REGULATOR INFORMATION DISTRIBUTION TEM (RIDS)

ACCESSION NBR:8108040092 DOC.DATE: 81/07/09 NOTARIZED: NO DOCKET #
FACIL:50-397 WPPSS Nuclear Project, Unit 2, Washington Public Powe 05000397
AUTH.NAME AUTHOR AFFILIATION
BOUCHEY,G.D. Washington Public Power Supply System
RECIP.NAME RECIPIENT AFFILIATION
SCHWENCER,A. Licensing Branch 2

SUBJECT: Forwards responses to Round Two questions from Containment Sys Branch.Responses will be incorporated into FSAR amend within 4 months.GE proprietary figures sent under separate cover by 810709 ltr.

DISTRIBUTION CODE: B001S COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 26
TITLE: PSAR/FSAR AMDTS and Related Correspondence

NOTES:PM: 2 copies of all material.1 cy:BWR-LRG PM(L.RIB) 05000397

	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME	COPIES LTTR	COPIES ENCL
ACTION:	A/D LICENSNG	1	0	LIC BR #2 BC	1	0
	LIC BR #2 LA	1	0	AULUCK,R. 04	1	1
INTERNAL:	ACCID EVAL BR26	1	1	AUX SYS BR 27	1	1
	CHEM ENG BR 11	1	1	CONT SYS BR 09	1	1
	CORE PERF BR 10	1	1	EFF TR SYS BR12	1	1
	EMRG PRP DEV 35	1	1	EMRG PRP LIC 36	3	3
	EQUIP QUAL BR13	3	3	FEMA-REP DIV 39	1	1
	GEOSCIENCES 28	2	2	HUM FACT ENG 40	1	1
	HYD/GEO BR 30	2	2	I&C SYS BR 16	1	1
	I&E 06	3	3	LIC GUID BR 33	1	1
	LIC QUAL BR 32	1	1	MATL ENG BR 17	1	1
	MECH ENG BR 18	1	1	MPA	1	0
	NRC PDR 02	1	1	OELD	1	0
	OP LIC BR 34	1	1	POWER SYS BR 19	1	1
	PROC/TST REV 20	1	1	QA BR 21	1	1
	RAD ASSESS BR22	1	1	REAC SYS BR 23	1	1
	REG FILE 01	1	1	SIT ANAL BR 24	1	1
	STRUCT ENG BR25	1	1			
EXTERNAL:	ACRS 41	16	16	LPDR 03	1	1
	NSIC 05	1	1	NTIS	1	1

AUG 07 1981

MAY

65 60

TOTAL NUMBER OF COPIES REQUIRED: LTTR ~~62~~ ENCL ~~57~~

Washington Public Power Supply System
P.O. Box 968 3000 George Washington Way Richland, Washington 99352 (509) 372-5000

Docket No. 50-397

July 9, 1981
G02-81-183
NS-L-02-CDT-81-007

Director, Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RECEIVED AUG 03 1981 U.S. NUCLEAR REGULATORY COMMISSION

Attention: Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing

Subject: SUPPLY SYSTEM NUCLEAR PROJECT NO. 2
RESPONSES TO ROUND TWO QUESTIONS
CONTAINMENT SYSTEMS BRANCH

Reference: G02-81-184, letter, G. D. Bouchey to A. Schwencer, "Responses to Round Two Questions, Containment Systems Branch, GE Proprietary Figures", July 9, 1981

Dear Mr. Schwencer:

Enclosed are sixty (60) copies of the responses to Round Two questions from the Containment Systems Branch. These responses are to be formally incorporated into the FSAR in an amendment within four months.

Seven (7) copies of the GE proprietary figures were sent under separate cover by the referenced letter.

Very truly yours,

G D Bouchey

G. D. BOUCHEY
Director, Nuclear Safety

GDB:CDT:ct

Enclosure

cc: WS Chin, BPA
TA Mangelsdorf, Bechtel
J Plunkett, NUS Corporation
NS Reynolds, D&L
JJ Verderber, B&R (NY)
JA Satir, B&R (NY)
AD Toth, NRC
R Auluck, NRC

B001
S 1/1

Q. 022.053

The Caorso test results discussed in your report on the safety/relief valve (SRV) loads, "SRV Loads-Improved Definition and Application Methodology for Mark II Containments," exhibit some high frequency pressure spikes in the boundary pressure measurements during the initial phase of the air clearing transient. Since these spikes were not observed in previous quencher test data (i.e., the German quencher tests), this phenomenon suggests that the specific type of quencher design may be important in determining the characteristics of air clearing loads. Accordingly, provide a detailed description of the WNP-2 quencher geometry, including a description of the hub design. Compare the geometry of the WNP-2 quencher design with the device tested in Caorso. Discuss any differences that may exist between them. Indicate how these differences might influence air clearing loads.

Response:

As can be seen in Table 022.053-1, the geometric properties of the quencher devices used in WNP-2 and Caorso are essentially identical. The arms are of the same diameter and thickness and differ in length by only 3/4". The holes in the quencher arms are identical in number, size, spacing, orientation and location with respect to the center line of the quencher. The hubs are of the same size for both quenchers. WNP-2 has a slightly thicker quencher hub than Caorso. The conical transition piece from SRVDL to quencher hub has a slightly more gradual taper for WNP-2 as compared to Caorso (10^o vs. 13.5^o). Since the quencher configurations are nearly identical as outlined above, there is no reason to expect a difference in the characteristics of air clearing loads.

The only geometric difference in the plan orientation of the quencher arms is illustrated in Figure 022.053-1. WNP-2 quencher arms form two central angles of 80^o and two central angles of 100^o. At Caorso the quencher arms form three central angles of 80^o and one central angle of 120^o. This results in two of four arms being shifted 20^o with respect to Caorso quencher arms. This minor difference in arm orientation should have no effect on air clearing loads.

The SRV report defines two types of time histories for the forcing function: one which exhibits some initial high frequency pressure spikes and another which looks more like

a typical single frequency wave form (claimed to be observed during German quencher tests). Both types were observed during Caorso tests. Consequently, since the WNP-2 design basis time history specifies use of both, this should take care of the specified concern.

TABLE 022.053-1

COMPARISON OF QUENCHER GEOMETRY

	WNP-2	Caorso
Number of Arms	4	4
Length of Arms (from ℄ Hub)	4'-11 1/4"	4'-10 1/2"
Diameter & Thickness of Arms	12" sch. 80	12" sch. 80
Number of Holes per Arm	1496	1496
Size of Holes (Ø)	0.39"	0.39"
Spacing of Holes	1.96"	1.96"
℄ Quencher to First Row of Holes	1'-10 3/4"	1'-10 3/4"
Hub Size (Ø)	24"	24"
Hub Thickness	2.3"	2.0"

Q. 022.054

The Caorso test results discussed in the SRV report cited above, indicate that the size of the vacuum breaker on the SRV line is important in determining the reflood transient after valve closure and, consequently, the subsequent valve actuation loads. Indicate whether the size, number and characteristics of the vacuum breakers installed on the SRV lines of the WNP-2 facility are similar to those of the Caorso plant. If there are differences, discuss what effects you expect these differences may have on your facility. State how there differences and their effects will be incorporated in your load definition for the WNP-2 facility.

Response:

Two vacuum breakers in parallel are installed on each of the 18 main steam relief valve discharge lines in WNP-2. In designing the vacuum breakers, the effects of the sizing, opening time, pressure losses and delta P were considered for each discharge line. From these considerations, a set of conservative characteristics necessary to provide protection for the discharge lines for subsequent actuation was determined. A comparison of the characteristics of the WNP-2 vacuum breakers with those in the Caorso plant is as follows:

	WNP-2	Caorso
Manufacturer	GPE Controls	Atwood & Morrill Co.
Size (in.)	10	10
Type	Single wafer type with swinging disk	Single straight through with swinging disk
Number	18	16
Flow area (in.^{2})	38.48	78.54
Design Conditions:		
Flow	1966 SCFM*	14000 CFM
Pressure (psig)	-0.5 to 2	0.0
Delta P (psid)	0.115	7
Set point (psid)	0.1	Not available
Opening time (sec. at psid)	0.21 @ 0.4	Not available
$A/\sqrt{K}$ (ft.^{2})	0.278 (40 in.^{2})	0.72 (104 in.^{2})

* Acceptance point at 0.115 psid.

Differences between the values listed are apparent; the flow area, design flow, delta P, and $A/\sqrt{K}$ of the Caorso vacuum breakers are larger. This arises because they are expressed in terms of quantities occurring at different operating points of their respective operating characteristic curves. The WNP-2 vacuum breakers, for example, are expressed in terms of values occurring at delta P = 0.115 psid, whereas those in Caorso are expressed in terms of values occurring at delta P = 7 psid. At these unequal differential pressures, the flows, pressure losses ($\sqrt{K}$) and area resistance coefficients ($A/\sqrt{K}$) are expected to be different. If the 14,000 cfm flow through the Caorso vacuum breakers is scaled down by the square root of the ratio 0.115 psid/7 psid (since the flow through the vacuum breakers varies approximately as the square root of delta P), the Caorso vacuum breakers are calculated to pass approximately the same equivalent flow as the WNP-2 vacuum breakers. As a result, the two vacuum breakers should behave in essentially the same manner.

As has been indicated, vacuum breakers determine the reflood transient within the SRV line. The reflood transient establishes the initial water level condition within the SRV line prior to an SRV discharge event, i.e., an initial condition for the event. Test data for a diversity of initial SRV line water level conditions (low, normal and high water level), * were gathered during the Caorso tests. The WNP-2 SRV load definition envelopes the loads observed at Caorso. As such, differences which might exist in vacuum breakers are accounted for by this bounding approach to load definition which envelopes test data obtained for low, normal and high water level initial conditions.

*See Reports: NEDE-25100-P and NEDE-24757-P, Caorso Phase I and II test reports.

Q. 022.055

The design values for the transient SRV loads in the WNP-2 facility are based on single valve, subsequent actuation data from Caorso in-plant tests. These design values are then used in load cases involving multiple valve actuations based on the assumption that actuation of multiple valves occurs only for the first actuation of the SRVs. State whether this assumption can be supported by a transient analysis of the worst transient event expected in the WNP-2 facility. If this is not the case, revise your load definition to consider the multiple valve effect on the design basis pool boundary loads. Our concern is that the Caorso test results indicate that pressure loads from multiple-valve actuations are greater than those from single-valve actuations under similar first actuation conditions.

Response:

The SRV report states that a multiple valve actuation case is more likely to be an initial actuation rather than a subsequent actuation. This statement is only made to show added conservatism in the design value since initial actuations are expected to be lower in peak pressure amplitude than subsequent actuations.

There is insufficient data from the Caorso tests to provide a statistical base for multiple valve actuations. For comparison purposes though the maximum measured pressures at P19 may be examined:

P_{max} for single valve (valve A), initial actuations = 5.96 psi (See Table 4.1 of SRV report.)

P_{max} for multiple valve, initial actuations = 5.87 psi (See Table 4.5 of SRV report.)

If the initial actuation tests measured at Caorso are used as the data base for comparison purposes, it is found that a single valve test has recorded the highest pressure amplitude.

If all of the Caorso tests are used as the data base, it is again found that a single valve test has recorded the highest pressure amplitude.

Furthermore, in comparing design envelope frequency spectra with multiple valve actuation data from the Caorso tests, (see Question 022.056, Figure 022.056-2), conservative results are observed.

It was concluded that, since single valve actuations of Caorso tests yields higher maximum pressure amplitudes and since the frequency spectra envelope of all multiple valve tests performed at Caorso is enveloped by the design envelope frequency spectra, the load definition is indeed adequate.

Q. 022.056

In Figure 6.8 of the SRV report cited above, you indicate that the frequency spectrum of the design pressure-time histories can bound the experimental pressure-time traces at a statistical confidence level of 90 percent/90 percent and also bounds the envelope of the single valve subsequent actuation pressure traces from the Caorso tests. Provide similar comparisons for leaky valve (LV) first actuation data and for multiple valve actuation (MVA) data. Our concern is that the distinct differences in the characteristic in LV data (e.g., the frequency and amplitude) and the greater number of initial pressure spikes in MVA data.

Response:

Comparison of Design Envelope Versus Leaky Valve Actuation Data

A comparison between the design envelope response spectra and the leaky valve first actuation response spectra (measured at P19) is shown in Figure 022.056-1. The design curve completely envelopes the leaky valve first actuation envelope recorded from Caorso data thereby justifying the design curve as adequate. The leaky valve first actuation envelope is developed from tests, 41, 42, 43 and 44 of Caorso Phase II tests.

Comparison of Design Envelope Versus Multiple Valve Actuation Data

In the case of single valve actuations, valve "A" was considered and, as shown in the SRV reports, data recorded by sensor P19 was considered adequate to represent the local as well as the global boundary pressure frequency content. In the case of multiple valve actuation, in order to obtain a valid comparison with the design (global) pressure, one must determine a global (averaged) frequency content about the quenchers which are actuated. Pressure sensors corresponding approximately to the position of P19 in reference to valve "A" are selected for each of the actuated quenchers. Their readings could be used as a measure of local boundary pressure frequency content. However, their average is used for comparison with the design (global) pressure. Caorso tests were instrumented to record local data for quenchers "A" (sensor P19), "E" (sensor P50) and "U" (sensor P51). Therefore, for each test in which quenchers A, E, and/or U are actuated, the locally recorded frequency spectra are averaged to give a measure of global response for that test. An averaged frequency spectrum envelope is then generated for the multiple valve actuation tests considered, and is

compared to the design envelope in Figure 022.056-2 with conservative results. The multiple valve actuations frequency spectrum envelope is developed from tests 24-27, 29, 30, 32, 45-1 and 45-2.

Q. 022.057

Many of the Caorso subsequent actuation tests were conducted with one of the two vacuum breakers blocked. You used the results from these particular tests to derive the design values of SRV pressure transients for the WNP-2 facility. However, the maximum pool boundary pressure measured in the Caorso tests is from a subsequent actuation test with both vacuum breakers operating (Test 22A02), which we believe to be prototypical for Mark II plants. The maximum measured value of the peak positive pressure is 8.7 psi and the mean value is 5.9 psi for subsequent actuation tests with only one vacuum breaker functioning. They are 9.4 psi and 7.3 psi, respectively, when two vacuum breakers are functioning. This represents a potential nonconservatism in the data base used in the derivation of design values of SRV pressure transients for the WNP-2 facility. Accordingly, discuss this phenomenon and its effect on the data evaluation, including your derivation of the design basis SRV loads.

Response:

As indicated in the response to Question 022.054, vacuum breakers affect SRV loads by influencing the reflood transient which in turn establishes initial SRV line water level, i.e., the vacuum breakers influence one of the initial conditions for SRV discharge. The Caorso test matrix includes few subsequent actuations with both vacuum breakers operating; too few actuations to make any statistical conclusions. However, the maximum pressure amplitude is of interest. The P 90/90 value for Caorso data equals 9.37 psi.

The maximum pressure amplitude recorded at Caorso for subsequent actuations for cases involving the operation of either one or two vacuum breakers is 9.4 psi which is equivalent to the statistically derived P 90/90 value.

It can, therefore, be concluded that the approach used in the development of a design pressure amplitude for WNP-2 is indeed a justified and conservative approach since the P 90/90 pressure amplitude used in the determination of a WNP-2 design pressure amplitude is not exceeded by any pressure amplitude measured during the Caorso tests. For further discussion, see the response to Question 022.054.

Q. 022.058

In order to account for the differences between the WNP-2 design conditions and the Caorso test conditions (e.g., the pool geometry, the number of SRVs and the initial pool temperature), you used a pressure amplitude multiplier based on a correlation in the Design Forcing Function Report (DFFR) to obtain the WNP-2 design values for SRV loads. This procedure involves the extrapolation of pressure amplitudes measured in the Caorso tests with respect to some parameter values (e.g., the SRV steam flow rate) to WNP-2 design conditions using the trends established in the DFFR. Accordingly, provide justification for your position that the trends used in this extrapolation can be supported by available Caorso data.

Response:

The DFFR established trends for pressure amplitude variation with different parameters such as steam flow rate, initial pool temperature, etc., are supported by available Caorso data.

As can be seen from Figure 022.058-1 the DFFR predicted pressure amplitudes increase with steam flow rate. Caorso Phase II Tests #35 and #38 were selected since all test conditions, other than steam flow rate, were maintained approximately equal during these tests:

$$\left[\Delta P_{\substack{\text{predicted}\\ \text{(DFFR)}}} = 1.45 \text{ psi}\right] \approx \left[\Delta P_{\text{measured}} = 1.5 \text{ psi}\right]$$

Similarly, Figure 022.058-2 illustrates that the DFFR predicted pressure amplitude increases with initial pool temperature. This is also verified by available Caorso data. Caorso Phase I Tests #7 and #1301 were selected in this case since all conditions, other than the initial pool temperature, were maintained approximately equal during these tests:

$$\left[\Delta P_{\substack{\text{predicted}\\ \text{(DFFR)}}} = 0.4 \text{ psi}\right] \approx \left[\Delta P_{\substack{\text{predicted}\\ \text{(Caorso Phase I SVA)}}} = 0.5 \text{ psi}\right]$$

It is concluded from the above examples that DFFR established trends are supported by available Caorso data and could be used to account for the differences between the WNP-2 design conditions and the Caorso test conditions.

Q. 022.059

The proposed vertical pressure distribution in the SRV report cited above, is constant between the bottom of the suppression pool and the quencher elevation and then decreases linearly to zero at the pool surface. You stated that you derived this particular spatial variation by reviewing the maximum pressures measured at various elevations in the Caorso tests. However, as shown in Figure 3.8a of the cited report, this proposed pressure distribution cannot bound the maximum measured values of pressure for all Caorso tests. Furthermore, the use of the maximum measured pressure values in the comparison cannot reveal the effect of bubble vertical motion on the measured pressure distribution. Our concerns are that the bubble vertical motion will result in a more severe pressure distribution in the later part of the SRV transient and your model may not yield the correct pressure distribution. Specifically, the cross-correlation coefficient of pressure traces measured at different elevations is less than 1 (about 0.9) which indicates that there may be some effect from bubble motion on the pressure distribution. Accordingly, modify your proposed vertical pressure distribution, as required, to assure conservatism in the design load specifications for SRV transients in the WNP-2 facility.

Response:

1. <u>Proposed Vertical Pressure Distribution</u>

Figure 3.8a of the SRV report may more appropriately be shown as in Figure 022.059-1 such that the measured pressures are normalized to the maximum value of pressure sensor P19 instead of P13, as was used in the original SRV load definition report, since P19 corresponds to the sensor selected in the development of the load definition.

The proposed vertical distribution is compared against the average and maximum values of pressure measured at five locations during six representative tests. Tests 4402, 2325, 2324, 2305, 2202, and 1104 were chosen as representative since these tests measured some of the highest pressures at P19.

This alternate figure shows the proposed vertical distribution as adequate. The pressure distribution which would envelope the maximum values shown in the figure is adequately represented by the proposed pressure distribution.

2. Bubble Vertical Motion

The suggested "bubble vertical motion" will not result in a more severe pressure distribution in the latter part of the transient. It can be shown, using Test 2202 as an example, that the vertical pressure distribution is preserved. Figure 022.059-2 compares the normalized first peak positive and negative maximum pressure amplitudes of pressure sensors located along the vertical face of the containment with the proposed vertical pressure distribution, with satisfactory results. The second positive and negative peak amplitudes as well as the third positive and negative peak amplitudes for the applicable pressure sensors plotted in Figures 022.059-3 and 022.059-4, respectively, again show the distribution as adequate.

Q. 022.061

You use the methodology in the DFFR to establish the circumferential pressure distribution for the WNP-2 facility. State whether you use the line-of-sight and square-root-of-the-sum-of-the-squares (SRSS) assumptions of the DFFR in your calculations. If so, provide justification for using these assumptions in the WNP-2 facility. Your justification should be based on the Caorso test results. Indicate to what extent these assumptions affect the WNP-2 load cases. Provide representative figures showing the pressure distributions on the basemat, the pedestal wall and the containment wall for the various SRV discharge cases considered in WNP-2 plant design assessment.

Response:

The circumferential pressure distribution actually used for the WNP-2 facility is derived from a conservative and more realistic application of the pressure distribution on the suppression pool boundary recommended in DFFR (Reference 1). This conservative application is supported by Caorso test data as described below.

a. The line-of-sight assumption is not used for WNP-2. To calculate the boundary pressure at a given location resulting from actuation of a single quencher the "straight line" distance is used instead of the "line-of-sight" distance recommended in DFFR:

$$p^{(r)} = \begin{cases} P_B \dfrac{2r_o}{r} & \text{for } \dfrac{2r_o}{r} \leq 1.0 \\ P_B & \text{for } \dfrac{2r_o}{r} \geq 1.0 \end{cases}$$

where:

$p^{(r)}$ = attenuated bubble pressure;
P_B = bubble pressure;
r_o = quencher radius;
r = straight line distance from quencher center point to the location of interest

This results in finite pressure values being calculated over the entire suppression pool boundary, not only over the "viewed" portion of the boundary, a fact verified by Caorso test data. Indeed, during Caorso Phase II Test 501 X (see Reference 2) quencher "V" was actuated and the available instrumentation, although located in a shaded or "non-viewed" boundary area with respect to the actuated quencher as seen from Figures 4-1, 4-2 and 4-3 of Reference 2, recorded finite boundary pressure values as follows:

Sensor	P_{13}	P_{14}	P_{15}	P_{17}	P_{18}
Recorded pressure value, (psi)	0.4	0.4	0.5	0.5	0.7

The bubble pressure value was not recorded during this specific test but can be estimated to lie in the range of values recorded during Phase I Tests 19 and 20, and Phase II Test 22 A01 performed with quencher "U" at similar conditions: single valve first actuations, cold pipe, normal water leg and two 10-inch vacuum breakers (see References 2 and 3). Then, the pressure value recorded at location of sensor P_{17}, located approximately 180° from the actuated quencher "V", is estimated to be in the range of 6.4% to 16.1% of the bubble pressure. This is comparable to the 13% prediction calculated using the "straight line" distance assumption.

b. The SRSS assumption is replaced with the more conservative linear superposition (LS) assumption for the WNP-2 facility. In the case of two quenchers this LS rule becomes:

$$P = P_1 + P_2 \leq P_B$$

where:

P = total pressure at the location of interest;
P_1, P_2 = contributions from quencher #1 and #2, respectively, calculated using eq. (1), above.

Justification for the use of the LS assumption is provided by two Caorso Phase II two-valve tests: Test 24 and Test 25 (see Reference 2). In Table 022.061-1 attached, pressures calculated at different pool boundary locations using the LS rule and the SRSS rule are identified. For comparison purposes pressures recorded at the same locations during the two tests are also listed. From examination of the data it is concluded that the LS rule is adequate and, as expected, more conservative than the SRSS rule.

Figures 022.061-1 and 022.061-2 illustrate the pressure distributions along the suppression pool floor and on the pedestal and containment walls for two SRV discharge cases, the all-valves case and single outer valve case. These two cases were determined to be the governing cases for the WNP-2 plant design, although the plant was also assessed for a single inner valve discharge case, a two valve discharge case and for the ADS case.

Figure 022.061-3 illustrates the circumferential distribution of pressure loading for the single outer valve case. It should be noted that there is no pressure variation in the circumferential direction for the all valves discharge case.

References:

1. "Mark II Containment Dynamic Forcing Functions Information Report (DFFR)," NEDO-21061, Rev. 3, dated June 1978.

2. "Mark II Containment Supporting Program. CAORSO Safety Relief Valve Discharge Tests. Phase II Test Report," NEDE-24757-P, date May 1980, General Electric Company Proprietary.

3. "CAORSO SRV Discharge Tests. Phase I Test Report," NEDE-25100-P, dated May 1979, General Electric Company Proprietary.

COMPARISON OF WETWELL BOUNDARY PRESSURE AMPLITUDES PREDICTED BY THE LINEAR SUPERPOSITION (LS) METHOD AND THE SRSS METHOD (DFFR, REV. 3) WITH PRESSURES RECORDED DURING CAORSO TWO-VALVE TESTS 24 & 25

SENSOR	PRESSURE AMPLITUDE (PSI)			RATIO	
	CALCULATED BY		MEASURED	L.S. / MEASURED	SRSS / MEASURED
	L.S. METHOD	SRSS METHOD			
TEST 24					
13	5.2	5.2	5.2	1.00	1.00
18[2]	4.7	3.7	3.3	1.42	1.13
23	5.2	5.2	3.6	1.44	1.44
32[2]	4.9	3.5	2.0	2.45	1.75
35	5.2	5.2	4.2	1.24	1.24
36	5.2	5.2	3.1	1.68	1.68
37[1]	5.2	5.2	2.8	1.86	1.86
50	5.2	4.5	3.6	1.44	1.25
51	5.1	3.6	2.1	2.43	1.71
AVERAGE RATIOS				1.66	1.45
TEST 25					
13	3.7	3.7	3.4	1.09	1.09
18[2]	3.6	2.7	2.8	1.29	0.96
23	3.7	3.7	3.3	1.12	1.12
32[2]	3.7	2.7	2.7	1.37	1.00
35	3.7	3.7	3.7	1.00	1.00
36	3.7	3.7	3.2	1.16	1.16
37[1]	3.7	3.7	3.1	1.19	1.19
50	3.7	3.4	3.8[3]	0.97	0.89
51	3.7	2.8	3.0	1.23	0.93
AVERAGE RATIOS				1.16	1.08

For Test 24: $(P_B)_A$ = 5.2 psi, $(P_B)_F$ = 2.7 psi

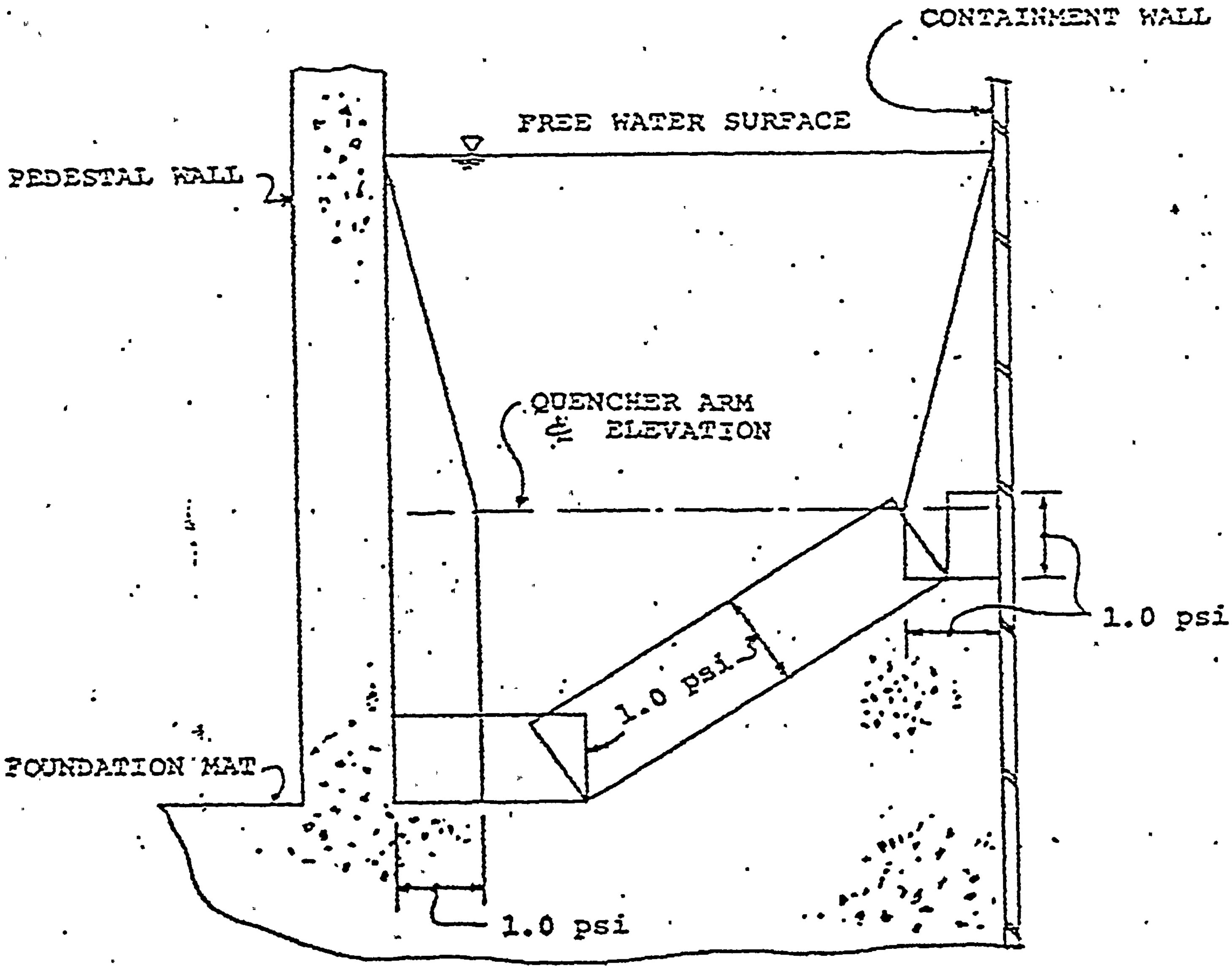
For Test 25: $(P_B)_A$ = 3.7 psi, $(P_B)_F$ = 2.3 psi

P_B = bubble pressure

$(P_B)_A$ = bubble pressure @ quencher A (recorded by sensor P19)

$(P_B)_F$ = bubble pressure @ quencher F (recorded by sensor P25)

1 Exceeds 2 r_o slightly
2 At quencher elevation
3 Exceeds P_B

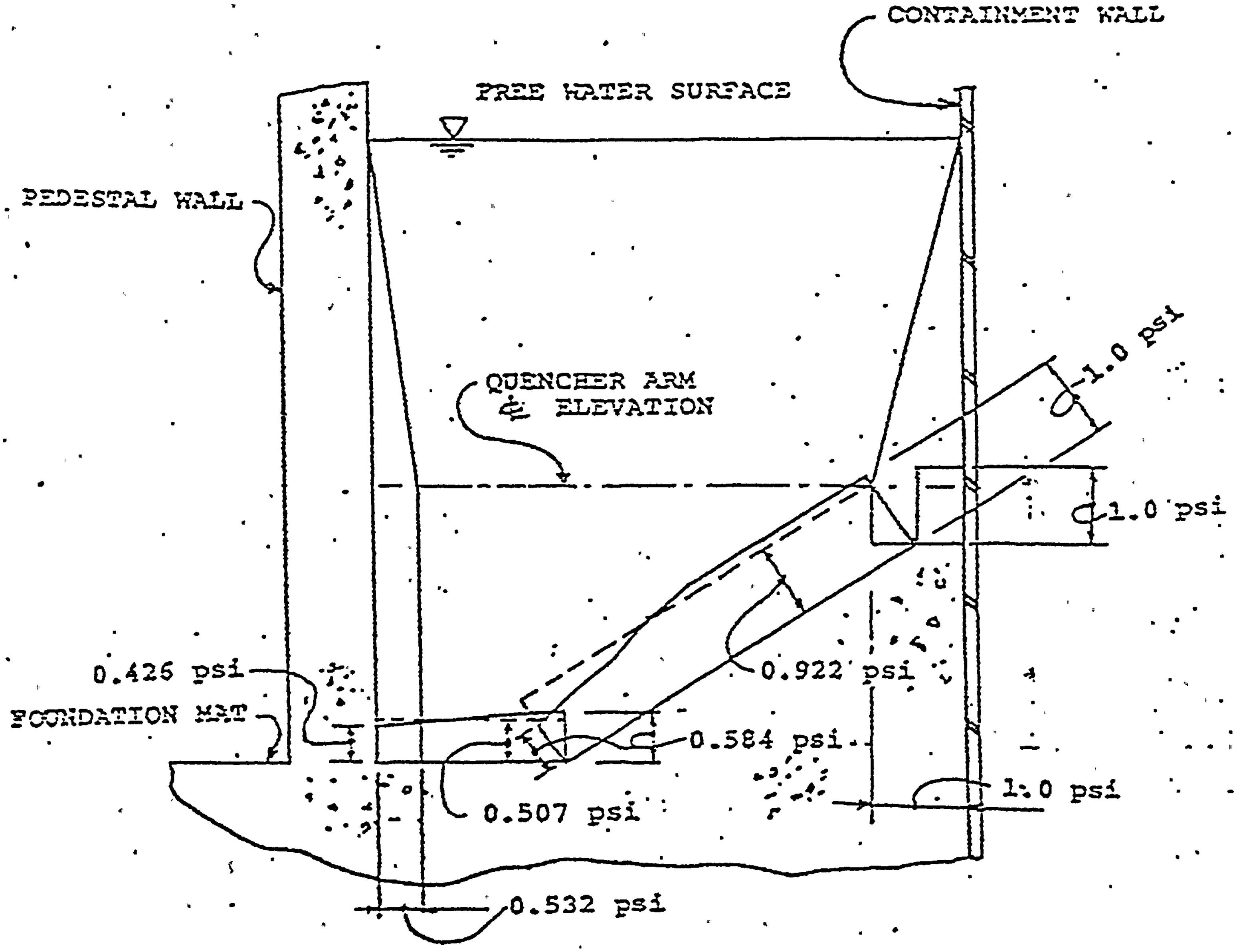


NOTE: FOR ALL VALVES CASE CIRCUMFERENTIAL DISTRIBUTION IS CONSTANT

2/4

FIGURE Q 022.061-1

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	ALL VALVES CASE RADIAL PRESSURE DISTRIBUTION (Hischal) CORRESPONDING TO θ = 0°



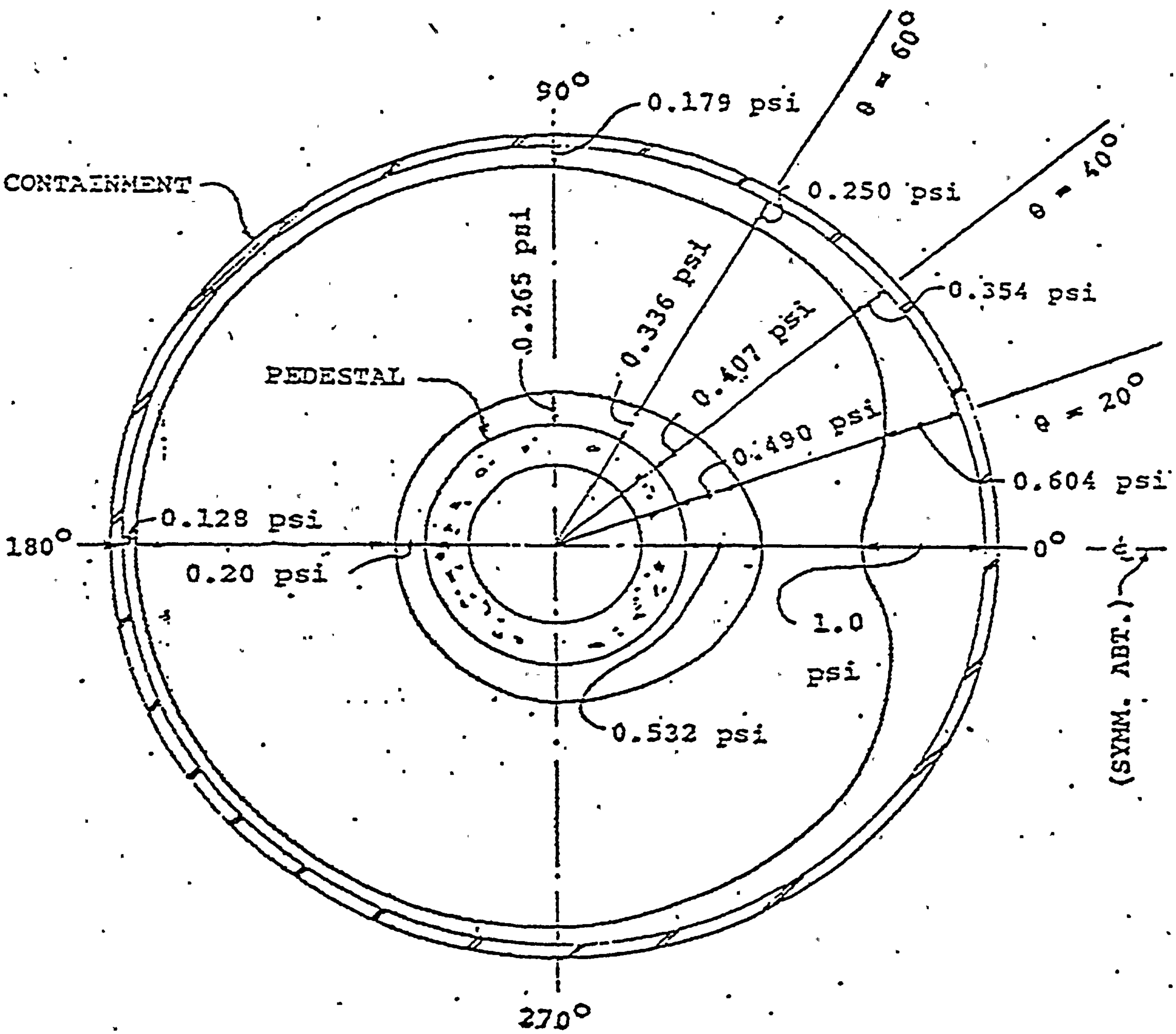
—— CALCULATED PRESSURE DISTRIBUTION

– – – PRESSURE DISTRIBUTION USED FOR ANALYSIS

3/4

FIGURE Q 022.061-2

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	SINGLE OUTER VALVE CASE RADIAL PRESSURE DISTRIBUTION (NORMALIZED) CORRESPONDING TO $\theta = 0°$



4/4

FIGURE Q 022.061-3

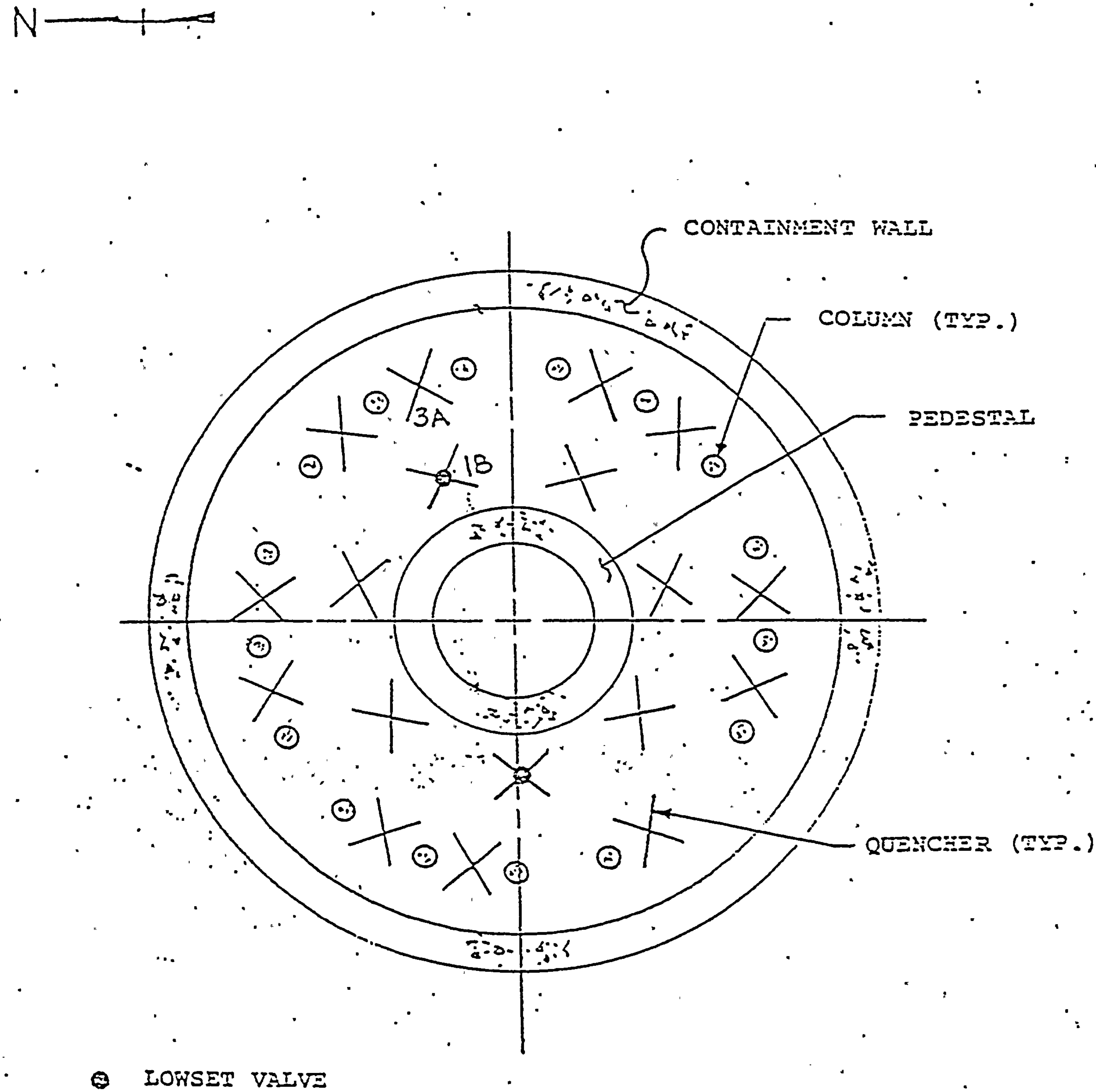
WASHINGTON PUBLIC POWER SUPPLY SYSTEM	SINGLE OUTER VALVE CASE

Q. 022.062

Indicate what two valves are selected for the two-valve discharge case. State whether the two quenchers selected are in the inner or the outer circle. Provide justification for the two valves selected and for their location.

Response:

The two valves selected for the two-valve discharge case are identified as 1-B and 3-A; one quencher lies in the inner circle while the other lies in the outer circle. There are a large number of cases to be considered, however, certain DFFR criteria limit this selection. One such criterion specifies that the required combination include one lowset valve and any adjacent valve. This statement limits the number of cases to be considered to seven. Of these seven tests analyzed, the arrangement chosen yields the most critical asymmetric loading condition thereby establishing the basis for the selection. Refer to Figure 022.062-1 for the location of the two selected quenchers.



PLAN

FIGURE Q 022.062-1

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT NO. 2	QUENCHER LOCATION FOR TWO VALVE DISCHARGE CASE

Q. 022.063

In your analyses of SRV transients in the WNP-2 facility, you assume that the pool water is incompressible. Your only justification for this assumption is that the cross-correlation coefficients between pressure time histories measured at different locations are high. Our concern is that this is insufficient justification since the relationship between the cross-correlation coefficient and the time phase shift has not been established; this relationship will influence the effect of compressibility on pressure measurements. You use the incompressible flow assumption in your analyses addressing the fluid-structure interaction (FSI) effect and in the WNP-2 structural analyses. Even though the incompressible flow assumption can be justified for the Caorso plant, it is still questionable whether it holds true for the WNP-2 facility. Specifically, our concern is that the fluid-structure coupling effect may be more significant in the WNP-2 plant which has a steel containment than in the Caorso facility which has a concrete containment. Further, the velocity of sound in water is greatly reduced by the presence of air and steam bubbles in the water; the conditions in the WNP-2 facility may differ to the extent that the amount of air and steam bubbles in the pool water will be significantly different for the two facilities. Accordingly, since your assumption regarding the incompressibility of water in your analyses of SRV transients in the WNP-2 facility is important but not adequately supported, provide additional justification on this matter.

Response:

For any boundary pressure, P, it can be shown that

$$P = P_i + P_a \quad \text{(See p. 32, SRV report)}$$

where P_i = rigid wall pressure
P_a = interaction pressure due to wall flexibility
= Ma

in which M = hydrodynamic added mass
a = wall acceleration

It was found during the Caorso tests that containment wall acceleration measurements were very small (see Appendix 5-1, SRV report). One may conclude that the interaction pressure, P_a, is to be considered negligible for the Caorso facility so that

$$P = P_i$$

The SRV load definition was then based on the rigid wall pressures recorded at the Caorso facility.

In the design assessment phase of the WNP-2 facility, the rigid wall pressure, P_i, was applied at the pool boundary and since the acceleration of the containment wall may no longer be considered negligible (WNP-2, steel containment versus Caorso, concrete containment), the interaction pressure, P_a, is completely accounted for my a set of hydrodynamic added masses using the approach specified in Reference 1.

The high cross-correlation coefficient between pressure-time histories measured at different locations in the Caorso facility is merely a reinforcement of the fluid incompressibility assumption for the Caorso plant.

REFERENCES:

1. Bedrosian, B., "Analysis of a Mark II Containment Structure for Hydrodynamic Loads in Suppression Pool", Proceedings, Conference on Structural Analysis, Design, and Construction in Nuclear Power Plants, Vol. 2, Porto Alegra, Brazil, April 1978.