NUCLEAR POWER BUSINESS UNIT

CALCULATION ~~REVIEW AND APPROVAL~~

NIMS ✓

FILE I7.44

Calculation # 96-0278	
Number of Pages 7+ 7attachments 8	

Title of Calculation:
Uncertainty Associated with Instrumentation used in IT-17 & IT-18 for BAT Pumps

☒ Original Calculation ☒ QA-Scope

☐ Revised Calculation. Revision # ________

☐ Superseding Calculation. Supersedes Calculation # ____________

Modification #	Description:

Other References:

Prepared By:	Date: 12/17/96

This Calculation has been reviewed in accordance with NP 7.2.4. The review was accomplished by one or a combination of the following (as checked):

____ A review of a representative sample of repetitive calculations.

✓ A detailed review of the original calculation.

____ A review of the calculation against a similar calculation previously performed.

____ A review by an alternate, simplified, or approximate method of calculation.

Comments: None

Reviewed By:	Date: 12/23/96	Approved By:	Date: 12/27/96

PBF-1608
Revision 1 02/27/95

Reference(s): NP 7.2.4

A. Purpose

The purpose of this calculation is to determine the uncertainty associated with the instrumentation used in inservice test procedures IT-17 & 18, for the boric acid transfer pumps, (reference 2). The final uncertainty value must include a combination of the uncertainties for all the instrumentation used in the test that will have an impact on the ability to measure the IST acceptance value during the test performance for comparison to the design basis acceptance value.

B. Method

Instrument uncertainties will be calculated for the instruments used in the boric acid transfer pump Inservice Test procedure IT-17 and IT-18, (reference 2). These inservice tests determine the developed head across the boric acid transfer pumps (1&2P-4A&B) by adjusting the pump flow to 40 gpm ±0.5 gpm by throttling valves 1HC-105 and 1BS-344 (or HC-104 and BS-329 if T-6B is aligned to unit 1). Once the correct flow value is achieved, the suction and discharge pressures are measured and the total developed head across the pump is determined. This value is compared to the boric acid transfer pump acceptance criteria.

This calculation was performed on the unit 1 instrumentation, however the results are also applicable to unit 2.

C. References

1. Boric Acid Transfer Pump operability determination, 10/1/1996.
2. PBNP Inservice Test, IT-17 and IT-18, "Boric Acid Transfer Pumps and Valves (Quarterly)"; Unit 1, Revision 7, November 15, 1996; and Unit 2, Revision 6, November 15, 1996.
3. MR 91-133, install permanent instrumentation to allow inservice testing for boric acid transfer pumps, accepted 4/29/1993.
4. Rosemount Model 8712C Magnetic Flowmeter Transmitter, Component Instruction Manual control #01479, dated November 1991.
5. Technical Specification Table 15.3.2-1, "Boric Acid Storage Tank(s) Minimum Volume/Temperature/Concentration", dated December 12, 1994.
6. PBNP Instrumentation and Control Procedures, ICP-6.41, "Three Year Calibration on Local Instrumentation," Rev 7, August 27, 1996.
7. DG-I01 "Instrument Setpoint Methodology", Revision 1, September 12, 1995.
8. Perma-Cal direct drive test and process gauge, component manual, dated 2/94. (selected pages attached)
9. Ashcroft Pressure, Temperature, Control, Instrument Ordering Handbook, Duraguage Pressure Guage Section, I&C library. (selected pages attached)

10. Duke Engineering & Services letter to WE, "SI Pump IST Flow Test Uncertainty Evaluation", September 25, 1996.
11. WE Calculation 96-0191, "Minimum Allowable IST Acceptance Criteria for SI Pump Performance", dated 9/25/1996.
12. WE Calculation N-94-008, New Tech Spec Minimum Volume and Temperature Requirements for Boric Acid Concentration Reduction, February 23, 1994.

D. Assumptions

1. The temperature effect on the instrumentation will be assumed to be negligible as the transmitters are calibrated and used in essentially the same temperature environment.

2. The acceptance criteria for the BAT pumps is between 15 gpm, (reference 1), and 40 gpm, the point at which the pumps are currently being tested in the Inservice Testing program, (reference 2). The method to convert an error from gpm to psi, as accepted by Duke Engineering (reference 10), requires determining the slope of the pump curve at the point of interest. The pump curve for the boric acid transfer pump (from reference 1) is attached. As can be seen from the curve, the slope of the pump curve is more negative at 40 gpm than it is at 15 gpm, or at any point between 15 and 40 gpm. Using the slope at 40 gpm to determine the conversion factor between gpm and psi will result in a conservatively high error term that will bound any acceptance value between 15 gpm and 40 gpm.

3. The pressure indicators are assumed to be near the pipe centerlines, and any elevation difference between the instruments and the pipe centerlines will be ignored.

4. The velocity head developed by the pump is ignored.

5. If manufacturer's data was not located, uncertainties associated with drift of an instrument have been assumed to be the smaller of either 0.5% of full scale, or the instrument calibration tolerance. This value (0.5%) is based on engineering judgment of the maximum expected drift between calibrations for the instrumentation involved. Alternatively, the calibration accuracy is used if smaller, because instrumentation found regularly out of calibration are typically either repaired or replaced.

6. The M&TE error is assumed to be the smaller of either 0.5% of the instrument range, or the calibration tolerance, for all IST instruments. This value (0.5%) is conservative based on the research performed for Calculation 96-0191, "Minimum Allowable IST Acceptance Criteria for SI Pump Performance" (reference 11). The calibration accuracy is used if

smaller because it is the practice of I&C to use a calibration instrument which is at least as accurate as the instrument being calibrated.

E. Inputs

For this calculation, the total uncertainty associated with the instrumentation used to perform the IST test must considered. Contributors to this total uncertainty include:

- Instrument (transmitter & indicator) accuracy
- Indicator readability
- Repeatability & Sensitivity
- Tolerance
- Drift

F. Instrument Uncertainty Determinations

1. Instrument Uncertainties for FT-185, P-4A/B BA Transfer Pump Flow Transmitter, Rosemount Model #8712CR12M4, Range 0-100 gpm

a. Instrument accuracy: The system accuracy, with the Model 8701 flowtube (which is installed per champs record) is ±0.5% of rate from 1 to 30 ft/sec (reference 4). From Mod Request 91-133, (reference 3), the rate is approximately 3.51 ft/s, thus this is the correct accuracy value to use. Since the measured value in IT-17 and IT-18 (reference 2) is 40 gpm, the accuracy is:

$$\pm 0.5\% \times 40 \text{ gpm, or } \pm 0.2 \text{ gpm}$$

Based on telecon with Jennifer Yeatts, of Rosemount Technical Service on 12/16/1996, this accuracy is the combined accuracy of the flow measuring device (Model 8701 Magnetic Flowmeter Flowtube) and the transmitter.

b. Calibration Setting Tolerance; This instrument is not presently being calibrated. This failure to calibrate is being accounted for as an increase in the assumed drift, thus no error for calibration tolerance is calculated.

c. Drift (transmitter stability); ±0.1% of rate over 6 months. (reference 4) The instrument was installed in 6/93, and hasn't been calibrated in 3 1/2 years. In order to account for an assumed linear drift until the calibration of the instrument can be initiated, it will be assumed that the instrument could drift in a linear fashion for 5 years. This would represent an error of:

$$5 \text{ years} \times \frac{\pm 0.1\ \%}{0.5 \text{ years}} \times 40 \text{ gpm} = \pm 0.4 \text{ gpm}$$

d. M&TE (Instrumentation uncertainty due to calibration); This instrument is not presently being calibrated. This failure to calibrate is being accounted for as an increase in the assumed drift, thus no error for M&TE is calculated.

e. Repeatability; ±0.1%, or ±0.04 gpm. (reference 4)

2. Instrument Uncertainties for 1-PI-108, Boric Acid Filter Inlet Pressure, Perma-Cal model #111TIB23A21-V, range 0-160 psig.
   a. Indicator readability; minor divisions at 2 psi, thus the meter can be read to ±1.0 psi. (reference 8)
   b. Instrument accuracy, ±0.5% of full scale (160 psi) or ±0.8 psi, (reference 8). Also repeatabiltiy of ±0.01% (0.016 psi) and Sensitivity of ±0.01% (0.016 psi) (reference 8)
   c. Calibration Tolerance; The as left tolerance for the instrument is ±1.0 psi. (reference 6)
   d. Drift; assumed to be ±0.5%, or 0.8 psi, (assumption 5)
   e. M&TE (Instrumentation uncertainty due to calibration); assumed to be ±0.5%, or 0.8 psi. (assumption 6)

3. Instrument Uncertainties for 1-PI-184, 1P-4A Suction Pressure, Ashcroft model #45-2462SS-02L-160#, range 0-160 psig.

   a. Indicator readability; Based on plant walkdown, the smallest division is 1 psi, thus indicator readability would be ±0.5 psi
   b. Instrument accuracy, ±0.5% of full scale, ±0.8 psi (reference 9)
   c. Calibration Tolerance; The as left tolerance for the instrument is ±1.0 psi (reference 6)
   d. Drift; assumed to be ±0.5%, or 0.8 psi, (assumption 5)
   e. M&TE (Instrumentation uncertainty due to calibration); assumed to be ±0.5%, or 0.8 psi. (assumption 6)

G. Determine Conversion Factor for Boric Acid Solution

The boric acid transfer pumps can transfer a solution with a concentration of boric acid as high as 12.5% by weight. This boric acid solution is more dense than water, thus the actual assumed density for boric acid must be used when determining the conversion factor from feet to psi. Calculation N-94-008, (reference 12) calculated a density of 12% boric acid solution to be 1.0293 kg/l at 170 °F. This calculation also stated that the density change due to temperature change should go as it does for water. In order to determine the maximum density of the 12.5% boric acid solution at the

minimum allowed Technical Specification temperature of 145 °F, (reference 5) it is necessary to ratio this density value by the change in density of water between 170 °F and 145 °F.

$$\frac{1.0293\ \text{kg}}{\text{liter}} \times \frac{55.37\ \text{lbm/ft}^3\ (\rho\ 145\ ^\circ\text{F})}{54.91\ \text{lbm/ft}^3\ (\rho\ 170\ ^\circ\text{F})} \times \frac{\text{liter}}{0.03532\ \text{ft}^3} \times \frac{2.2046\ \text{lbm}}{\text{kg}} = 64.78\ \text{lbm/ft}^3$$

To develop the conversion factor calculate the equivalent number of feet for the column height (h) of fluid corresponding to a static pressure of 1 psi.

Static Pressure = (Density of fluid) (Gravitational acceleration) (column height of fluid)

Solving for the column height of fluid (h):

$$h = \frac{\text{Static Pressure}}{\text{(Density of fluid) (Gravitational acceleration)}}$$

$$h = \frac{1\ \text{lbf/in}^2 (32.17\ \text{ft lbm/ lbf s}^2)(144\ \text{in}^2/\text{ft}^2)}{64.78\ \text{lbm/ft}^3 (32.17\ \text{ft/s}^2)}$$

$h = 2.223$ ft

The column height of the pump fluid equivalent to a static pressure of 1 psi is therefore, 2.223 ft.

H. Calculation

The uncertainties of the Inservice test instrumentation have been determined above, and will be combined using a systematic method established in reference 7 and reference 10. This best estimate or realistic approach combines uncertainties using the statistical square root sum of squares (SRSS) method. This uncertainty value will be added to the design basis charging pump flow requirement and this will become the IST design basis limit, and will be used as an acceptance value for the charging pumps.

a. Uncertainty associated with PI-108 (see Section F.2)

$$U108 = \pm\sqrt{(1.0\ \text{psi})^2 + (0.8\ \text{psi})^2 + (1.0\ \text{psi})^2 + (0.8\ \text{psi})^2 + (0.8\ \text{psi})^2 + (0.016\ \text{psi})^2 + (0.016\ \text{psi})^2}$$

$U108 = \pm\ 1.98$ psi

b. Uncertainty associated with PI-184 (see Section F.3)

$$U184 = \pm\sqrt{(0.5\ psi)^2 + (0.8\ psi)^2 + (1.0\ psi)^2 + (0.8\ psi)^2 + (0.8\ psi)^2}$$
$$U184 = \pm\ 1.78\ psi$$

c. Uncertainty associated with FT-185 (see Section F.1)

$$U185 = \pm\sqrt{(0.2\ gpm)^2 + (0.4\ gpm)^2 + (0.04\ gpm)^2}$$
$$U185 = \pm\ 0.45\ gpm$$

In addition, there is an uncertainty associated with the ± 0.5 gpm tolerance allowed for setting the pump flow (See section B.). This error will be added to the instrument uncertainty.

U185 (total) = ± 0.45 gpm ± 0.5 gpm = ± 0.95 gpm

The uncertainties associated with FT-185, in gpm, must be converted to an equivalent uncertainty in psi in order to combine the flow uncertainty with those associated with the pressure instrumentation. Therefore, the pump curve at the test point (40 gpm) was used to approximate an associated change in developed head due to a change in flow (assumption 2). A tangential line to the pump curve was drawn at the testing point from which a slope (psi/gpm) was obtained to convert the uncertainty in gpm to an uncertainty in psi. This method has been determined to be an acceptable approach and has been evaluated independently by Duke Engineering Services. (reference 10)

The two points taken off the tangential line to develop the slope were 35 feet at 60 gpm, and 215 feet at 30 gpm. The slope is calculated below and the conversion from feet to psi used the factor developed in Section G.

$$m = \left|\frac{215\ ft - 35\ ft}{30\ gpm - 60\ gpm}\right| = -6\ ft/gpm \times \frac{psi}{2.223\ ft} = 2.70\ psi/gpm$$

$$U185 = 0.95gpm \times \frac{2.70\ psi}{gpm} = \pm\ 2.57\ psi$$

Now that the units of the individual uncertainties are consistent, the total uncertainty associated with the instruments used to test the SI pumps can be calculated via the SRSS method.

d. Combining the uncertainties from these three instruments gives the following for total uncertainty:

$$Utotal = \pm \sqrt{(U185)^2 + (U108)^2 + (U184)^2}$$

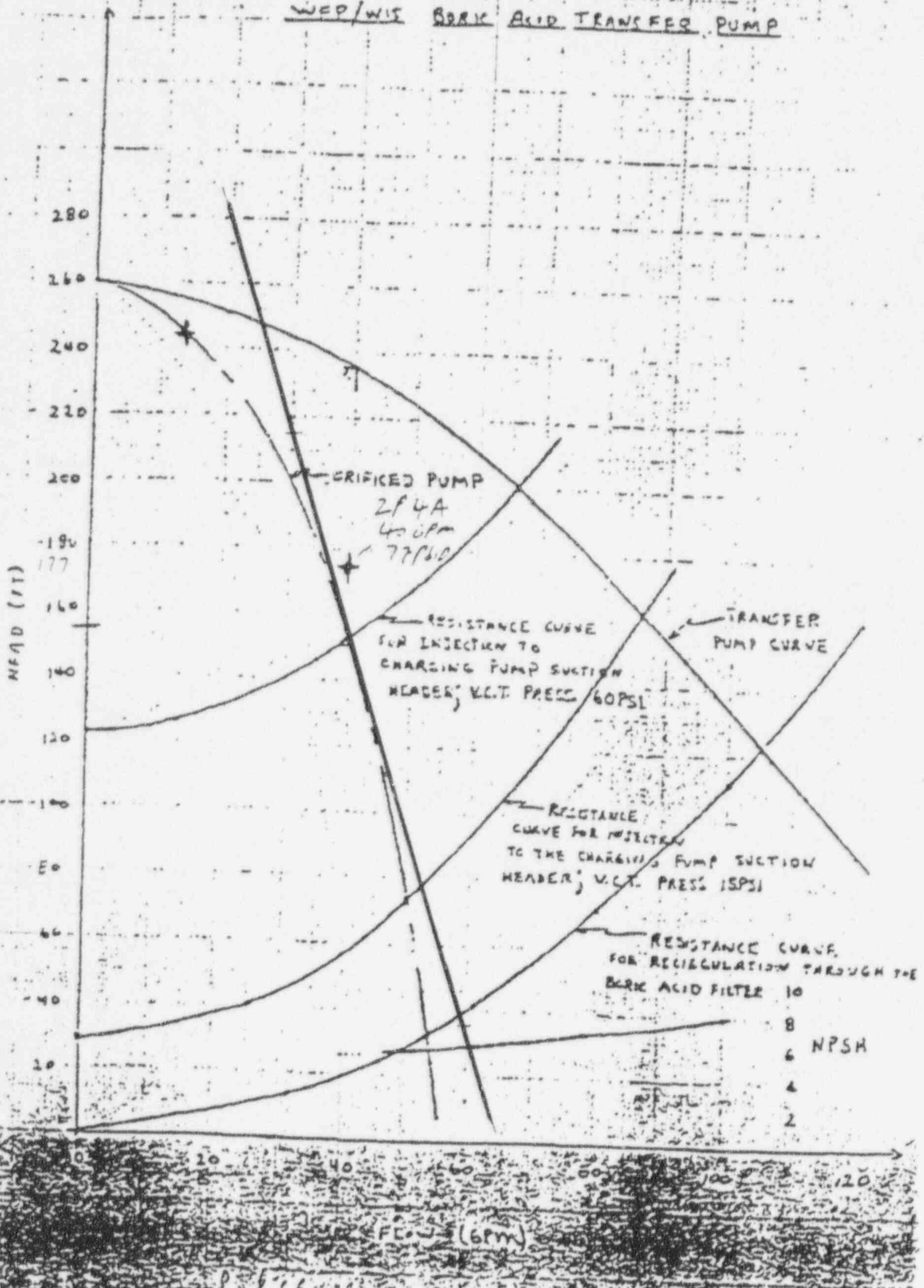
$$Utotal = \pm \sqrt{(2.57\ psi)^2 + (1.98psi)^2 + (1.78psi)^2}$$

$$Utotal = \pm\ 3.70\ psi$$

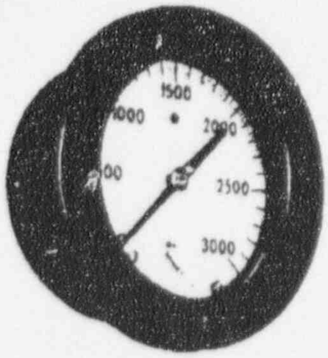
H. Results

The total instrument uncertainty associated with the inservice test procedure for the boric acid transfer pumps is ± 3.70 psi

WESTINGHOUSE ELECTRIC CORPORATION



Type 1279



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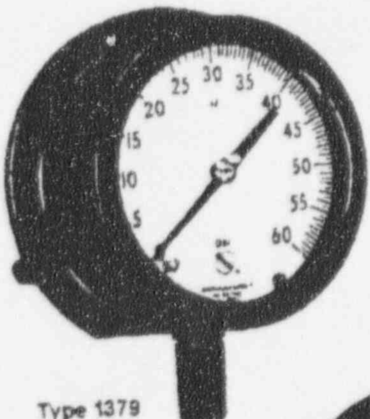


Type 1379

Type 2462

The Ashcroft® Duraguage® Pressure Gauge is the finest production gauge on the market for industrial use where precise indications are required. The line offers a wide variety of case styles, Bourdon tubes, and pressure ranges to meet any conceivable application.

With the component combinations available in the Duragauge Gauge line, over a million variations are possible to serve the needs of all types of industries, including process, power, chemical, petrochemical, petroleum, nuclear, aerospace, and cryogenics.

Several important variables must be considered when selecting the type of case for the application. A gauge is subject to environmental and atmospheric conditions, and the gauge internals must be protected from these elements.

All Duragauge gauges have solid front cases which provide maximum safety for all gauge locations, type of processes, or mediums being monitored. Viewing ease and readability from a distance will determine the dial size of the gauge.

Type of mounting — stem, surface or flush — is important, as is the pressure connection location, lower or back.

General characteristics of case style are described briefly here.

Type 1279
Black phenol turret design. Integrally molded threads front and back of gauge. Ring threaded, glass filled polypropylene, back cover polypropylene with stainless steel screw. Available with lower or back connection. Can be field converted to hermetically sealed or liquid filled versions. Stem or surface mounted; can be flush panel mounted with an accessory ring.

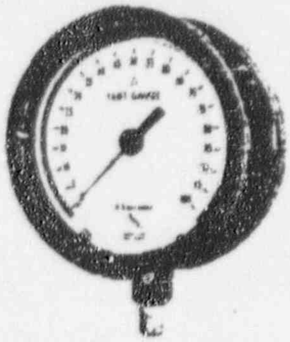
Type 1377
Aluminum case. Steel ring hinged at top, retained by a clamp screw at the bottom. Case and ring are black epoxy coated. Flush mounted, back connection only.

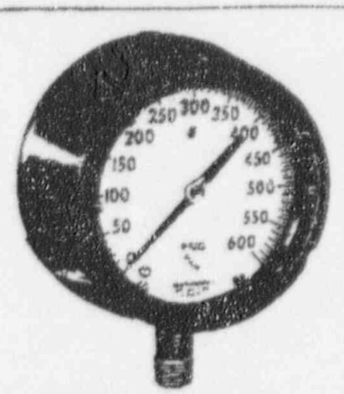
Type 1379
Aluminum case, threaded aluminum ring (bronze in 8½"). Case and ring are black epoxy coated. Stem or surface mounted. Wide flange flush mounting ring supplied on back connected gauges.

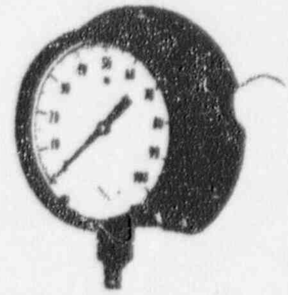
Type 2462
Polypropylene, fiberglass reinforced, black. Bayonet lock polypropylene ring. Features 6" dial readability using 4½" internals. Available for stem, surface, or flush mounting.

For additional information refer to Bulletin DU-1

ASHCROFT PRESSURE GAUGES







	TEST GAUGE	DURAGAUGE	GENERAL SERVICE
Accuracy	¼%	½%	2-1-2%
Dial Size	2½", 3½", 4½", 6", 8½"	4½", 6", 8½"	2½", 3½", 4½", 6", 8½", 12"
Tube Material	Bronze, ST. ST., Monel, Beryllium Copper	Bronze, Steel, ST. ST., Monel	Bronze, Steel, ST. ST., Monel
Bellows Selection	—	—	Brass, ST. ST., Monel
Connection - NPT	¼ Lower or Back	½ Lower or Back. ¼ HP tubing over 20,000 psi	¼ (2½" & 3½") ¼, ½ Lower or Back
Ranges	Vac to 10,000 psi	Vac to 100,000 psi	10" Water Vac to 20,000 psi
Case Material	Phenolic, Aluminum, ST. ST., Polypropylene	Phenolic, Aluminum, Polypropylene	Phenolic, Aluminum, ST. ST.
Movement	ST. ST.	ST. ST.	Bronze, ST. ST. (2½" & 3½" 1009, 1187, 1188, 1189)
Pointer	Adjustable	Micrometer	Adjustable (1009 only) Fixed (all others)
Weatherproof	Yes	Yes	Yes (except 1010)
Type Numbers	1080 (8½" only) 1082-S (4½", 6", 8½") 1084-S (2½", 3½") 1083-S (8½" only)	1279 Phenolic (4½") 1377 Alum. Flush (4½", 6", 8½") 1379 Alum. Threaded (4½", 6", 8½") 2462 Polypropylene (6") Pressure, Vacuum, Compound	1009 ST. ST. (2½", 3½", 4½") 1010 Alum. (4½", 6", 8½", 12") 1017 Alum. Flush (4½", 6") 1220 Phenolic (4½", 6", 8½") 1187* Alum. Threaded 1188* Phenolic 1189* Alum. Flush (*Low Pressure-below 15 psi) Pressure, Vacuum, Compound
Ask For	**Bulletin TG-1**	**Bulletin DU-1**	**Bulletin GS-1**
Applications	Maximum accuracy industrial and laboratory uses	Usage requiring high accuracy in chemical, petrochemical, refinery, oil production, other process, power, and general industry	General industrial applications such as boilers, pumps, compressors, machinery, process and chemical plants, power plants, pulp and paper mills, etc

To Order A Gauge:

Select: 4½" 1279(*TA)S Back ½ NPT w/1278M Ring 0/2000 psi

1. Dial Size — Table A
2. Case Type Number — Table A
3. Bourdon System (*) (ordering code) — Table B
4. Connection: Location — Table A; Size — Table B
5. Mounting Accessory or Variation (if required) — Table A
6. Range — Table C
7. Accessories and Optional Feature — pages

TABLE A — CASE SELECTION

Case Type Number	Dial Size — in.	Case Style	Case: Material Finish	Style Ring: Material Finish	Mounting and Connection
1279(*)S**	4½	Solid Front	Phenol Black	Threaded Reinforced Polypropylene Black	Stem — Lower or Back Surface — Lower or Back Flush — Back: order 1278M ring.
1377(*)S	4½, 6, 8½	Solid Front	Aluminum Black epoxy coated	Hinged Steel Black wrinkle enamel coated	Flush — Back connection only
1379(*)S	4½, 6, 8½	Solid Front	Aluminum Black epoxy coated	Threaded Aluminum: 4½, 6 Bronze: 8½ Black epoxy coated	Stem — Lower or Back Surface — Lower or Back Flush — Back
2462(*)	6	Solid Front	Polypropylene (fiberglass reinforced) Black	Bayonet Lock Polypropylene Black	Stem — Lower or Back Surface — Lower or Back: Specify XBF Flush — Back: Specify XBQ

(*) Bourdon tube ordering code from Table B
** Available Liquid Filled or Hermetically Sealed

TABLE B — BOURDON SYSTEM SELECTION

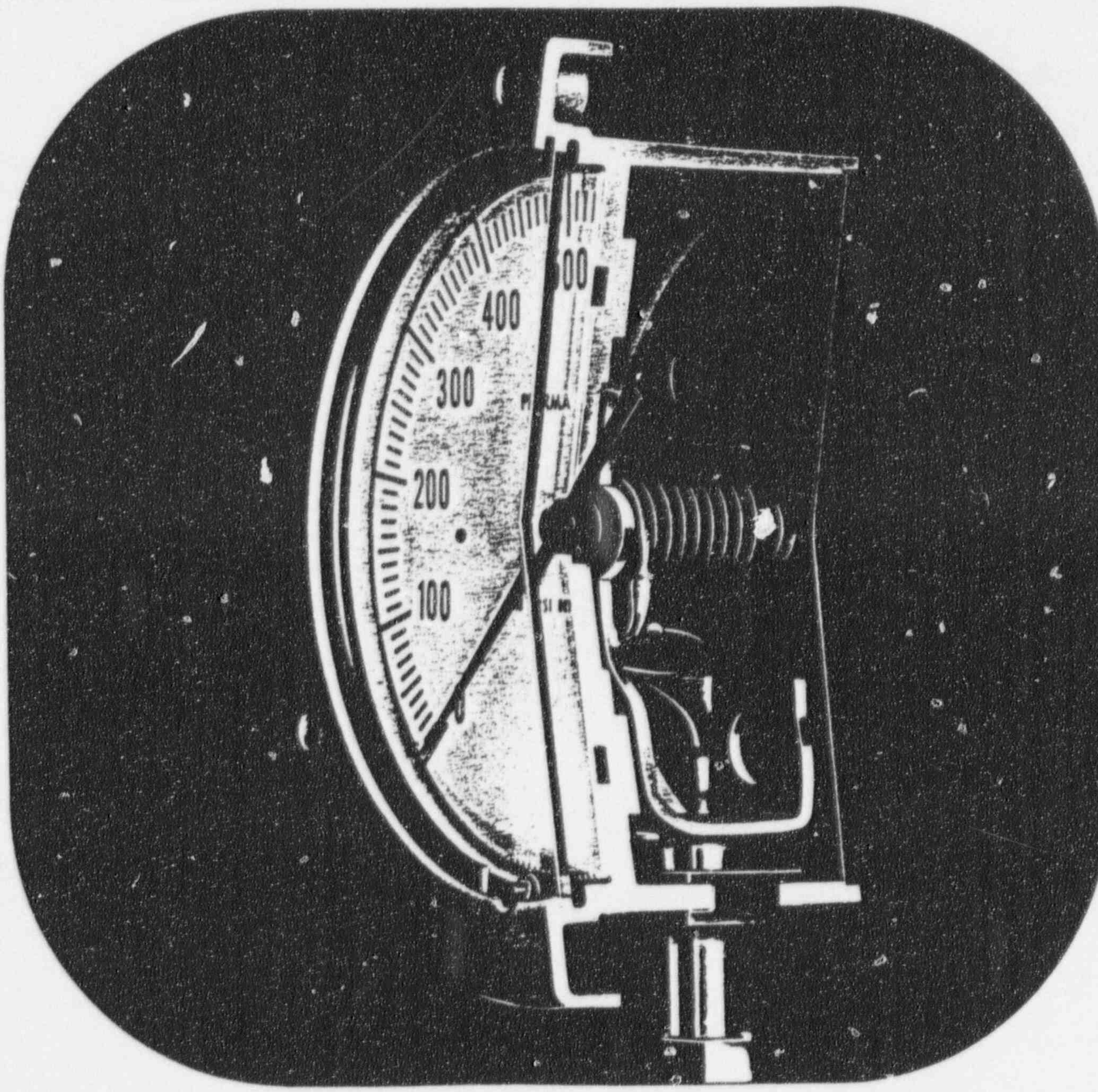
Ordering Code	Bourdon Tube and Tip Material (all joints TIG welded except "A")	Socket Material	Tube Type: Drawn or Bored	Pressure Range (PSI)	NPT Connection (1)
A	Grade A Phosphor Bronze Tube—Brass Tip, Silver brazed	Brass	Drawn	12/1000	½
B	AISI 4130 alloy steel	AISI 1019 steel	Drawn	12/1000	½
D	AISI 4130 alloy steel	AISI 1019 steel	Bored	1000/20,000	½
		AISI 316 stainless steel	Drawn (spiral)	100,000 (2)	¼ high pressure (lower conn. only)
R	AISI 316 stainless steel	AISI 1019 steel	Drawn	12/1000	½
RT	AISI 316 st. st. tube AISI 1019 steel tip	AISI 1019 steel	Bored	1000/20,000	½
S	AISI 316 stainless steel	AISI 316 stainless steel	Drawn	12/1000	½
TA	AISI 316 stainless steel	AISI 316 stainless steel	Bored	1000/20,000	½
			Drawn (spiral)	30,000/80,000 (2)	¼ high pressure
P	K Monel	R Monel (3)	Drawn	12/1000	½
Q	K Monel	R Monel (3)	Bored	1000/20,000	½

(1) Optional connections available: ¼ NPT where ½ NPT is standard
(2) 30,000-80,000 psi available in 6" lower & back and 8½" back connection only. Type 1377-1379 solid front cases. 100,000 psi available in 8" lower connection only Type 1379 solid front case.
(3) For applications where NACE standard MR-01-75 is specified the socket material will be Monel 400.

PERMA-CAL
CORPORATION

5 YEAR WARRANTY INCLUDING WEAR

Perma-Cal Direct Drive Test and Process Gauges



Specifications

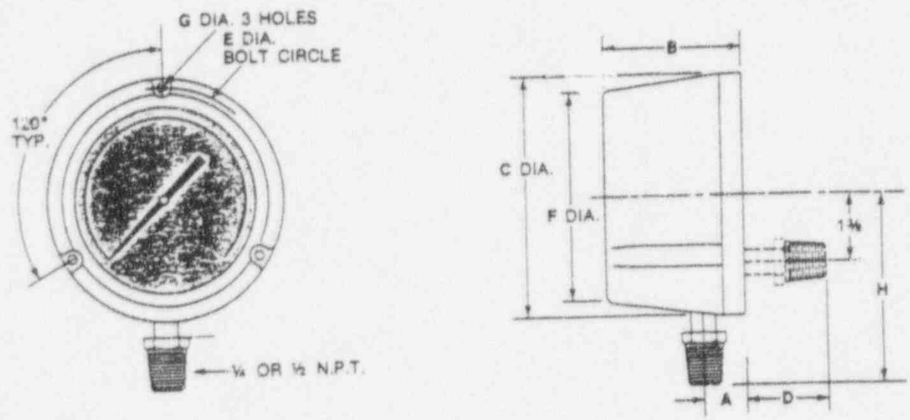
Proof Pressure without calibration shift	150% of F.S. pressure[1]
Burst Pressure	500% of F.S. pressure[2]
Wetted Parts	Inconel X-750, 316SS, 304SS and silver braze. For other options, consult factory.
Media Temperature	−65° to +250°F
Ambient Temperature	−65° to +190°F
Response Time	Approx. 100 msec to F.S.[3]
Life	250,000 cycles min., 20%-80% full scale on ranges below 3000 psi.
Accuracy:[4]	
Grade 3A	±.25% full scale[5]
Grade 2A	±.5% full scale
1/2% M.S.	±1% full scale, ±.5% mid scale
Repeatability & Sensitivity	±.01% full scale
Calibration	Vertical mounting standard[6]

NOTES:

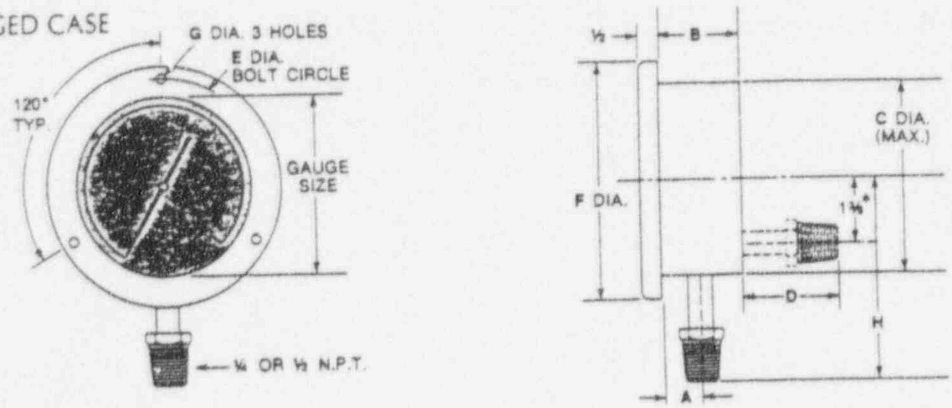
[1] 125% of F.S pressure, 8,000 PSI and above
[2] Or 25,000 psi, whichever is less
[3] Gas operation with no coil dampening.
[4] Specified accuracy includes all friction error, hysteresis and linearity variations.
[5] On 8,000 PSI and above, accuracy is ±1/4% F.S. ascending and ±1% F.S. descending.
[6] Calibration in other mounting positions available upon request.

Specifications subject to change without notice.

TURRET CASE



FRONT FLANGED CASE



GAUGE SIZE	A	B	C	D	E	F	G	H	PANEL OPENING (REF.)	WRENCH SIZE (HEX) ¼"	WRENCH SIZE (HEX) ½"
8½" Flange	1⅛	2 1/32	6 5/16	1 7/16	9⅝	10⅜	9/32	5 1/16	9	⅝	⅞
6" Flange	1⅛	2 1/32	6 5/16	1 7/16	7	7¾	9/32	5 1/16	6½	⅝	⅞
4½" Flange	1⅛	2 1/32	4⅞	1 7/16	5⅜	6	7/32	4⅛	4 15/16	⅝	⅞
4½" Turret	1 1/16	2 11/16	5⅞	1 7/16	5⅜	5¼	7/32	4⅛	N.A.	⅝	⅞
3½" Turret	1 1/16	2 11/16	4¾	1 7/16	4¼	3⅞	7/32	4⅛	N.A.	⅝	⅞
2½" Flange	1½	2 1/16	2¾	2⅛	3⅛	3⅝	5/32	3 7/16	2 13/16	⅝	N.A.

How to order

To order a Perma-Cal gauge with the exact specifications you require, simply go through the eleven blocks of options listed below and note one option code for each specific feature you need. In section "K," you may select none or as many as desired. Write the option codes down in order and you will have created the actual part number for the gauge you desire. See example.

EXAMPLE:

OPTION SECTION:	A	B	C	D	E	F	G	H	I	J—K
PART NUMBER:	1	0	1	F	T	M	XX	Y	0	1—V

- **Product type:** Pressure Gauge — 1
- **Accuracy:** ¼% full-scale — 0
- **Dial size:** 4½" — 1
- **Case type:** front flange — F
- **Pointer type:** test — T
- **Dial trim:** mirror band and zero adjust dial — M
- **Pressure range:** specify pressure range or see Bulletin T-103 for pressure codes — XX
- **Case color:** yellow — Y
- **Fitting position:** back — 0
- **Fitting type:** ¼" NPT — 1
- **Misc. options:** Model 400 Viton Isolator installed — V

OPTION	CODE NO.	FEATURES		
A PRODUCT TYPE	1	Pressure Gauges		
	2	Seawater Depth Gauges		
B ACCURACY	0	¼% Full scale (8½," 6," 4½" and 2½"; calibration certification incl.)		
	1	½% Full scale (6," 4½," 3½" and 2½" dials)		
	2	1% Full scale, ½% Mid scale (6," 4½," 3½" and 2½" dials)		
C DIAL SIZE	8	8½-inch (zero adj. dial incl.)		
	0	6-inch (zero adj. dial incl.)		
	1	4½-inch (zero adj. dial incl. on test gauges; opt'l. on process gauges)		
	2	3½-inch (zero adj. dial not available; zero adj. pointer incl.)		
	3	2½-inch (zero adj. dial incl. on test gauges; opt'l. on process gauges)		
D CASE TYPE	F	Front flange (8½," 6," 4½" and 2½" only)	Solid front safe case standard on all models.	
	R	Rear flange (6" and 4½" only)		
	N	No flange (6," 4½" and 2½" only)		
	T	Turret (4½" and 3½,")		
E POINTER TYPE	I	Process (bold, easy-reading)		
	T	Test (knife-edged, precision reading)		
F DIAL TRIM		**Dial Size**	**Mirror Band**	**Zero Adj. Dial**
	M	2½," 4½," 6," 8½"	Yes	Yes
	D	2½," 3½," 4½"	No	No
	B	2½," 4½," 6"	No	Yes
G PRESSURE RANGE	XX	Specify pressure range and units of measurement, i.e., PSI, Pascals, Bar, etc. or see Bulletin T-103 for pressure codes.		
H COLOR	A	Black	R	Red
	B	Blue	W	White
	G	Green	Y	Yellow
I FITTING POSITION	0	Rear		
	2	Bottom (6 o'clock position)		
J FITTING TYPE	1	¼" NPT	6	MS 33649E4
	3	½" NPT	7	¼" Aminco
	4	MS 33514E4	8	MIL-G-18997
	5	MS 33656E4	9	¼" BSP
K MISC. OPTIONS	C	Calibration certificate (not apropos on ¼%)	O	Oxygen cleaned and capped
	E	EPDM Isolator installed	V	Viton Isolator installed
	H	Helium leak test (pressurized immersion)	Z	Aluminum case
	N	Nicrobraze	J	Jewel Bearing

___ CR 96 - 416

OPERABILITY DETERMINATION

1. Degraded or potentially nonconforming equipment:

   1P4A, 1P4B, 2P4A, 2P4B, Boric Acid Transfer Pumps

2. Safety function(s) performed:

   The boric acid transfer pumps are not safety related and are not relied upon to mitigate the consequences of a design basis accident.

   When the Boric Acid Transfer Pumps (BATP) are relied upon as a source of boric acid for one unit, they shall deliver boric acid solution to the charging pumps to bring the unit to cold shutdown with the required margin at any time during core life, assuming that the most conservative control rod is stuck in the fully withdrawn position.

   The BATPs shall supply concentrated boric acid to the charging pumps as required to establish and maintain shutdown margins and to compensate for slow changes in reactivity associated with normal power operation.

3. Circumstances of potential nonconformance, including possible failure mechanisms:

   Condition Report 96-416 identified a potential concern for adequacy of the IST program to ensure that pumps meet design basis as well as ASME Section XI requirements. This evaluation supports determination of operability pending completion of detailed analysis

4. Requirement or commitment established for the equipment, and why it may not be met:

   Technical Specifications Section 15.3.2 provides the design basis for CVCS control of RCS Boron inventory. The boration volume available through any flow path is sufficient to provide the required shutdown margin at cold shutdown, Xenon free conditions from any expected operating condition. The maximum volume requirement is associated with boration from just critical , hot zero or full power, peak xenon with control rods at the insertion limit , to xenon-free, cold shutdown with the highest worth control rod assembly fully withdrawn.

   FSAR Section 9.2.1 States that the boric acid transfer pumps can supply design rated flow (which is 40 gpm)at the VCT relief valve set point (75 psig).

   IST acceptance criteria may not be conservative when compared to design basis criteria.

5. How and when the potentially nonconforming equipment was first discovered:

   This generic concern was first identified in June 1996 as a specific concern for safety injection pump acceptance criteria from ASME Section XI versus design requirements

6. Basis for declaring affected equipment operable:

   Calculation P-93-014 was performed to show that for a typical cycle, assuming worst case conditions, the reactor can be maintained subcritical following a reactor trip. Specifically, the amount of negative reactivity that can be inserted by one charging pump borating at a minimum speed (15gpm) using the refueling water storage tank (RWST) as the suction source is greater than the positive reactivity added from the decay of xenon. Calculation P-93-014 showed that at a rate of 15 gpm from the RWST that the intent of tech spec 15.3.2 for maintaining shutdown margin has been satisfied. The calculation did not look at the capability of the boric acid storage tanks ability to provide shutdown margin. The RWST is more limiting for a minimum flow requirement than the Boric acid storage tanks as the boric acid concentration is maintained higher in the boric acid storage tanks than the RWST. Conservatively assuming that one BATP needs to supply 15 gpm to maintain shutdown the IST program is conservative as it tests the pumps well above this capability. The pumps are tested by setting flow at 40 gpm in a recirc mode and measuring differential pressure or developed head. The worst case pump 2P4A provides 40 gpm at 77psid (see attached IST data). This falls above the pump curve developed by Westinghouse in calculation RFS-W-960 when the pump had a 19/32" orifice plate installed in 1971. Following the curve neglecting that the pump is actually operating above the curve the pump would provide 15 gpm at 245 ft hd or 105 psid. The VCT relief valve setpoint is 75 psig so the pump develops adequate flow and discharge head to meet the design basis requirements at maximum operating pressure of 75 psig . 2P4A is the most limiting pump thus all of the boric acid transfer pumps are capable of meeting the design basis and are considered operable. (see attached IST data for all BATPs)

Note: There is a open condition report 96-598 concerning a statement in the FSAR. The FSAR states that the BATPs can provide design flow at the VCT relief valve setpoint. The relief valve setpoint is 75 psig and the boric acid transfer pump design flow is 40 gpm. The .9" discharge orifice on the valve was replaced in the early seventies with a 19/32" orifice. This limited the design flow of the pumps to 40 gpm at 60 psig VCT pressure reference Westinghouse Calc RFS -W-960. The FSAR was never updated to reflect this change. There is no design basis or accident analysis that was found which requires the BATP to provide 40 gpm at maximum VCT pressure.

Prepared By: _ Date: 10/1/96

Approved By: _ Date: 10/1/96

:ES Manager

Reviewed By: _ Date: 10/1/96

PRESSURE TEST

Pump Reference
Values and Limits

Pump#: 2P4A   IT-018   Date Established: 9/20/96
Entered By: LEH

Reference Values

Reference Pressure: 77.00 psig   Flow: 40.00 gpm

Reference Vibration	Motor End		Pump End	
	Point C:	.101 ips	Point A:	.109 ips
	Point D:	.080 ips	Point B:	.046 ips
	Point E:	.071 ips		

Acceptable Range

Pressure: 71.60 psig to 78.50 psig

Vibration	Motor End		Pump End	
	Point C: ≤	.253 ips	Point A: ≤	.272 ips
	Point D: ≤	.200 ips	Point B: ≤	.116 ips
	Point E: ≤	.177 ips		

Alert Range

Low Pressure: 69.30 psig to 71.60 psig
High Pressure: 78.50 psig to 79.30 psig

Vibration	Motor End	Pump End
	Point C: .253 ips to .608 ips	Point A: .272 ips to .654 ips
	Point D: .200 ips to .481 ips	Point B: .116 ips to .278 ips
	Point E: .177 ips to .425 ips	

Required Action Range

Low Pressure: 69.30 psig
High Pressure: 79.30 psig

Vibration	Motor End		Pump End	
	Point C: >	.608 ips	Point A: >	.654 ips
	Point D: >	.481 ips	Point B: >	.278 ips
	Point E: >	.425 ips		

Comment: New reference values established due to pump rebuild.

TEST DATA FOR ONE PUMP 9/23/96 Page 1

Pump: 2P4A

Test: 018

Pressure Test

Test Date	Diff P	Vibrations (ips) A	B	C	D	E	Int	Remarks
9/23/92	76							
9/23/92	76						BAT	ROUTINE SURVEILLANCE
11/08/92	77							
11/08/92	77						LEH	ROUTINE SURVEILLANCE
11/14/92	76						JAH	MOD 91-133 TGST
1/05/93	75							
1/05/93	75						LEH	ROUTINE SURVEILLANCE
3/16/93	80							
6/16/93	79							
9/18/93	80							
12/17/93	81							
6/19/94	81	.172	.063	.239	.119	.119	KKW	ROUTINE SURVEILLANCE
9/16/94	81	.174	.061	.384	.246	.112	LEH	ROUTINE SURVEILLANCE
12/18/94	87	.184	.078	.401	.235	.099	LEH	ROUTINE SURVEILLANCE
4/27/95	85	.233	.079	.432	.281	.095	BAT	INCREASED FREQUENCY
6/16/95	88	.233	.079	.432	.281	.095	LRD	ROUTINE 9506566
7/29/95	89	.203	.072	.445	.171	.090	LRD	INCREASED FREQUENCY
8/29/95	93	.304	.072	.442	.244	.114	LEH	INCREASED FREQUENCY
9/16/95	89	.213	.085	.410	.199	.104	LEH	ROUTINE SURVEILLANCE
11/12/95	88	.214	.077	.480	.153	.111	LEH	INCREASED FREQ. 2P4A
12/16/95	84	.195	.113	.361	.146	.100	LEH	ROUTINE SURVEILLANCE
1/27/96	82	.267	.081	.348	.197	.155	LEH	INCREASED FREQUENCY
3/16/96	83	.246	.076	.343	.172	.109	LEH	ROUTINE SURVEILLANCE
5/06/96	83	.188	.081	.378	.142	.108	LEH	INCREASED FREQ. 2P4A
6/16/96	80	.218	.082	.382	.142	.097	LRD	ROUTINE SURV., 96062
7/27/96	80	.294	.066	.371	.171	.100	LEH	INCREASED FREQUENCY
9/20/96	77	.109	.046	.101	.080	.071	LEH	ROUTINE, WO 9602246,

PRESSURE TEST

Pump Reference
Values and Limits

Pump#: 2P4B   IT-018   Date Established: 12/18/94
Entered By: DEK

Reference Values

Reference Pressure: 85.00 psig   Flow: 40.00 gpm

Reference Vibration	Motor End		Pump End	
	Point C:	.183 ips	Point A:	.111 ips
	Point D:	.067 ips	Point B:	.029 ips
	Point E:	.076 ips		

Acceptable Range

Pressure: 79.05 psig to 86.70 psig

Vibration	Motor End		Pump End	
	Point C: ≤	.325 ips	Point A: ≤	.278 ips
	Point D: ≤	.168 ips	Point B: ≤	.073 ips
	Point E: ≤	.190 ips		

Alert Range

Low Pressure: 76.50 psig to 79.05 psig
High Pressure: 86.70 psig to 87.55 psig

Vibration	Motor End	Pump End
Point C:	.325 ips to .700 ips	Point A: .278 ips to .666 ips
Point D:	.168 ips to .402 ips	Point B: .073 ips to .174 ips
Point E:	.190 ips to .456 ips	

Required Action Range

Low Pressure: 76.50 psig
High Pres-ure: 87.55 psig

Vibration	Motor End		Pump End	
	Point C: >	.700 ips	Point A: >	.666 ips
	Point D: >	.402 ips	Point B: >	.174 ips
	Point E: >	.456 ips		

Comment: New values generated following initiation of vibration measurements.

TEST DATA FOR ONE PUMP 9/23/96 Page 1

Pump: 2P4B

Test: 018

Pressure Test

Test Date	Diff P	Vibrations (ips) A	B	C	D	E	Int	Remarks
9/23/92	74							
9/23/92	74						BAT	ROUTINE SURVEILLANCE
11/08/92	73							
11/08/92	73						LEH	ROUTINE SURVEILLANCE
11/14/92	73						JAH	MOD 91-133 TGST
1/05/93	76							
1/05/93	76						LEH	ROUTINE SURVEILLANCE
3/16/93	74							
6/16/93	75							
9/18/93	77							
12/17/93	80							
6/19/94	77	.183	.067	.130	.038	.074	KKW	ROUTINE SURVEILLANCE
9/16/94	82	.116	.031	.193	.068		LEH	ROUTINE SURVEILLANCE
12/19/94	85	.111	.029	.183	.067	.076	LEH	ROUTINE SURVEILLANCE
4/27/95	82	.206	.105	.105	.044	.090	BAT	INCREASED FREQUENCY
6/16/95	82	.142	.051	.199	.087	.110	LRD	ROUTINE 9506566
9/16/95	86	.174	.053	.249	.115	.196	LEH	ROUTINE SURVEILLANCE
12/16/95	84	.189	.111	.203	.083	.139	LEH	ROUTINE SURVEILLANCE
1/27/96	76	.169	.060	.184	.082	.511	LEH	INCREASED FREQUENCY
1/31/96	77	.172	.065	.192	.076	.186	LEH	Special test. 2P4B
3/16/96	77	.181	.073	.199	.074	.141	LEH	ROUTINE SURVEILLANCE
5/06/96	82	.170	.104	.199	.098	.183	LEH	INCREASED FREQ. 2P4A
6/16/96	81	.188	.107	.212	.099	.236	LRD	ROUTINE SURV., 96062
7/27/96	75	.181	.078	.215	.102	.293	LEH	INCREASED FREQUENCY
7/30/96	78	.192	.087	.216	.094	.185	LRD	PMT FOR 2P4B, PI-184
9/20/96	79	.264	.078	.327	.173	.269	LEH	ROUTINE, WO 9602246,

PRESSURE TEST

Pump Reference
Values and Limits

Pump#: 1P4A   IT-017   Date Established: 12/16/94
Entered By: DEK

Reference Values

Reference Pressure: 88.50 psig   Flow: 40.00 gpm

Reference Vibration

Motor End		Pump End	
Point C:	.088 ips	Point A:	.053 ips
Point D:	.149 ips	Point B:	.059 ips
Point E:	.051 ips		

Acceptable Range

Pressure: 82.30 psig to 90.30 psig

Vibration

Motor End		Pump End	
Point C: ≤	.220 ips	Point A: ≤	.132 ips
Point D: ≤	.325 ips	Point B: ≤	.148 ips
Point E: ≤	.128 ips		

Alert Range

Low Pressure: 79.60 psig to 82.30 psig
High Pressure: 90.30 psig to 91.20 psig

Vibration

Motor End		Pump End	
Point C:	.220 ips to .528 ips	Point A:	.132 ips to .318 ips
Point D:	.325 ips to .700 ips	Point B:	.148 ips to .354 ips
Point E:	.128 ips to .306 ips		

Required Action Range

Low Pressure: 79.60 psig
High Pressure: 91.20 psig

Vibration

Motor End		Pump End	
Point C: >	.528 ips	Point A: >	.318 ips
Point D: >	.700 ips	Point B: >	.354 ips
Point E: >	.306 ips		

Comment: New values due to instrumentation modification.

TEST DATA FOR ONE PUMP 9/16/96 Page 1

Pump: 1P4A

Test: 017

Pressure Test

Vibrations (ips)

Test Date	Diff P	A	B	C	D	E	Int	Remarks
9/24/92	90						BAT	ROUTINE SURVEILLANCE
12/16/92	91							
12/16/92	91						LEH	ROUTINE SURVEILLANCE
3/16/93	90							
6/14/93	92							
9/17/93	86							
12/16/93	87							
1/17/94	81							
3/18/94	86							
3/18/94	86							
6/17/94	82	.066	.065	.140	.281	.047	KKW	ROUTINE SURVEILLANCE
9/16/94	86	.101	.064	.255	.218		LEH	ROUTINE SURVEILLANCE
12/16/94	89	.088	.149	.530	.059	.051	LEH	ROUTINE SURVEILLANCE
2/17/95	79	.164	.148	.118	.059	.095	LEH	1P-4A, WO 940213, 94
4/15/95	88	.113	.065	.218	.205	.050	LEH	ROUTINE SURVEILLANCE
9/16/95	90	.139	.059	.187	.172	.198	LEH	ROUTINE SURVEILLANCE
12/16/95	86	.112	.073	.204	.235	.158	LEH	ROUTINE SURVEILLANCE
1/27/96	88	.104	.065	.181	.188	.171	LEH	INCREASED FREQ, 1P4A
3/16/96	80	.120	.067	.181	.203	.155	LEH	ROUTINE SURVEILLANCE
5/03/96	78	.073	.101	.155	.226	.123	LEH	Increased freq, 1P4A
5/06/96	89	.123	.072	.198	.138	.184	LEH	INCREASED FREQ. 1P4A
6/15/96	86	.102	.065	.175	.189	.152	LRD	ROUTINE SURV., 96062
7/27/96	90	.104	.070	.191	.187	.128	LEH	INCREASED FREQUENCY
9/15/96	89	.112	.069	.144	.197	.122	LEH	ROUTINE SURVEILLANCE

PRESSURE TEST

Pump Reference
Values and Limits

Pump#: 1P4B   IT-017   Date Established: 12/16/94
Entered By: DEK

Reference Values

Reference Pressure: 83.50 psig   Flow: 40.00 gpm

Reference Vibration	Motor End		Pump End	
	Point C:	.164 ips	Point A:	.107 ips
	Point D:	.197 ips	Point B:	.073 ips
	Point E:	.067 ips		

Acceptable Range

Pressure: 77.66 psig to 85.17 psig

Vibration	Motor End		Pump End	
	Point C: ≤	.325 ips	Point A: ≤	.268 ips
	Point D: ≤	.325 ips	Point B: ≤	.183 ips
	Point E: ≤	.168 ips		

Alert Range

Low Pressure: 75.15 psig to 77.66 psig
High Pressure: 85.17 psig to 86.01 psig

Vibration	Motor End		Pump End	
	Point C:	.325 ips to .700 ips	Point A:	.268 ips to .642 ips
	Point D:	.325 ips to .700 ips	Point B:	.183 ips to .438 ips
	Point E:	.168 ips to .402 ips		

Required Action Range

Low Pressure: 75.15 psig
High Pressure: 86.01 psig

Vibration	Motor End		Pump End	
	Point C: >	.700 ips	Point A: >	.642 ips
	Point D: >	.700 ips	Point B: >	.438 ips
	Point E: >	.402 ips		

Comment: New values due to instrumentation modification.

TEST DATA FOR ONE PUMP 9/16/96 Page 1

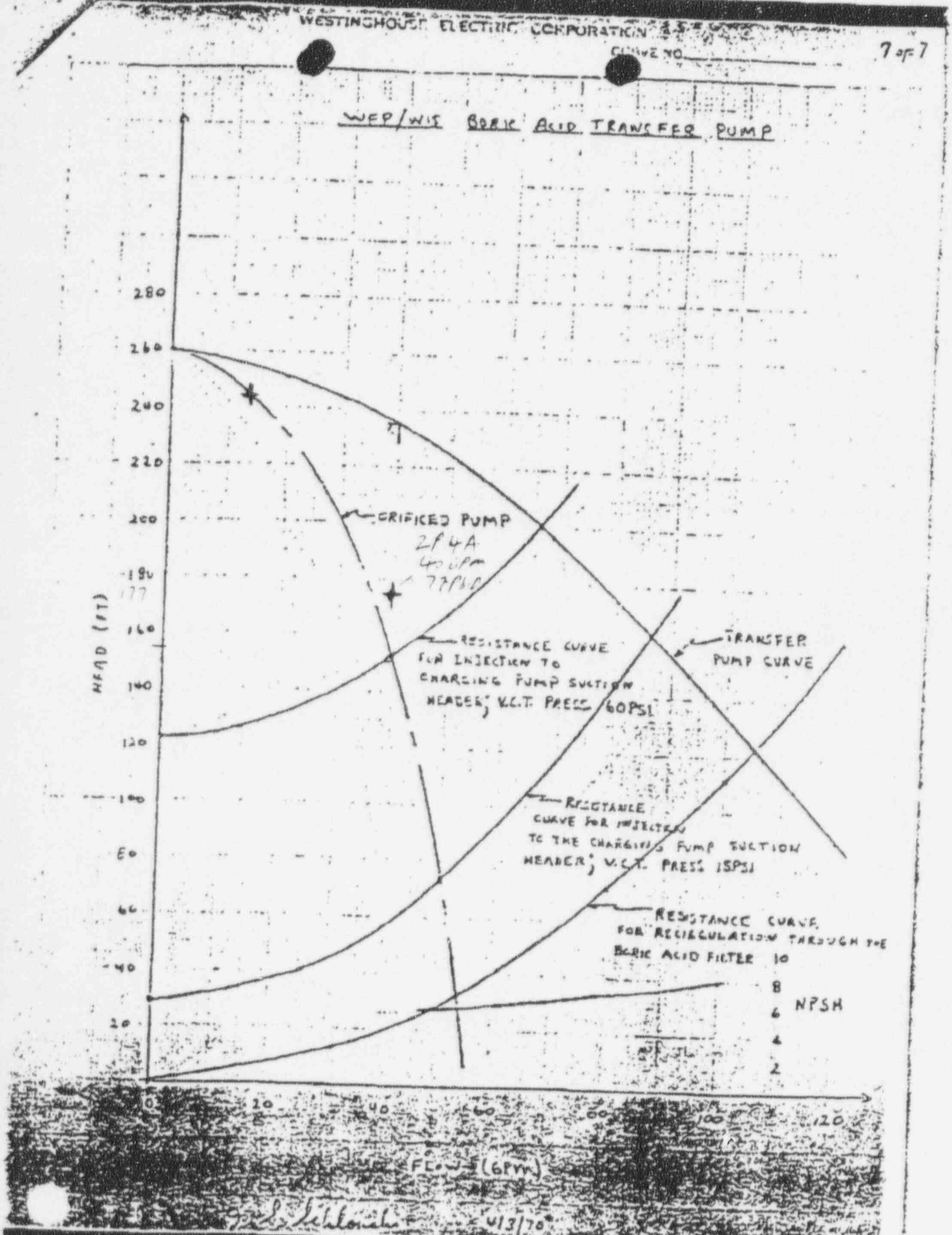
Pump: 1P4B

Test: 017

Pressure Test

Vibrations (ips)

Test Date	Diff P	A	B	C	D	E	Int	Remarks
9/24/92	89						BAT	ROUTINE SURVEILLANCE
12/16/92	90							
12/16/92	90						LEH	ROUTINE SURVEILLANCE
3/16/93	89							
4/22/93	88							
6/14/93	89							
9/18/93	80							
9/30/93	80							
12/16/93	81							
1/17/94	87							
3/18/94	81							
3/18/94	81							
6/17/94	77	.111	.100	.146	.226	.106	KKW	ROUTINE SURVEILLANCE
9/16/94	82	.104	.086	.016	.205		LEH	ROUTINE SURVEILLANCE
12/16/94	84	.107	.073	.197	.164	.067	LEH	ROUTINE SURVEILLANCE
4/15/95	78	.089	.080	.140	.235	.063	LEH	ROUTINE SURVEILLANCE
5/27/95	82	.086	.078	.130	.178	.057	LRD	INCREASED FREQUENCY
6/19/95	82						LRD	DATA FOR EVALUATION
9/16/95	83	.120	.096	.166	.234	.06[illegible]	LEH	ROUTINE SURVEILLANCE
12/16/95	80	.098	.100	.130	.319	.076	[illegible]H	ROU[illegible]E SURVEILLANCE
1/27/96	[illegible]1	.120	.078	.038	.229	.082	LEH	INCREASED FREQ. 1P4A
3/16/96	7[illegible]	.111	.089	.161	.207	.060	LEH	ROUTINE SURVEILLANCE
5/[illegible]/96	8[illegible]	.810	.088	.205	.056	.129	LEH	INCREASED FREQ. 1P4A
6/15/9[illegible]	[illegible]0	.096	.095	.140	.218	.070	LRD	ROUTINE SURV., 96062
7/27/96	82	.089	.085	.162	.233	.074	LEH	INCREASED FREQUENCY
9/15/96	82	.114	.072	.180	.170	.061	LEH	ROUTINE SURVEILLANCE


WESTINGHOUSE ELECTRIC CORPORATION
CURVE NO.
7 of 7
WEP/WIS BORIC ACID TRANSFER PUMP
HEAD (FT)
280
260
240
220
200
180
177
160
140
120
100
80
60
40
20
ORIFICED PUMP
2P4A
40 GPM
77 PSIG
RESISTANCE CURVE FOR INJECTION TO CHARGING PUMP SUCTION HEADER; V.C.T. PRESS 60PSI
TRANSFER PUMP CURVE
RESISTANCE CURVE FOR INJECTION TO THE CHARGING PUMP SUCTION HEADER; V.C.T. PRESS 15PSI
RESISTANCE CURVE FOR RECIRCULATION THROUGH THE BORIC ACID FILTER
10
8
6
4
2
NPSH
0
20
40
60
80
100
120
FLOW (GPM)
4/3/70

INTERNAL CORRESPONDENCE

PBM 93-0985

TO:

FROM:

DATE: December 21, 1993

SUBJECT: SUBCRITICALITY CALCULATION FOR BORIC ACID CONCENTRATION REDUCTION TECH SPEC CHANGE

REFERENCE(S): Calculation P-93-014

COPY TO:
File: T1.5

Calculation P-93-014 has been performed to support the proposed boric acid reduction Tech Spec change. This calculation shows that for a typical fuel cycle, and assuming worse-case conditions, the reactor can be maintained subcritical following a trip. Specifically, the amount of negative reactivity that can be inserted by one charging pump borating at a minimum speed using the RWST as the suction source is greater than the positive reactivity added from the decay of Xenon.

The effects of the proposed changes on the operational capability of the plant were also investigated. Although not a part of the above referenced calculation, it can be shown that boration via normal charging can easily keep up with the reactivity changes resulting from Xenon burnout following a reactor restart to full power during peak Xenon conditions.

From these calculations, it can be concluded that the proposed boric acid concentration reduction presents no additional safety or operational risks to the plant.

caw

DEC 2 3 1993