Error: Repeatability = ± 0.03% of full scale (950 inches)
= ± (.0003) (950) = ± 0.285 inches
S_{G2} = Standard Deviation = ± (1/3) (.285)
= ± 0.10 inches

Temperature Effects: Maximum is 0.1% of full scale per $18^{o}F$ change from $77^{o}F$. The instrument loop calibration task requires use of the pneumatic calibrator unit in a plant location where ambient temperatures are usually elevated. Assume ambient at approximately $95^{o}F$. Therefore, the normal temperature effect = ± (.001) (950) = ± 0.95 inches

S_{G3} = Standard Deviation = ± (1/3) (0.95) = ± 0.32 inches

Power Supply Voltage: Not applicable

Hysteresis: 0.1% of full scale
= (.001) (950) = 0.95 inches
$H_G(s)$ = Hysteresis Loop Half Width ≈ 0.48 inches

Deadband: Sensitivity = 0.01% of full scale
= (.0001) (950) = 0.095 inches
$D_G(s)$ = Deadband Loop Half Width ≈ 0.048 inches

CAC-LT-2601: ROSEMOUNT 1153 DIFFERENTIAL PRESSURE TRANSMITTER (REFERENCE #5)

General Accuracy: ± 0.25% of calibrated span (192 inches)
= ± (.0025) (192) = ± 0.48 inches
S_{T1} = Standard Deviation = ± (1/3) (0.48) = ± 0.16 inches

Random Error: Stability = ± 0.25% of upper range limit (750 inches)
= ± (.0025) (750) = ± 1.88 inches
S_{T2} = Standard Deviation = ± (1/3) (1.88) = ± 0.63 inches

Temperature Effects: For Rosemount range code 5 (0-125 to 0-750 inches H_2O):
± (0.75% Upper Range Limit + 0.5% span) per $100^{o}F$ ambient temperature change.
= ± [(.0075) (750) + (.005) (192)]
= ± 6.59 inches/$100^{o}F$ ambient temperature change

Post-accident temperature at instrument location peaks at $295^{o}F$ ($225^{o}F$ above normal ambient, therefore, the maximum temperature effect = ± (6.59) (2.25) = ± 14.83 inches
S_{T3} = Standard Deviation = ± (1/3) (14.83) = ± 4.94 inches

Power Supply Voltage: <.005% of span (192 inches) per volt $= \pm (.00005)(192) = \pm .0096$ inches/volt
Negligible compared to other effects considered

Hysteresis: Included in general accuracy statement

Deadband: None

CAC-LI-2601: INTERNATIONAL INSTRUMENTS SERIES 1151 INDICATOR (REFERENCE #4)

General Accuracy: $\pm$ 1.5% of span (192 inches)
$= \pm (0.15)(192) = \pm 2.88$ inches
S_{I1} = Standard Deviation $= \pm (1/3)(2.88)$
$= \pm 0.96$ inches

Random Error: Repeatability = $\pm$ 2.0 % full scale (192 in.)
$= \pm (.02)(192) = \pm 3.8$ inches
S_{I2} = Standard Deviation $= \pm (1/3)(3.8)$
$= \pm 1.27$ inches

Temperature Effect: Not stated

Power Supply Voltage: Not applicable

Hysteresis: Not stated

Deadband: Not stated

(3c1) OVERALL SYSTEM UNCERTAINTY

Under normal plant ambient temperature conditions, the standard deviation of the total measurement error is bounded by:

$$S^2 \text{ (total system)} = S^2(s) = S^2(s,b) + H^2(s) + H(s) * D(s) + D^2(s)/2$$

$$S(s,b) = \sqrt{S_{G1}{}^2 + S_{G2}{}^2 + S_{G3}{}^2 + S_{T1}{}^2 + S_{T2}{}^2 + S_{I1}{}^2 + S_{I2}{}^2}$$

$$= \sqrt{.32^2 + .10^2 + .32^2 + .16^2 + .63^2 + .96^2 + 1.27^2}$$

$$= \sqrt{3.17} = \pm 1.78 \text{ PSIG}$$

$$H(s) = H_G(s) = 0.48 \text{ inches}$$

$$D(s) = D_G(s) = 0.048 \text{ inches}$$

$$\underline{S \text{ (total system)}} = \sqrt{1.78^2 + .48^2 + (.48)(.048) + .048^2/2}$$

$$= \sqrt{3.54} = \underline{\pm 1.88 \text{ inches}}$$

Under maximum accident temperature conditions at the transmitter location, the standard deviation of the total measurement error is calculated as follows:

$$S(s,b) = \sqrt{S_{G1}^2 + S_{G2}^2 + S_{G3}^2 + S_{T1}^2 + S_{T2}^2 + S_{T3}^2 + S_{I1}^2 + S_{I2}^2}$$

$$= \sqrt{.32^2 + .10^2 + .32^2 + .16^2 + .63^2 + 4.94^2 + .96^2 + 1.27^2}$$

$$= \sqrt{27.58} = \pm 5.25 \text{ inches}$$

$H(s) = H_G(s) = 0.48$ inches

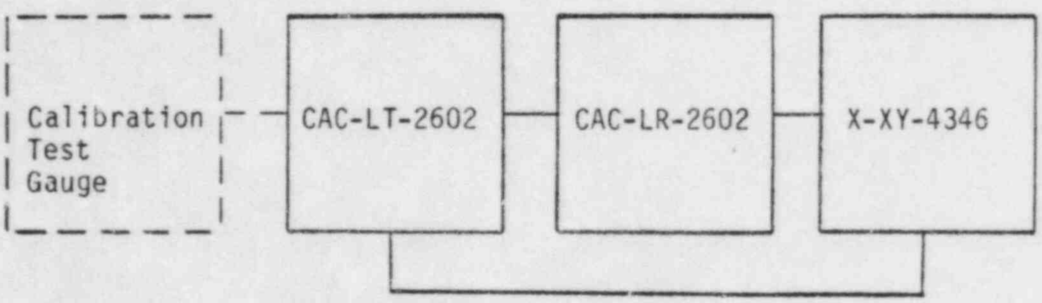
$D(s) = D_G(s) = 0.048$ inches

$$S \text{ (total system)} = \sqrt{5.25^2 + .48^2 + (.48)(.048) + .048^2/2}$$

$$= \sqrt{27.82} = \pm 5.27 \text{ inches}$$

LOOP # 2

(3a2) BLOCK DIAGRAM



(3b2) MODULE UNCERTAINTY PARAMETERS

CALIBRATION TEST GAUGE: WALLACE & TIERNAN SERIES 65-120 PORTABLE PNEUMATIC CALIBRATOR (REFERENCE #6), or better

Same range and uncertainty parameters as stated above for Loop #1. Use:

$S_{G1} = \pm 0.32$ inches

$S_{G2} = \pm 0.10$ inches

$S_{G3} = \pm 0.32$ inches

$H_G(s) = 0.48$ inches

$D_G(s) = 0.048$ inches

CAC-LT-2602: ROSEMOUNT 1153 DIFFERENTIAL PRESSURE TRANSMITTER (REFERENCE #5)

Same range and uncertainty parameters as stated above for LT-2601. Use:

S_{T1} = [illegible]6 inches

S_{T2} = ± 0.63 inches

S_{T3} = ± 4.94 inches

CAC-LR-2602: BAILEY CONTROLS SR-1110 RECORDER (REFERENCE #3)

General Accuracy:

± 0.5% of span (192 inches)
= ± (.005) (192) = 0.96
S_{R1} = Standard Deviation = ± (1/3) (0.96)
= ± .32 inches

Random Errors:

Linearity: ± 0.25% of span (192 inches)
= ± (.0025) (192) = ± 0.48 inches
S_{R2} = Standard Deviation = ± (1/3) (0.48)
= ± 0.16

Repeatability = ± 0.1% of span (192 inches)
= ± (.001) (192) = ± 0.19 inches
S_{R3} = Standard Deviation = ± (1/3) (0.19)
= ± 0.06 inches

Power Supply Voltage:

<0.02% of span (192 inches) per volt over the normal supply range of 23-29 VDC = ± (.0002) (192) = ± 0.05 inches/volt

Negligible compared to other effects considered.

Hysteresis:

0.15% of span (192 inches)
= (.0015) (192) = 0.29 inches
$H_R(s)$ = Hysteresis Loop Half Width = 0.15 inches

Deadband:

0.1% of span (192 inches)
= (.001) (192) = 0.19 inches
$D_R(s)$ = Deadband Loop Half Width = 0.10 inches

(3c2) OVERALL SYSTEM UNCERTAINTY

Under normal plant ambient temperature conditions, the standard deviation of the total measurement error is bounded by:

$$S^2 \text{ (total system)} = S^2(s) = S^2(s,b) + H^2(s) + H(s) * D(s) + D^2(s)/2$$

$$S(s,b) = \sqrt{S_{G1}{}^2 + S_{G2}{}^2 + S_{G3}{}^2 + S_{T1}{}^2 + S_{T2}{}^2 + S_{R1}{}^2 + S_{R2}{}^2 + S_{R3}{}^2}$$

$$= \sqrt{.32^2 + .10^2 + .32^2 + .16^2 + .63^2 + .32^2 + .16^2 + .06^2}$$

$$= \sqrt{.769} = \pm .88 \text{ inches}$$

$$H(s) = H_G(s) + H_R(s) = 0.48 + 0.15 = 0.63 \text{ inches}$$
$$D(s) = D_G(s) + D_R(s) = .048 + 0.10 = 0.15 \text{ inches}$$

$$\underline{S \text{ (total system)}} = \sqrt{.88^2 + .63^2 + (.63)\ (.15) + .15^2/2}$$

$$= \sqrt{1.28} = \underline{\pm 1.13 \text{ inches}}$$

Under maximum accident temperature conditions at the transmitter location, the standard deviation of the total measurement error is calculated as follows:

$$S(s,b) = \sqrt{S_{G1}{}^2 + S_{G2}{}^2 + S_{G3}{}^2 + S_{T1}{}^2 + S_{T2}{}^2 + S_{T3}{}^2 + S_{R1}{}^2 + S_{R2}{}^2 + S_{R3}{}^2}$$

$$= \sqrt{.32^2 + .10^2 + .32^2 + .16^2 + .63^2 + 4.94^2 + .32^2 + .16^2 + .06^2}$$

$$= \sqrt{25.17} = \pm 5.02 \text{ inches}$$

$$H(s) = 0.63 \text{ inches}$$

$$D(s) = 0.15 \text{ inches}$$

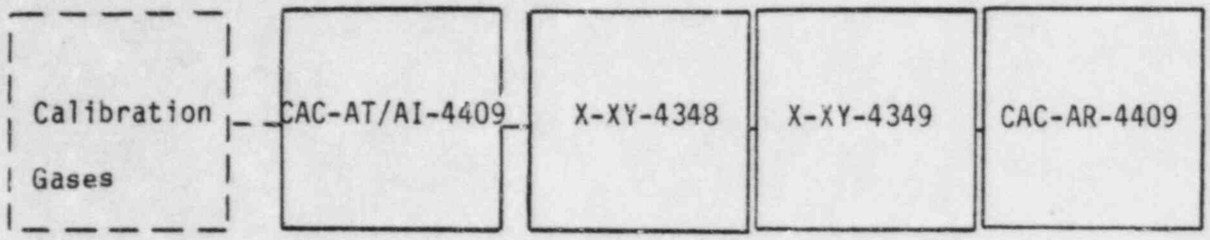
$$\underline{S \text{ (total system)}} = \sqrt{5.02^2 + .63^2 + (.63)\ (.15) + .15^2/2}$$

$$= \underline{\pm 5.07 \text{ inches}}$$

(4) II.F.1.6 - HYDROGEN MONITORING SYSTEM (HMS) - ACCURACY & PLACEMENT

The containment hydrogen (and oxygen) monitoring system consists of two independent, but identical, sampling and instrument systems. The range of the analyzers is 0-30% for hydrogen and 0-25% for oxygen. Only the hydrogen loop calculations are performed here; however, since the corresponding module uncertainties are identical for the hydrogen and oxygen loops in terms of percent of full scale, the oxygen standard deviation may be assumed at 25/30 of that calculated herein for the hydrogen.

(4a) BLOCK DIAGRAM



(4b) MODULE UNCERTAINTY PARAMETERS

CALIBRATION GASES: "UNION CARBIDE" PRIMARY STANDARD GRADE MIXTURES (REFERENCE #11)

General Accuracy:

"Blended gravimetrically on sophisticated electronic balances. Each 'primary' grade mixture is subsequently analyzed by gas chromatography against a gravimetric UCRM, an "NBS" SRM or an "NBS Traceable" CRM. The concentrations determined analytically will agree with the concentrations calculated from the measured weights of the component gases within ± 1% relative uncertainty at the ninety-five percent confidence interval.

For the 30% span Hydrogen loop, the calibration span gases used are 9.5% H_2/N_2 and 28.0% H_2/N_2. A conservative approach to accounting for loop uncertainties due to span gas mixture uncertainty is to utilize the higher gas tolerance = ± (.01) (28.0) = ± .28% H_2 The, S_{G1} = Standard Deviation = ± (1/3) (.28) = ± .09% H_2

CAC-AT/AI-4409: TELEDYNE ANALYTICAL INSTRUMENTS CONTAINMENT MONITOR 225 CMA (REFERENCE #5)

General Accuracy:

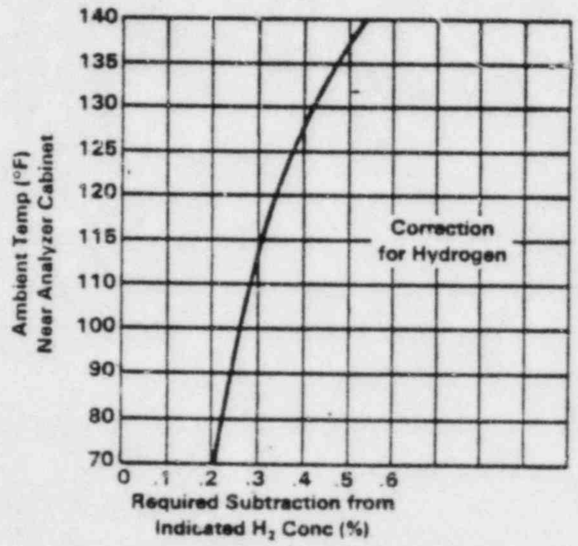
± 2.5% full scale (30% H_2)
= ± (0.25) (30) = ± 0.75% H_2
S_{T1} = Standard Deviation = ± (1/3) (0.70)
= ± 0.25% H_2

Random Error:

Stability = ± 2.0% full scale (30% H_2)
= ± (.02) (30) = ± 0.60% H_2
S_{T2} = Standard Deviation = ± (1/3) (0.60)
= ± 0.20% H_2

Temperature Effect:

Effect of water vapor in sample on hydrogen indication: The water vapor left in the sample after passing through the analyzer cabinet cooler and dryer still has a minor effect on the hydrogen readings. It is a function of the ambient temperature in the reactor building adjacent to the analyzer cabinet. Refer to the following water vapor correction graph.



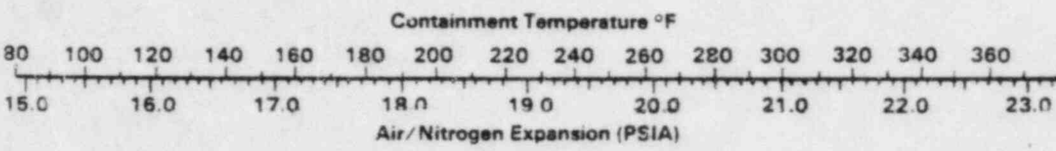
Water Vapor Correction

In abnormal conditions where steam becomes a significant percentage of containment atmosphere (such as relief valves lifting or loss of coolant accident), a major correction factor must be applied to both the hydrogen and oxygen indicated values. Since the analyzer system conditions the sample via cooling and drying, the indicated concentrations are dry-basis values, which will be conservatively higher than the actual in containment wet-basis concentrations. The required correction can be calculated from the following instructions and must be applied to both the hydrogen and oxygen indicated concentrations.

1. Match the air/nitrogen expansion pressure with the containment temperature.
   Example: At 320°F, the air/nitrogen = 21.6 psia.

2. Add 15 psi to the containment pressure to obtain the absolute pressure:
Example: If the containment pressure is 30 psig, the absolute pressure = 30 + 15 = 45 psia.

3. To obtain the wet-basis value inside containment, multiply the dry-basis value obtained by the analyzer times the air expansion pressure found in 1. divided by the total pressure found in 2. above.
Example: If the hydrogen monitor reads 3.0% hydrogen, the wet-basis reading would be 3.0 x (21.6/45) = 1.4% hydrogen.



Wet-Basis (Steam) Correction

The above corrections are published in the system Operating Procedure, OP-24, for application when necessary. On that basis, they will not be included in the calculations performed in this report on total system uncertainty parameters.

Power Supply Voltage: No effect stated

Flow Measurement: Flow measurement does not effect the system accuracy. Flow rate, however, would be a factor in calculation of the system response time.

Transducer/Transmitter Separate: The Teledyne system is composed of a variety of sub-modules; however, all accuracy and performance specifications are stated by the vendor on a system-only basis. For purposes of this report, the entire Teledyne - supplied system will be treated as a single module. Uncertainty parameters associated with the external recording loop are defined in the following section and are included in the system uncertainty calculations.

Hysteresis: Not stated

Deadband: Not stated

X-XY-4348: FOXBORO COMPANY SPEC 200 SERIES CURRENT-TO-VOLTAGE CONVERTER MODEL 2AI-I2V (REFERENCE #8)

General Accuracy: ± 0.25% of output span (30% H_2)
$= \pm (.0025)(30) = \pm .075\%\ H_2$
S_{Y1} = Standard Deviation = $\pm (1/3)(.075)$
$\approx \pm .03\%\ H_2$

Random Error: Not stated

Temperature Effects: ±0.5% of output span for ± 50°F in ambient temperature = $\pm (.005)(30) = \pm 0.15\%\ H_2$ for ± 50°F change. This instrument is located in the main control room and will not be subjected to significant temperature variation. This effect is then considered negligible for purposes of these calculations.

Power Supply Voltage: ± 0.2% of span (30% H_2) for a ± 5% change within normal operating limits of + 15 and - 15 VDC supply. Negligible compared to other factors considered.

Hysteresis: Not stated

Deadband: Not stated

X-XY-4349: FOXBORO COMPANY SPEC 200 SERIES VOLTAGE-TO-CURRENT CONVERTER MODEL 2AO-VAI (REFERENCE #9)

General Accuracy: ± 0.5% of output span (30% H_2)
$= \pm (.005)(30) = \pm .15\%\ H_2$
S_{X1} - Standard Deviation = $\pm (1/3)(.15)$
$\approx \pm .05\%\ H_2$

Random Error: Repeatability = $< \pm 0.1\%$ of input span (30% H_2)
$= \pm (.001)(30) = \pm .03\%\ H_2$
S_{X2} = Standard Deviation = $\pm (1/3)(.03)$
$= \pm .01\%\ H_2$

Temperature Effects: ±0.5% of output span for ± 50°F in ambient temperature = ± (.005) (30) = ± 0.15% H_2 for ± 50°F change. This instrument is located in the main control room and will not be subjected to significant temperature variation. This effect is then considered negligible for purposes of these calculations.

Power Supply Voltage: ± 0.5% of span (30% H_2) for a ± 5% change within normal operating limits of +15 and -15 VDC supply. Negligible compared to other factors considered.

Hysteresis: Not stated

Deadband: Not stated

CAC-AR-4409: LEEDS & NORTHRUP SPEEDOMAX M MARK II MULTIPOINT RECORDER (REFERENCE #10)

General Accuracy: ±0.5% of full scale (30% H_2) = ± (.005) (30) = ± .15% H_2
S_{R1} = Standard Deviation = ± (1/3) (.15) = ± .05% H_2

Deadband: 0.25% of full scale (30 % H_2) = (.0025) (30) = .075% H_2
Deadband Loop Half Width = .038 ≈ .04% H_2

(4c) OVERALL SYSTEM UNCERTAINTY

The standard deviation of the total measurement error is bounded by:

$$S^2 \text{ (total system)} = S^2(s) = S^2(s,b) + H^2(s) + H(s) * D(s) + D^2(s)/2$$

$$S(s,b) = \sqrt{S_{G1}^2 + S_{T1}^2 + S_{T2}^2 + S_{Y1}^2 + S_{X1}^2 + S_{X2}^2 + S_{R1}^2}$$

$$= \sqrt{.09^2 + .25^2 + .20^2 + .03^2 + .05^2 + .01^2 + .05^2}$$

$$= \sqrt{.117} = \pm .34 \% H_2$$

$$H(s) = 0$$

$$D(S) = .04\% H_2$$

$$\underline{S \text{ (total system)}} = \sqrt{.34^2 + 0 + 0(.04) + .04^2/2}$$

$$= \sqrt{.116} \quad \underline{\pm .34\% H_2}$$

(4d) SAMPLING CONSIDERATIONS

Each of the two instrument systems is connected to four different sample points from the primary containment (General Electric Mark I). The sample sources are:

1) Suppression pool atmosphere
2) Drywell lower (plant elevation (-) 6')
3) Drywell mid (plant elevation 50')
4) Drywell head (above reactor well seal, plant elevation 100')

Normal sample lineup is for one system to draw off the suppression pool atmosphere and the other from a drywell source.

(4e) OBSTRUCTIONS

Any hydrogen gas that escapes the core and is released from the primary coolant system boundary (either via steam relief valves or coolant system rupture) will become mixed in either the suppression pool or drywell general air space. There are no compartments or barriers in Brunswick's General Electric Mark I containment design that would prohibit or delay such mixing from taking place.

REFERENCES

1) Heise Gauge Data obtained from CP&L Test Equipment Room

2) Rosemount Product Data Sheet 2235, Revised 11/80

3) Bailey Controls Manual E12-10, CP&L Foreign Print F.P.-7550

4) International Instruments Series 1151/1251, Bulletin 1C-158R-281-3M-S, and clarified via telecon with vendor

5) Rosemount Product Data Sheet 2388, Revised 9/82

6) Wallace & Tiernan Catalog File 650.120, Revised 11/76

7) Teledyne Analytical Instruments, Model 225 CMA Instruction Manual, CP&L Foreign Print F.P.-9541

8) Foxboro Technical Information Bulletin TI 2AI-130, Oct. 1977

9) Foxboro Technical Information Bulletin TI 2AO-130, Oct. 1977

10) Information obtained via telecon with vendor

11) Linde-Union Carbide Catalog L-3396E, Pg. 59, printed 1/82