PSE&G Public Service Electric and Gas Company

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Robert L. Mittl General Manager
Nuclear Assurance and Regulation

January 31, 1985

Director of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, MD 20814

Attention: Mr. Albert Schwencer, Chief
Licensing Branch 2
Division of Licensing

Gentlemen:

REQUEST FOR ADDITIONAL INFORMATION - HCGS PUAR
HOPE CREEK GENERATING STATION
DOCKET NO. 50-354

Pursuant to Enclosure 1 of the NRC request for additional information regarding the Hope Creek Generating Station Plant Unique Analysis Report (PUAR) (letter from A. Schwencer, NRC to R. L. Mittl, PSE&G, dated November 16, 1984), Public Service Electric and Gas Company hereby submits the attached information (See Attachment 1) needed to conclude the hydrodynamic loads review of the PUAR.

Pursuant to Enclosure 3 of the request for additional information referenced above, NUTECH Engineers has, on behalf of the Mark I Owners' Group, provided information regarding the CMDOF validation program in letter, R. H. Buchholz, NUTECH, to D. B. Vassallo, NRC, dated January 11, 1985 (See Attachment 2). This letter summarizes the Mark I Owners' Group position on the use of CMDOF for the plant unique analysis.

Response to Enclosure 2 of this request for additional information was submitted by letter, R. L. Mittl, PSE&G, to A. Schwencer, NRC, dated January 8, 1985.

This completes our response to your request for additional information regarding the Hope Creek Plant Unique Analysis Report.

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Add: F. Eltawila CSB
B. Siegel LB2

Should you have any questions in this regard, please contact us.

Very truly yours,

Attachment 1 - HCGS PUAR - Additional Information on Hydrodynamic Load for NRC Review
Attachment 2 - Mark I Owners's Group CMDOF Validation Program Review Summary Letter (NUTECH to NRC)

C D. H. Wagner
USNRC Licensing Project Manager

A. R. Blough
USNRC Senior Resident Inspector

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ATTACHMENT 1

HOPE CREEK GENERATING STATION

PLANT UNIQUE ANALYSIS REPORT

ADDITIONAL INFORMATION ON HYDRODYNAMIC LOADS FOR NRC REVIEW

HOPE CREEK GENERATING STATION
PLANT UNIQUE ANALYSIS REPORT
ADDITIONAL INFORMATION ON HYDRODYNAMIC LOADS FOR NRC REVIEW

ITEM 1: Provide the Plant Unique Load Definition Report (PULD) for Hope Creek for examination by the staff.

RESPONSE TO ITEM 1:

General Electric Report NEDO-24579-1, Revision 1, January 1982, titled Mark 1 Containment Program - Plant Unique Load Definition - Hope Creek Generating Station: Unit 1, is enclosed for examination by the NRC Staff.

HOPE CREEK GENERATING STATION

PLANT UNIQUE ANALYSIS REPORT

ADDITIONAL INFORMATION ON HYDRODYNAMIC LOADS FOR NRC REVIEW

ITEM 2: Hope Creek does not use a vent header deflector. Provide details of the vent header pool swell impact load calculation for Hope Creek.

RESPONSE TO ITEM 2:

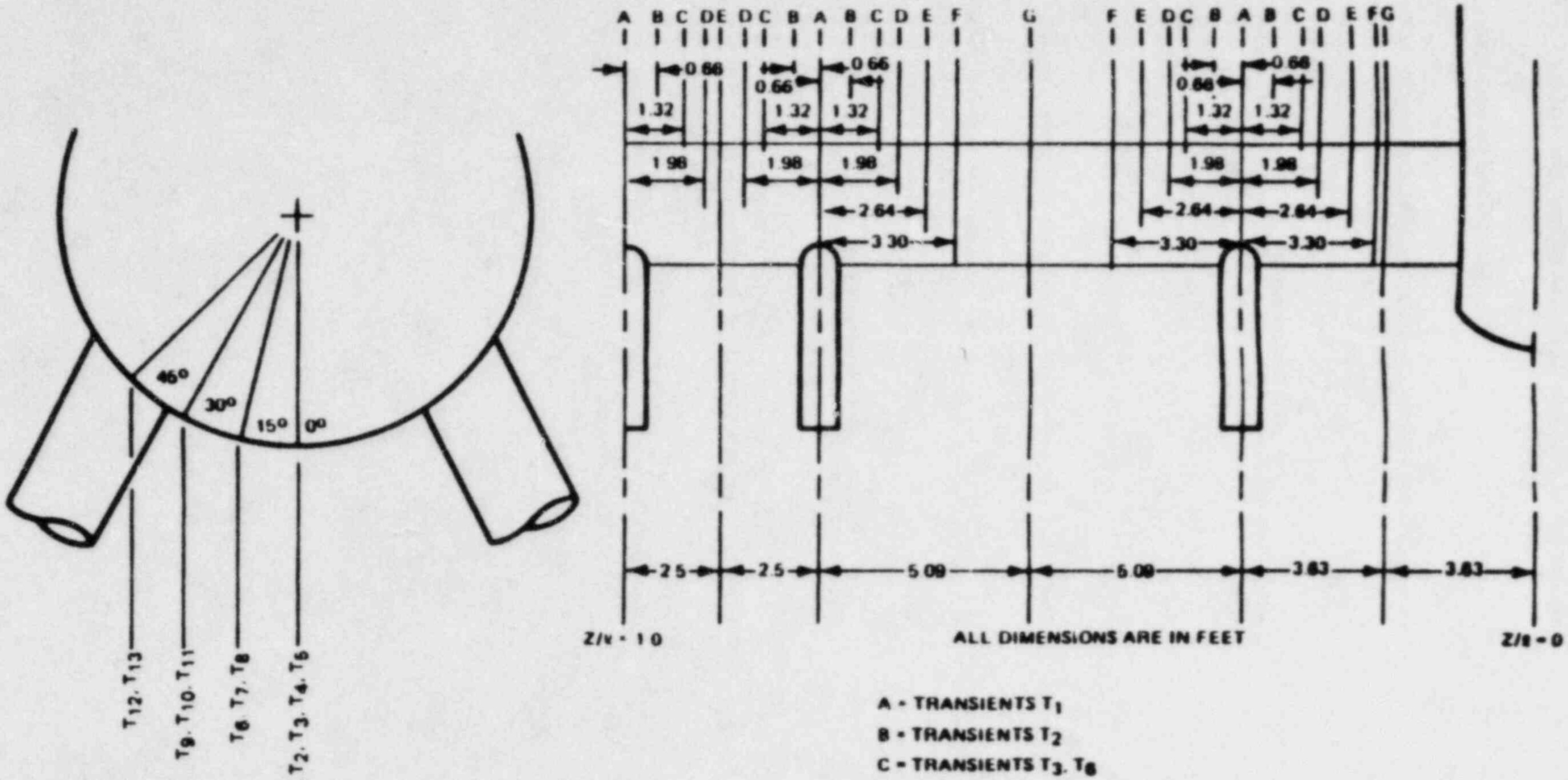
The procedure described in Section 3.5.1.1 of NUREG-0661 was used to evaluate the pool swell impact loads on the vent header. As Hope Creek does not have a vent-header deflector, the vent header is directly impacted by the pool swell. Hope Creek Plant Unique Load Definition (PULD) report provides the pool swell impact pressure transients on the vent header as a function of position and time. Figure 2-1 provides the locations where the pressure transients on the vent header were obtained from the QSTF plant-unique tests.

Pool swell first impacts at the midcylinder (longitudinal location parameter $Z/\ell=1.0$) and then travels towards the vent line in the other bay ($Z/\ell=0.0$). The plant unique vent header impact timing, i.e., longitudinal and circumferential time delays from PULD are shown in Figures 2-2 and 2-3. As per NUREG-0661, the longitudinal time delays are based on EPRI Main Vent Orifice Test while circumferential time delays are based on QSTF generic test series.

In order to calculate pressure time histories at the 1/16th vent system model nodes, interpolation from locations shown in Figure 2-1 was performed along the longitudinal and circumferential direction taking into account the time delays in Figures 2-2 and 2-3.

Longitudinal vent header impact normalized velocity distribution based on EPRI Main Vent Orifice Test is shown in Figure 2-4 (from PULD). Since pressure is proportional to the square of velocity, the pressure values in PULD were multiplied by the square of normalized velocity at each node corresponding to the normalized position of that node on the vent header.

Typical vent header pool swell loading transients are given in Table 3-2.2-5. These time histories were converted into force time histories by multiplying them with the corresponding nodal tributary area and then applied to the 1/16th vent system model for stress evaluation.



A - TRANSIENTS T_1
B - TRANSIENTS T_2
C - TRANSIENTS T_3, T_6
D - TRANSIENTS T_9, T_{12}
E - TRANSIENTS T_4, T_7
F - TRANSIENTS T_{10}
G - TRANSIENTS T_5, T_8, T_{11}, T_{13}

Figure 2-1

LOCATION OF IMPACT/DRAG PRESSURE TRANSIENTS ON HEADER

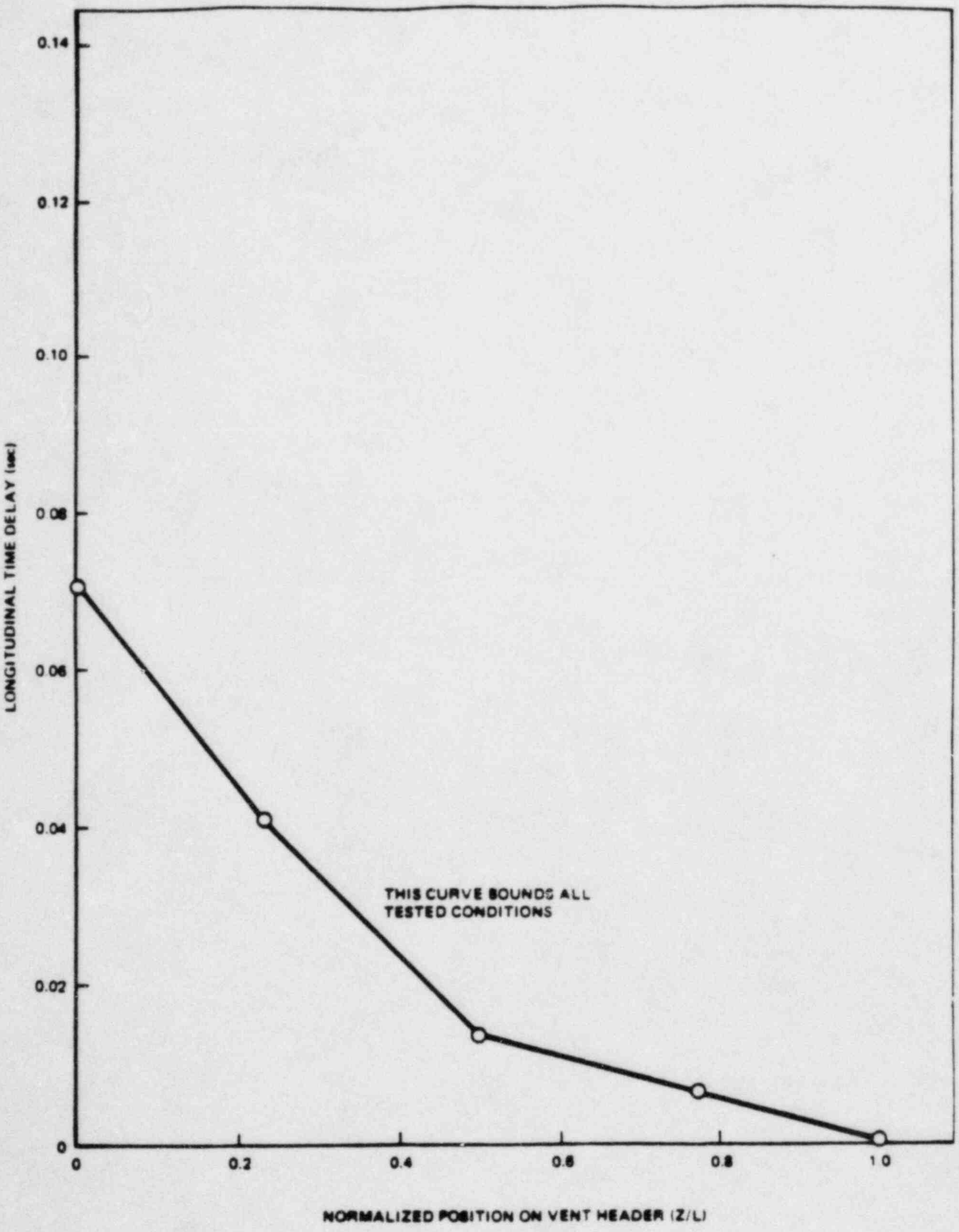


Figure 2-2

LONGITUDINAL TIME DELAY DISTRIBUTION BASED ON EPRI MAIN VENT ORIFICE TEST

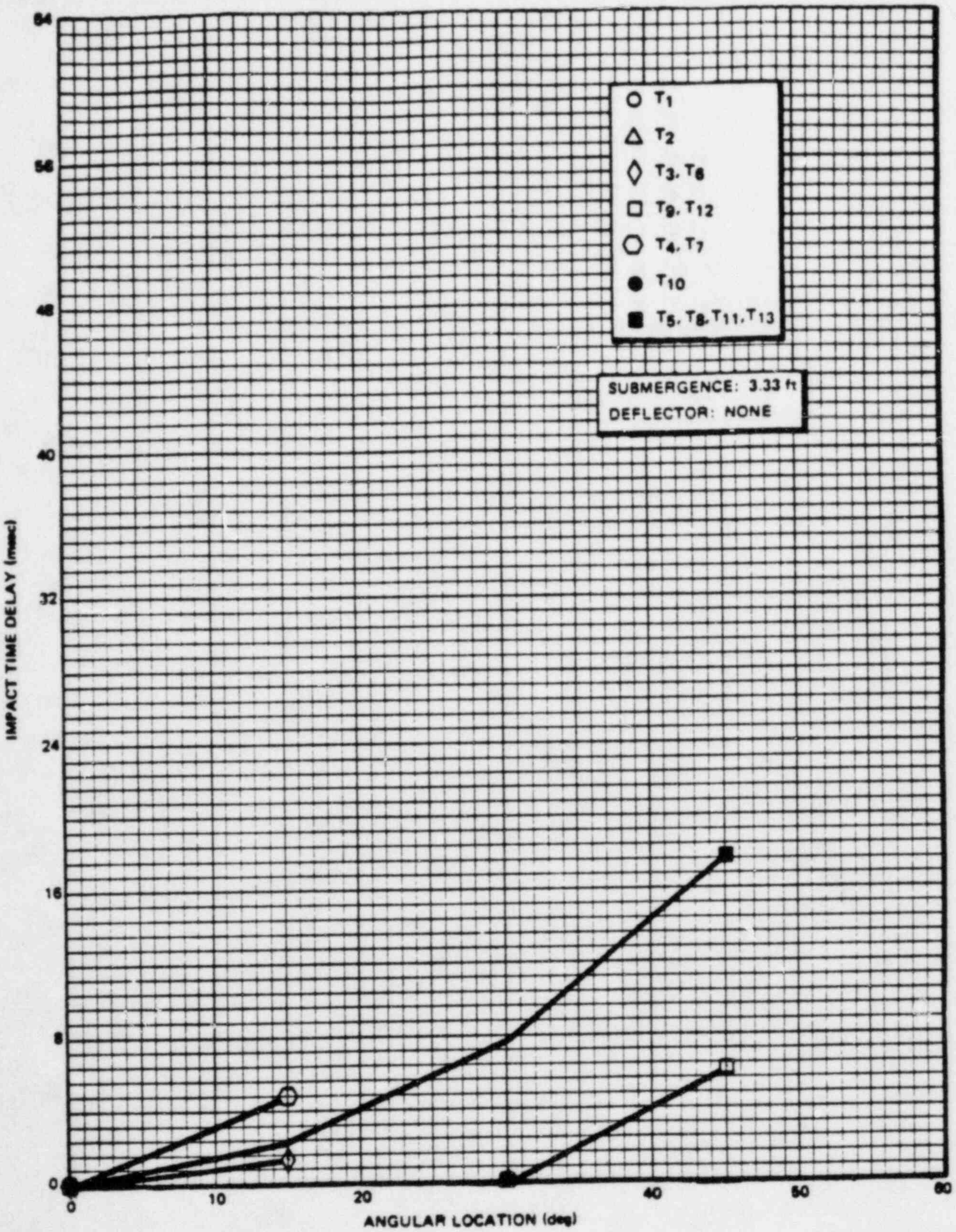


Figure 2-3

CIRCUMFERENTIAL TIME DELAY DISTRIBUTION (ZERO ΔP)

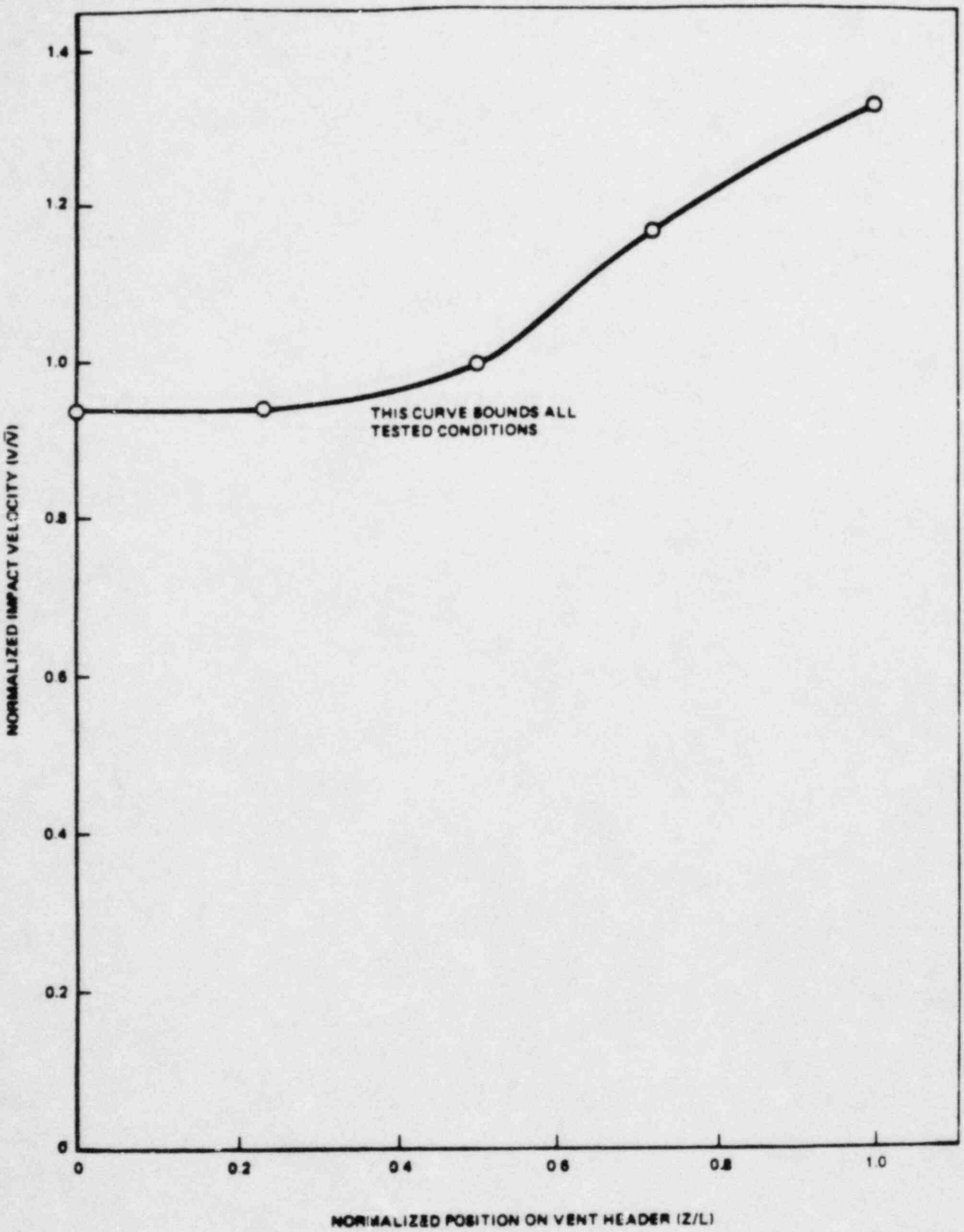


Figure 2-4

LONGITUDINAL VENT HEADER IMPACT VELOCITY DISTRIBUTION BASED ON EPRI MAIN VENT ORIFICE TEST

HOPE CREEK GENERATING STATION

PLANT UNIQUE ANALYSIS REPORT

ADDITIONAL INFORMATION ON HYDRODYNAMIC LOADS FOR NRC REVIEW

ITEM 3: In order to analyze the various loads associated with SRV actuation, which line or lines were chosen for calculation purposes and on what basis was the choice made? Could other lines give higher loads than the ones used for analysis?

RESPONSE TO ITEM 3:

The loads associated with SRV discharge lines were calculated such that it bounded the results for all the SRV lines. For example, SRV line thrust loads were calculated for all the fourteen SRV lines and for all the cases defined in the PUAR Table 1-4.2-2. The effect of each of these loads was then evaluated on different SRV lines.

The loads due to SRV air bubble oscillation on torus shell and submerged structures were calculated for the longest and the shortest SRV discharge lines. The enveloping pressure magnitude and the frequency range was then used for analysis purpose. This method would conservatively bound the pressure magnitude as well as the frequency range of SRV loads due to all the other SRV lines.

HOPE CREEK GENERATING STATION

PLANT UNIQUE ANALYSIS REPORT

ADDITIONAL INFORMATION ON HYDRODYNAMIC LOADS FOR NRC REVIEW

ITEM 4: For what environmental temperature range have the Hope Creek SRV lines been analyzed?

RESPONSE TO ITEM 4:

There are two thermal cases for which SRV piping has been analyzed for. One thermal case bounds the normal operating and accident condition temperatures without the SRV actuation. The other case is the envelope of normal operating and accident condition temperatures occurring concurrent with SRV actuation.

Temperatures used in the analysis for the wetwell SRV piping are given in PUAR Table 5-3.2-2. For the drywell portion of SRV piping, temperature range without SRV actuation is 70°F to 340°F, and with the SRV actuation is up to 475°F.

HOPE CREEK GENERATING STATION

PLANT UNIQUE ANALYSIS REPORT

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ITEM 5: Will the confirmatory SRV tests to be carried out in Hope Creek be conducted according to the guidelines provided in NUREG-0763? Is our assumption correct that no load reduction will be requested by the applicant based on these tests and that their only purpose is to confirm the conservatism of the SRV loads provided in the PUAP?

RESPONSE TO ITEM 5:

SRV test for Hope Creek will be conducted according to the guidelines provided in NUREG-0763. The purpose of this test is to confirm the conservatisms in the computed loadings and structural responses for SRV discharge loads presented in the PUAR. No load reduction will be requested based on these tests.

HOPE CREEK GENERATING STATION

PLANT UNIQUE ANALYSIS REPORT

ADDITIONAL INFORMATION ON HYDRODYNAMIC LOADS FOR NRC REVIEW

ITEM 6: The Hope Creek torus has ring girders at mid bay as well as near the miter joints between bays, all supported by external columns. What are the loads on these columns due to pool swell and other LOCA loads, as well as SRV discharge?

RESPONSE TO ITEM 6:

Maximum vertical support loads on external midcylinder (MC) and miter joint (MJ) columns for governing suppression chamber loads are given in PUAR Table 2-2.5-2. Support loads due to pool swell are not included in this table as load combinations including pool swell torus shell loads are not governing load combinations.

Table 2-2.4-2 in the PUAR provides a comparison of total vertical reaction load (summation of MC and MJ columns) per miter for pool-swell, other LOCA, and SRV discharge loads. It is seen that SRV discharge cases produce the largest total vertical reaction loads.

HOPE CREEK GENERATING STATION
PLANT UNIQUE ANALYSIS REPORT
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ITEM 7: Figure 1-2.1-4 of the PUAR shows what is apparently the RCIC turbine exhaust sparger. How were loads associated with this steam discharge into the suppression pool developed? What source terms are used? What submerged structure loads were applied?

RESPONSE TO ITEM 7:

Hydrodynamic loads associated with steam discharge into the suppression pool from the RCIC turbine exhaust sparger were not included in the loading combinations used in the suppression chamber analysis. The maximum steam flow rate expected from the RCIC-turbine exhaust sparger is approximately 10 lb/sec., less than one-twentieth the flow rate and line pressure from a single main steam safety relief valve (SRV). Since loads are somewhat proportional to flow rate and line pressure, it is expected that the loads associated with the RCIC turbine exhaust would be considerable less than the load from a single main steam SRV. Thus, the contribution of the RCIC turbine exhaust-related loads, when combined with the other conservatively combined loads considered in the suppression chamber analysis are expected to be negligible. It is on this basis that the hydrodynamic loads associated with RCIC steam discharge into the suppression pool were neglected.

HOPE CREEK GENERATING STATION

PLANT UNIQUE ANALYSIS REPORT

ADDITIONAL INFORMATION ON HYDRODYNAMIC LOADS FOR NRC REVIEW

ITEM 8: The Hope Creek PUAR states that acceleration drag volumes for structures with sharp corners, such as I-beams, are computed using Table 1-4.1-1 when submerged structure drag loads due to pool swell, CO, chugging and SRV actuation are calculated. Since direct use of Table 1-4.1-1 is not possible for the ring girders, the specific formulas and acceleration volume values used for the ring girders are needed. Provide details of the acceleration volume calculation for drag loads in direction normal to the flange, web and stiffeners, respectively, for both the mitered joint and midcylinder ring beams. Provide final values of acceleration drag volumes in each direction for two or three segments of each beam.

RESPONSE TO ITEM 8:

For the purpose of calculating submerged structure loads on the ring girders, midcylinder and miter ring girders were divided into 11 and 14 segments as shown in Figures 8-1 and 8-2. The geometry of the ring girders and the models used to calculate the acceleration drag volumes for the in-plane and out-of-plane (normal to web) directions for the midcylinder and miter ring girders are shown in Figures 8-3 and 8-4.

For the in-plane direction (normal to the flange) the ring girders were modeled as I-beams, and the formula used to develop the acceleration volumes (Table 1-4.1-1 in PUAR) is:

$$V = [2.11\pi \, a^2 + 2c\,(2a + b - c)]\, L\, A_w$$

where

Parameter	Midcylinder Value (Segments 1 through 5 and 7 through 11)	Miter Value (Segments 1 through 6 and 9 through 14)
a (ft)	0.625	0.5
b (ft)	1.312	1.045
c (ft)	0.104	0.125
L (ft)	3.830	2.983
A_w	2.0	2.0
V (ft^3)	23.75	12.76

The dimensions a, b, and c are shown in Figures 8-3 and 8-4. The distance L is the segment length; A_w is the factor to account for wall interference effects.

For the out-of-plane direction, the acceleration volumes for the ring girders were based on the hydrodynamic volume (Table 1-4.1-1 in PUAR) of a rectangle combined with the actual volume of the ring girder. The formula used to develop the acceleration volumes of midcylinder and miter ring girders is:

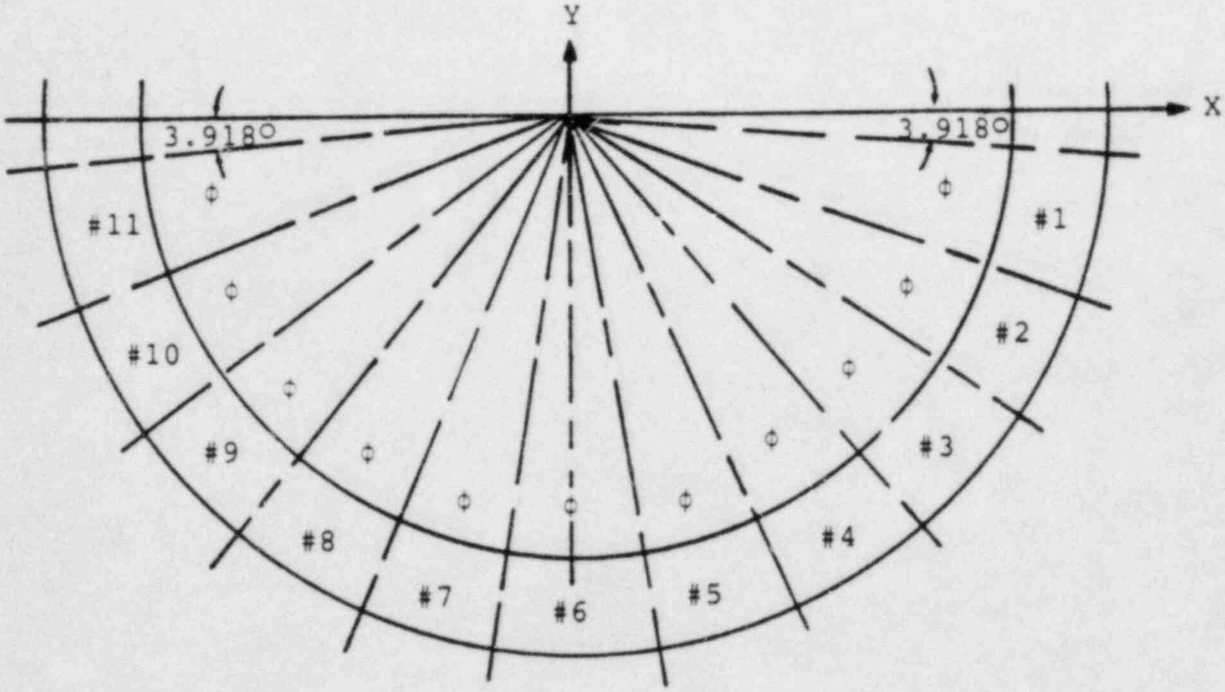
$$V = [\, 1.36\pi a^2 + (2b-c)2c + 2ac\,]\, L\, A_w$$

where

Parameter	Midcylinder Value (Segments 1 through 5 and 7 through 11)	Miter Value (Segments 1 through 6 and 9 through 14)
a (ft)	1.312	1.045
b (ft)	0.625	0.5
c (ft)	0.104	0.125
L (ft)	3.830	2.983
A_w	2.0	2.0
V (ft^3)	60.30	30.72

Segment 6 of the midcylinder ring girder and segments 7 and 8 of the miter ring girder, has a plate attached to the top flange of the I-section. For these segments, an additional drag volume for the plate as given in Table 1-4.1-1 of the PUAR ($\pi a^2 L$, where a is the plate height) was added to the above acceleration volumes of the ring girder in both the in-plane and out-of-plane directions.

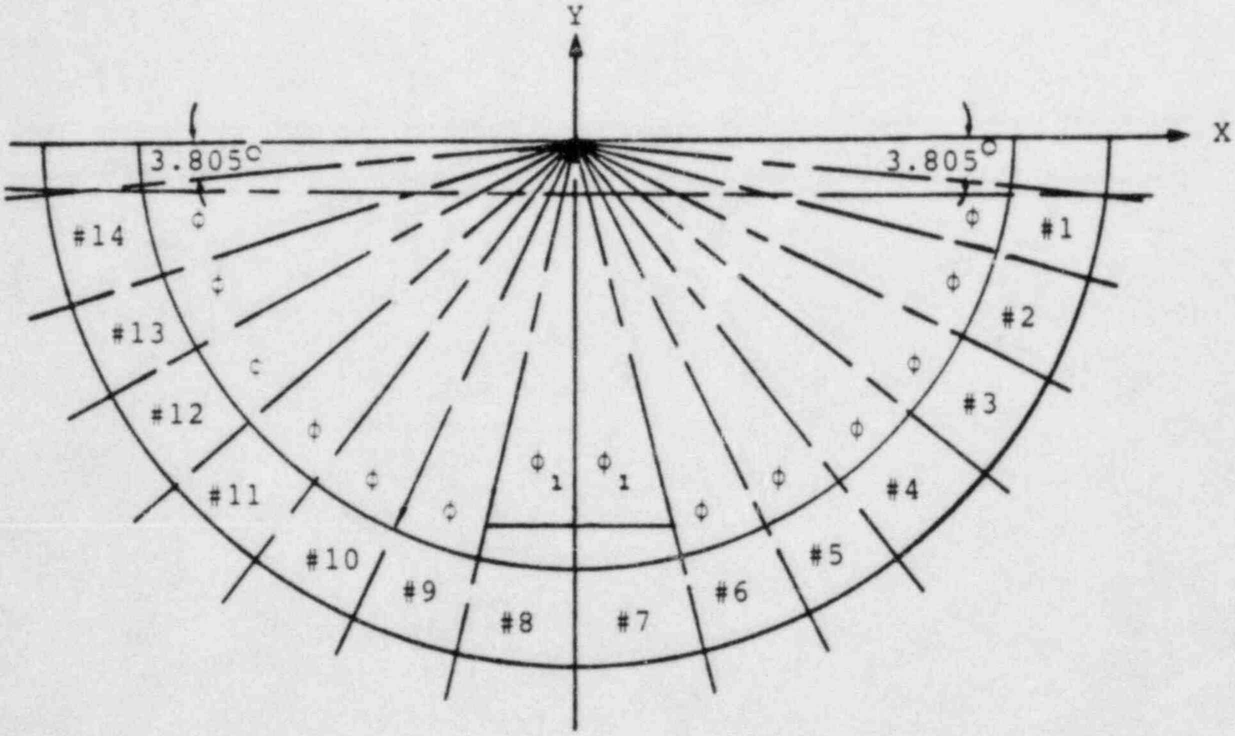
Acceleration drag volumes in the direction normal to the stiffeners (gusset plates) were calculated conservatively using the acceleration drag volume for the equivalent cylinder ($2\pi a^2 L$) of the plate as per the LDR. Corresponding acceleration volumes in this direction including the wall interference effect for various stiffeners were calculated in the range of 45.5 to 116.0 ft^3.



(φ = 15.651°)

Figure 8-1

MIDCYLINDER RING GIRDER SEGMENTS

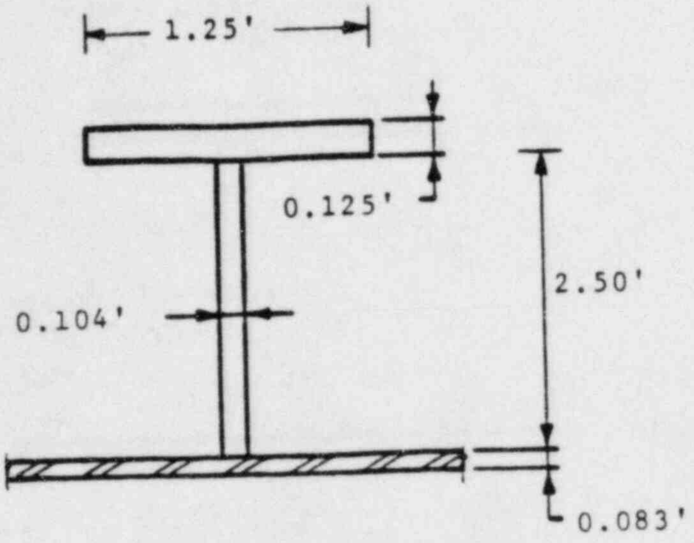


($\phi = 11.838^\circ$)

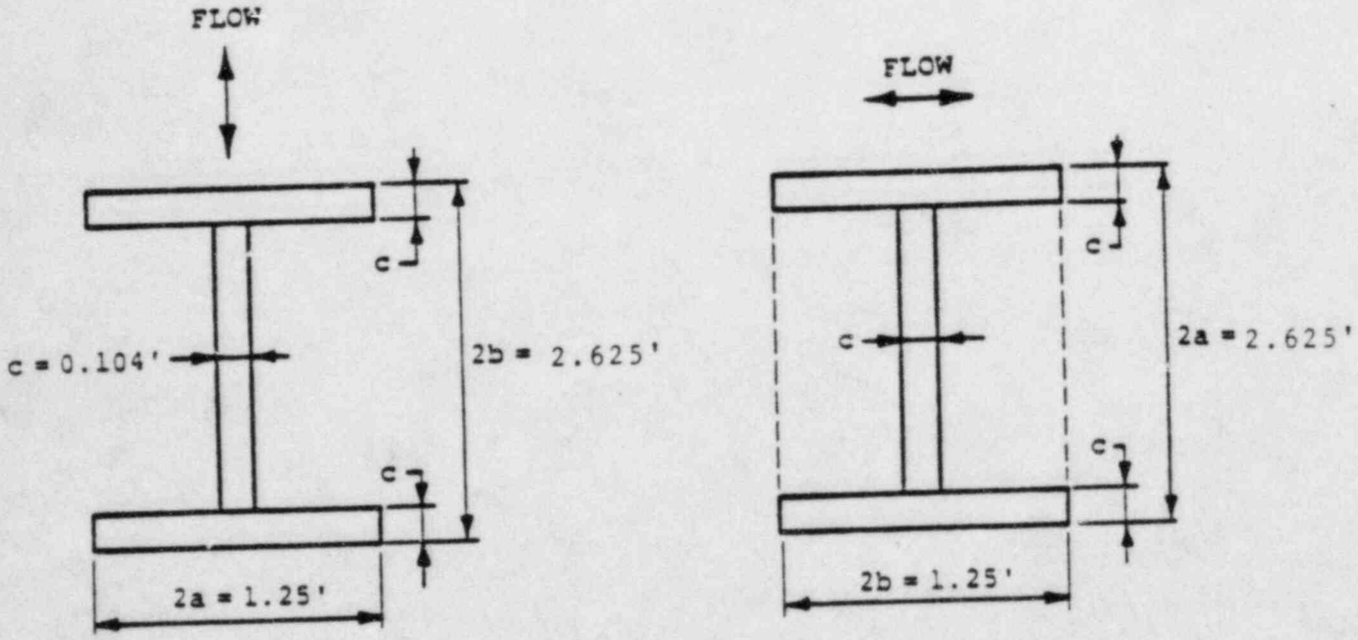
($\phi_1 = 15.17^\circ$)

Figure 8-2

MITER RING GIRDER SEGMENTS



I - ACTUAL GEOMETRY

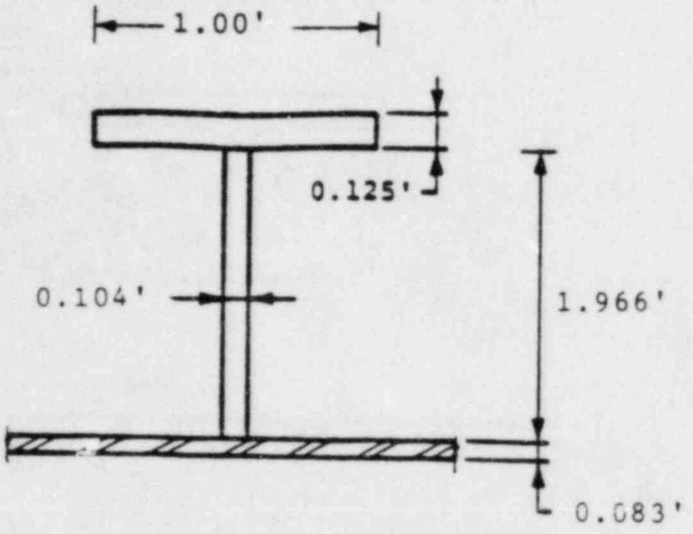


II - MODEL FOR IN-PLANE FLOW

III - MODEL FOR OUT-OF-PLANE FLOW

Figure 8-3

MIDCYLINDER RING GIRDER



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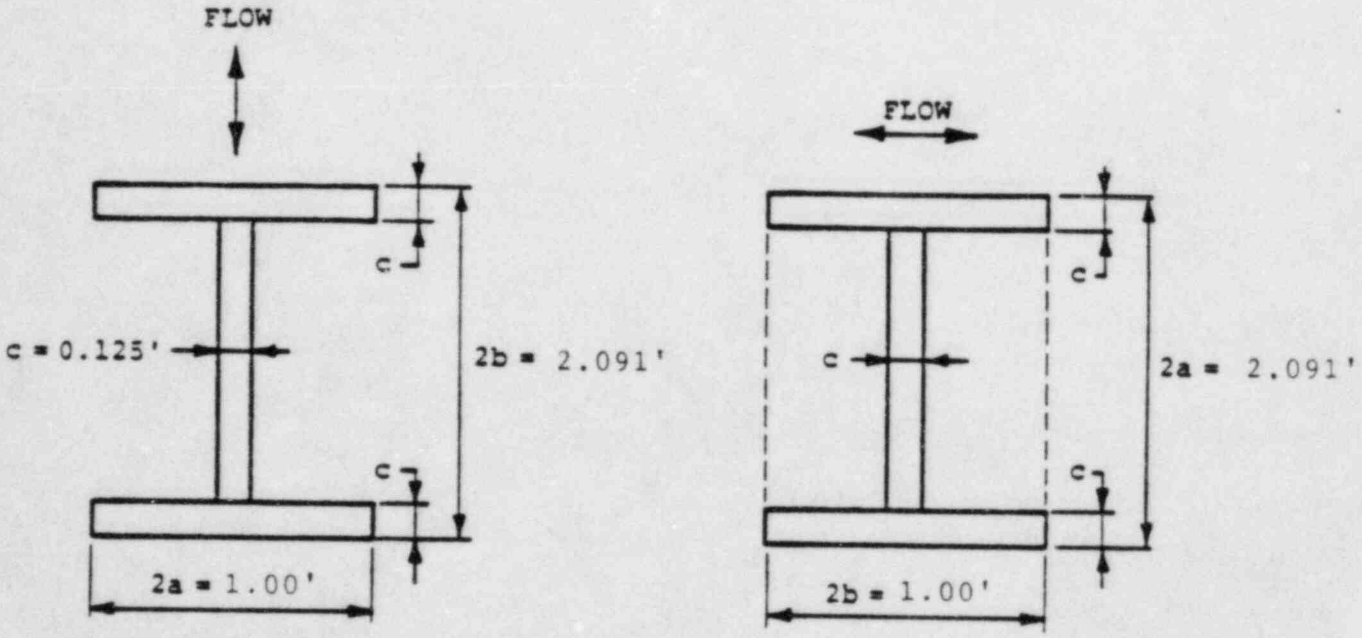

II - MODEL FOR
IN-PLANE FLOW

III - MODEL FOR
OUT-OF-PLANE
FLOW

Figure 8-4

MITER RING GIRDER

ITEM 9: Table 2-2.2-6 of the PUAR which summarizes the ring beam submerged structure loads states that the loads shown include dynamic amplication factors. What kind of model was used to determine the critical frequencies of the ring beams? What are the critical in-plane and out-of-plane frequencies for the midbay and miter joint ring beam? How were dynamic amplification factors for each of the submerged structure loads listed in Table 2-2.2-6 calculated? Were the same amplification factors used for both the flange and web forces? If so, justify this procedure.

RESPONSE TO ITEM 9:

The finite element model of the torus and ring girders shown in PUAR Figure 2-2.4-1 was used to determine the critical frequencies of the ring girders. For the in-plane direction, the frequency was obtained from the dynamic modal extraction results used in the torus shell loads evaluation. The critical frequency in the in-plane ring girder direction (ovalling mode frequency) from PUAR Table 2-2.4-1 is 15.12 Hz.

For the out-of-plane direction, critical frequency was obtained using Rayleigh's method. 1/32nd torus finite element model shown in Figure 2-2.4-1 was again used to calculate deflections due to applied loads required in this method. Since the method is not as accurate as a detailed modal extraction method, a band width of ±10% on the calculated frequency was applied. Thus, for the out-of-plane direction, frequency ranges as shown in Table 9-1 were used for miter and midcylinder ring girders.

For condensation oscillation (CO) and chugging (CH) submerged structure loads, these natural frequencies were used to calculate dynamic load factors (DLF) for each of the 50 harmonics defined for these loads in the in-plane and out-of-plane directions. The summation of each DLF times the CO or CH load associated with each of the 50 harmonics was then applied to the finite element model as an equivalent static load. Thus, different dynamic load factors depending upon the natural frequencies were used for the flange and web forces.

As defined in LDR, LOCA air-bubble drag load is conservatively represented by a rectangular step function. The maximum possible DLF of 2.0 for a rectangular step function was used in the analysis for this load.

As discussed in the response to Item 10, a bounding DLF of 2.5 was used in the analysis for SRV bubble drag submerged structure loads in the in-plane direction. For out-of-plane direction, a DLF of 2.0 was used as the out-of-plane ring girder frequencies are outside the range of SRV load frequencies.

Table 9-1

RING GIRDER OUT-OF-PLANE FREQUENCIES

Ring Girder Location	Rayleigh Frequency (Hz)	Frequency Range Used in Dynamic Amplification Factor Calculations (Hz)
Miter Joint	39.23	35.31 - 43.15
Midcylinder	35.86	32.27 - 39.45

HOPE CREEK GENERATING STATION

PLANT UNIQUE ANALYSIS REPORT

ADDITIONAL INFORMATION ON HYDRODYNAMIC LOADS FOR NRC REVIEW

ITEM 10: Section 1-4.2.4 of the PUAR states that dynamic load factors for SRV bubble-induced drag loads in Hope Creek are derived from Monticello in-plant SRV test data. Describe in detail how these factors are derived and applied to Hope Creek, giving numerical values of the factors for major structural components. Describe how extrapolation from test to design conditions is made and why Monticello data provides a conservative basis for Hope Creek.

RESPONSE TO ITEM 10:

As permitted by NUREG-0661 (Section 3.10.2.13), Dynamic Load Factors (DLF) for SRV bubble drag submerged structure loads were calculated using SRV discharge bubble pressure time histories measured during the Monticello SRV in-plant test. These bubble pressure time histories were applied to a damped single degree-of-freedom model. Attached Figure 10-1 is a typical DLF versus structural frequency plot for these pressure time histories.

A bounding DLF of 2.5 was generated from Monticello SRV in-plant test data. The same bounding DLF was used for Hope Creek. Test data from other plants like Dresden 2 and Duane Arnold produced DLF values which were also bounded by 2.5. Thus, Monticello test data was considered to be a conservative basis for Hope Creek.

Submerged structures were analyzed using the bounding DLF of 2.5 times the maximum calculated design bubble pressure loads. For structures whose natural frequency was outside the range of SRV bubble drag loads (such as ring girders out-of-plane direction, and vent header support columns), a DLF of 2.0 was conservatively used. The DLF values at resonant condition were developed from the measured pressure time histories at test conditions and were applied to the design basis event conditions as permitted by NUREG-0661, Section 3.10.2.13.

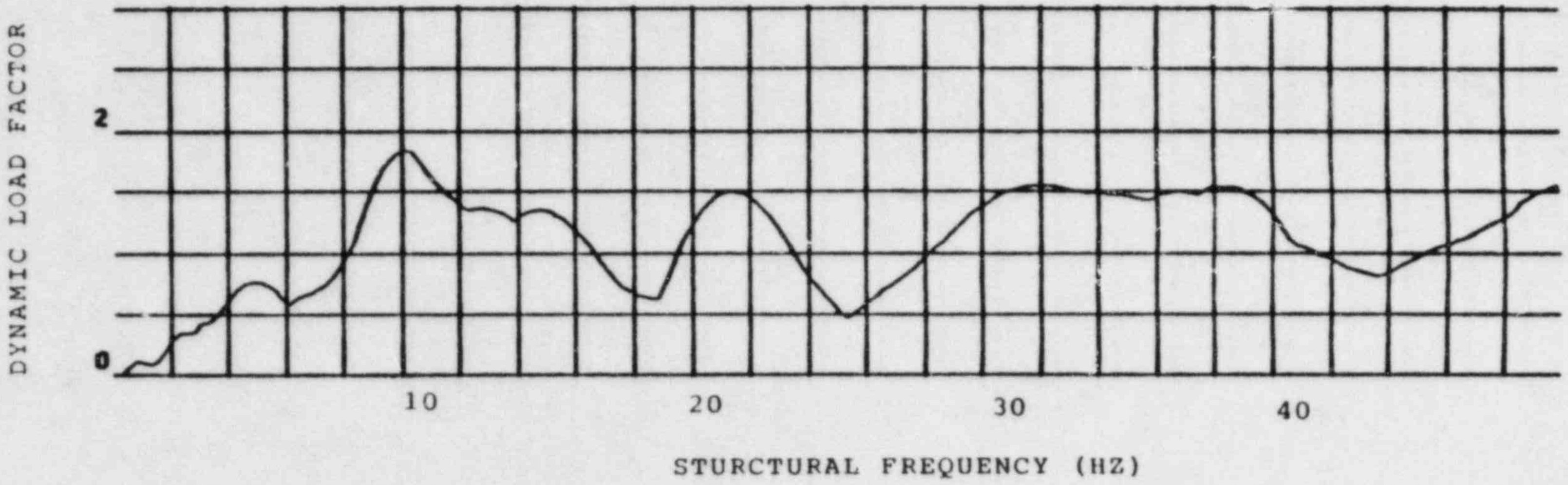

Figure 10-1

TYPICAL DLF VS. FREQUENCY PLOT FOR MONTICELLO
MEASURED BUBBLE PRESSURE TIME HISTORY

HOPE CREEK GENERATING STATION

PLANT UNIQUE ANALYSIS REPORT

ADDITIONAL INFORMATION ON HYDRODYNAMIC LOADS FOR NRC REVIEW

ITEM 11: Is the rectangular bay model described in Table 1-4.1-2 of the PUAR used for LOCA bubble drag loads also used for CO, chugging and SRV loads on submerged structures? If yes, justify the use of this model for structures near the bay boundary which undergo asymmetric loading conditions. If a different model is used, give details.

RESPONSE TO ITEM 11:

The rectangular bay model for CO, chugging and SRV loads on submerged structures is similar to that used for LOCA bubble drag loads. As required in Appendix A of NUREG-0661, Model E in NEDE-21983-P is used for the method of images simulation of the torus cross-section for LOCA air bubble, CO, chugging and SRV analyses. The length of the bay model for LOCA air bubble analysis varies from one and a half to two bays for Hope Creek, and structures may be close to the bay boundary.

However, for the CO, chugging and SRV analyses, structures are always placed at or very near the center of the rectangular bay model (1/2 D) as shown in Figures 11-1, 11-2, 11-3, and 11-4. From these figures it can be seen that the torus is unwrapped to a length D which is equal to the torus circumference ($D = 2\pi R_{major}$, $D_{Hope\ Creek} = 354$ ft). Hence, structures are never near the bay boundary and asymmetric loading conditions, i.e., sources acting in one bay only, are readily accommodated.

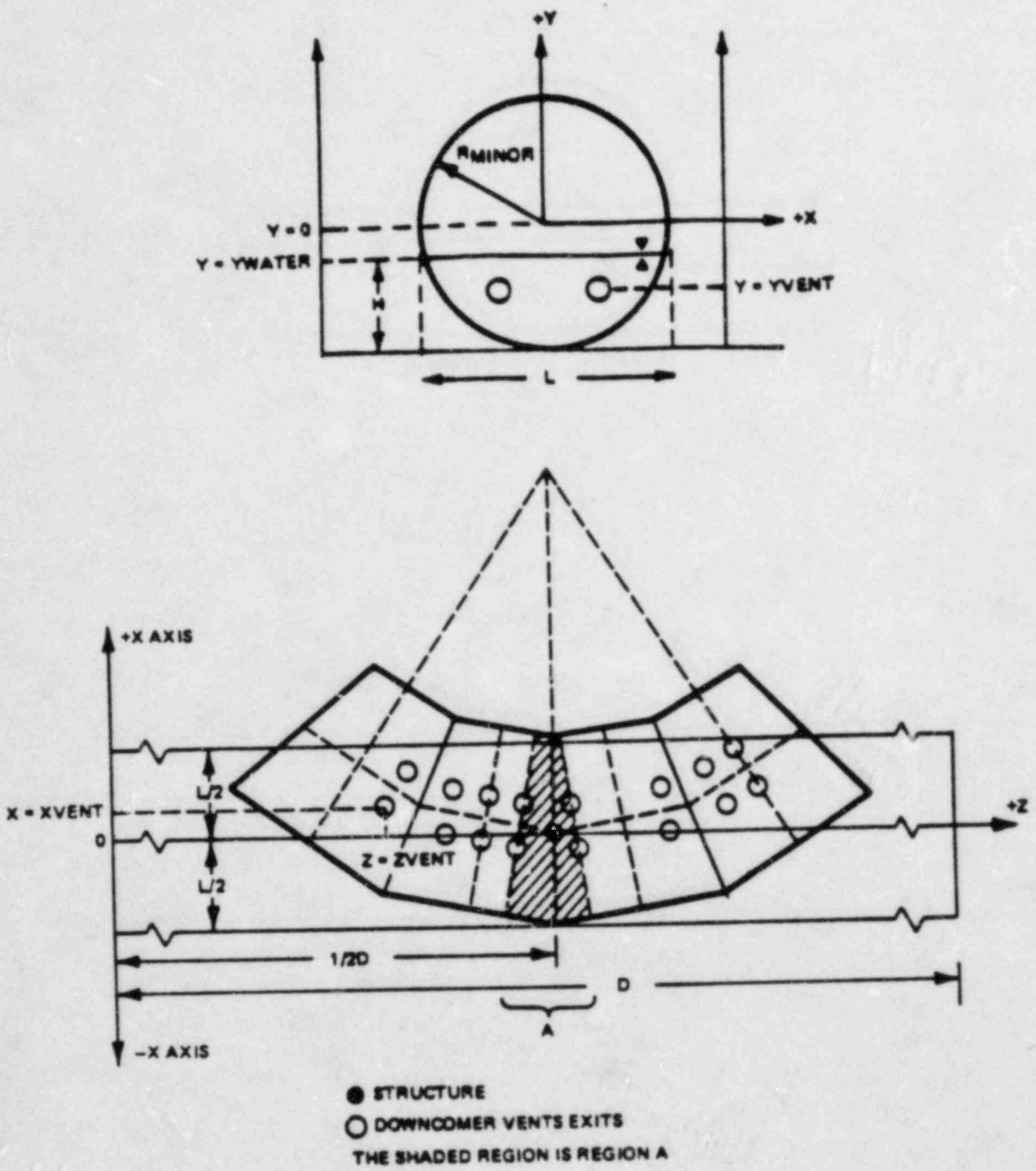

Figure 11-1

RECTANGULAR CELL MODELING FOR PLANTS WITH 80 DCS

C.O. AND CHUGGING (CELL A)

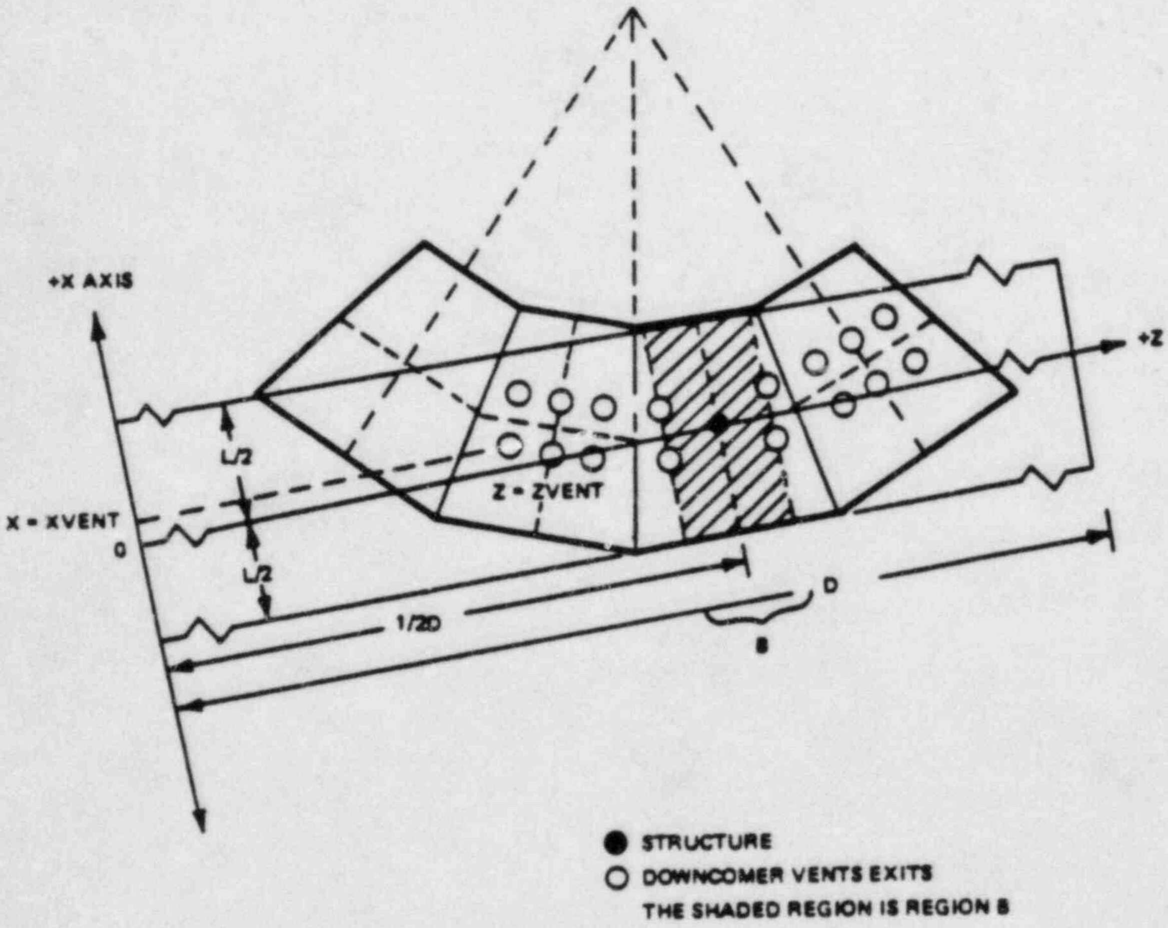

Figure 11-2

RECTANGULAR CELL MODELING FOR PLANTS WITH 80 DCS

C.O. AND CHUGGING (CELL B)

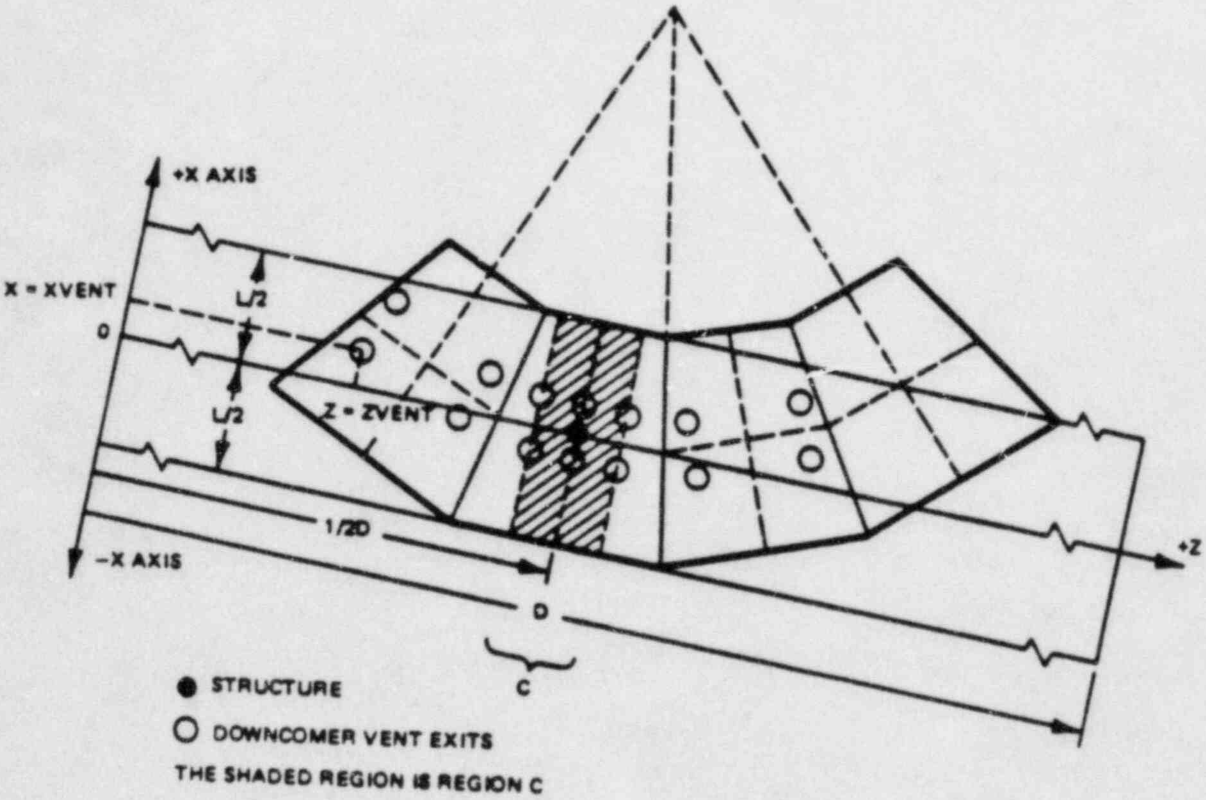

Figure 11-3

RECTANGULAR CELL MODELING FOR PLANTS WITH 80 DCS

C.O. AND CHUGGING (CELL C)

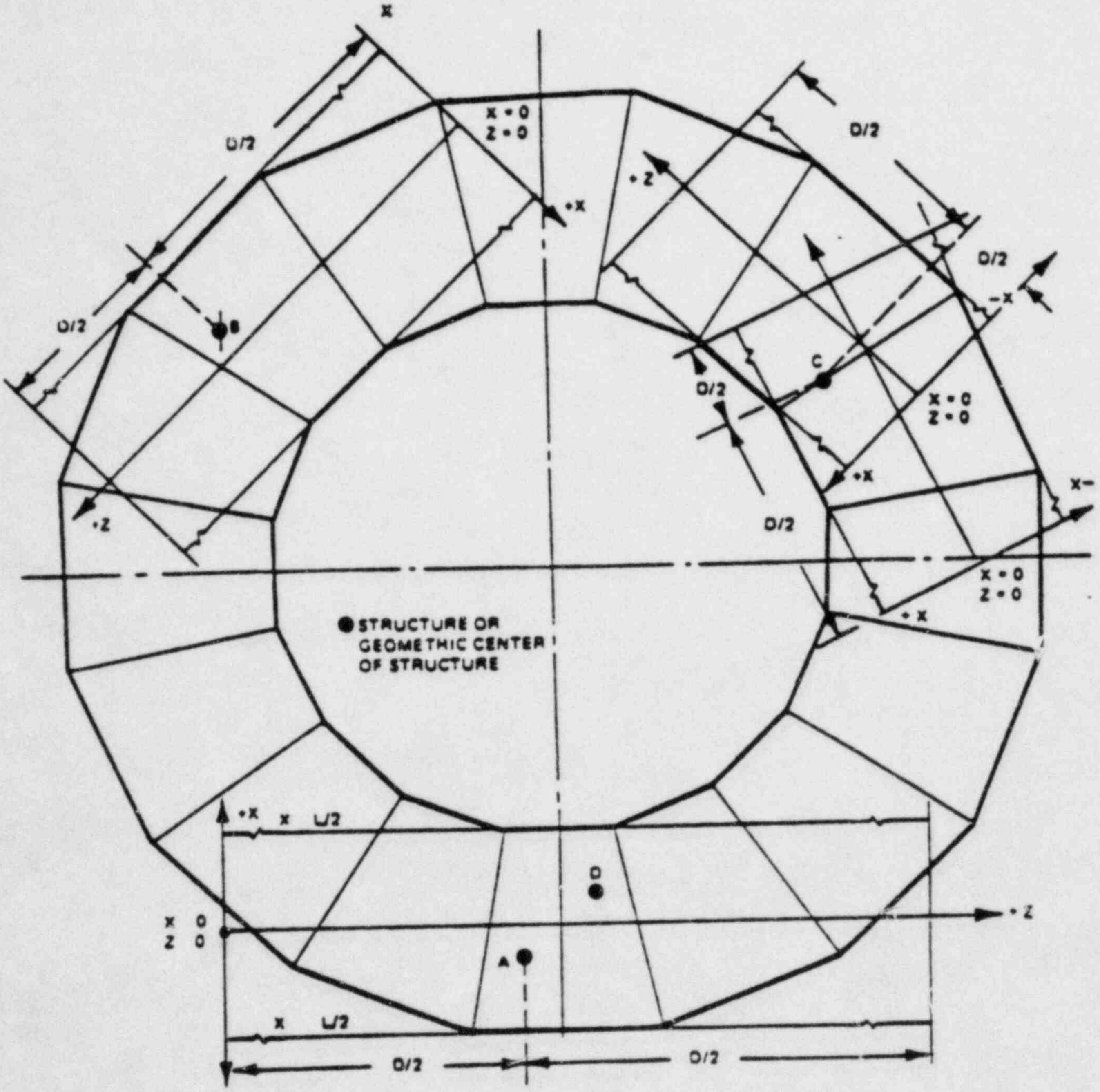

Figure 11-4

RECTANGULAR CELL MODELING -
SRV AIR BUBBLES