Attachment to UC-34198

RESPONSE

TO

NRC

(BROOKHAVEN NATIONAL LABORATORY)

REQUEST FOR ADDITIONAL INFORMATION

MARK I CONTAINMENT LONG TERM PROGRAM

PLANT UNIQUE ANALYSIS REPORT

STRUCTURAL EVALUATION

FOR

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

Prepared By: R. Toland 8-24-83
R.H. Toland — Date

R F Perry 8/24/83
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F. A. Cook — Date

K L Bar 8/24/83
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OA Review: J. Freeman 8/24/83
J. Freeman — Date

Approved By: L. R. Scott 8-24-83
L. R. Scott — Date

INDEX

Responses To Brookhaven National Laboratory

MARK I CONTAINMENT LONG TERM PROGRAM

PLANT UNIQUE ANALYSIS REPORT LOADS EVALUATION

REQUEST FOR ADDITIONAL INFORMATION

(BROOKHAVEN NATIONAL LABORATORY)

FOR BRUNSWICK UNITS 1 & 2

RAI 1a — PUAR Section 1.5
Justify the assumption that the unit S/RV forces and moments are approximately the same as the unit pre-chugging load.

RAI 1b — PUAR Section 1.5
Provide a comparison of the longitudinal distributions for both the unit S/RV and pre-chugging loads and discuss any available conservatisms which may offset the differences between the two distributions.

RAI 2a — PUAP Section 2.2.1.2, AC Section 2.7
Describe the alternate procedure used to calculate the pool swell impact and drag loads for structures located above the initial pool surface and below the maximum pool swell height.

RAI 2b — PUAR Section 2.2.1.2, AC Section 2.7
Provide all pertinent documentation on the method used to develop the load definition for Brunswick from the Monticello test results and indicate why these pool swell profiles are a conservative representation for the Brunswick geometry.

RAI 2c — PUAR Section 2.2.1.2, AC Section 2.7
In addition, justify the use of the first set of pool swell profiles which were obtained in the Bruinswick test using a wingless deflector in regions where no deflector exists.

RAI 3 — PUAR Section 2.2.1.3, AC Section 2.8
The QSTS plant-specific movies were utilized in the calculation of the froth impingement loads, as allowed by the AC, on the RHR test lines, RHR containment cooling line and the monorail. Which QSTF tests were used. Describe how a conservative load specification was achieved and what uncertainty limits were applied as discussed in the AC. Discuss in detail the

RAI 3 (Continued)
method used to determine the froth source velocity. Were Region II froth loads considered as part of the PUA?

RAI 4 PUAR Section 2.2.2, AC Section 2.13.8
The AC required that each licensee demonstrate that previously submitted pool temperature analyses are sufficient or provide plant-specific pool temperature response analyses to asssure that S/RV discharge transients will not exceed the pool temperature limits specified in the AC as supplemented by NUREG-0783. Provide sufficient information to satisfy the above requirement concerning the pool temperature elevation including the maximum bulk pool temperature and maximum local pool temperature obtained for each SRV discharge transient considered. In addition, explain in detail and justify how the local-to-bulk pool temperature differences was determined.

RAI 5 PUAR Section 2.2.2, AC Section 2.13.8.3
The AC stipulates that the Suppression Pool Temperature Monitoring System (SPTMS) is required to ensure that the suppression pool is within the allowable temperature limits set forth in the Plant Technical Specifications. Provide sufficient information to demonstrate that the Brunswick SPTMS design is in accordance with the requirements of AC Section 2.13.8.3.

RAI 6 PUAR Section 2.2.2, AC Section 2.13.7
During the discussion concerning the SRV load cases which are applicable to Brunswick, various load cases were eliminted by stating that these load cases were bounded by others, e.g. case A1.2 (SBA) bounds A1.2 (IBA), thus only A1.2 (SBA) was analyzed. Justify these statements by providing the results of the computer analysis which were performed or the reasons why various cases bound others.

RAI 7 PUAR Section 2.2.2, AC Section 2.13.7
The AC required that an asymmetric SRV discharge load case be considered for both first and subsequent actuations with the degree of asymmetric discharge for each event combination being determined from a plant-specific primary system analysis designed to maximize the asymmetric condition. No mention of an asymmetric SRV discharge load case is made in the PUAR load care discussion. Provide sufficient information to satisfy the AC requirements concerning this matter.

RAI 8a PUAR Section 3.3.2.3, AC Section 2.10.1
The equations presented in the PUAR for interpolating the vent header deflector forces at various Z/L's are not consistent with the AC. These equations utilized the longitudinal multiplier distribution from NEDO-24612 and thus do not incorporate

RAI 8a (Continued)
the AC specification that the three-dimensional load variation shall be based on the EPRI "main vent orifice" tests. Describe in detail how the vent deflector forces were calculated at the various Z/L's.

RAI 8b PUAR Section 3.3.2.3, AC Section 2.10.1
Specify as part of your response which longitudinal multipliers and set of equations were used in the interpolation process.

RAI 8c PUAR Section 3.3.2.3, AC Section 2.10.1
In addition, specify what the Z/L is for the typical pool swell impact and drag load given in Figure 3.3.2.3-1 of the PUAR.

RAI 8d PUAR Tables 3.9.2.1-1 and 3.9.2.1-2
Indicate service levels for bolts and welds listed in Tables 3.9.2.1-1 and 3.9.2.1-2 of PUAR.

RAI 9 PUAR Section 3.3.2.5, AC Section 2.12.2
Describe what analyses were done to satisfy the AC requirement for multiple downcomer chugging synchronization. Indicate what exceedance probability was used to assess the statistical directional dependence and what the corresponding force per downcomer was.

RAI 10a PUAR Section 1.3.4, AC Section 2.13
Provide more detailed information concerning the T-quencher utilized in the Brunswick plants.

RAI 10b PUAR Section 1.3.4, AC Section 2.13
Specify any differences such as hole spacing, hole diameter, etc. between the Brunswick T-quencher and the T-quencher tested at Monticello.

RAI 11 PUAR Section 2.2.1.8, AC Section 2.14.8
Provide the details of a post chug submerged structure load calculation for a given segment of a vent header support column. Include numerical values of source strength and DLF as a function of frequency. In addition, provide the acceleration volume, drag coefficient, interference effect multiplier and pertinent geometric parameters, and configuration used in the calculation.

RAI 12 DELETED

RAI 13a Provide the impact/drag load transients used in the analysis of the main vent, vent header, vacuum breaker and downcomers.

RAI 13b In addition, provide the position of the maximum pool swell height and its relation to the main vent.

RAI 14 Provide the loads that were used in the Torus attached piping.

RAI 1a - PUAR Section 1.5

Justify the assumption that the unit S/RV forces and moments are approximately the same as the unit pre-chugging load.

RESPONSE

The unit pre-chugging load is higher than the unit S/RV load used in the analysis, except at the longitudinal angles between 0 and 10°. However, asymmetric loads on the torus will produce shear forces F_{NT} and F_{ST} in addition to forces and moments F_S, F_T, F_{NS}, M_S, and M_T. F_{NT} and F_{ST} are maximum when there is a sharp change in the applied loads, in this case between 0 and 40° in the longitudinal direction. The shear forces then decrease in the longitudinal direction. Maximum shear forces are obtained when the unit S/RV load analysis is used for the pre-chugging load. Although the forces along the longitudinal direction from the unit S/RV and unit pre-chugging loads are not the same, the maximum shear forces from the unit S/RV loads is approximately the same or even higher than shear forces from the unit pre-chugging loads. The maximum forces and moments F_T, F_S, F_{NS}, M_s and M_T are controlled either by the symmetric distribution of pre-chugging load or occur at the same locations as F_{NT} and F_{ST} between 0 and 20°.

In addition, the maximum pre-chugging load, including the effect of fluid-structure interaction, is approximately 2.26 psi at the dead bottom center of the torus which can be considered negligible when compared to other loads due to LOCA conditions (max. of 44 psi). Therefore, the unit S/RV load was used in lieu of unit pre-chugging load to reduce computer cost.

RAI 1b - PUAR Section 1.5

Provide a comparison of the longitudinal distributions for both the unit S/RV and pre-chugging loads and discuss any available conservatisms which may offset the differences between the two distributions.

RESPONSE

Calculation sheet 50 of 187, Attachment RAI 1b, shows the longitudinal distribution of the:

a) unit S/RV load.

b) unit S/RV load used in the analysis.

c) unit pre-chugging asymmetric load.

d) uniform pre-chugging symmetric load.

CALCULATION SET NO.

9527-040-E-SC-TS-3

SHEET 50 OF 187

(ONE PAGE)

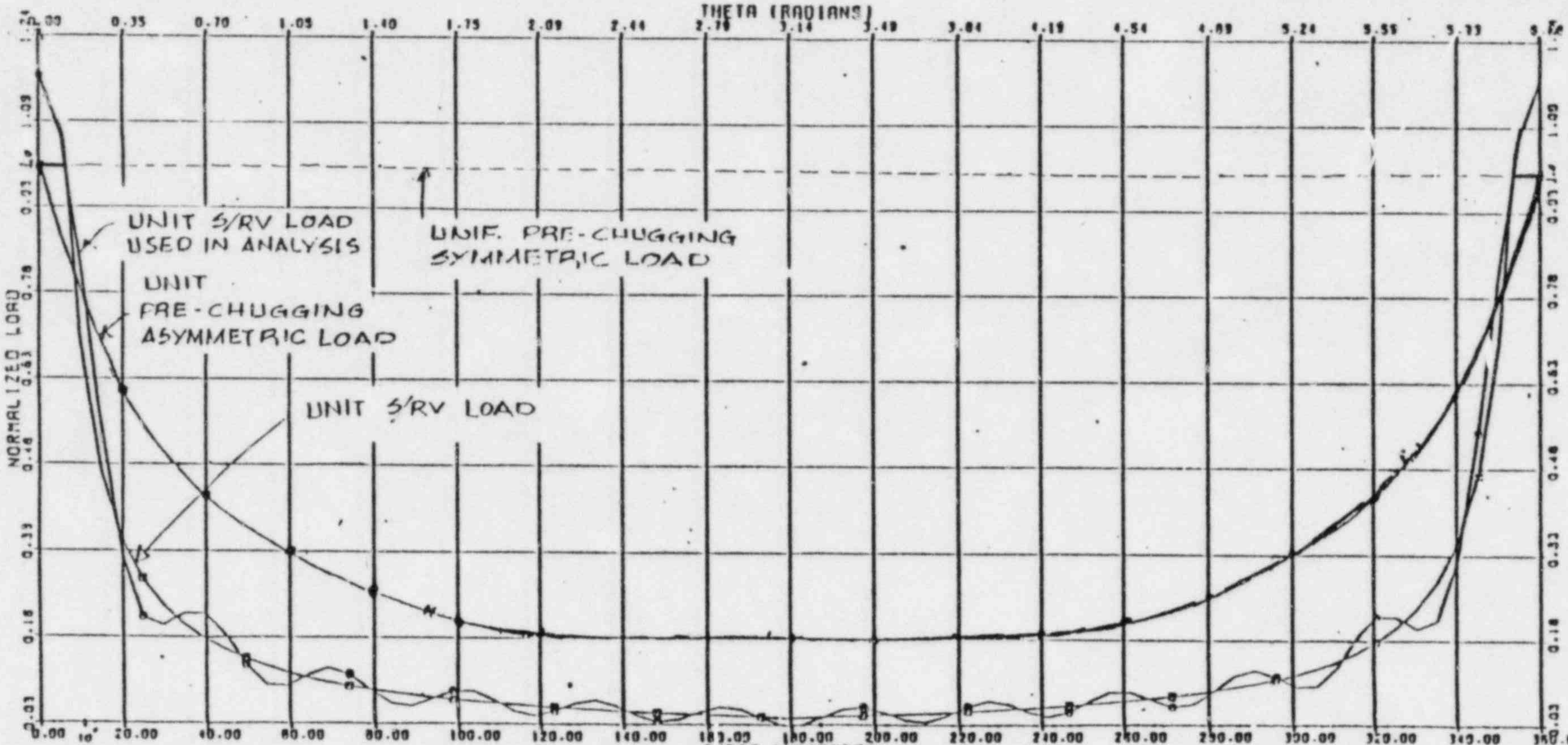
CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

ATTACHMENT RAI 1b

CALC SET NO		REV	COMP BY	CHK'D BY
PRELIM				
FINAL	E-SC-TS-3	0	DATE	DATE
50 of 187		2	R-oR	KC
JO 9527-040			DATE 7-28-80	DATE 7-28-80



□ ORIGINAL CURVE
○ CALCULATED CURVE - 12. COEFFICIENTS

LONGITUDINAL

MODE 33 OF WILSON II MODEL
S/RV LOAD REV. 2
07/22/80

RAI 2a - PUAR Section 2.2.1.2. AC Section 2.7

Describe the alternate procedure used to calculate the pool swell impact and drag loads for structures located above the initial pool surface and below the maximum pool swell height.

RESPONSE

The alternate procedure provided by the NRC was used to calculate the pool swell impact and drag loads for structures located above the initial pool surface and below the maximum pool swell height. Structures are classified as either cylindrical, exposed flat surfaces or gratings and different calculation methods apply. The longitudinal displacement and velocity distributions were based on the "main vent" EPRI pool swell tests as shown in Figures 4.3.4-2 and 4.3.4-4 of the LDR. Described below is the NRC alternate procedure used in the entire load specification:

a) Cylindrical Structures

1. The maximum pressure of impact P_{max} was determined by

$$P_{max} = 7.0 \times 1/2 \left(\frac{\rho}{144} \frac{v^2}{g_c} \right)$$

where

P_{max} = the maximum pressure averaged over the projected area (psi)

ρ = the density of water (62.4 lbm/ft^3)

v = the impact velocity (ft/sec)

g_c = 32.3 ft-lbm/lbf-sec^2

2. The hydrodynamic mass per unit area for impact loading was obtained from Fig. 6-8 of NEDE-13426-P. A margin of $\pm$35% was added to account for data scatter.

RESPONSE (Continued)

3. The impulse of impact per unit area was determined by:

$$I_p = \frac{M_H}{A} \left(\frac{V}{144 g_c} \right)$$

where

I_p = the impulse per unit area (psi-sec)

M_H/A = hydrodynamic mass from 2 above

4. The pulse duration was determined from the following equation:

$$\tau = 2I_p/P_{max}$$

5. The pressure due to drag following impact was determined by:

$$P_D = \frac{C_D}{2} \frac{\rho V^2_{max}}{144 g_c}$$

where

P_d = the average drag pressure acting on the projected area of the target (psi)

C_D = the drag coefficient as defined by Fig. 2.7-2 of the Acceptance Criteria.

V_{max} = the maximum vertical velocity attained by the pool (ft/sec)

b. Flat-Surface Structures

1. The pulse duration (τ) was defined as a function of the impact velocity:

$$\tau = 0.0016w \quad \text{for } V \leq 7 \text{ ft/sec}$$

$$\tau = \frac{0.011w}{V} \quad \text{for } V > 7 \text{ ft/sec}$$

where w = the width of the flat surface (ft)

2. The pressure due to drag following impact was determined by:

$$P_D = \frac{C_D}{2} \frac{\rho V^2_{max}}{144 g_c}$$

RESPONSE (Continued)

b. Flat-Surface Structures (Continued)

3. From Fig. 6-8 of NEDE-13426-P, M_H/A was obtained. A margin of $\pm 35\%$ was added to account for data scatter.

4. The impulse of impact p.r unit area was determined by:

$$I = \frac{M_H}{A} \qquad \frac{V}{144 g_c}$$

5. The maximum pressure (P_{max}) was calculated from the impulse per unit area and the drag pressure as follows:

$$P_{max} = \frac{2Ip}{t} + P_D$$

c. Gratings

The force on the grating was calculated as follows:

$$D = \Delta P \times A_{grating} \left(\frac{V_{max}}{40}\right)^2$$

where

ΔP = pressure differential (lbf/in^2) from Fig. 2.7-4 in the Acceptance Criteria

To account for the dynamic nature of the initial loading, the load was increased by a multiplier given by:

$$F_{SE}/D = 1 + [1 + (0.0064\ wf)^2]^{1/2} \text{ for } wf \leq 2000 \text{ in/sec}$$

where

F_{SE} = Static equivalent load

w = width of grating bars, inches

f = natural frequency of lowest mode, Hz

D = Static drag load

This procedure was used to develop the Brunswick load definition for all internal structures except the vent header, downcomers, and vent header deflectors.

RAI 2b - PUAR Section 2.2.1.2, AC Section 2.7

Provide all pertinent documentation on the method used to develop the load definition for Brunswick from the Monticello test results and indicate why these pool swell profiles are a conservative representation for the Brunswick geometry.

RESPONSE

Figures 1 and 2, Attachment RAI 2b-1, were the pertinent documents utilized to develop the load definition for Brunswick from the Monticello test results. The use of the Brunswick pool swell profiles is conservative and is justified by the General Electric Company's "MARK I SSE Ouestion Response", Attachment RAI 2b-1. GE's justification did not include the effects of modified downcomer submergence which is 1 ft. shorter than the original submergence on which the QSTF test and load specification were based.

GENERAL ELECTRIC COMPANY

MARK I SSE QUESTION RESPONSE

QUESTION 262.1

(Total 2 Pages)

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

Attachment RAI 2b-1

MARK I SSE QUESTION RESPONSE

QUESTION# 262.1 DATE October 31, 1980

REQUESTOR United Engineers TASK# 9.5.1

RESPONSIBLE ENGINEER DRF# T23-226

TASK MANAGER Apurba Mukherjee A. Mukherjee 10/31/80 EWA# EAF79 - 04 SUPPS

APPROVALS: G Wade 10-31-80

G.E. Wade, Manager
Mark I Containment Design

QUESTION:

In Reference 1, we requested that GE provide a load definition for Brunswick for pool swell impact and drag forces for a deflector configuration that was modified from what was used in our plant unique quarter scale tests. In Reference 2, GE provided new load definitions for the ring header and deflector. In a telephone conversation (S. Hucik, GE to H. Painter, UE&C, 5-14-80), GE stated that to calculate pool swell loads on other structures, the pool swell displacement and velocity distributions as originally provided in the PULD should still be used.

We understand that conservatism exists in this load definition. Please provide a quantitative statement of the conservatism and provide justificaiton for it.

G.E. RESPONSE:

The following information is provided as an addendum to the previous response to EDT Question 262.1 dated 10-22-80 .

Pool swell velocity and displacement profiles were requested for Brunswick for a deflector configuration different from the one that was used in the QSTF tests.

Monticello is the most similar plant with a T-deflector. Tests 17 and 18 were chosen to represent Brunswick velocity and displacement profiles and that will give conservative loads for the following reasons:

This answer to a Mark I Owner/AE question on the Load Definition Report (LDR), Application Guide (AG) or Plant Unique Load Definition (PULD) is provided for clarification. This answer is not to be construed as modifying any of the design loads which have been formally issued in the LDR or PULD.

MARK I SSE QUESTION RESPONSE

(CONTINUATION SHEET)

QUESTION # 262.1 REV. 1

Sensitivity test shows that higher $\dot{p}$ by 27.60% will result in higher pool velocity and higher displacement profiles. Also the header at a higher level will allow the pool to swell higher.

Conclusion: By using Monticello (tests 17 and 18) pool swell velocity and displacement profiles for Brunswick will be conservative.

	BRUNSWICK (NEW)	MONTICELLO
DEFLECTOR WIDTH		
Header diameter	0.52	0.51
Submergence (ft)	*4.3'	3.58'
$\dot{P}$ (PSI/SEC.)	56.7	72.5
p (psid)	0	0
FL/D	5.17	5.17
Water/Deflector Gap (in)	3.75	5.85
Water/Header Gap (in)	33.7	41.8

* Submergence has been reduced to 3.3'

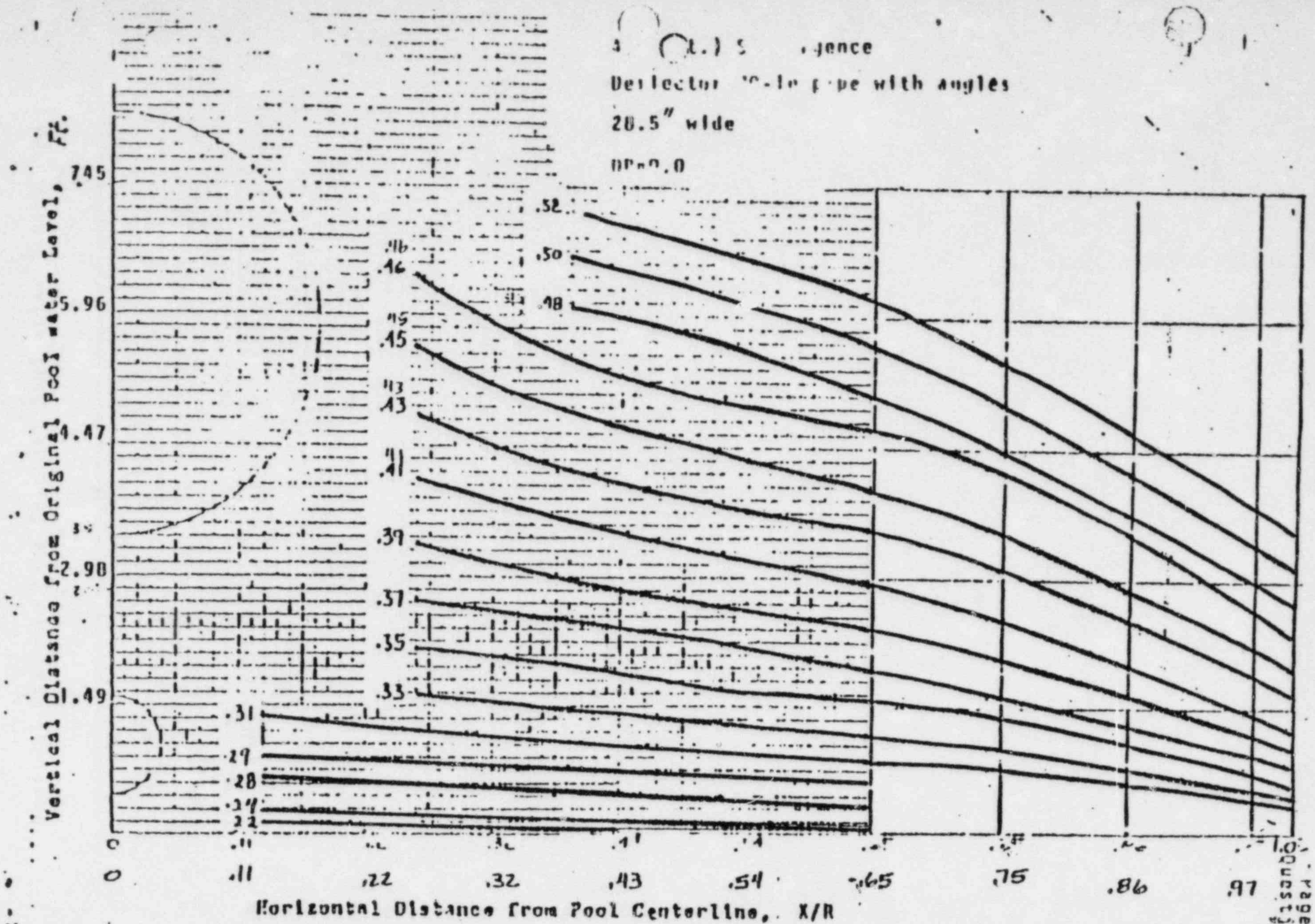


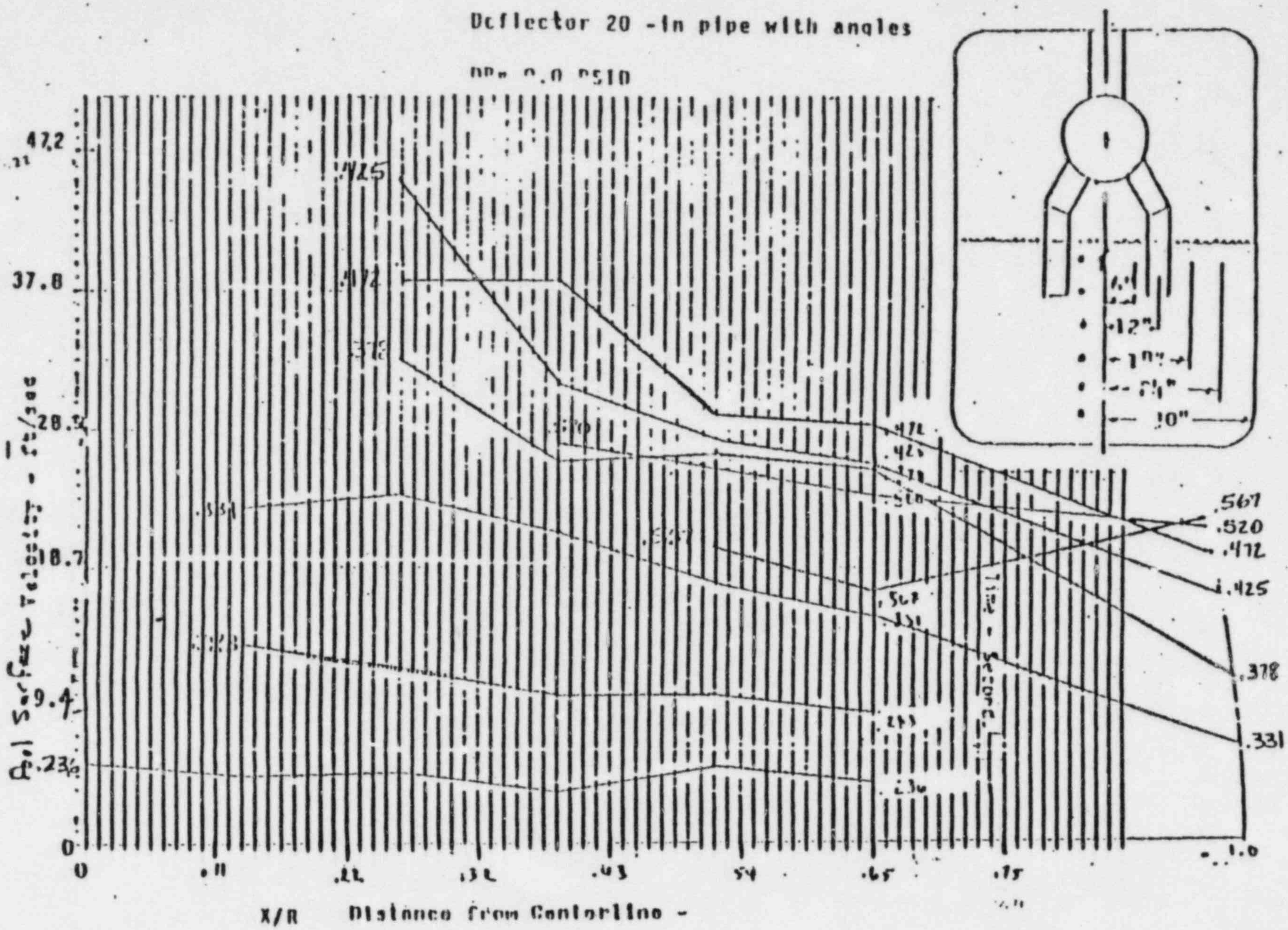
Fig. 1 Pool Swell Displacement Distribution

Brunswick

4.3 (ft.) Submergence

Deflector 20 -in pipe with angles

DP= 0.0 PSID



X/R Distance from Centerline -

Fig. 2 Pool Swell Velocity Distribution

RAI 2c - PUAR Section 2.2.1.2, AC Section 2.7

In addition, justify the use of the first set of pool swell profiles which were obtained in the Brunswick test using a wingless deflector in regions where no deflector exists.

RESPONSE

Two sets of pool swell profiles were used in the load calculation. The first set is a result of Brunswick quarter scale test with wingless deflector. The second set is the load definition for Brunswick developed by the General Electric Company based on the Monticello test.

When calculating pool swell loads, the first set of curves were used for structures located in the region without the deflector while the second set of curves were used for structures located in the region with the winged deflector. Figure 3, Attachment RAI 2c-1 shows the regions in which different pool swell profiles were applied. Both Brunswick and Monticello pool profiles were derived from QSTF tests with deflectors. The former was specifically tested for the Brunswick plants. There is no test data available for pool swell without deflector. For regions where no deflector exists, Brunswick pool profiles were used since they are closer to the actual plant geometry than those based on the Monticello test. The use of the Brunswick pool swell profiles is conservative and is justified by the General Electric Company's MARK I SSE Question Response", Attachment RAI 2c-2.

PARTIAL PLAN

DWG. 9527-F-1322

(Total one sheet)

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

Attachment RAI 2c -1

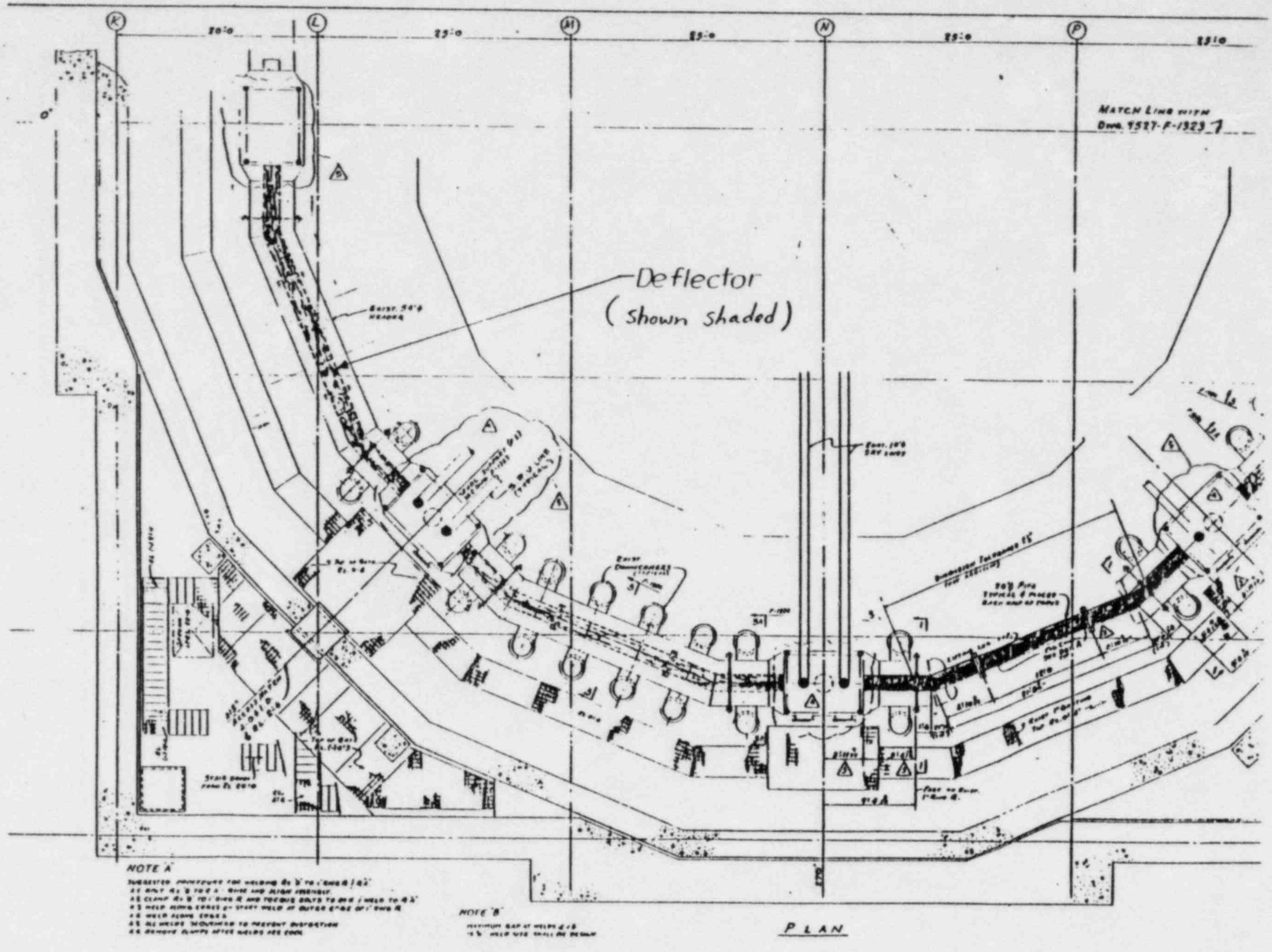

K
L
M
N
P
20'-0
25'-0
25'-0
25'-0
25'-0
MATCH LINE WITH
DWG. 9527-F-1323
Deflector
(Shown shaded)
NOTE 'A'
NOTE 'B'
PLAN

Fig 3

GENERAL ELECTRIC COMPANY

MARK I SSE QUESTION RESPONSE

SHEETS 1 to 3

FIGURES 114.1-1

FIGURES 114.1-2

(TOTAL 5 SHEETS)

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

ATTACHMENT RAI 2C-2

G.E. COMPANY PROPRIETARY

SHEET 1 of ____

MARK I SSE QUESTION RESPONSE

QUESTION # 114.1 DATE August 17, 1979

REQUESTOR CP&L TASK # 9.1.1

RESPONSIBLE ENGINEER Gary W. Lawson DRF # T23-233

TASK MANAGER Aburba Mukherjee A. Mukherjee 9/7 EWA # EAC78-6F, Rev. D

APPROVALS: VS Tashjian S.J. Stark G.E. Wade 9.7.79

VS Tashjian, Tech. L. Mark I/II Containment Engineering

SJ Stark, Manager Mark I/II Containment Engineering

G.E. WADE, Manager Mark I Containment Design

QUESTION:

Carolina Power & Light Company is currently planning to install the vent header deflector in only the non-vent bay. Our 1/4 scale tests were conducted with the vent deflector, and thus our plant unique load definition for pool swell is with the vent deflector. This letter is to request that General Electric provide a load definition for pool swell without a deflector for our use in the analysis of the vent-bay. This subject has been discussed previously between United Engineers and Constructors (Mr. H.E. Painter) and General Electric (Mr. B.W. Smith).

RESPONSE:

The effects of not having a vent header deflector (vs. having a deflector) on the vent header impact transients is well documented. The purpose of a vent header deflector is to mitigate vent header impact/drag loads during pool swell. The Mark I Containment Program Plant Unique Quarter Scale tests were evaluated to establish the effect of not having a vent header deflector on vent header impact loads. This evaluation led to the definition of vent header impact loads for plants that have tested with a deflector and do not wish to install deflectors in the vent bays. The details of the vent header impact load definition for use in the analysis of the vent-bay (without a deflector) is provided in response to Question 103.1. The attached Figure 114.1-1 is plant unique and replaces Figure 103.1-3 of the response to Question 103.1. This figure represents the plant unique location of the impact pressure transients on the vent header to be used on conjunction with the generic procedure outlined in the response to Question 103.1.

The sensitivities of other pool swell loads (e.g., torus vertical loads, torus airspace pressure loads, and torus submerged pressure loads) and pool swell displacements and velocities to the absence of a vent header deflector in a vent bay have been evaluated using the quarter scale generic

This answer to a Mark I Owner/AE question on the Load Definition Report (LDR), Application Guide (AG) or Plant Unique Load Definition (PULD) is provided for clarification. This answer is not to be construed as modifying any of the design loads which have been formally issued in the LDR or PULD.

G.E. COMPANY PROPRIETARY

MARK I SSE QUESTION RESPONSE

(CONTINUATION SHEET)

QUESTION # 114.1

sensitivity tests (NEDE 23545-P) and the quarter scale plant unique tests (NEDE 21944-P and NEDE 24615-P). These evaluations lead to the following recommended margins to be applied to the existing plant unique pool swell loads defined in the PULD's if a utility wishes not to install a deflector in the vent bays while the plant unique quarter scale tests were performed with a deflector.

1) Torus vertical loads

   a) Download - No margins, in addition to those required by the NRC, are necessary because presence or absence of a deflector does not influence the torus download.

   b) Uploads - The NRC imposed margins on uploads are adequate and contain sufficient margin for uncertainty due to presence of deflectors in the QSTF plant unique tests. Therefore, no additional margins, other than those imposed by the NRC, are recommended.

2) Torus submerged pressure - No margins in addition to those required by the NRC are recommended.

3) Torus airspace pressure - No margins in addition to those required by the NRC are recommended.

5) Impact and drag on strucures above the pool surface - The load definition procedure for calculating impact and drag on structures located above the pool surface documented in the Mark I LDR (NEDO 21888, Section 4.3.4) utilizes plant unique pool swell displacement and velocity profiles obtained from the plant unique QSTF tests. The absence of a deflector in a vent bay alters the pool swell displacement and velocity profiles near the vicinity of the vent header. Therefore, the following margins and changes are recommended to be applied to the plant unique pool swell displacement and velocity profiles:

   a) Pool swell displacement - Extrapolate the plant unique pool swell displacement profiles directly above the vent header deflector to $\hat{z}$ values equal to zero. A sketch demonstrating this recommended extrapolation is presented in Figure 114.1-2.

   b) Pool swell velocity - Pool swell velocities near the pool centerline are affected by the presence of a deflector. However, pool swell velocities near the pool centerline given by the plant unique quarter scale tests are conservative when applied to vent bays without deflectors, therefore, no margins, in addition to those required by the NRC, are necessary.

   Pool swell velocities at locations away from the pool centerline and near the torus shell are not affected by the presence of a deflector. It should be noted that the NRC criteria requires adding a 35% margin to the impact loads on structures above the pool and, therefore, no additional margins are recommended.

G.E. COMPANY PROPRIETARY

MARK I SSE QUESTION RESPONSE

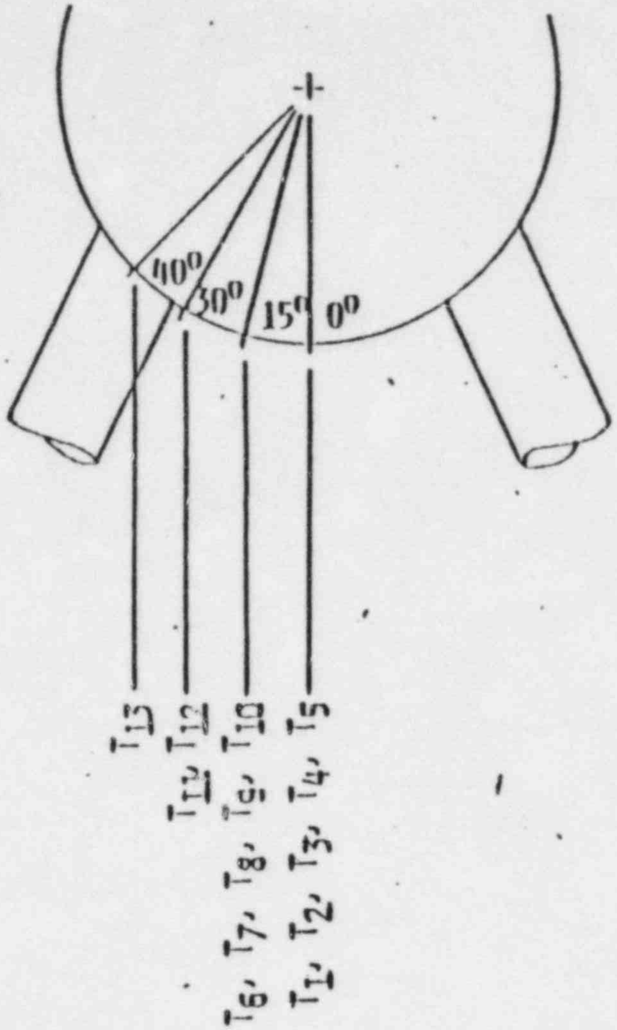
(CONTINUATION SHEET)

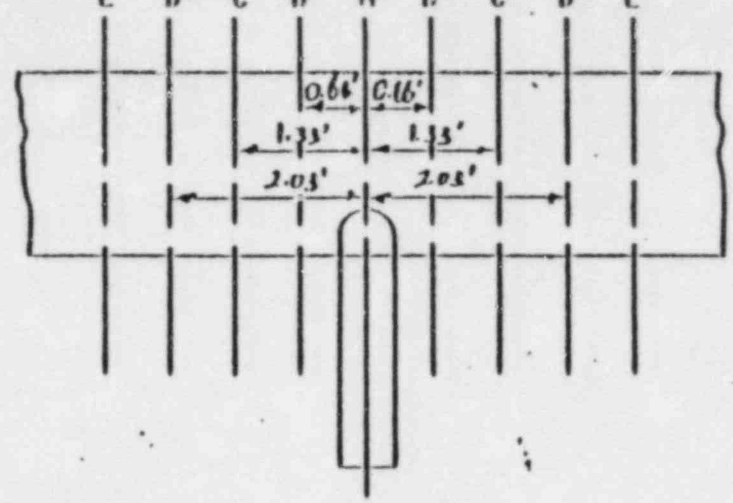
QUESTION # 114.1

6) Froth impingement loads - The NRC criteria on froth impingement velocities and froth densities to be used in calculating froth impingement loads are sufficiently conservative to offset any uncertainties due to the absence of a deflector in a vent bay. No additional margins are recommended.

7) Pool fallback loads - Use the extrapolation recommended for the pool swell displacement profile (item 5a above) to obtain the bulk pool swell height used in calculating the fallback loads. No additional margins are recommended.

8) Froth fallback loads - The froth fallback loads are not affected by the absence of a deflector in a vent bay. No margins are recommended.





TRANSDUCER SPACING AROUND DOWNCOMER ON UNPROTECTED VENT HEADER

A = Transients T_1, T_6

B = Transients T_2, T_7

C = Transients T_3, T_8, T_{11}

D = Transients T_4, T_9, T_{13}

E = Transients T_5, T_{10}, T_{12}

FIGURE 114.1-1

LOCATION OF IMPACT PRESSURE TRANSIENTS
ON VENT HEADER
WITH NO DEFLECTOR

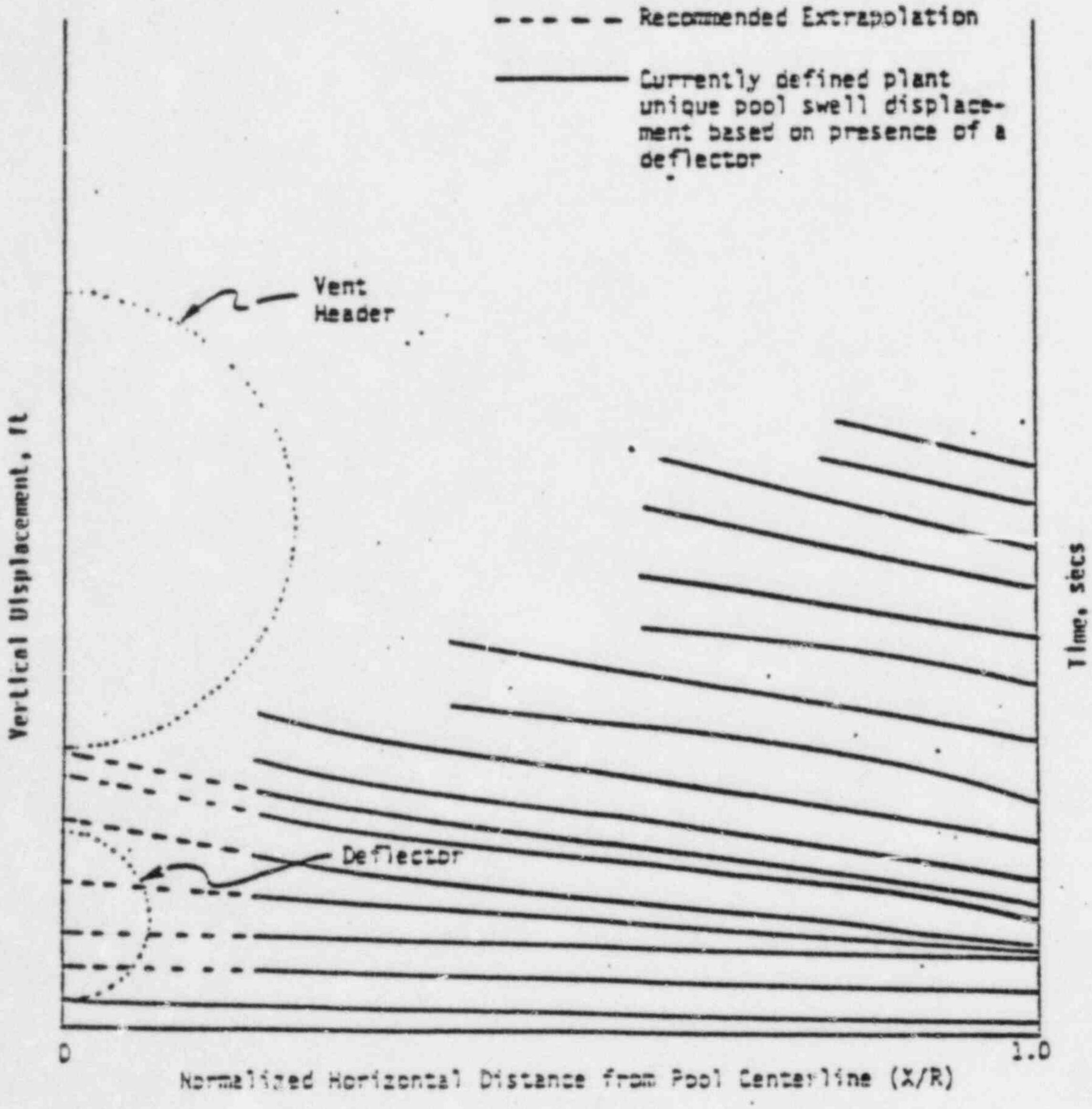


Figure 114.1-2 - Recommended Extrapolation of Pool Swell Displacement Profiles

RAI 3 - PUAR Section 2.2.1.3, AC Section 2.8

The QSTF plant-specific movies were utilized in the calculation of the froth impingement loads, as allowed by the AC, on the RHR test lines, RHR containment cooling line and the monorail. Which QSTF tests were used? Describe how a conservative load specification was achieved and what uncertainty limits were applied as discussed in the AC. Discuss in detail the method used to determine the froth source velocity. Were Region II froth loads considered as part of the PUA?

<u>RESPONSE</u>

Brunswick plant unique QSTF movies were used in the calculation of the froth impingement loads. Described below are the method and procedures used to determine the froth source velocity:

1. Three tests were filmed at a rate of 498 frames per second. The films were viewed and individual frames were numbered.
2. A Bell & Howell 1592 16mm projector was set up.
3. A frame prior to downcomer discharge was frozen. Figure 1 lists the distances between the downcomers, diameters of the vent header, downcomers and deflector that were measured to determine the scale factor between the QSTF and the film. The scale factor for the Brunswick QSTF was taken from Reference 1.
4. The position of the projector was noted to detect any accidental movement.
5. Sheets of tracing paper with the outline of the vent header were taped to the wall. The frame and test numbers were noted.
6. Tracings of the pool surface and any froth due to the pool impacting the vent header were made on approximately every five frames. The pool surface and froth were diverted to each side of the vent header after impact. Figure 2 shows the measurements on each

RAI 3 PUAR Section 2.2.1.3, AC Section 2.8 (Continued)

RESPONSE: (Continued)

6. (Continued)

   side used in calculating the froth velocity. After analyzing the tracings, it was found that the maximum froth velocity occurred between frames 65 and 75 in Test 1, between frames 60 and 70 in Test 2 and between frames 50 and 60 in Test 3. Measurements of froth displacement, froth angle and froth width for these frames were then taken on a frame-by-frame basis.

7. Due to the small elapsed time between frames, a discrepancy of 0.01 inches in measured displacement will change the calculated velocity 4.6 ft/sec. Because a frame-by-frame result is so sensitive to error, running average values of ten consecutive frames in each test were calculated (Fig. 3). The maximum calculated velocities (vertical and horizontal) from three tests were used in the design. A comparison of frame-by-frame horizontal velocity, running average velocity and the design velocity for Test 1 is shown in Fig. 4.

A conservative load specification, based on the procedures discussed above, with uncertainty limits properly accounted for, was achieved in the following manner:

1. Maximum horizontal and vertical velocity never took place in the same frame of the film, however, they were applied to structures simultaneously.

RAI 3 - PUAR Section 2.2.1.3, AC Section 2.8 (Continued)

RESPONSE: (Continued)

2. According to the Acceptance Criteria a separate, lower bound froth source velocity was used to estimate the froth density. This resulted in a froth density greater than that of water and the LDR procedure was used for the calculation of froth density.
3. The calculated duration of the froth impingement was shorter than 0.080 seconds specified in the LDR. The LDR specified duration was used for the load specification.

Region II froth loads were considered as part of the PUA. The LDR procedure was employed for the load specification. In the overlap region where both Region I and II froth loads must be calculated, it was found that Region I loads always govern.

Reference:

1. Mark I Containment Program Quarter Scale Plant Unique Tests, Vol. I, page 2-27, NEDE-21966-P, April 1979.

CALCULATION SET NO.

9527-E-SC-AP-1-F

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

Attachment RAI 3

FORM 5007 REV. 7/79

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc

NAME OF COMPANY C.P.&L. BSEP UNIT/S 1&2

SUBJECT OSTF POOL SWELL

CALC. SET NO.		REV	COMP BY	CHK'D BY
PRELIM.		0	I.DT.	KDC
FINAL	9527-E-SC-AP-1-F		DATE 4·10·81	DATE 5-19-81
VOID				
SHEET	314 OF 356		DATE	DATE
J.O. 9527.01(C)				

VENT & DOWNCOMER DIMENSIONS

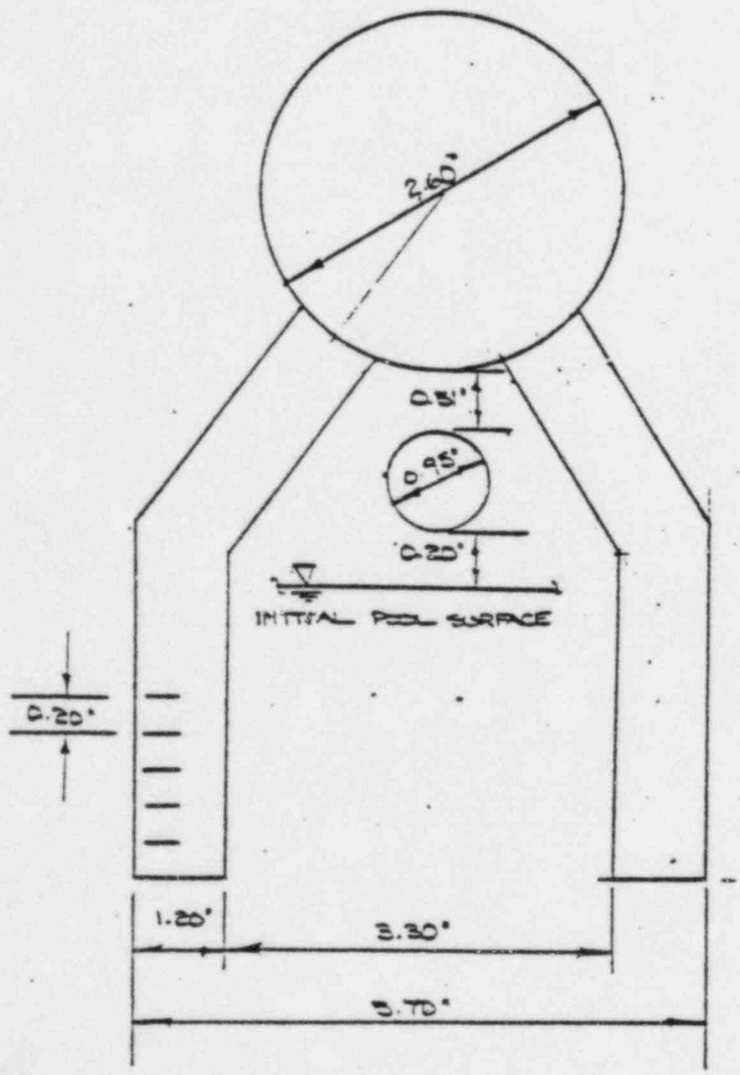


Fig. 1 DIMENSIONS

FORM 3007 REV 7/79

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc

NAME OF COMPANY C.P.&L BSEP UNIT/S 1&2.

SUBJECT QSTF PD SWELL

CALC. SET NO		REV	COMP. BY	CHK'D BY
PRELIM.		0	J.D.T.	KDC
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VOID				
SHEET	319 OF 356		DATE	DATE
J.O. 9527.DAD				

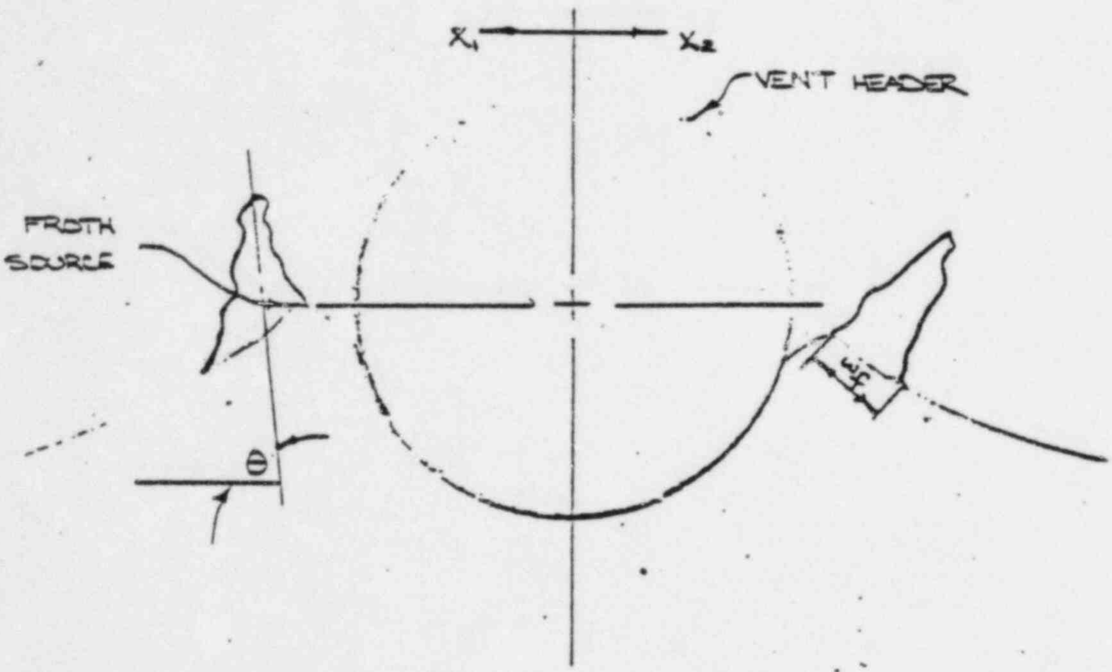

Fig. 2 Froth Source Measurements

FORM 5007 REV. 7/79

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers

NAME OF COMPANY: BSEP   UNIT/S: 1 & 2

SUBJECT: QSTF – Froth Impingement Forces

CALC. SET. NO.		REV	COMP. BY	CHKD. BY
PRELIM.				
FINAL	9527-E-SCAP-1-F	0	YLT DATE 4-28-81	S.T. DATE 5-7-81
VOID				
SHEET	344 OF 356		DATE	DATE
J.O.	9527040			

Test 1

	X1				X2			
† $\Sigma\Delta t$ (sec)	$\Sigma\Delta Y$ Film (in)	$\Sigma\Delta H$ Film (in)	* $(V_Y)_{QSTF\ model} = \frac{\Sigma\Delta Y}{\Sigma\Delta t}$ (ft/sec)	* $(V_H)_{QSTF\ model} = \frac{\Sigma\Delta H}{\Sigma\Delta t}$ (ft/sec)	$\Sigma\Delta Y$ Film (in)	$\Sigma\Delta H$ Film (in)	$(V_Y)_{QSTF\ model} = \frac{\Sigma\Delta Y}{\Sigma\Delta t}$ (ft/sec)	$(V_H)_{QSTF\ model} = \frac{\Sigma\Delta H}{\Sigma\Delta t}$ (ft/sec)
0.002	0.05	0.00	12.02	0.0	0.07	0.038	16.86	9.15
0.004	0.07	0.034	8.44	4.09	0.17	0.083	20.47	9.99
0.006	0.25	0.160	20.06	12.84	0.28	0.184	22.48	14.77
0.008	0.25	0.280	15.09	16.86	0.31	0.330	18.66	19.87
0.010	0.37	0.521	17.80	25.09	0.45	0.383	21.68	18.45
0.012	0.55	0.647	22.08	25.97	0.51	0.383	20.47	15.37
0.014	0.56	0.647	19.25	22.26	0.53	0.460	18.23	15.83
0.016	0.56	0.797	16.88	23.99	0.57	0.490	17.16	14.75
0.018	0.70	0.850	18.73	22.75	0.65	0.550	17.39	14.72
0.020	0.78	0.850	18.79	20.47	0.79	0.603	19.03	14.52

* Scale factor = 5.78

† Frame rate = 1/498 sec

$$V_{BSEP} = \frac{V_{QSTF}}{\sqrt{0.2672}} = 1.93\ V_{QSTF}$$

Fig. 3 Running Average Calculation

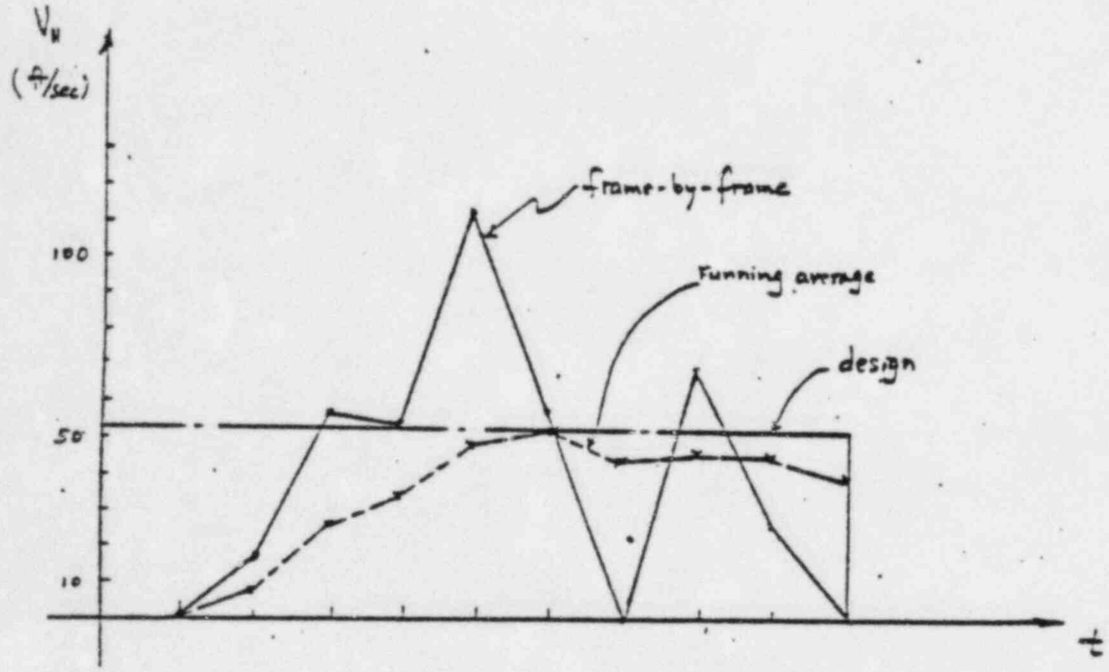

Fig. 4 Froth Source Velocity (X1, TEST 1).

RAI 4 - PUAR Section 2.2.2, AC Section 2.13.8

The AC required that each licensee demonstrate that previously submitted pool temperature analyses are sufficient or provide plant-specific pool temperature response analyses to assure that S/RV discharge transients will not exceed the pool temperature limits specified in the AC as supplemented by NUREG-0783.
Provide sufficient information to satisfy the above requirement concerning the pool temperature evaluation including the maximum bulk pool temperature and maximum local pool temperature obtained for each SRV discharge transient considered.
In addition, explain in detail and justify how the local-to-bulk pool temperature differences were determined.

RESPONSE

Previously submitted pool temperature analyses were documented in "Brunswick Steam Electric Plant Unit 1 and 2 Suppression Pool Temperature Response" (NEDC-24364-P) issued by General Electric in 1981.

This document has provided process transient analyses of seven (7) postulated events including various SRV and RHR system failures, as outlined in NUREG-0783, Section 5.6.

Two (2) GE proprietary computer codes and models were used to perform the analyses.

1. The coupled reactor and suppression pool model uses a thermodynamic code to calculate the transient response of the suppression pool during long-term events which add heat to the pool. This code performs fluid mass and energy balances in the reactor primary system and suppression pool, and calculates the reactor vessel water level, pressure, and long-term response of the suppression pool bulk temperature.

RAI 4 - PUAR Section 2.2.2, AC Section 2.13.8 (Continued)

RESPONSE: (Continued)

The calculations include the temperatures in the bay(s) of discharge, downstream of the quencher device, on the bay centerline, and at elevations above and below the quencher device.

The local temperature is the average of the temperatures calculated in the vicinity of (above and below) the T-quencher in the downstream portion of the bay.

The reported local temperatures correspond to the highest temperature calculated in this manner.

Updated design data unique to the Brunswick Plant were submitted by licensee and used by GE for adjusting the computer models, setting up the necessary assumptions and inputting the events' initial conditions.

Summary of Results:

1. The maximum local temperatures in all cases remained below the 200°F limit throughout the transients analyzed.

2. The maximum local temperature achieved is 196°F for SBA with one RHR loop available.

3. The maximum local-to-bulk temperature difference (ΔT) equals 50°F, which occurred at the beginning of two (2) events and prior to the RHR suppression pool cooling mode initiation.

RAI 4 - PUAR Section 2.2.2, AC Section 2.13.8 (Continued)

RESPONSE (Continued)

1. (Continued)

   The various modes of operation of all important auxiliary systems, such as the SRV's, MSIV's, ECCS, RHR and Feedwater System are modeled.

   To simulate a specified reactor cooldown and/or depressurization rate(s), a predetermined rate of change of temperature may be imposed onto the reactor vessel.

   In addition, the model also simultes system set points (automatic and manual), and specified operator actions.

2. The local pool temperature model is used to calculate the water temperature in the vicinity of the quencher during SRV discharge events which add heat to the pool.

   Results obtained from the previously described calculations such as the mass and energy added to and/or removed from the pool during each transient (i.e. RHR and SRV flows), are input into this model along with pool geometry, submerged structures geometry and pool initial conditions.

   The overall local temperature analysis consists of two major coupled components; a momentum balance to solve for the bulk pool velocity, and a two-dimensional energy model which superimposes the local recirculation on the bulk velocity to determine the temperature distribution in the pool.

RAI 4 - PUAR Section 2.2.2, AC Section 2.13.8 (Continued)

RESPONSE: (Continued)

3. (Continued)

   It should be noted that the corresponding pool bulk temperatures were around 120°F in both cases but subsequent pool thermal mixing and cooling, performed by RHR, have decreased the ΔT to 25-30°F in 3 to 5 minutes.

4. ΔT at the time of maximum temperatures (local as well as bulk) are about 15°F for cases where two RHR loops are assumed operational and about 30°F for cases where only one RHR loop is available.

   It may be concluded that RHR induced suppression pool circulation leads to good thermal mixing, which effectively lowers water temperatures in the vicinity of discharging T-quencher, thus improving the steam condensing process.

RAI 5 - PUAR Section 2.2.2, AC Section 2.13.8.3

The AC stipulates that the Suppression Pool Temperature Monitoring System (SPTMS) is required to ensure that the suppression pool is within the allowable temperature limits set forth in the Plant Technical Specifications. Provide sufficient information to demonstrate that the Brunswick SPTMS design is in accordance with the requirements of AC Section 2.13.8.3.

RESPONSE:

CP&L's commitment with regard to installation of the modified suppression pool water temperature monitoring systems (SPTMS's) is to have them operational prior to the start of the fuel cycle 6 on Unit 2 and fuel cycle 5 on Unit 1.

This translates into December 1984 and July 1934 respectively.

The design status of the above systems is described below:

A. The suppression pool water temperature sensor location analysis with regard to the requirements of NUREG-0661 and 0783 was performed by NUTECH Engineering, San Jose, California. The final report with recommendations as to quantity and exact placing of sensors was submitted: See Attachment 5-1.

   This analysis was based on the Monticello test results.

B. Subsequent structural modifications of the in-torus equipment (service) platforms, walkways, etc.) prompted a need for minor relocation of the above sensors, preserving though the elevation and the torus bays where the sensors were previously placed and analysed. Presently NUTECH is finalizing the relocation evaluation. Preliminary results indicate that the new locations will be feasible, which will improve the accessibility and maintainability of the SPTMS's temperature sensors without sacrificing the accuracy of measurements.

RAI 5 - PUAR Section 2.2.2, AC Section 2.13.8.3 (Continued)

RESPONSE (Continued)

C. The design of the balance of the systems is presently in progress. We are evaluating alternate methods of data processing, communication lines, hardware, software, etc. The necessary changes to the existing temperature monitoring systems are being identified to avoid duplication of information.

The above design is proceeding in compliance with the NUREG-0661 NUREG-0783. The subject systems will possess the following features:

1. Two redundant networks of resistance temperature detectors - thirteen (13) RTD's in each loop - will be located about the perimeter of the vent header at approved locations and calculated elevations: See Attachment 5-1.
2. Separate Class 1E circuits will carry the RTD signals out of the torus via fully qualified electrical penetrations.
3. The computing device (either micro-processor based or existing computer) will compute the bulk temperature reading and transmit the signal to:
    a. Data logger for the plant monitoring system.
    b. Main control room for indication, recording and alarms, as required.
    c. Remote shutdown panel to substitute the presently used single point signal, if necessary.
4. Alarm set points will be established in strict compliance with the NRC requirements and necessary modifications to operational procedures will be made accordingly.

RAI 5 - PUAR Section 2.2.2, AC Section 2.13.8.3 (Continued)

RESPONSE: (Continued)

NOTE: (1) Redundancy is to be consistently maintained to provide the necessary reliability of the system.

(2) Item 3.c. is still being evaluated.

Ref.: Attachment 5-1

"Final Results on temperature sensor locations for the Brunswick Plant" - 47 pages plus 1 drawing.

Attachment
BNL - RAI 5

JUL 27 '81 H.E.P.

nutech

6835 VIA DEL ORO • SAN JOSE, CALIFORNIA 95119 • PHONE (408) 629-9800 • TELEX 352062

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VU-90193

July 22, 1981
UEC-01-05

L.R.S
BJH
RHK
KLB
V DEO
Dcc(2)
R.FORD
W. PAINTER

Mr. L. R. Scott
United Engineers and
Constructors, Inc.
30 South 17th Street
P. O. Box 8223
Philadelphia, PA 19101

SUBJECT: FINAL RESULTS ON TEMPERATURE SENSOR LOCATIONS FOR THE BRUNSWICK PLANT

REFERENCES:
1) NUTECH Proposal N81-038, dated March 12, 1981
2) Letter from L. R. Scott (UEC) to P. M. Donnelly, UV06072, dated June 23, 1981

Dear Mr. Scott:

Per the scope of work identified in Reference 1, please find enclosed Attachment A outlining our recommendations and justifications for sensor placements, Attachment B containing the calculation package supporting our recommendations, and a copy of the final drawing indicating sensor locations.

Addressing the concerns itemized in Reference 2:

1. The RHR line locations and direction of flow are indicated on the attached drawing.

2. The reference to temperature monitoring system has been changed to read, "RTD sensors for temperature monitoring system".

3. The length of the RTD is unimportant from a thermal mixing viewpoint, as long as the sensitive portion of the RTD is only in contact with water. Therefore, the length will be dictated by the method of attachment and other system requirements.

4. We are recommending that two sensors be placed at each location to provide redundancy at each location. The use of separate and redundant recording systems has not been addressed in the enclosed recommendations.

RECEIVED

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BY UE&C

5. All sensors are placed so as to yield an accurate bulk temperature. Currently, none of the sensor locations are intended to measure local temperature. However, an appropriate algorithm can be developed to infer the local temperature at each T-Quencher location.

In summary, NUTECH recommends that RTD sensors for the temperature monitoring system should be placed at thirteen locations as indicated in the attached drawing. NUTECH is also recommending placement of a redundant RTD at each location to ensure accurate measurement of the suppression pool bulk temperature in the event of a sensor failure.

If you have any questions, please call Pat Donnelly or me.

Yours very truly,

Erik R. Matheson
Erik Matheson
Consultant

Tom J. Mulford
T. J. Mulford, Manager
Thermal-Hydraulics
Engineering Group

John W. Kin, P.E.
J. W. Kin, P.E.
Project Engineer

Patrick M. Donnelly
P. M. Donnelly, P.E.
Project Manager

hg

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SEP 30 '81 H.E.P.

JOB NO. (1–7)	PURCHASE ORDER COMM. (8–10)	PURCHASE ORDER SEQ. (SUBT. NO.) (11–14)	FOREIGN PRINT NO. (15–19)	ISSUE / R.O. (20–21)	ACTION / DISC (22–23)	STATUS (24–25)	VENDOR DRAWING OR DOCUMENT NO. (26–42)	REV. NO. (43–44)	SIZE (45)	ORIG. DISC. (46–47)	ACTION (79)	CODE (80)
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DESCRIPTION LINE 1 (24–43)	LINE 2 (44–63)	VENDOR'S NAME (64–72)	ACTION (79)	CODE (80)
RTD SENSOR LOCATIONS	SUPPRESSION POOL SNS	NUTECH		2

LETTER TO UE&C (24–29)	UE&C LOG-IN DATE (30–35)	CLIENT'S REVIEW TO CLIENT (36–41)	CLIENT'S REVIEW FROM CLIENT (42–47)	UE&C REVIEW TO VENDOR (48–53)	STATUS (54–55)	FINAL DISTRIBUTION DATE (56–61)	ACTION (79)	CODE (80)
072281	072881	IV901	93R	R0208				3

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UNITED ENGINEERS & CONSTRUCTORS INC.
[illegible]

☐ PROCEED AS PER P.O. OR CONTRACT

☐ SUBMIT REVISED DRAWINGS FOR REVIEW

☐ SEND CORRECTED DRAWINGS FOR RECORD

BY ______________________ DATE ____________

FORM 5041
REV 7/74

F.P.-9527 30396

ATTACHMENT A

FINAL DESIGN RECOMMENDATIONS CONCERNING RTD SENSOR LOCATIONS FOR THE SUPPRESSION POOL TEMPERATURE MONITORING SYSTEM

Reference:

1) NUTECH Proposal N81-038 to Provide Engineering Services to United Engineers and Constructors, Inc., March 12, 1981.

2) Monticello T-Quencher Thermal Mixing Test Final Report, Task No. 7.5.2, General Electric Co., April 1979.

3) Safety Evaluation Report - Mark I Containment Long-Term Program, U. S. Nuclear Regulatory Commission, NUREG-0661, July 1980.

4) Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident, U. S. Nuclear Regulatory Commission, Regulatory Guide 1.97, December 1980.

5) "Carolina Power and Light Company, Brunswick Steam Electric Plant Unit 2, RTD Sensor Locations - Suppression Pool Installation Drawing", NUTECH Drawing No. UEC-01-200, Rev. 0, NUTECH File No. 155.2301.0200.

This letter report completes the objectives of the Phase I work defined in NUTECH Proposal N81-038 (Reference 1). The primary objectives were to evaluate and make recommendations concerning the present location of RTD sensors for the suppression pool temperature monitoring system, to make a recommendation with respect to bulk versus local temperature measurement, and to recommend sensor locations in accordance with References 3 and 4.

The necessity to perform the first two tasks outlined in NUTECH Proposal N81-038 (Reference 1) was eliminated after the conversation with Mr. Vasant Deo on May 18, 1981. In this conversation, Mr. Deo informed NUTECH that the catwalk structure, where the present monitoring system is mounted, will be removed from the wetwell in the future. Therefore, the need to evaluate the existing system was eliminated.

The Monticello thermal mixing test report (Reference 2) was extensively reviewed and evaluated with respect to temperature sensor placement. NUREG-0661 (Reference 3) was also utilized for determination of requirements for bulk and local temperature measurements. Likewise, Regulatory Guide 1.97 (Reference 4) was the basis for system redundancy requirements. Upon completion of these reviews, it was apparent that there were two options which would meet the system requirements and regulatory guidelines. These are:

1) Place sensors for local temperature determination per Reference 3 guidelines and compute the bulk temperature, if desired, from these measurements.

2) Place sensors for optimum bulk temperature determination and apply a local-to-bulk temperature difference for local pool temperature determination.

DESIGN RECOMMENDATIONS

NUTECH is recommending that the sensors be placed for optimum bulk temperature determination. There should be at least one sensor location for each discharge device. NUTECH recommends that two additional sensor locations be utilized in order to avoid undue conservatism in computing the bulk temperature. A diagram of the thirteen recommended sensor locations is presented in Reference 5. The vertical location of the sensors about the torus remains at a constant elevation which is also indicated in Reference 5. This sensor elevation corresponds to the level at which the centroid of the pool water volume is located for average operating water level.

It should be noted that the sensors are placed on the vent header support columns on the Reactor Pressure Vessel (RPV) side of the torus to account for the lesser capacity of that side to condense steam due to the smaller cross-section as viewed from above. It is also recommended that a redundant sensor be placed at each location specified, thus a total of 26 sensors are required for the monitoring system. Both sensors at each location should have the sensitive portion of the device located at the elevation specified. As long as the sensitive portion of the sensor is not touching the vent header support column, almost any sensor mounting scheme which provides the proper support is acceptable from a temperature measurement standpoint.

A volumetric weighting factor will be assigned to each sensor in the Phase II work described in Reference 1. Finally, a local-to-bulk temperature difference will be determined during the Phase III work described in Reference 1.

DESIGN JUSTIFICATIONS

There are several reasons why the bulk temperature measurement system is chosen over the local temperature measurement. First, plant operational procedures are written in terms of bulk pool temperature and providing a local measurement would require a rewriting of operational procedures. Also, if the sensors were placed at a low enough elevation to measure the local temperature, a non-conservative estimate of the bulk temperature would be obtained. This is due to the fact that the pool flow is stratified, i.e., the cool water tends to be near the bottom, which would result in low values of the local temperature everywhere except at the discharge quencher.

The justification for the sensor placement primarily stems from the Monticello tests. These tests demonstrated that the placement of the sensors on the vent header support columns on the RPV side of the torus and at the elevation of the pool centroid, along with a volumetric average of the temperatures at these locations, will give a very good prediction of the bulk temperature throughout the transient.

Secondly, installation of the system should be simplified since the leads for the present system are routed through the vent header distribution system and the torus liner plate is backed with concrete, i.e., it is easier to mount the sensors on the vent header support columns than on the torus walls. Also, since the T-Quenchers are approximately symmetric with respect to the torus miter joints and the vent header support columns are located near the miter joints, these locations give a good indication of the average cell temperature in all bays, including the discharging bay.

It is recommended that there is at least one sensor location in every bay with a discharge device. This arrangement assures a conservative measurement of the bulk pool temperature since the hottest bay, i.e., the discharging bay, will always be monitored. Redundancy is also recommended in each bay with a discharge device for this same reason. The possibility of a failure of the sensor in the bay with the discharging device could lead to a nonconservative indication of the bulk pool temperature. Finally, the failure of any sensor would unnecessarily complicate the algorithm for determining the bulk temperature from the sensor readings. Without redundancy, the algorithm would have to search for the failed sensor and determine its proximity to the discharging device and make adequate corrections. This could lead to a fairly large number of permutations that the algorithm would have to consider.

After considering all of these possibilities, NUTECH recommends that 26 sensors be located in sets of two for bulk temperature measurements according to the diagrams in Reference 5.

SEP 30 '81 H.E.P.

ATTACHMENT B

DATA REDUCTION OF MONTICELLO T-QUENCHER THERMAL MIXING TEST RESULTS

JOB NO. (1–7)	PURCHASE ORDER COMM. (8–10)	PURCHASE ORDER SEQ. (SUBT. NO.) (11–14)	FOREIGN PRINT NO. (15–19)	ISSUE (20)	NO. (21)	ACTION (22)	DISC (23)	STATUS (24–25)	VENDOR DRAWING OR DOCUMENT NO. (26–42)	REV. NO. (43–44)	SIZE (45)	ORIG. DISC. (46–47)	ACTION (79)	CODE (80)
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DESCRIPTION LINE 1 (24–43)	LINE 2 (44–63)	VENDOR'S NAME (64–72)	ACTION (79)	CODE (80)
DATA REDUCTION OF	MONTICELLO T-QUENCH	NUTECH		2

LETTER TO UE&C (24–29)	UE&C LOG-IN DATE (30–35)	CLIENT'S REVIEW TO CLIENT (36–41)	CLIENT'S REVIEW FROM CLIENT (42–47)	UE&C REVIEW TO VENDOR (48–53)	STATUS (54–55)	FINAL DISTRIBUTION DATE (56–61)	ACTION (79)	CODE (80)
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☐ SEND CORRECTED DRAWINGS FOR RECORD

BY ______________ ______________ DATE __ __________

FORM 5041
REV. 7/74

CALCULATION COVER SHEET

nutech
San Jose, California

Project: Brunswick Steam Electric Plant — File No. 155.2301.0300
Owner: Carolina Power and Light Company
Client: United Engineers and Constructors, Inc.

TITLE: Data Reduction of Monticello T-Quencher Thermal Mixing Test Results

DESCRIPTION: Transient temperature data measured throughout the suppression pool at specific locations and at a single elevation are volume-averaged, and the resulting bulk temperature transient is compared with the computed bulk temperature transient for two operational cases.

METHODS: An appropriate elevation to study is selected by computing the time-averaged absolute deviation from the local bulk temperature. Then the temperature responses at this elevation at several locations are volume-averaged and compared with the computed bulk-temp. response

RESULTS DOCUMENT: A favorable comparison is made between the volume-averaged response and the computed response for the cases of one RHR loop circulating and no RHR circulation.

REV	DATE	REVISION DESCRIPTION	RUN	DESCRIPTION	TAPE NO.
0	7/14/81	N/A	N/A	N/A	N/A

Prepared By/Date: Erik R. Matheson 7/14/81
E. R. Matheson

Checked By/Date: [signature] 7/15/81
J. G. Hwang

Revision	0				
Prepared By/Date	ERM 7/14/81				
Checked By/Date	JGH 7/15/81				

File No. 155.2301.0300

REVISION CONTROL SHEET

TITLE: Data Reduction of Monticello T-Quencher Thermal Mixing Test Results

PAGE	REV	PRE-PARED	ACCURACY CHECK	CRITERIA CHECK	PAGE	REV	PRE-PARED	ACCURACY CHECK	CRITERIA CHECK
1-40	0	ERM	SGH						

QEP-001.3-00

REVISION 0 PAGE 2
PREPARED BY ERM 7/15/81
CHECKED BY SGH 7/15/81

TABLE OF CONTENTS

1.0 INTRODUCTION

Temperatures were measured in several bays, including the discharging quencher bay, at various elevations during the Monticello T-Quencher thermal mixing tests. The tests were conducted for two cases: 1.) one RHR loop providing circulation, and thus, enhanced thermal mixing, in the suppression pool, and 2.) no RHR circulation of the suppression pool. The test data is analyzed, herein, in order to determine a method for monitoring the bulk temperature of the suppression pool during transients, such as, SRV actuations and DBA-LOCA's.

2.0 TECHNICAL APPROACH

In all but the discharging quencher bay, there are three sensors mounted on the inner vent header support column at different elevations in the monitored bay during the Monticello tests. The sensors at the intermediate elevation are all located at the vertical centroid of the suppression pool, i.e., there are equal volumes of water above and below this elevation. Therefore, the sensor readings at this elevation are compared with the average responses of the three sensors in each bay to see if the intermediate elevation is a good indicator of the average temperature in a given bay. This comparison is performed by time-averaging the absolute difference between the response of the intermediate sensor and the response of the three sensors averaged together for each bay. Since there was no sensor at the intermediate elevation in the discharging quencher bay, it is necessary to extrapolate the responses from sensors above this elevation in order to obtain a response at this elevation.

After it is determined that the intermediate elevation is a good indicator of the average temperature in a bay, it is necessary to assign a volumetric weighting factor to each bay which contains temperature sensors since these locations are not evenly distributed about the suppression pool. After assigning appropriate volumetric weighting factors, these factors are used in conjunction with the transient temperature data at the intermediate elevation in each monitored bay to estimate the bulk suppression pool temperature response. This response is then compared with the computed temperature response found in Reference 1.

Finally, the elevation for sensor placement is computed for the Brunswick plant based on the vertical centroid of its suppression pool.

3.0 CALCULATIONS

The calculations for the two cases described in the introduction are performed as outlined in Section 2.0 in this section. The elevation for sensor placement in the Brunswick plant is also computed in this section.

3.1 DATA REDUCTION FOR CASE OF ONE RHR LOOP CIRCULATING

In order to place the RTD's at the proper elevation for monitoring the bulk pool temperature, it is desirable that the sensors be placed at the elevation which would correspond to the average temperature over the pool cross-section at each bay location. From Figures 4-3 through 4-6 of Reference 1, it is found that there are three RTD's distributed vertically on vent header support columns located in five separate bays which do not house the discharging quencher. From the dimensions given, it is also found that the RTD's at the intermediate elevation of 80" above the base of the suppression pool are positioned such that exactly half of the volume of water lies above the RTD and half lies below. This particular elevation should be ideal for measurement of the local temperature averaged over the pool cross-section. However, the temperatures measured at this elevation should be compared with the averages of the temperatures measured by all three RTD's at each bay. The average bay temperatures for the bays not housing the discharging quencher are tabulated as functions of time in Table 3.1.1. These values are taken from Figure 5-8 of Reference 1 for the case of one RHR loop circulating. In Table 3.1.2, the temperatures for each monitor in the bay with the discharging quencher* are tabulated along with the resultant average bay temperature as a function of time. The average bay temperature was computed with no attempt to assign weighting factors to the monitors. The temperatures measured 80" from the base of

* See Figures A-14 and A-15 of Reference 1.

the suppression pool for each bay are also tabulated in Table 3.1.3. The temperatures in the first five columns were taken from Figures A-9 through A-13 of Reference 1. The temperatures for Bay D had to be extrapolated from other information since no monitor was placed 80" from the base of the suppression pool in this particular bay. From Figures A-14 and A-15 of Reference 1, it is found that monitors T16 and T22 are mounted 122.4" from the base of the suppression pool, while, the monitors T17 and T23 are at 95.5". These temperatures are tabulated as functions of time in Table 3.1.2. The first two temperatures are averaged to obtain a representative temperature at 122.4", and, the other two monitors are averaged to obtain a temperature at 95.5". Then, the temperature gradient between these two stations is linearly extrapolated to the 80" elevation to obtain the temperatures for Bay D in Table 3.1.3. In order to establish the appropriateness of employing the monitor at the elevation 80" as a measure of the average bay temperature, the time-averaged deviation of the temperature measured at elevation 80" from the average bay temperature is reported for each bay in Table 3.1.4. The deviation is computed as the absolute value of the difference between the temperature measured at 80" and the average bay temperature. This deviation is computed at each point in time, and then, averaged over time to obtain the numbers in Table 3.1.4. With a maximum time-averaged deviation of 2.4°F for Bay D/E, this elevation chosen seems to be a very good choice for measuring the average bay temperature.

In Table 3.1.5, the bulk suppression pool temperature as a function of time and the deviation from the bulk temperature as a function of time for each bay at the elevation of 80" are tabulated. The bulk temperature may be obtained from any of the figures in Appendix A of Reference 1. The deviations are computed from the difference of the temperatures at an elevation of 80" and the bulk temperature (note that the sign is retained for these deviations unlike the time-averaged deviations in Table 3.1.4). Since the RTD's are not located about the torus in a symmetric fashion (see Figure 4-1 of Reference 1), a weighting factor for the individual monitors must be estimated based on the volume of water represented by each station. In Figure 3.1.1, the locations of the RTD's and the approximate volumes they represent are indicated by the crosses and the dashed lines, respectively. Monitors B, C, D/E, and E/F are all indicated exactly in the middle of a volume spanning two bays, while, Monitor D (actually the intermediate position of monitors T16, T17, T22, and T23) is a little off-center of a volume spanning one bay. Finally, Monitor H is exactly one half bay off-center of the remaining seven bays, which should be close enough to center since this position is approximately 180° from the discharging quencher. The number of bays represented by each monitor and the resultant volumetric weighting factors are tabulated in Table 3.1.6. The weighting factors are used in conjunction with the deviations from the bulk temperature to determine the deviation from the bulk temperature that one would see if the bulk temperature was monitored by computing the average of the individual sensors in the suppression pool. At each point in time, the overall deviation from the bulk temperature may be computed as follows:

$$\sigma = \sum_i \omega_i \sigma_i ,$$

where, σ is the overall deviation, ω_i is the volumetric weighting factor for a given sensor, and σ_i is the deviation from the bulk temperature for a given sensor. The resultant overall deviation from the bulk temperature as a function of time is tabulated in Table 3.1.7. The magnitude of the greatest deviation is only 4.1°F. Therefore, it seems safe to say that if the sensors are located such that equal volumes of water are above and below and if there are a minimum of six sensor locations, then, the bulk suppression pool temperature may be predicted within ±5°F.

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Of course, this accuracy for predicting the bulk pool temperature should improve as the number of sensor locations increases. Also, a more symmetric arrangement of sensors would improve the accuracy by eliminating the necessity to estimate the volume associated with each sensor, i.e., equal spacing would yield equal representative volumes. Finally, it should be noted that the accuracy of such a monitoring system will be affected by any deviation from the normal operating water level in the suppression pool. As the water level drops, the monitoring system should predict too high a temperature due to stratification; i.e., the monitor will be above the elevation which divides the water into equal volumes, and therefore, it will be in the hotter half. Likewise, as the pool level rises the monitoring system will underpredict the temperature.

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Owner: Carolina Power and Light Company

Client: United Engineers and Constructors, Inc.

TABLE 3.1.1. AVERAGE BAY TEMPERATURES (°F)

Time (min)	Bay C	Bay B	Bay H	Bay E/F	Bay D/E
0	53.3	53.3	53.3	53.3	53.3
2	68.5	62.2	53.3	53.3	58.8
4	79.5	76.0	57.5	53.3	58.0
6	87.5	84.1	68.5	54.6	59.2
8	91.2	89.2	76.7	63.8	63.8
10	95.0	93.7	83.2	72.0	72.5
12	100.7	100.0	89.0	78.0	82.3
14	93.3	100.8	95.6	82.8	81.5
16	89.3	94.5	97.5	88.8	85.8
18	90.0	91.0	94.3	92.0	90.0
20	91.8	91.7	92.0	93.0	92.0
22	93.7	93.5	90.9	90.0	90.0
24	94.0	94.5	92.0	89.3	89.3
26	92.4	94.5	93.0	90.0	90.0
28	91.2	93.0	94.0	90.9	88.9
30	91.2	92.0	94.0	92.0	90.2
32	92.0	92.0	93.2	93.0	91.0
34	92.0	92.0	92.0	93.0	92.0
36	92.5	92.5	92.5	92.5	92.5

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TABLE 3.1.2. TEMPERATURES IN BAY D (°F) (Discharging Quencher)									
Time (min)	T_{16}	T_{17}	T_{18}	T_{19}	T_{20}	T_{21}	T_{22}	T_{23}	Ave. Temp.
0	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3
2	74.0	74.0	81.2	65.0	80.0	86.0	78.6	79.2	77.3
4	79.6	78.8	88.0	69.5	88.0	96.0	85.0	85.9	83.9
6	79.3	78.8	90.4	68.5	92.2	98.0	86.8	88.0	85.3
8	84.4	84.0	91.0	73.5	92.7	100.8	89.0	90.0	88.2
10	91.2	90.4	97.8	80.8	98.3	106.4	96.0	98.0	94.9
12	98.0	96.3	100.5	87.3	106.5	113.5	104.0	104.8	101.4
14	94.5	89.0	82.0	82.8	88.0	83.6	92.0	88.0	87.5
16	90.2	87.8	82.8	85.0	90.0	88.3	90.0	90.0	88.0
18	96.0	93.0	83.1	89.5	90.8	91.7	94.0	90.0	91.0
20	98.0	96.0	86.9	93.4	94.8	93.0	98.0	96.8	94.6
22	98.0	96.2	89.3	94.2	95.0	93.8	97.0	98.0	95.2
24	94.8	93.8	90.8	93.2	94.8	92.7	94.8	94.8	93.7
26	92.0	91.0	90.5	91.0	92.2	91.4	92.2	92.2	91.6
28	90.3	90.0	90.5	90.5	92.0	90.9	92.0	92.0	91.0
30	90.0	90.0	92.0	91.8	92.0	92.0	92.0	92.0	91.5
32	91.0	91.0	92.2	92.0	92.0	92.8	92.0	92.0	91.9
34	92.0	92.0	93.2	92.7	92.0	93.4	92.0	92.0	92.4
36	92.0	92.0	93.6	93.6	92.0	92.9	92.0	92.0	92.5

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TABLE 3.1.3. TEMPERATURE MEASURED 80" FROM BOTTOM OF BAY (°F)						
Time (min)	Bay C	Bay B	Bay H	Bay E/F	Bay D/E	Bay D
0	53.3	53.3	53.3	53.3	53.3	53.3
2	59.0	60.8	53.3	54.0	53.0	76.8
4	75.9	76.6	55.6	54.0	53.3	82.4
6	85.2	84.6	69.5	54.9	53.0	83.6
8	89.2	90.7	79.1	63.3	60.2	87.2
10	93.0	94.0	85.5	74.0	72.0	94.5
12	97.2	100.8	90.3	79.7	79.1	100.3
14	92.0	102.0	96.5	86.0	82.0	85.8
16	88.6	93.8	99.6	91.3	86.3	88.2
18	89.2	90.5	96.8	97.2	93.0	89.5
20	91.0	91.5	92.8	97.3	95.9	95.5
22	93.0	93.5	91.2	94.8	95.4	96.9
24	93.3	94.5	92.0	91.0	92.0	94.0
26	92.6	94.3	93.2	91.2	89.8	91.3
28	91.4	93.4	94.1	92.0	90.0	90.9
30	91.0	92.5	93.5	92.8	90.7	91.0
32	91.2	92.4	92.5	94.0	91.9	91.5
34	91.4	92.7	92.1	94.0	92.1	92.0
36	92.0	93.0	92.1	94.0	92.5	92.0

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TABLE 3.1.4

TIME-AVERAGED DEVIATION OF TEMPERATURE @ 80" FROM THAT OF AVERAGE BAY TEMPERATURE

Bay	Deviation(°F)
C	1.7
B	0.6
H	1.0
E/F	1.9
D/E	2.4
D	0.8

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TABLE 3.1.5. BULK TEMPERATURE AND DEVIATIONS FROM BULK @ 80" (°F)

Time (min)	T_{bulk}	σ_C	σ_B	σ_H	$\sigma_{E/F}$	$\sigma_{D/E}$	σ_D
0	53.3	0.0	0.0	0.0	0.0	0.0	0.0
2	59.1	-0.1	1.7	-5.8	-5.1	-6.1	17.7
4	66.0	9.9	10.6	-10.4	-12.0	-12.7	16.4
6	72.2	13.0	12.4	-2.7	-17.3	-19.2	11.4
8	79.0	10.2	11.7	0.1	-15.7	-18.8	8.2
10	85.2	7.8	8.8	0.3	-11.2	-13.2	9.3
12	92.0	5.2	8.8	-1.7	-12.3	-12.9	8.3
14	92.8	-0.8	9.2	3.7	-6.8	-10.8	-7.0
16	92.8	-4.2	1.0	6.8	-1.5	-6.5	-4.6
18	92.8	-3.6	-2.3	4.0	4.4	0.2	-3.3
20	92.8	-1.8	-1.3	0.0	4.5	3.1	2.7
22	92.8	0.2	0.7	-1.6	2.0	2.6	4.1
24	92.8	0.5	1.7	-0.8	-1.8	-0.8	1.2
26	92.8	-0.2	1.5	0.4	-1.6	-3.0	-1.5
28	92.8	-1.4	0.6	1.3	-0.8	-2.8	-1.9
30	92.8	-1.8	-0.3	0.7	0.0	-2.1	-1.8
32	92.8	-1.6	-0.4	-0.3	1.2	-0.9	-1.3
34	92.8	-1.4	-0.1	-0.7	1.2	-0.7	-0.8
36	92.8	-0.8	0.2	-0.7	1.2	-0.3	-0.8

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TABLE 3.1.6

NUMBER OF BAYS REPRESENTED BY EACH MONITOR AND RESULTANT VOLUMETRIC WEIGHTING FACTORS

Bay	No. of Bays	Weighting Factor
C	2	0.1250
B	2	0.1250
H	7	0.4375
E/F	2	0.1250
D/E	2	0.1250
D	1	0.0625

TABLE 3.1.7

VOLUME-AVERAGED DEVIATIONS FROM BULK @ 80" (°F)

Time (min)	σ	Time (min)	σ
0	0.0	20	0.7
2	-2.6	22	0.2
4	-4.1	24	-0.3
6	-1.9	26	-0.3
8	-1.0	28	-0.1
10	-0.3	30	-0.3
12	-1.6	32	-0.4
14	0.0	34	-0.5
16	1.3	36	-0.3
18	1.4		

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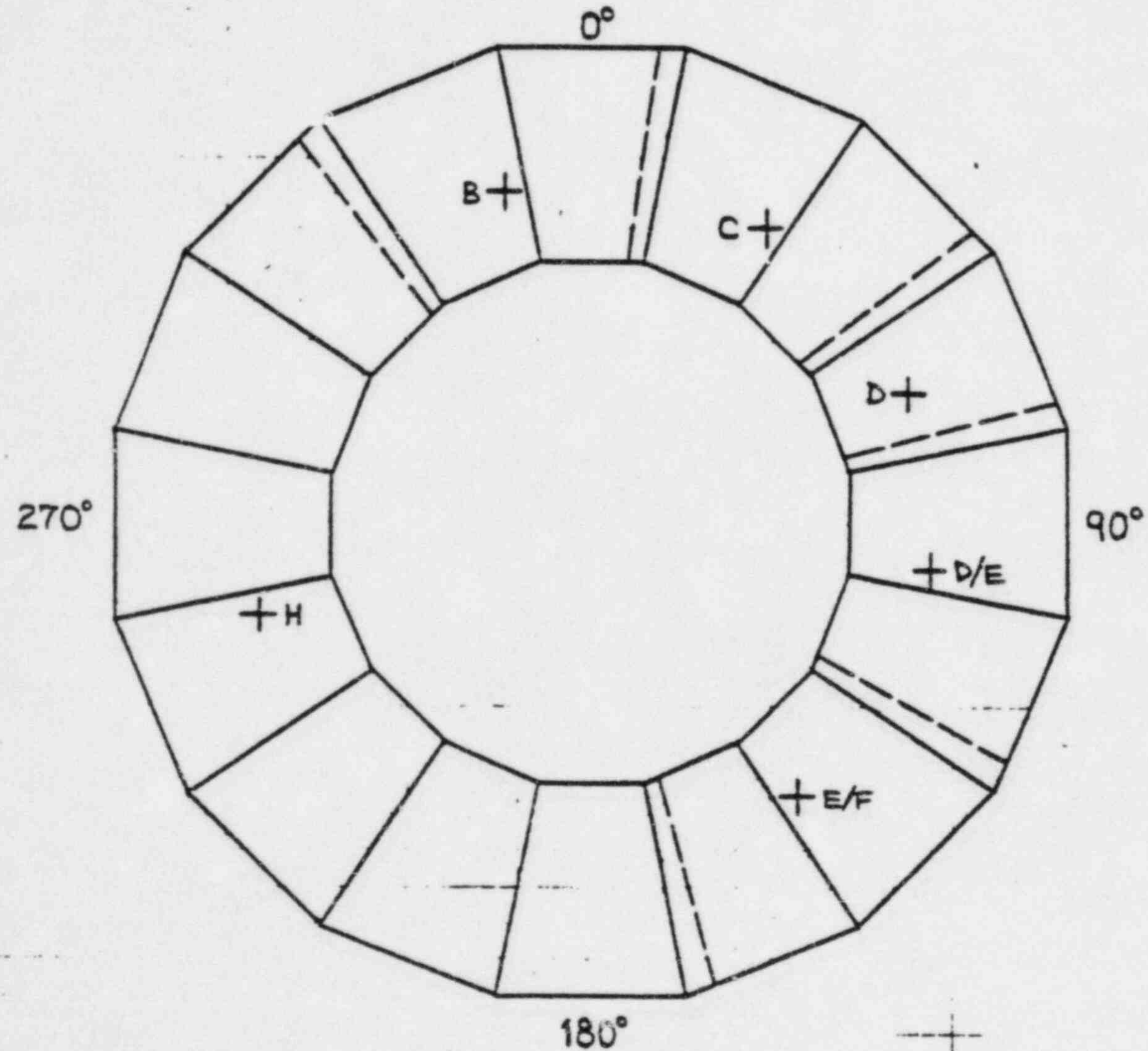
Figure 3.1.1. Diagram of Monitor Locations and Approximate Volumes Represented by Each Monitor



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3.2 DATA REDUCTION FOR CASE OF NO RHR CIRCULATION

In order to establish a more solid foundation, the analysis in the previous section will be repeated here for the case of no RHR circulation also found in Reference 1. The average bay temperatures for the bays not housing the discharging quencher are tabulated as functions of time in Table 3.2.1. These values are taken from Figure 5-7 of Reference 1. In Table 3.2.2, the temperatures for each monitor in the bay with the discharging quencher are tabulated along with the resultant average bay temperature as functions of time. These values are found in Figures A-6 and A-7 of Reference 1. The temperatures measured 80" from the base of the suppression pool for each bay are also tabulated in Table 3.2.3. The temperatures in the first five columns were taken from Figures A-1 through A-5 of Reference 1. The temperatures for Bay D were determined in the same manner as outlined in the previous section. The time-averaged deviation of the temperature measured at elevation 80" from the average bay temperature is reported for each bay in Table 3.2.4. With a maximum time-averaged deviation of 4.9°F, this elevation doesn't seem quite as good a choice as it did in the previous section. Of course, these deviations only indicate how well each monitor would track the local temperature averaged over the pool cross-section. They are not indicative of how well the total monitoring system would compare with the bulk pool temperature.

In Table 3.2.5, the bulk suppression pool temperature as a function of time and the deviation from the bulk temperature as a function of time for each bay at the elevation of 80" are tabulated. The bulk temperature may be obtained from any of the first eight figures in Appendix A of Reference 1. The deviations are computed in the same manner as in the previous section. The considerations for the volumetric weighting factors are also identical to those in the previous section. Finally, the resultant overall deviation from the bulk temperature as a function of time is tabulated in Table 3.2.6. The magnitude of the greatest deviation is 6.5°F, which is somewhat higher than for the previous case. But, of more significance is the fact that towards the end of the transient the deviation doesn't tend to die off. Instead, it hovers around a fairly constant value of +3°F. Therefore, it appears that the elevation of 80" is a little too high to be representative of the bulk conditions for this transient. However, for the overall transient the response of the monitors is still within ±7°F of the bulk temperature.

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TABLE 32.1. AVERAGE BAY TEMPERATURES (°F)					
Time (min)	Bay C	Bay B	Bay H	Bay E/F	Bay D/E
0	52.0	52.0	52.0	52.0	52.0
2	69.0	53.0	52.3	52.3	67.1
4	80.2	68.0	52.3	52.3	76.8
6	94.0	76.0	58.4	56.4	81.0
8	98.4	86.9	66.5	60.0	84.2
10	101.6	92.0	76.0	68.8	84.5
12	100.8	96.0	85.0	78.7	89.4
14	90.0	90.0	88.0	86.9	92.0
16	88.1	84.5	87.0	90.9	92.8
18	88.8	85.5	88.8	88.1	92.9
20	89.7	87.3	88.9	87.9	92.0
22	90.0	89.1	88.9	87.7	91.4
24	89.0	88.3	89.2	87.2	89.5
26	89.8	88.2	88.7	88.7	91.0
28	89.2	88.9	88.6	88.9	90.8
30	89.7	88.3	88.5	89.0	90.5
32	89.8	88.4	88.5	88.7	90.2
34	89.0	88.1	88.4	88.9	90.6
36	88.7	87.5	88.4	89.2	90.5

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TABLE 3.2.2. TEMPERATURES IN BAY D (°F) (Discharging Quencher)

Time (min)	T_{16}	T_{17}	T_{18}	T_{19}	T_{20}	T_{21}	T_{22}	T_{23}	Ave. Temp.
0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0
2	85.2	85.0	88.8	77.5	89.0	91.0	96.5	96.7	88.7
4	103.2	104.8	107.9	92.0	111.5	109.1	106.6	106.6	105.2
6	113.8	114.9	117.0	96.6	121.1	122.6	127.2	128.0	117.7
8	122.0	122.0	122.0	107.2	126.5	124.0	130.5	130.5	123.1
10	121.0	121.2	124.8	106.0	128.6	128.0	134.0	135.0	124.8
12	120.2	116.2	86.0	83.0	103.4	96.0	123.0	117.5	105.7
14	122.8	99.8	82.0	91.1	86.0	76.9	123.0	107.3	98.6
16	122.7	100.3	75.2	86.6	86.0	73.0	121.1	99.1	95.5
18	120.0	100.8	71.2	85.8	84.0	74.0	119.5	101.7	94.6
20	120.7	102.7	69.2	84.6	80.0	70.0	120.0	105.5	94.1
22	120.8	104.6	67.8	77.9	78.0	68.8	119.0	106.5	92.9
24	119.5	106.9	66.8	78.8	78.0	67.1	120.0	107.8	93.1
26	118.8	105.1	66.6	77.9	78.7	66.0	119.0	108.0	92.5
28	119.6	105.5	66.6	77.7	79.1	65.8	118.6	108.0	92.6
30	118.6	104.2	66.5	89.6	79.5	65.0	118.0	106.8	93.5
32	118.0	103.9	66.0	81.6	81.9	65.0	116.9	105.1	92.3
34	118.0	103.4	64.9	82.8	83.0	64.8	117.0	104.5	92.3
36	118.0	103.2	65.5	82.0	82.8	64.8	116.9	105.3	92.3

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TABLE 3.2.3. TEMPERATURE MEASURED 80" FROM BOTTOM OF BAY (°F)

Time (min)	Bay C	Bay B	Bay H	Bay E/F	Bay D/E	Bay D
0	52.0	52.0	52.0	52.0	52.0	52.0
2	71.0	52.0	52.0	52.8	62.0	91.6
4	72.8	67.8	52.0	53.1	72.8	111.1
6	104.0	73.0	54.0	53.2	70.2	121.9
8	112.4	94.0	55.0	53.3	78.3	125.9
10	119.4	103.9	70.8	72.4	76.3	128.6
12	115.4	111.2	87.5	89.2	86.0	112.5
14	85.7	90.6	92.6	97.0	94.0	92.5
16	84.6	78.9	86.8	97.1	93.2	87.0
18	88.0	81.5	90.8	94.7	92.8	90.5
20	90.8	87.4	94.7	93.8	90.5	94.7
22	90.8	92.3	94.0	91.5	87.9	97.2
24	88.7	92.4	92.8	89.8	87.3	100.1
26	91.4	91.0	92.5	91.3	88.8	99.5
28	90.0	94.0	92.0	92.2	89.4	99.7
30	92.0	92.0	91.5	92.0	90.2	98.2
32	93.2	92.5	91.8	91.6	89.8	97.0
34	92.2	91.4	90.8	92.6	91.2	96.1
36	91.0	90.8	91.3	92.8	91.2	96.6

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TABLE 3.2.4

TIME-AVERAGED DEVIATION OF TEMPERATURE @ 80" FROM THAT OF AVERAGE BAY TEMPERATURE

Bay	Deviation(°F)
C	4.9
B	4.2
H	3.5
E/F	4.3
D/E	2.9
D	4.8

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Owner Carolina Power and Light Company
Client United Engineers and Constructors, Inc.

TABLE 3.2.5. BULK TEMPERATURE AND DEVIATIONS FROM BULK @ 30" (°F)

Time (min)	T_{bulk}	σ_C	σ_B	σ_H	$\sigma_{E/F}$	$\sigma_{D/E}$	σ_D
0	52.0	0.0	0.0	0.0	0.0	0.0	0.0
2	58.6	12.4	-6.6	-6.6	-5.8	-3.4	33.0
4	65.3	7.5	2.5	-13.3	-12.2	7.5	45.8
6	72.0	32.0	1.0	-18.0	-18.8	-1.8	49.9
8	78.6	33.8	15.4	-23.6	-25.3	-0.3	47.3
10	85.2	34.2	18.7	-14.4	-12.8	-8.9	43.4
12	89.0	26.4	22.2	-1.5	0.2	-3.0	23.5
14	89.0	-3.3	1.6	3.6	8.0	5.0	3.5
16	89.0	-4.4	-10.1	-2.2	8.1	4.2	-2.0
18	89.0	-1.0	-7.5	1.8	5.7	3.8	1.5
20	89.0	1.8	-1.6	5.7	4.8	2.5	5.7
22	89.0	1.8	3.3	5.0	2.5	-1.1	8.2
24	89.0	-0.3	3.4	3.8	0.8	-1.7	11.1
26	89.0	2.4	2.0	3.5	2.3	-0.2	10.5
28	89.0	1.0	5.0	3.0	3.2	0.4	10.7
30	89.0	3.0	3.0	2.5	3.0	1.2	9.2
32	89.0	4.2	3.5	2.8	2.6	0.8	8.0
34	89.0	3.2	2.4	1.8	3.6	2.2	7.1
36	89.0	2.0	1.8	2.3	3.8	2.2	7.6

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Prepared By/Date	ERM 5/27/81					
Checked By/Date	JGH 6/4/81					

TABLE 3.2.6

VOLUME-AVERAGED DEVIATIONS FROM BULK @ 80" (°F)

Time (min)	σ	Time (min)	σ
0	0.0	20	3.8
2	-1.3	22	3.5
4	-2.3	24	2.7
6	-3.2	26	3.0
8	-4.4	28	3.2
10	0.3	30	2.9
12	6.5	32	3.1
14	3.2	34	3.8
16	-1.4	36	2.7
18	1.0		

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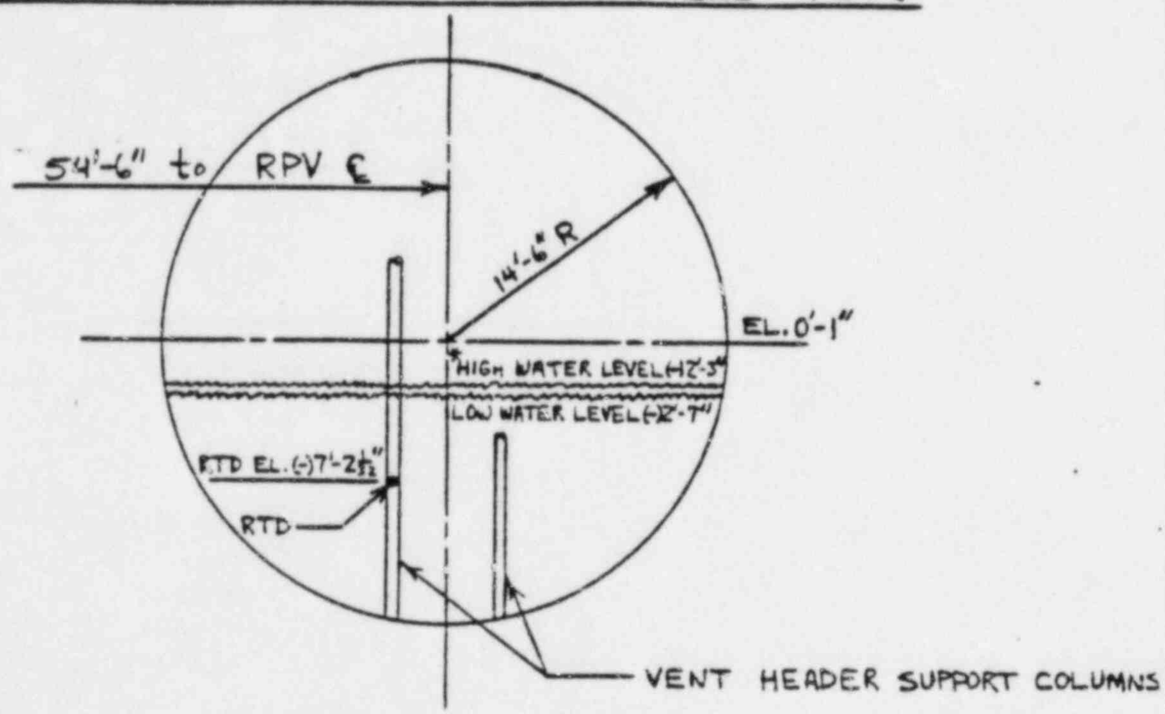
Owner Carolina Power and Light Company

Client United Engineers and Constructors, Inc.

3.3 CALCULATION OF SENSOR ELEVATION



Assume:

Average Operating Water Level $= \frac{1}{2}[(-)2'\text{-}3" + (-)2'\text{-}7"] = \underline{(-)2'\text{-}5"}$

$d = 0'\text{-}1" - (-)2'\text{-}5" = 30"$

$R = 14'\text{-}6" = 174"$

From CRC Standard Math Tables, 17th Ed., pg. 12:

$$A_{pool} = R^2 \cos^{-1}\left(\frac{d}{R}\right) - d\sqrt{R^2 - d^2}$$

* The high water level is given in Reference 3, while, all other dimensions are from Reference 2.

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Checked By/Date	JSH 6/4/81		

$$A_{pool} = (174'')^2 \cos^{-1}\left(\frac{30''}{174''}\right) - (30'')\sqrt{(174'')^2 - (30'')^2}$$
$$= 37{,}169.4 \text{ in}^2$$

Now solve for the value of d where the pool cross-sectional area is half of that above.

$$\frac{1}{2} A_{pool} = R^2 \cos^{-1}\left(\frac{d_{1/2}}{R}\right) - d_{1/2}\sqrt{R^2 - d_{1/2}^2}$$

$$\frac{A_{pool}}{2R^2} = \cos^{-1}\left(\frac{d_{1/2}}{R}\right) - \left(\frac{d_{1/2}}{R}\right)\sqrt{1 - \left(\frac{d_{1/2}}{R}\right)^2}$$

Let $d' = \frac{d_{1/2}}{R}$

$$\frac{37{,}169.4 \text{ in}^2}{2(174'')^2} = \cos^{-1}(d') - d'\sqrt{1-(d')^2}$$

$$0.61384 = \cos^{-1}(d') - d'\sqrt{1-(d')^2}$$

Iterating for d' : $d' = 0.5002$

$$d = 0.5002(174'') = \underline{87.0348''}$$

Elevation of Sensors $= (0'\text{-}1'') - 87.0348''$
$= \underline{(-)\ 7'\text{-}2\frac{1}{32}''}$

It should be pointed out that the RTD has been indicated on the vent header support column which is on the reactor vessel side of the torus ℄ in the previous figure. This column was chosen since it was the column where the sensors were mounted in the torus bays not housing the discharging quencher in the tests performed in Reference 1.

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4.0 RESULTS AND CONCLUSIONS

The calculations performed in Sections 3.1 and 3.2 indicate that the temperature measured at the vertical centroid of the suppression pool follows the temperature averaged over the pool cross-section within a few degrees Fahrenheit. The calculations also demonstrate that monitors at the elevation of the pool centroid which are distributed azimuthally about the torus will accurately predict the bulk pool temperature during transients if the proper volumetric weighting factors are assigned to each monitor. Therefore, it is concluded that the vertica' centroid of the suppression pool is the

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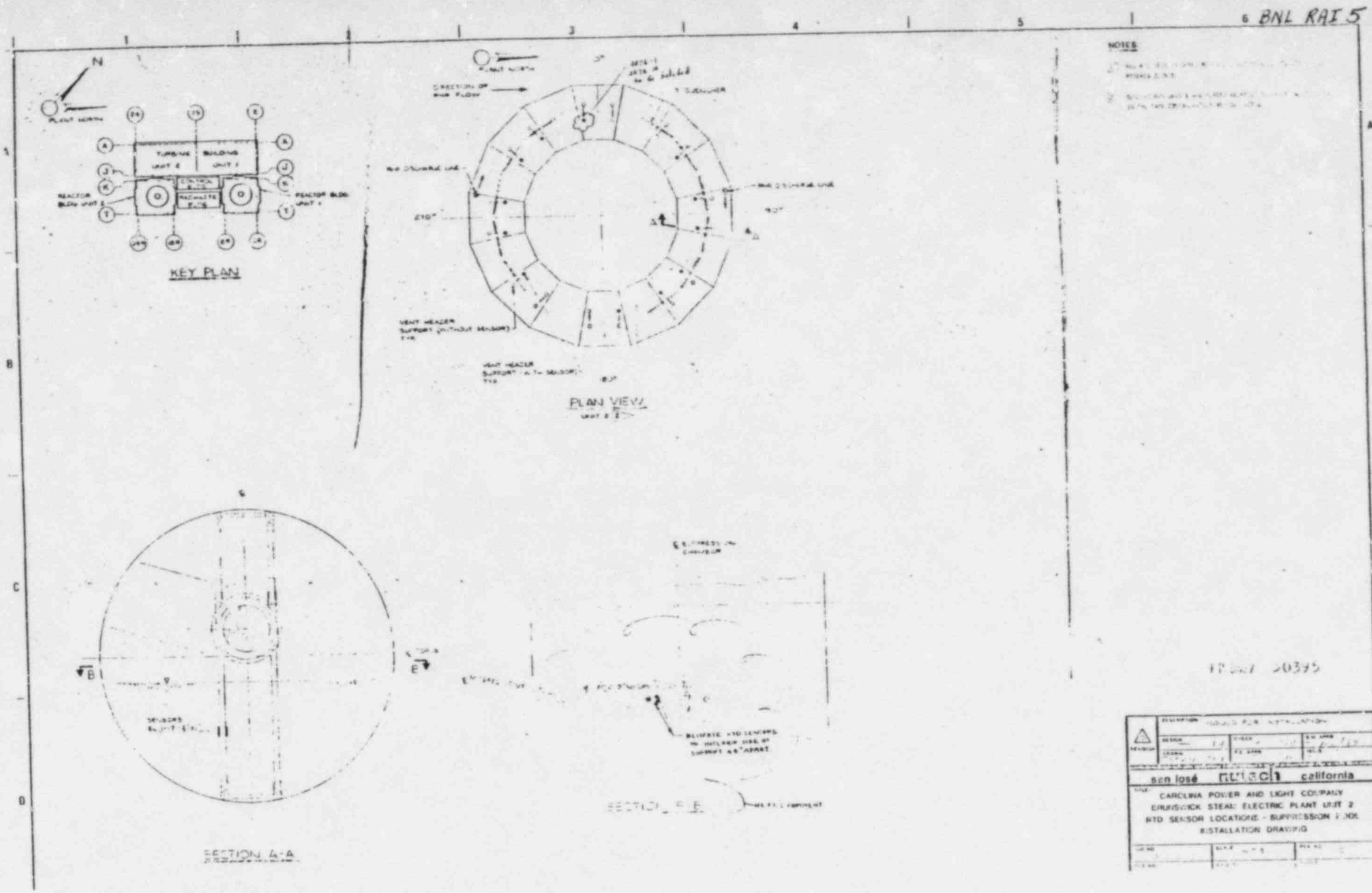
ideal location for mounting sensors to monitor the bulk suppression pool temperature during transients. Since the sensors were mounted on the vent header support columns on the RPV side of the torus during the Monticello tests, it is also concluded that this would be a good location for a permanent monitoring system also. In summary, the RTD sensor locations for the temperature monitoring system should be on the vent header support columns on the RPV side of the torus at elevation (-) 7'-2 $\frac{1}{32}$".

5.0 References

1.) Monticello T-Quencher Thermal Mixing Test Final Report, Task No. 7.5.2, General Electric Company, NEDE-24542-P, April 1979

2.) United Engineers and Constructors, Inc., DWG # 9527-D-2792, NUTECH File No.- 155.2301.0011

3.) Personal Communication with Vasant Deo of United Engineers and Constructors, Inc., on May 26, 1981


BNL RAI 5
NOTES
KEY PLAN
TURBINE BUILDING
UNIT 2
UNIT 1
REACTOR BLDG UNIT 2
REACTOR BLDG UNIT 1
PLANT NORTH
DIRECTION OF RHR FLOW
PLAN VIEW
VENT HEADER SUPPORT (WITHOUT SENSORS) TYP
VENT HEADER SUPPORT (WITH SENSORS) TYP
SECTION A-A
SECTION B-B
ELIMINATE RTD SENSORS
SENSORS
san josé
california
CAROLINA POWER AND LIGHT COMPANY
BRUNSWICK STEAM ELECTRIC PLANT UNIT 2
RTD SENSOR LOCATIONS - SUPPRESSION POOL
INSTALLATION DRAWING

RAI 6 - PUAR Section 2.2.2, AC Section 2.13.7

During the discussion concerning the SRV load cases which are applicable to Brunswick, various load cases were eliminated by stating that these load cases were bounded by others, e.g. case A1.2 (SBA) bounds A1.2 (IBA), thus only A1.2 (SBA) was analyzed. Justify these statements by providing the results of the computer analysis which were performed or the reasons why various cases bound others.

RESPONSE

A. The actuation of a Safety Relief Valve (SRV) results in the following loads:

1) Thrust loads on the SRV piping and T-Quencher (RVFOR)

2) T-Quencher water jet loads (TQJET)

3) Pressure loads on torus shell (QBUBS)

4) Drag loads on submerged structures (TQFOR)

These loads were calculated by GE's computer codes RVFOR, TQJET, QBUBS and TQFOR, respectively. Table 1, Attachment RAI 6 shows computer analyses performed for various SRV loading cases (marked by X), and reasons why various cases bound others.

For A1.2 and A3.2 load cases, both SBA and IBA are required in the load specification. The only input difference used in calculating thrust loads for SBA and IBA is the drywell pressure at the time of air purging from drywell to wetwell. For Brunswick, the drywell pressure is 22.6 psig at SBA and 21.6 psig at IBA. This small difference in input leads to small variations in the magnitude of the loads. Table 2, Attachment RAI 6 indicates that the loads from SBA are slightly greater than those from IBA, it was therefore concluded that A1.2 (SBA) bounds A1.2 (IBA) and A3.2 (SBA) bounds A3.2 (IBA).

RAI 6 - PUAR Section 2.2.2, AC Section 2.13.7 (Continued)

RESPONSE (Continued)

For cases A1.1 and A1.3 the same initial conditions apply in RVFOR, but the ASME S/RV flow rate for A1.3 is less than A1.1, therefore A1.1 bounds A1.3.

Table 1 Analysis for SRV Load Cases

Table 2 RVFOR -S/RVDL Discharge Loads

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

Attachment RAI 6

BNL RAI 6

Table 1 Analysis for SRV Load Cases

SRV Load Cases	RVFOR	TQJET	QBUBS	TQFOR
A1.1	X	X	X	X
A1.2	X	X	X	X
A1.3	Use A1.1 (2)	Use A1.1 (1)	Use A1.1 (1)	Use A1.1 (1)
A2.2	Use A1.2 (1)	N/A (3)	Use A1.2 (1)	X (4)
A3.1	Use A1.1 (1)	N/A (3)	Use A1.1 (1)	X (4)
A3.2	Use A1.2 (1)	N/A (3)	Use A1.2 (1)	X (4)
C3.1	X	X	X	X

Notes:

1. Same initial conditions apply, hence same results can be used.
2. Same initial conditions apply except the ASME S/RV flow rate. The flow rate for A1.3 is less than that for A1.1, therefore, A1.1 bounds A1.3.
3. Since the water jets from the arm of one quencher will not interact with the water jets from any adjacent quencher, only one valve discharge load should be considered (Application Guide 6).
4. In some cases, instead of computer analysis a multiplier was applied to corresponding single valve loads to bound the multiple valve loads.

BNL RAI 6

Table 2

LINE 59 – RVFOR – S/RVDL DISCHARGE LOADS – FROM OUTPUT

MAX. SEGMENT FORCES & WATER THRUST

SEG. NO	A1-2SBA	A1-2IBA	C3-2SBA	C3-2IBA	C3-3SBA	C3-3IBA
1	3337 t=.0042	3335 t=.0042	3168 t=.0039	3168 t=.0039	2736 t=.0086	3727 t=.0033
2	1345 t=.0054	1356 t=.0054	1195 t=.0051	1201 t=.0051	673. t=.0043	486 t=.0044
3	4610 t=.0084	4620 t=.0084	4179 t=.0081	4181 t=.0081	2897 t=.0153	3002 t=.0152
4	2605 t=.0100	2623 t=.0099	2334 t=.0097	2350 t=.0096	1325 t=.0082	1197 t=.0081
5	1946 t=.0110	1963 t=.0109	1721 t=.0107	1737 t=.0106	1396 t=.0090	1260 t=.0091
6	6622 t=.0149	6624 t=.0149	6038 t=.0144	6035 t=.0143	3775 t=.0123	3643 t=.0122
7	9714 t=.0223	9700 t=.0223	8989 t=.0213	8946 t=.0213	5836 t=.0183	5513 t=.0173
8	5974 t=.0240	5971 t=.0239	5390 t=.0232	5413 t=.0231	3099 t=.0196	2844 t=.0195
9	6725 t=.0259	6745 t=.0258	6104 t=.0248	6110 t=.0247	3824 t=.0211	3453 t=.0211
10	11049 t=.0331	11008 t=.0329	10215 t=.0318	10162 t=.0316	6554 t=.0272	6259 t=.0266
11	8625 t=.0354	8638 t=.0353	7830 t=.0340	7827 t=.0339	4902 t=.0291	4641 t=.0290
12	8764 t=.0375	8771 t=.0374	7985 t=.0360	7974 t=.0359	4825 t=.0307	4409 t=.0326
13	11265 t=.0442	11202 t=.0440	10922 t=.0437	10868 t=.0433	8230 t=.0413	8085 t=.0412
14	10424 t=.0534	10425 t=.0534	9717 t=.0514	9686 t=.0512	-16644 t=.1620	-1199 t=.1472
15	10482 t=.0563	10416 t=.0558	9995 t=.0544	9966 t=.0542	-77449 t=.2075	-63416 t=.1965
WTR TRST	-48316 t=.143088	-48217 t=.143208	-51614 t=.139479	-51555 t=.139266	-156842 t=.22106	-141635 t=.212722

NOTES: 1. UNITS ARE LBS. & SECONDS.

2. THIS TABLE SHOWS THE ABSOLUTE MAX. SEGMENT FORCES AND WATER THRUSTS

RAI 7 - PUAR Section 2.2.2, AC Section 2.13.7

The AC required that an asymmetric SRV discharge load case be considered for both first and subsequent actuations with the degree of asymmetric discharge for each event combination being determined from a plant-specific primary system analysis design to maximize the asymmetric condition. No mention of an asymmetric SRV discharge load case is made in the PUAR load case discussion. Provide sufficient information to satisfy the AC requirements concerning this matter.

RESPONSE

A. The various combinations of S/RV actuations was considered and the maximum possible effect of all the asymmetric effects are included by calculating the absolute sum of all the effects from the eleven S/RV's. See Section 1.5-d of PUAR for details.

RAI 8a - PUAR Section 3.3.2.3, AC Section 2.10.1

The equations presented in the PUAR for interpolating the vent header deflector forces at various Z/L's are not consistent with the AC. These equations utilized the longitudinal multiplier distribution from NEDO-24612 and thus do not incorporate the AC specification that the three-dimensional load variation shall be based on the EPRI "main vent orifice" tests. Describe in detail how the vent deflector forces were calculated at the various Z/L's.

RESPONSE:

The pool swell deflector loads were calculated in accordance with procedures are described below:

1. Figures 1, 2 and 3, Attachment RAI 8a-1, show the load histories presented in the PULD for Z/L locations, 1.0, 0.5 and 0 used as the calculation bases.
2. Figure 4, Attachment RAI 8a-1, show the load histories for intermediate Z/L stations. These were calculated using the following interpolation equations:

   For $0 \leq Z/L \leq 0.5$

   $$F(Z/L) = \frac{[F(0.5) - F(0)]\,[K(Z/L) - 0.830]}{0.170} + F(0)$$

   For $0.5 \leq Z/L \leq 1.0$

   $$F(Z/L) = \frac{[F(1.0) - F(0.5)]\,[K(Z/L) - 1.0]}{0.350} + F(0.5)$$

   where K is the acceleration multiplier derived from the EPRI 1/12 scale movie data (Ref. 1) shown in Fig. 3-21 of NEDO-24612, Attachment RAI 8a-2. The multiplier K, which is a function of longitudinal location, was developed in NEDO-24614 to take into account the three-dimensional effects.

RESPONSE: (Continued)

3. Figure 5, Attachment RAI 8a-1, show the Pool Swell Height versus Impact Time curves at Z/L locations, 0, 0.5 and 1.0. These curves were based on the Pool Surface Displacement Longitudinal Distribution curves shown in Figure 4.3.4.2 of the LDR and the Plant Pool Surface Displacement curves (PULD). Data for intermediate Z/L stations were linearly interpolated from the generated curves. This process, similar to that described for Figure 8-3, Attachment RAI 8a-3, was taken into account for the effect of impact time delay.
4. Figure 6, Attachment RAI 8a-1, show the Pool Swell Velocities versus Impact Time Curves at Z/L locations, 0., 0.5 and 1.0. These curves were based on the Pool Surface Velocity Longitudinal Distribution curves shown in Figure 4.3.4-4 of the LDR and the Plant Velocity Transient curves (PULD). Data for intermediate Z/L stations were linearly interpolated from the generated curves. This process, similar to that described for Figure 8-4, Attachment RAI 8a-3, was taken into account for the effect of pool swell velocity due to the uneven spacing of downcomer pairs.
5. The initial impact pressure (F) and the duration of the spike (t), for various Z/L stations were calculated using the following equations:

$$F = \frac{7\rho V^2 d}{2}$$

$$t = \frac{0.136d}{V}$$

where d = diameter of deflector (ft)

V = impact velocity (ft/sec)

ρ = water density (lbm/ft^3)

RESPONSE: (Continued)

5. (Continued)

   The impact pressure was conservatively added. Since the deflector is 3.75 inches above the pool surface, it will, however experience no impact as shown in Figures 1 through 3, Attachment RAI 8a-1.

6. Final pool swell deflector loads, Figure 7, Attachment RAI 8a-1, can be obtained by combining the impact and drag loads and considering the effects of time delay, (Reference Figure 2.10-3 of the Acceptance Criteria).

   The above procedure complies with the LDR, Revision 2, except step 2 which is further discussed in the Response of RAI 8b.

References

1. Three Dimensional Pool Swell Modelling of a Mark I Suppression System, EPRI NP-906, October, 1978.

2. Mark I Containment Program Vent Header Deflector Load Definition, NEDO-24612, April, 1979.

CALCULATION SET NO.

9527-E-SC-DV-1-F

Sheets 15, 16, 17, 19, 24, 26 and 31 of 217

(Total 7 sheets)

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

Attachment RAI 8a-1

FORM 5015

GENERAL COMPUTATION SHEET

united engineers & constructors inc.

NAME OF COMPANY: BSEP

SUBJECT: Pool Swell Loads

J.O. NO. 9527040
SHEET NO. 15 OF 217
DATE 2/12/81 4/3/81
COMP. BY JCM CHK'D BY VE

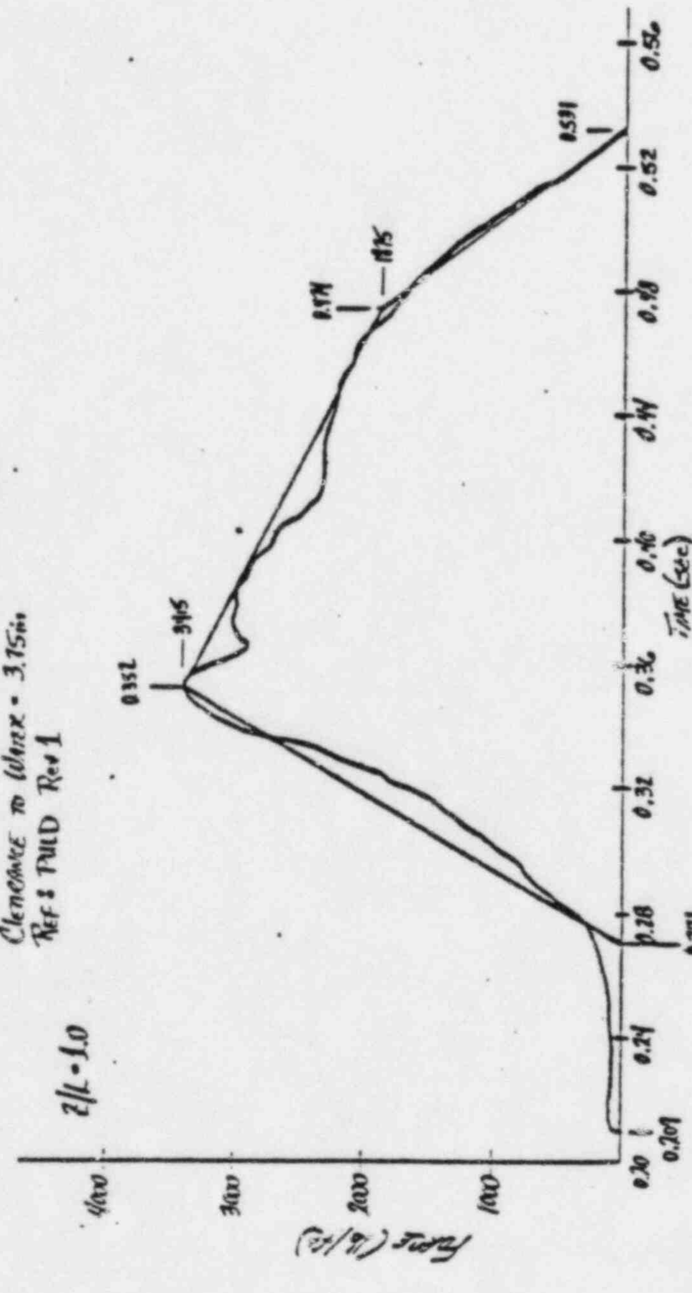


Fig: 1 PULD LOAD (Z/L = 1.0)

FORM 5015

GENERAL COMPUTATION SHEET

united engineers & constructors inc.

NAME OF COMPANY: ESED	J.O. NO. 9570PD
	SHEET NO. 16 OF 217
	DATE 2/12/81 6/3/81
SUBJECT: Pool Swell Loads	COMP. BY JCM CHK'D BY VE

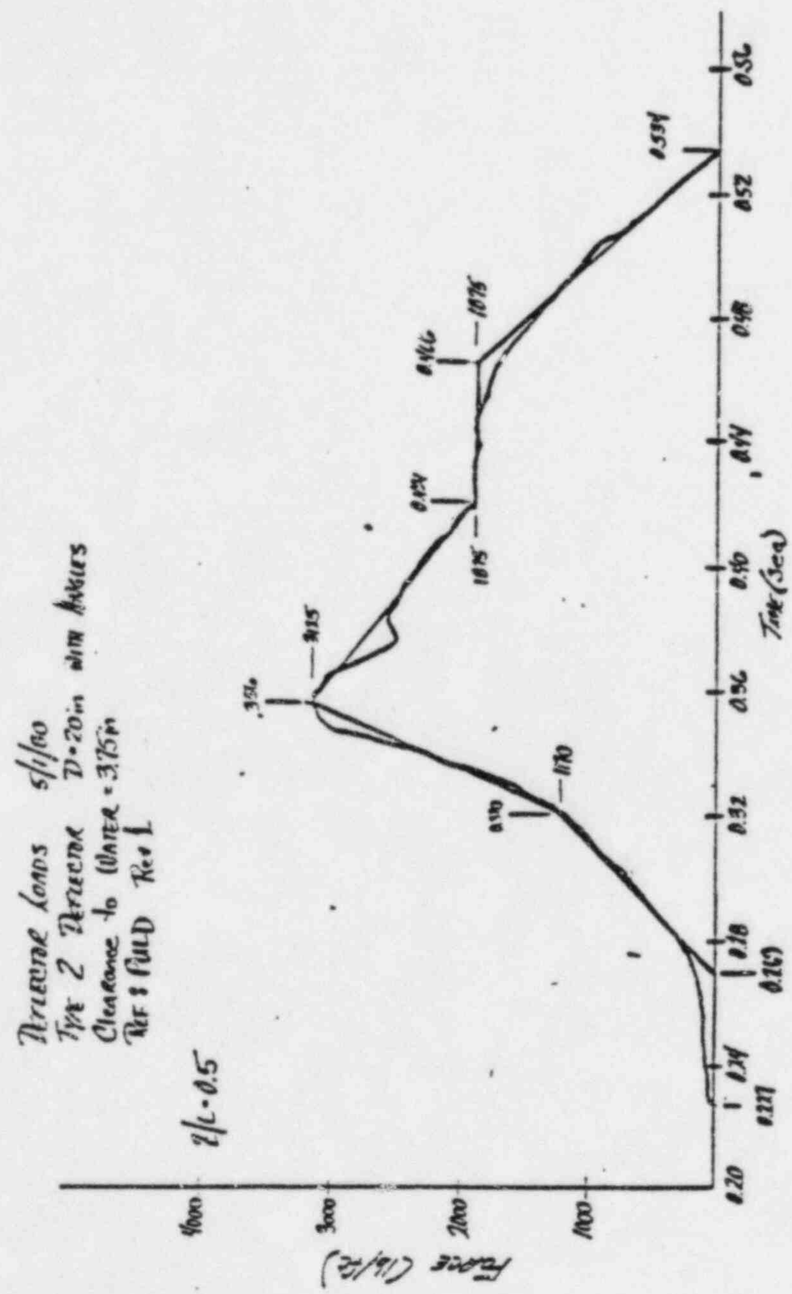


Fig. 2 PULD LOAD (Z/L = 0.5)

FORM 5015

GENERAL COMPUTATION SHEET

united engineers & constructors inc.

NAME OF COMPANY: BSEP	J.O. NO. 9527040
SUBJECT: Pool Swell Loads	SHEET NO. 17 OF 27
	DATE 2/21/81 4/3/81
	COMP. BY JCM CHK'D BY YCF

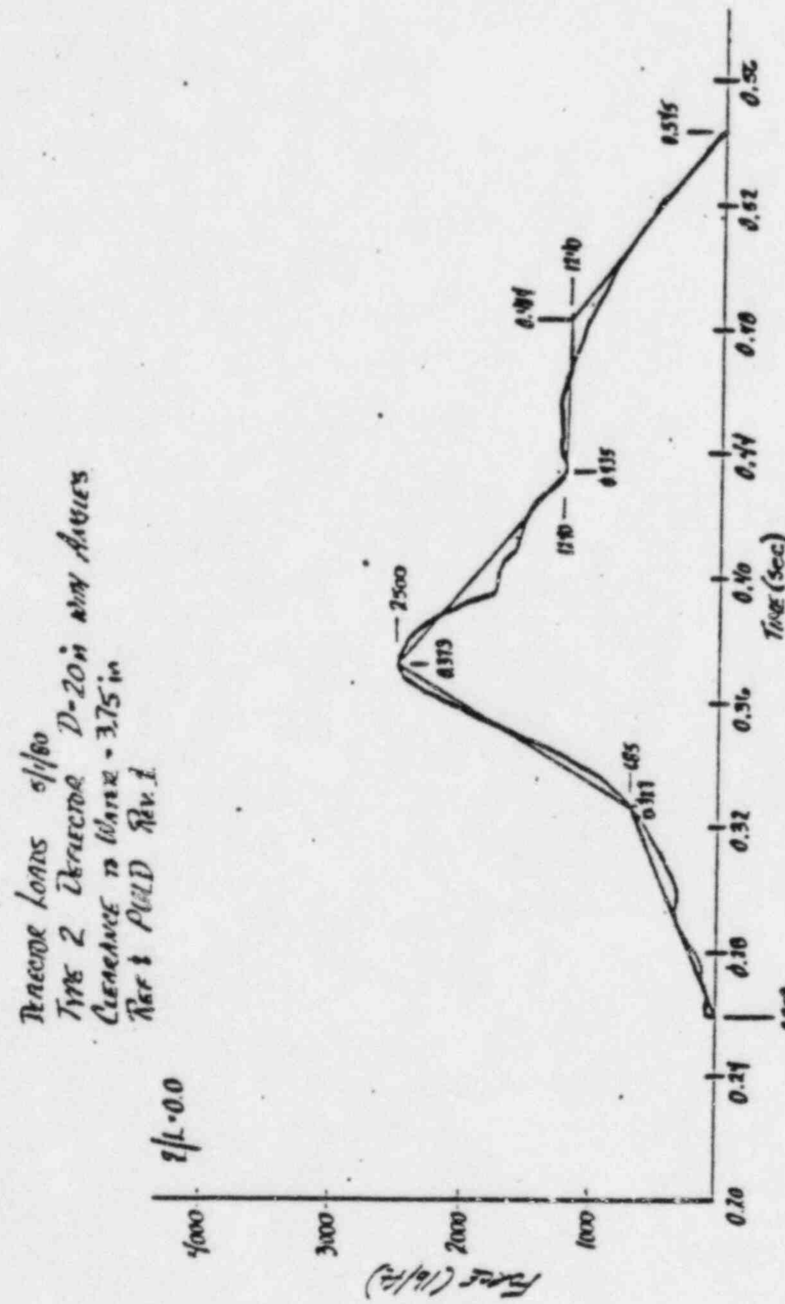


Fig. 3 PULD LOAD (Z/L = 0.0)

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers

CALC. SET NO.		REV	COMP. BY	CHKD. BY
PRELIM.		0	YLT	LFH
FINAL	9527-E-SC-DV-1-F		DATE 9-11-81	DATE 11-17-81
VOID				
SHEET	19 OF 217		DATE	DATE
J.O.	9527040			

NAME OF COMPANY: BSE UNIT/S: 1 & 2

SUBJECT: Pool Swell Loads

	Node 300	Node 308	Node 301	Node 302	Node 304	Node 305	Node 303
	Z/L = 1.0	Z/L = 0.5	Z/L = 0.921	Z/L = 0.862	Z/L = 0.713	Z/L = 0.657	Z/L = 0.792
t	F (lb/ft)	F (lb/ft)	F (lb/ft)	F (lb/ft)	F (lb/ft)	F (lb/ft)	F (lb/ft)
0.259	0	0	0	0	0	0	0
0.269	0	0	0	0	0	0	0
0.271	0	0	0	0	0	0	0
0.320	1700	1170	1655	1610	1475	1350	1550
0.327	2100	1200	2025	1945	1715	1510	1845
0.352	3415	3100	3390	3360	3280	3210	3325
0.356	3400	3125	3375	3350	3285	3220	3320
0.373	3000	2500	2960	2915	2785	2670	2860
0.421	2450	1875	2400	2350	2205	2070	2285
0.435	2400	1875	2355	2310	2175	2055	2250
0.466	2100	1875	2080	2060	2005	1950	2035
0.474	1875	1600	1850	1830	1760	1695	1795
0.484	1800	1250	1755	1705	1565	1440	1645
0.531	0	0	0	0	0	0	0
0.534	0	0	0	0	0	0	0
0.545	0	0	0	0	0	0	0

Fig. 4 LOAD HISTORIES FOR VARIOUS Z/L

CALC. SET NO.	
PRELIM.	
FINAL	9527-E-SC-D4-F
VOID	
SHEET	24 OF 27
J.O.	9527040

REV.	COMP. BY	CHK'D BY
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CLASS		

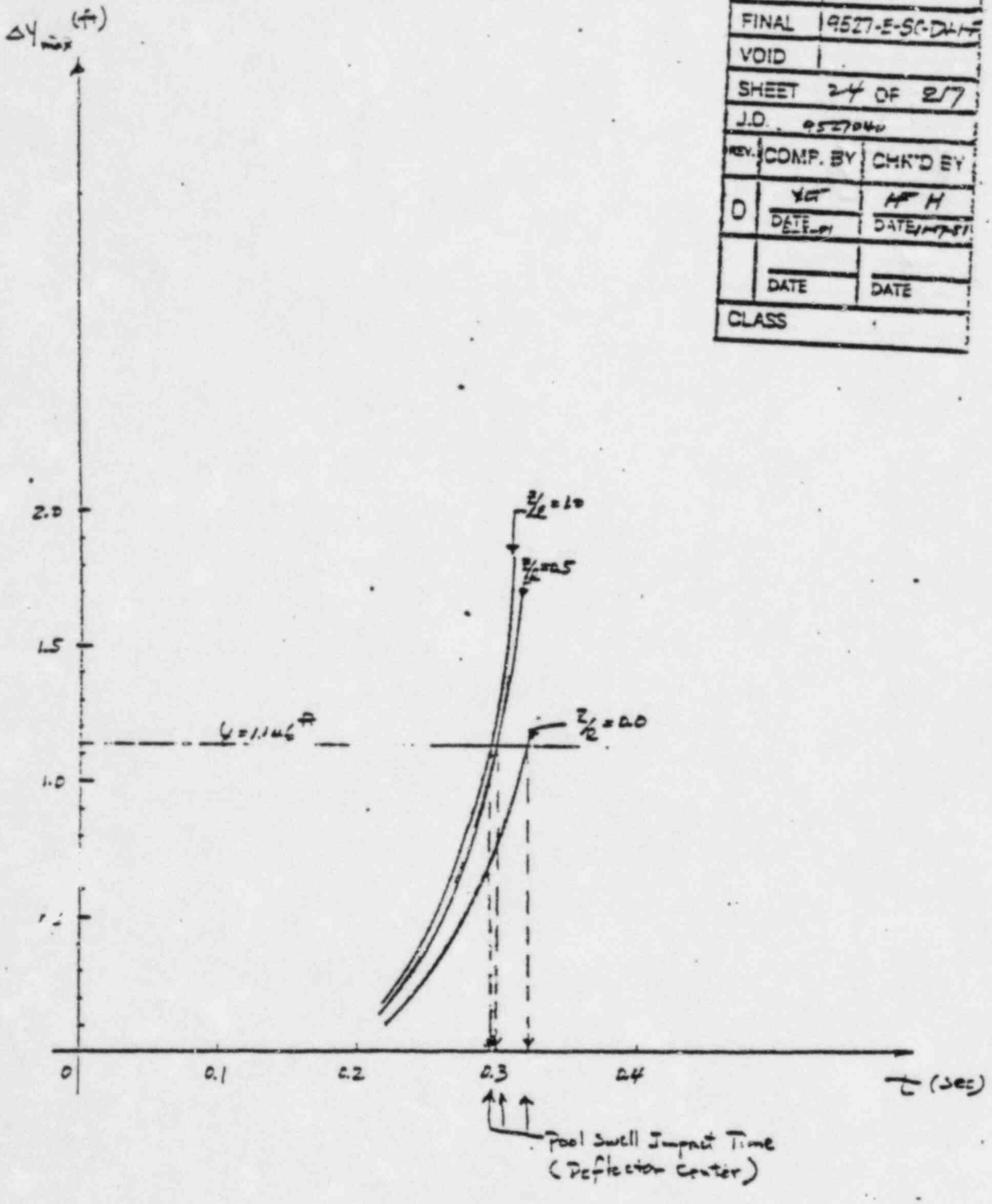

Fig. 5 Pool Swell Height vs Impact Time

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PRELIM.		
FINAL	9527-E-SC-D?-HF	
VOID		
SHEET 26 OF 217		
J.O. 9567040		
REV.	COMP. BY	CHK'D BY
0	YLT DATE ..-81	HFH DATE ..-17-81
	DATE	DATE
CLASS		

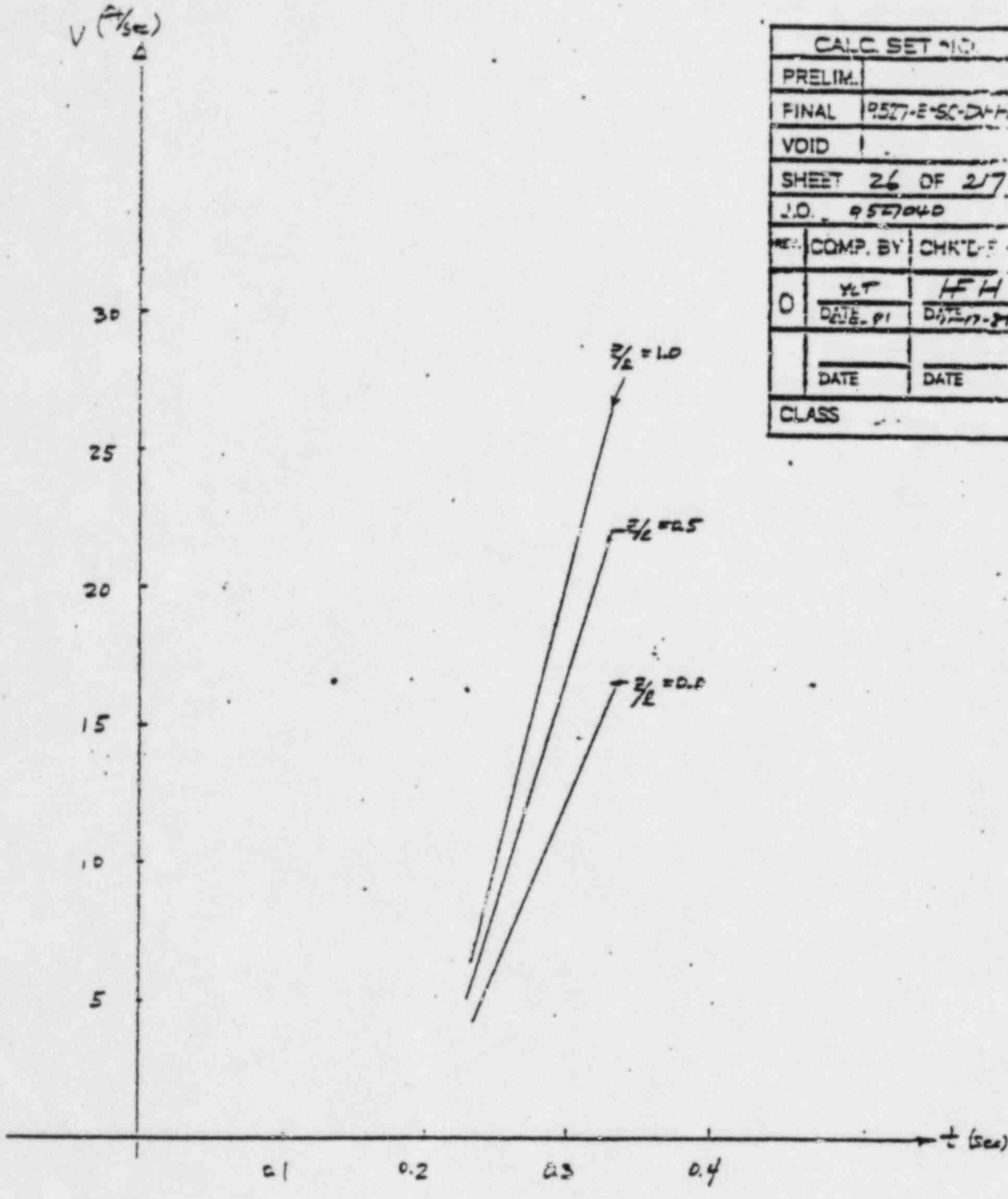
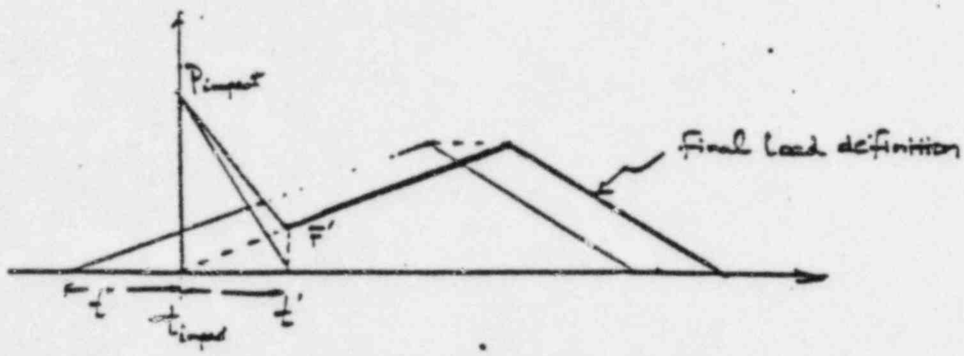


Fig. 6 Pool Swell Velocity vs Impact Time

t_{impact} , P_{impact}

t^* = time from $\frac{vt^*}{d} = 0.207$ at impact (shift time)

t' = impact duration, obtained from $\frac{vt'}{d} = 0.136$



F' = pool swell load at $t_{impact} + t'$

Fig. 7 Combined Impact and Drag Loads

NEDO-24612

Figure 3-21

Page 3-36

(Total 1 Sheet)

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BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

Attachment RAI 8a-2

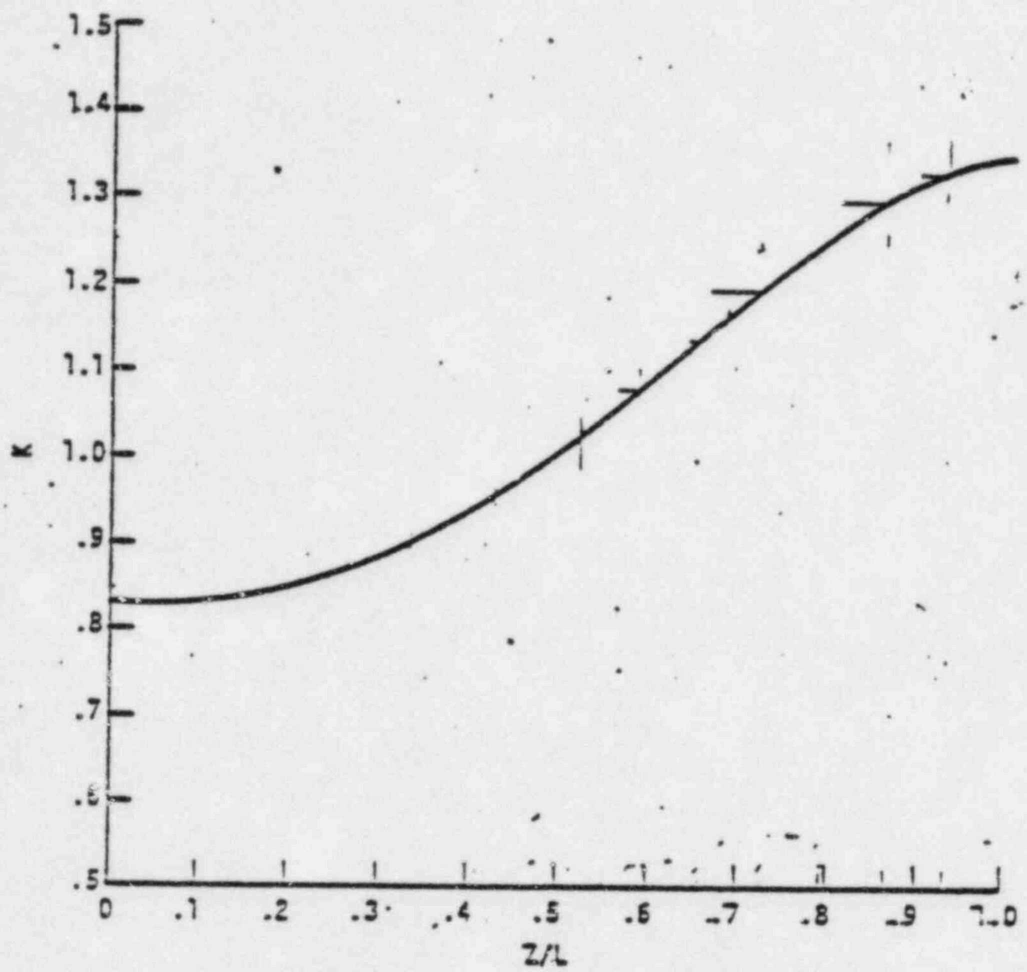

Figure 3-21. Pool Surface ~~Velocity~~ and ~~Acceleration~~ Multiplier as a Function of Longitudinal Location (Reference 7)

THREE DIMENSIONAL POOL SWELL MODELING

OF A

MARK I SUPPRESSION SYSTEM

EPRI NP-906, OCT. 1978

Pages 8-3 and 8-4

(Total 2 Pages)

CAROLINA POWER & LIGHT COMPANY

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UNITS 1 & 2

was necessary. Early attempts at numerical differentiation were unsatisfactory because the process of differentiation amplified any irregularities in the original data. The irregularities, manifested as wiggles in an otherwise smooth curve, were associated with film resolution and projector registration.

Figure 8-3 shows three of these untreated pool swell histories. The symbol points are identifiers; actual data points occurred every 2 ms. The corresponding velocity histories, obtained by differentiation, are shown in Figure 8-4, which clearly shows the amplification of irregularities. The adverse consequence of this amplification was that the pool swell velocity information had an unacceptably large scatter.

To correct this shortcoming, a special data reduction scheme was devised. First, the untreated pool swell history was replaced by a third-order polynomial fit, then the differentiation was performed. This scheme was justified because the mass of water participating in the pool swell was so large that a jerky motion was simply not possible. A least-squares-fit routine was specially developed for this purpose.

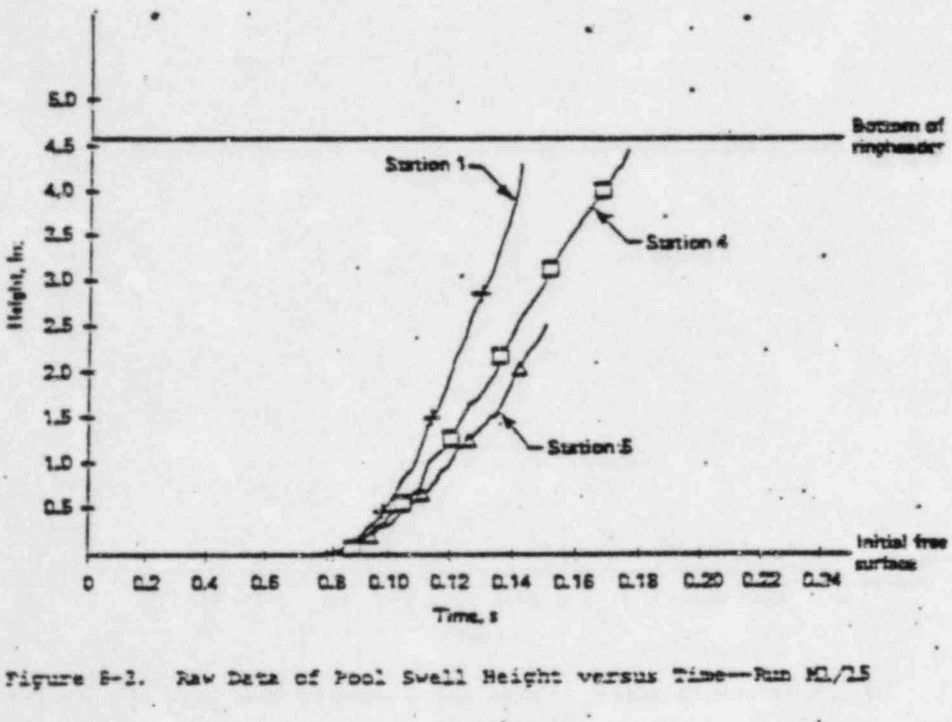

Figure 8-3. Raw Data of Pool Swell Height versus Time—Run M1/25

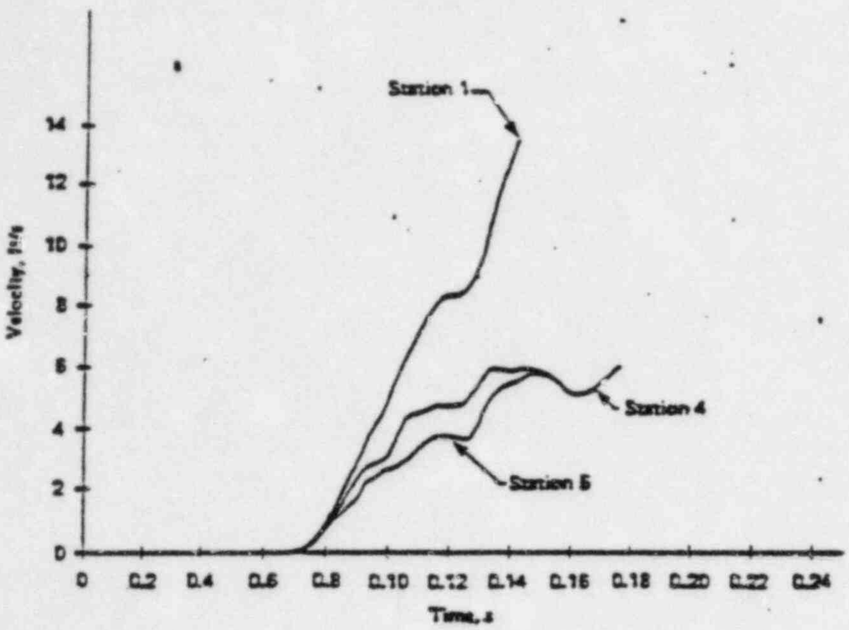

Figure 8-4.* Pool Swell Velocities Calculated from Untreated Pool Swell Data—Run #1/15

This fitting routine put extra emphasis on the last 10 data points prior to impact by assigning them a higher weighting factor. In so doing, the derived polynomial represented a truer average of these points, thus resulting in a more accurate impact velocity. Figure 8-5, a superposition of four pool swell histories of four repeated tests at station 1, shows the statistical variance in the raw data. Figure 8-6 shows the third-order polynomial fits to the raw data of Figure 8-3. For comparison, selected raw data points are superimposed. Figure 8-7 shows the corresponding pool velocity histories obtained by differentiation of these polynomials. If one overlays Figures 8-3 and 8-6 and Figures 8-4 and 8-7, the polynomials and their derivatives would represent smooth averages to the raw data.

A set of graphs was prepared for each motion picture matrix test. A typical set (Figure 8-8) shows the downcomer meniscus position (also a third-order polynomial fit), the meniscus velocity, the pool surface positions at the five stations shown in Figure 8-2, and the pool swell velocities.

RAI 8b - PUAR Section 3.3.2.3, AC Section 2.10.1

Specify as part of your response which longitudinal multipliers and set of equations were used in the interpolation process.

RESPONSE:

The longitudinal multipliers shown in Figure 3-21 of NEDO-24612, Attachment RAI 8a-2, and set of equations given in the response to RAI 8a were used in the interpolation for PUAR.

New loads were calculated herein using longitudinal multipliers based on EPRI "main vent orifice" test, Attachment RAI 8b-1, and following interpolation equations:

For $0 \leq Z/L \leq 0.5$

$$F(Z/L) = F(0) + \frac{[K(Z/L) - 0.825]}{0.235}[F(0.5) - F(0)]$$

For $0.5 \leq Z/L \leq 1.0$

$$F(Z/L) = F(0.5) + \frac{[K(Z/L) - 1.06]}{0.13}[F(1.0) - F(0.5)]$$

The new loads as shown in Figures 8 through 21, Attachment RAI 8b-2, reflect about 1% decrease at the non-vent bay and about 1-25% increase at the vent-bay. Structural analysis was performed using the newly calculated load. The impact spike forces which were conservatively added in the original load specification were not included in the new analysis. Comparing the results of the new analysis, (Figure 22, Attachment RAI 8b-2) with original analysis (Figure 23, attachment RAI 8b-2) show that newly calculated pool swell loads result in smaller element forces and smaller reactions at node 310. Structural evaluations based on the originally calculated pool swell loads as presented in the PUAR are conservative.

NEDO-21888

Figure 4.3.9-11

Page 4.3.9-15

(Total 1 Sheet)

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

Attachment RAI 8b-1

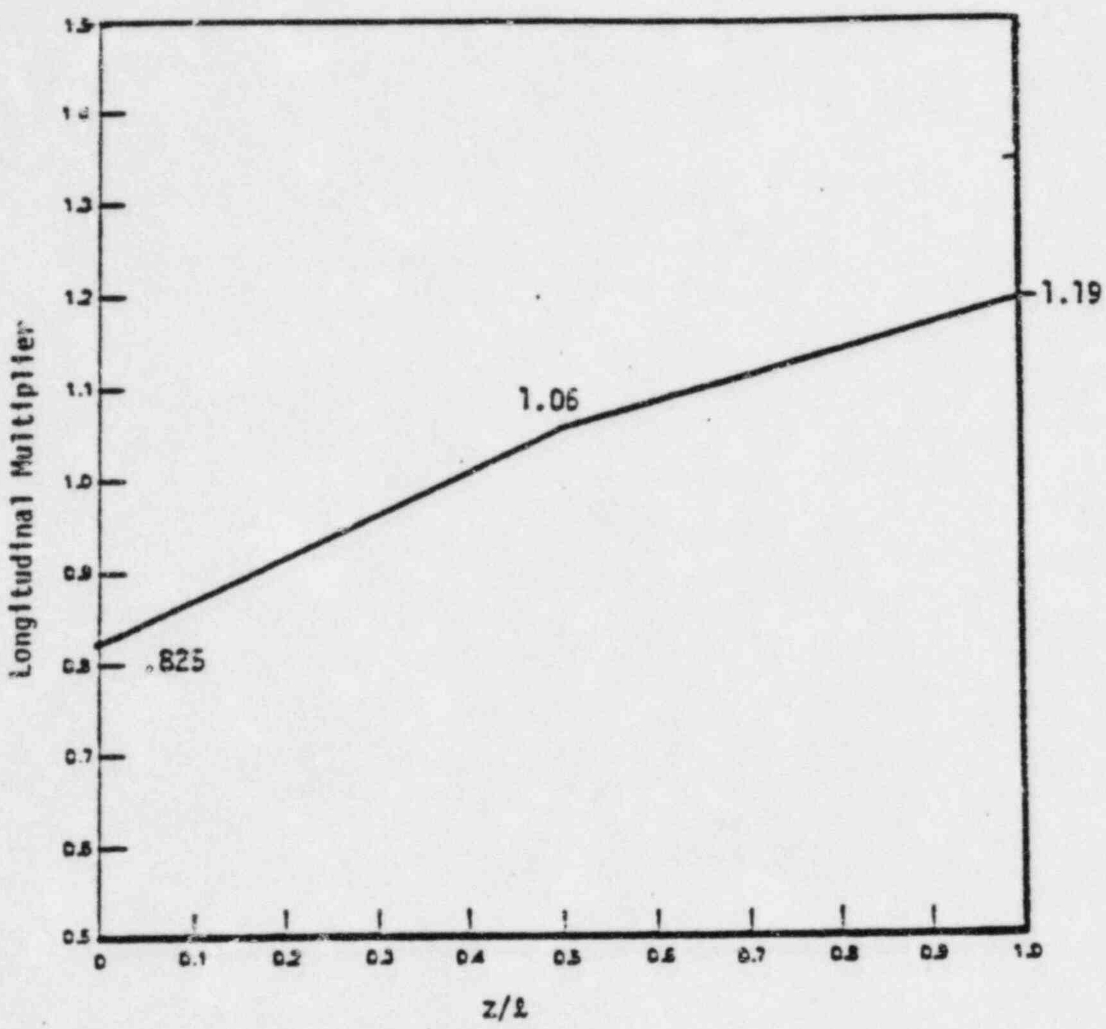

FIGURE 4.3.9-11 Longitudinal Multiplier for Fluid Displacement Velocity and Acceleration

CALCULATION SET NO.

9527-E-SC-DV-1-F

Sheets 33a thru 46a of 217

Sheet 73a of 217

Sheet 73 of 217

(Total 16 Sheets)

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

Attachment RAI 8b-2

FORM 5007 REV. 7/79

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc.

NAME OF COMPANY: BSEP UNIT/S: 1 & 2

SUBJECT: Pool Swell Loads

	CALC. SET NO.	REV.	COMP. BY	CHK'D. BY
PRELIM.		0	YLT DATE 9-11-81	HFH DATE 11-17-81
FINAL	9527-E-SC-DY-1-F			
VOID				
SHEET	33a OF 217	1	YLT DATE 8-16-83	HFH DATE 8-22-83
J.O.	9527040			

$t'' = 0.0166$

Mode 300

	t+t"	P (lb)
	0.3166	1275
	0.3036	1575
	0.3686	2560
	0.3726	2550
	0.3896	2250
	0.4376	1840
	0.4516	1800
	0.4826	1575
	0.4906	1405
	0.5016	1350
	0.5476	0
Impact	0.2999	3653
Impact	0.3108	380

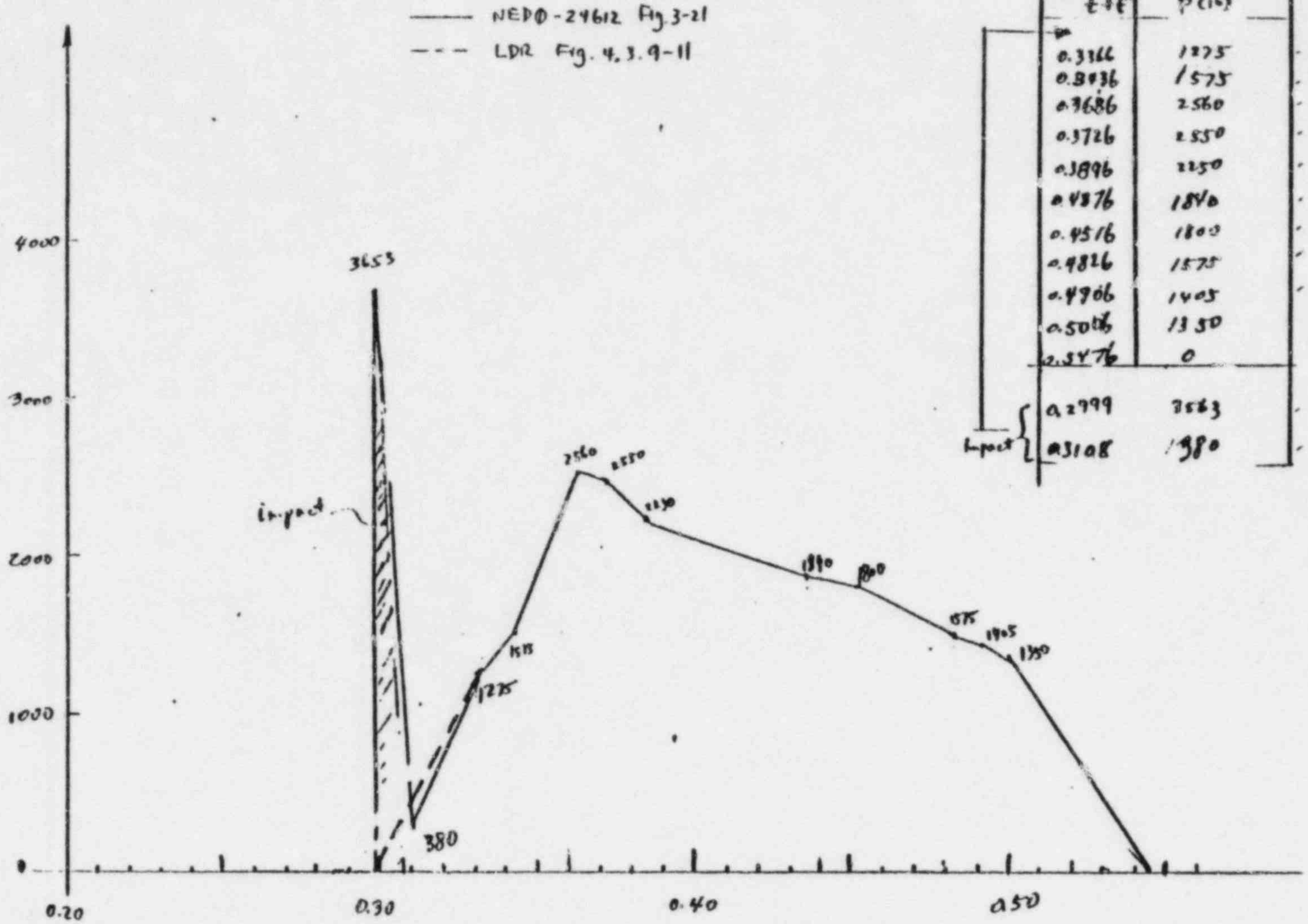

Fig. 8 Loads at Z/L = 1.0

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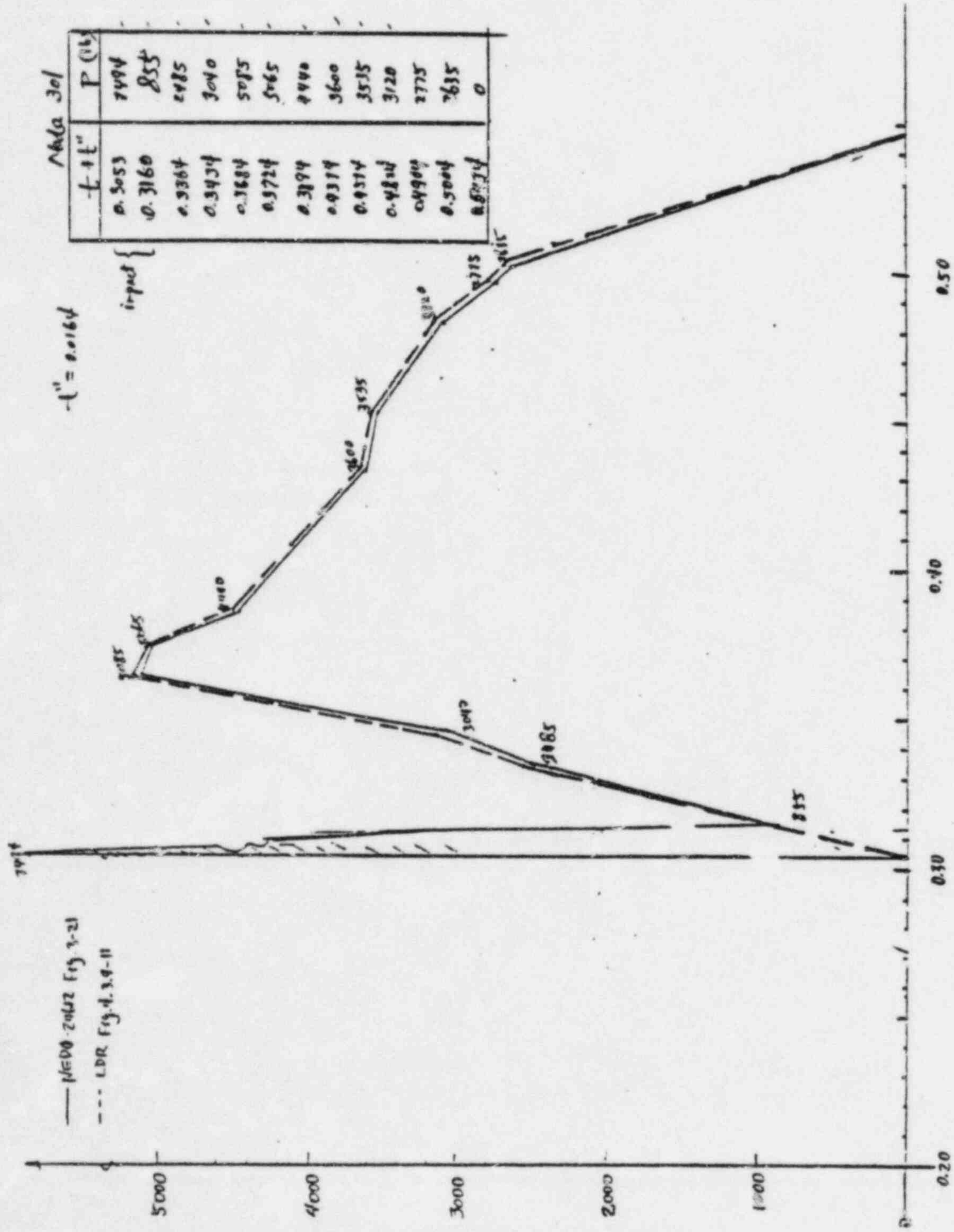
united engineers & constructors inc.

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.		0	YLT DATE 9-14-81	LFH DATE 11-17-81
FINAL	9527-E-SC-DV-1-F			
VOID				
SHEET	340 OF 217	1	YLT DATE 8-16-83	LFH DATE 8-22-83
J.O.	9527040			

NAME OF COMPANY: BSEP UNIT/S: 1 & 2

SUBJECT: Pool Swell Loads



Node 301

t + Δt"	P (lb)
0.3053	7494
0.3160	855
0.3364	2485
0.3434	3040
0.3684	5055
0.3724	5065
0.3894	4440
0.4314	3600
0.4514	3535
0.4814	3120
0.4904	2775
0.5004	2635
0.5534	0

Fig. 9 Loads at Z/L = 0.931

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CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.		0	YCT DATE 6-14-81	LFH DATE 11-17-81
FINAL	9527-E-SC-DV-1-F			
VOID				
SHEET	35 of 217	1	YLT DATE 8-16-83	LFH DATE 8-22-83
J.O.	9527040			

NAME OF COMPANY BSEP UNIT/S 1 & 2

SUBJECT Pool Swell Loads

Node 302

t (s)	P (lb)
0.3088	7383
0.3196	990
0.3365	2415
0.3435	2920
0.3685	5040
0.3725	5025
0.3895	4375
0.4315	3525
0.4515	3465
0.4825	3090
0.4985	2745
0.5005	2560
0.5875	0

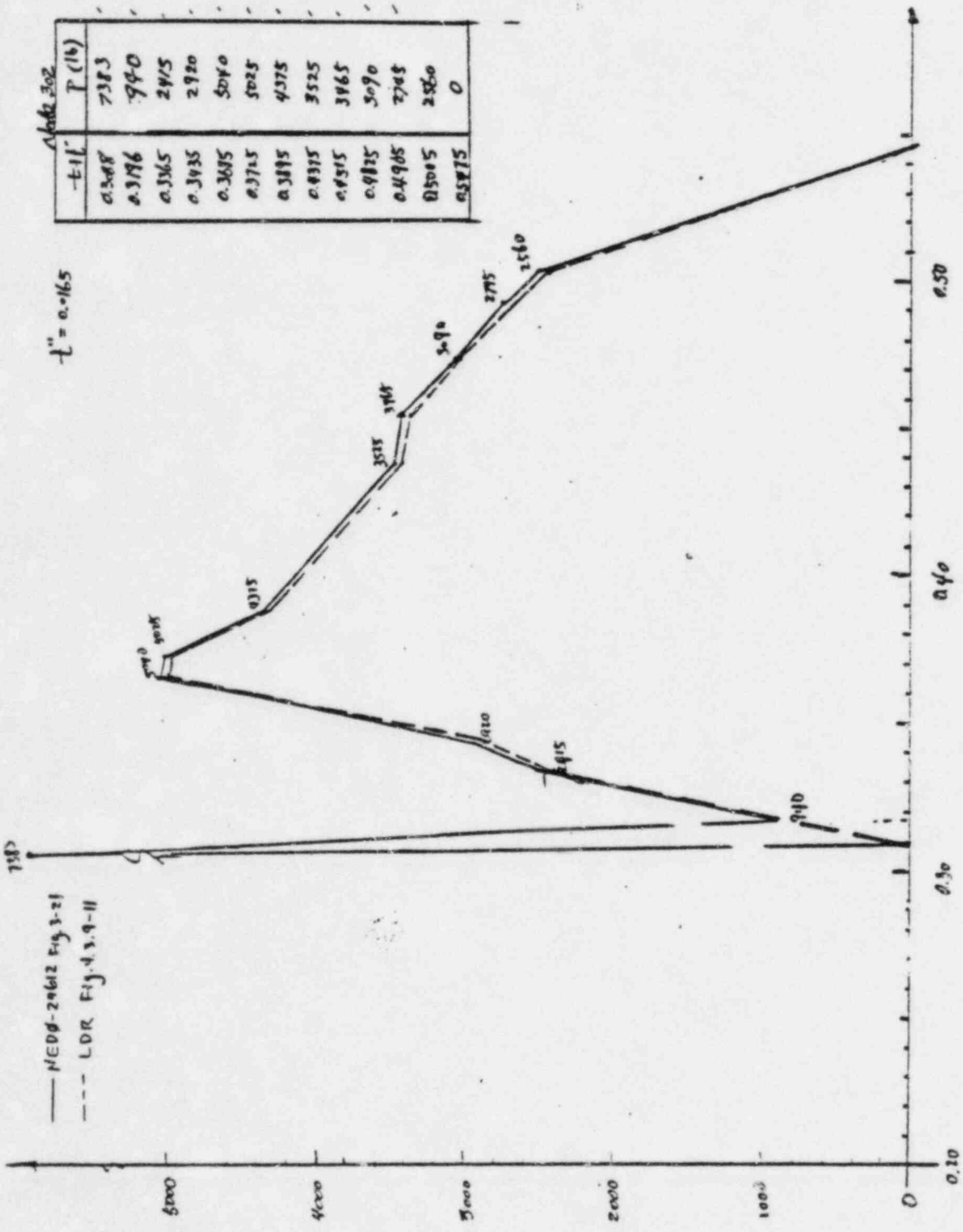

Fig. 10 Loads at Z/L = 0.862

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united engineers & constructors inc

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.		0	YCT DATE 9-14-81	IFH DATE 11-17-81
FINAL	9527-E-SC-DI-I-F			
VOID				
SHEET	36a OF 217	1	YCT DATE 2-16-83	IFH DATE 8-22-83
J.O.	9527040			

NAME OF COMPANY: SSEP UNIT/S: 1 & 2

SUBJECT: Pool Swell Loads

note 303

t (ft)	P (psi)
0.3096	6900
0.3208	945
0.3371	2325
0.3441	2770
0.3691	4990
0.3781	4880
0.3901	4790
0.4381	3450
0.4[illegible]	3375
0.4851	3055
0.4911	2895
0.5011	2470
0.5481	0

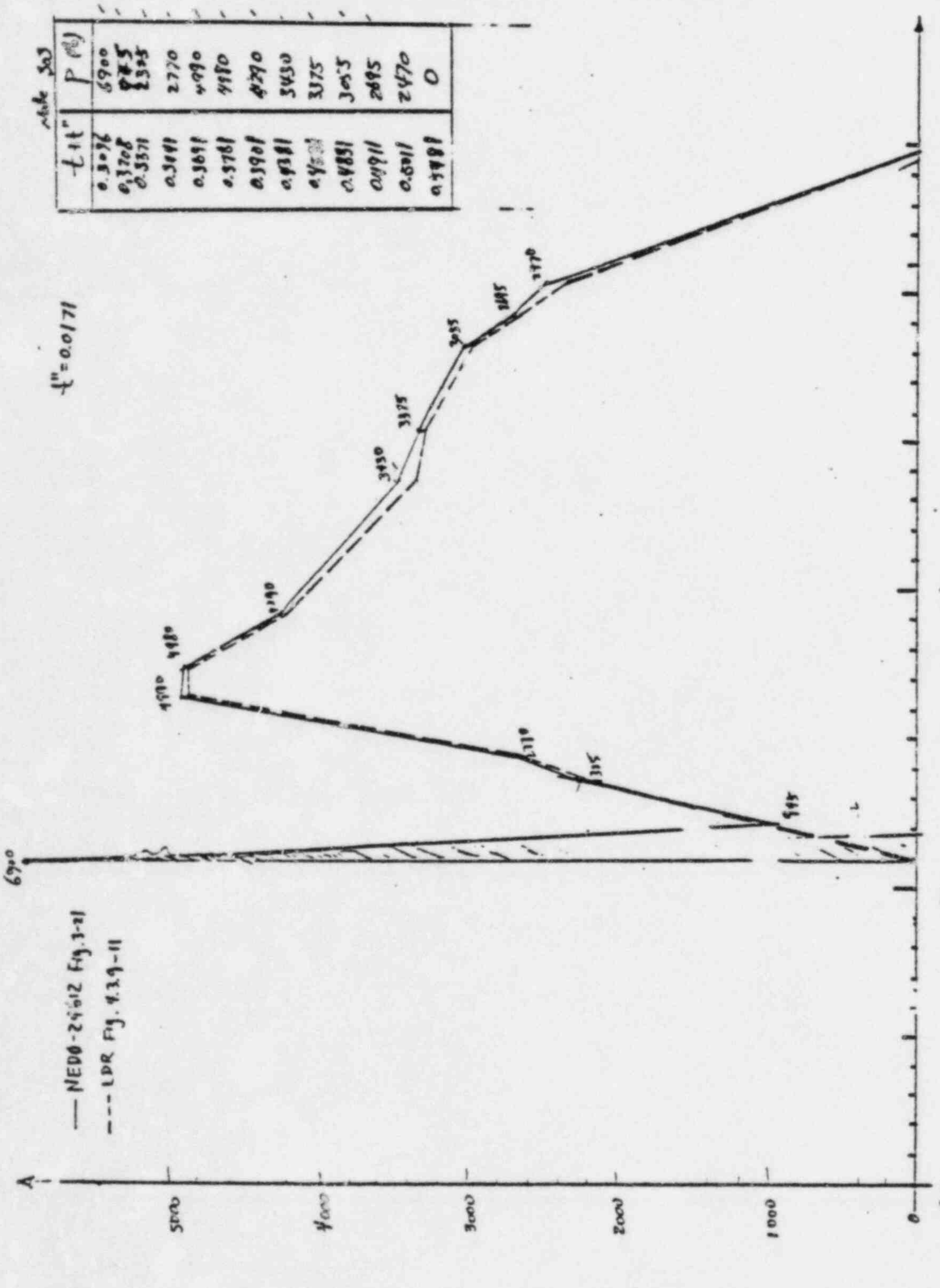

Fig. 11 Loads at z/L = 0.792

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NAME OF COMPANY: BSEP UNIT/S: 1 & 2

SUBJECT: Pool Swell Loads

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.		0	YLT DATE 9-14-81	HFH DATE 11-17-81
FINAL	9527-E-SC-DVLF			
VOID				
SHEET	37 OF 217	1	YLT DATE 8-16-83	HFH DATE 8-22-83
J.O.	9527040			

Node 301

t + t′	P (lb)
0.3103	6282
0.3219	915
0.3377	2165
0.3407	2515
0.3687	4810
0.3757	4815
0.3907	4085
0.4387	3235
0.4527	3190
0.4837	2940
0.4917	2580
0.5017	2295
0.5517	0

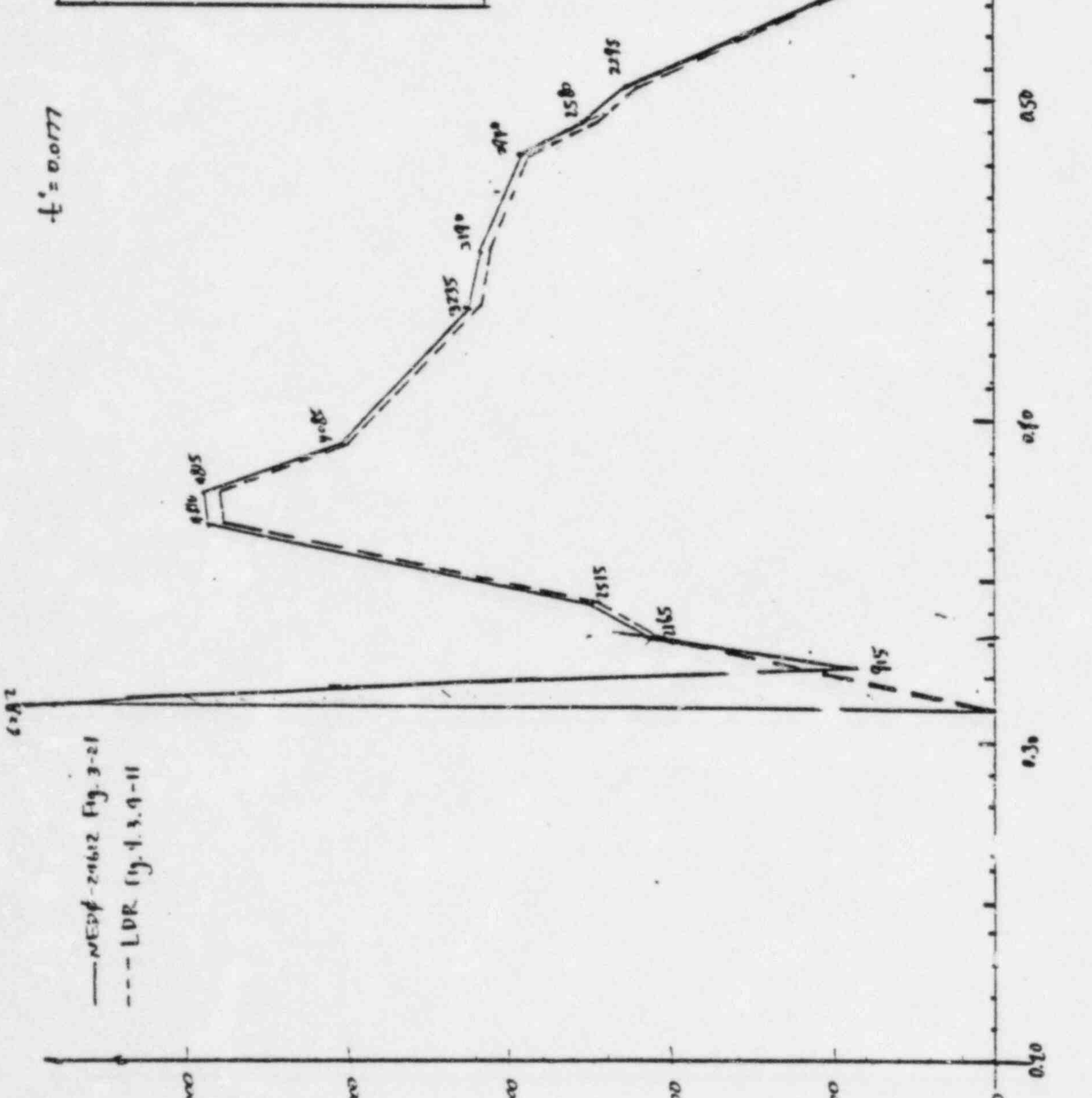

Fig. 12 Loads at Z/L = 0.723

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GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc.

NAME OF COMPANY: BSEP UNIT/S: 1 & 2

SUBJECT: Pool Swell Loads

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.		0	YLT DATE 9-14-81	HFH DATE 11-17-81
FINAL	9527-E-SC-D41-F			
VOID				
SHEET	38 OF 217	1	YLT DATE 8-16-83	HFH DATE 8-22-83
J.O.	9527040			

$t'' = 0.0180$

Node 505

t + t''	P (lb)
0.3109	5926
0.3234	820
0.3380	1985
0.3450	2165
0.3700	4595
0.3790	4610
0.3910	3825
0.4390	2965
0.4530	2945
0.4840	2793
0.4920	2430
0.5020	2065
0.5520	0

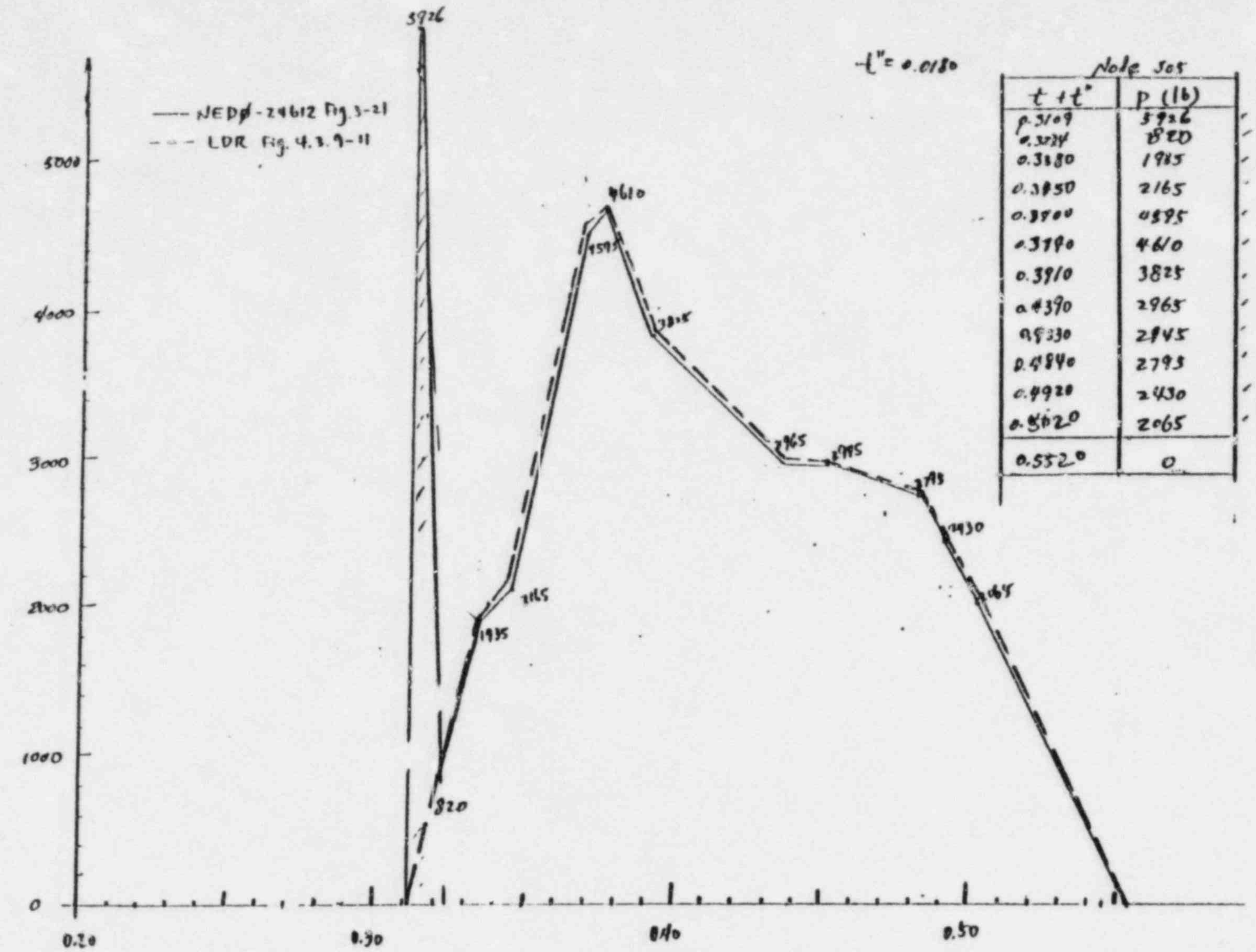

Fig. 13 Loads at $Z/L = 0.657$

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GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.		0	YLT DATE 9-14-81	HFH DATE 11-17-81
FINAL	9527-E-SC-DV-1-F			
VOID				
SHEET	39a of 217	1	YLT DATE 8-16-83	HFH DATE 8-22-83
J.O.	9527040			

NAME OF COMPANY: BS EP UNIT/S: 1 & 2

SUBJECT: Pool Swell Loads

Node 306

t + t*	P(lb)
0.3109	6063
0.3137	5410
0.3380	1925
0.3450	2105
0.3700	4685
0.3740	4705
0.3910	3875
0.4390	2985
0.4530	2960
0.4840	2850
0.4920	2450
0.5020	2050
0.5520	0

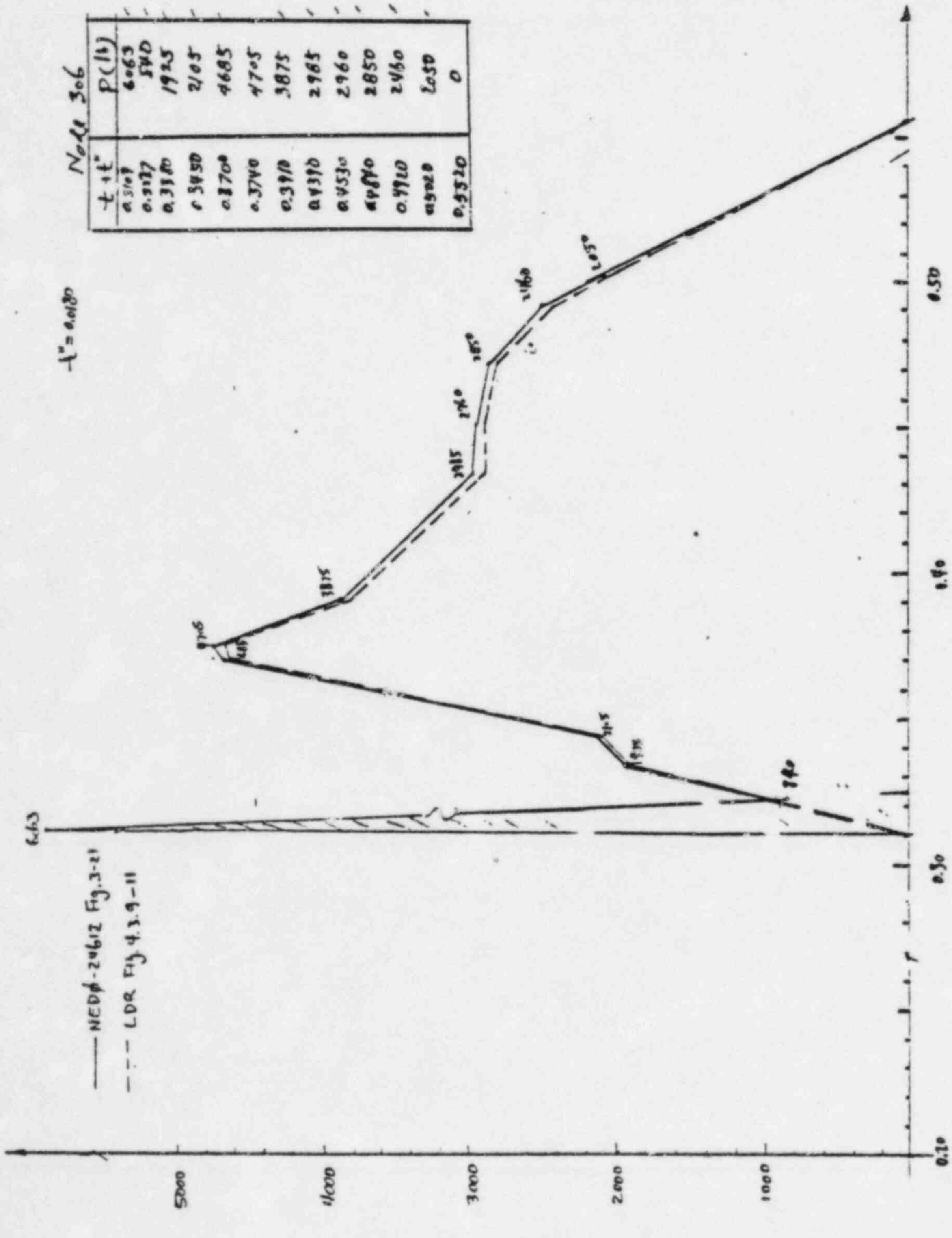

Fig. 14 Loads at Z/L = 0.591

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GENERAL COMPUTATION SHEET

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united engineers

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.		0	YLT	HFH
FINAL	9527-E-SC-D1-HF		DATE 9-15-81	DATE 11-17-81
VOID				
SHEET	400 OF 217	1	YLT	HFH
J.O.	9527040		DATE 8-16-83	DATE 8-22-83

NAME OF COMPANY BSEP UNIT/S 1 & 2

SUBJECT Pool Swell Loads

ℓ" = 0.0125

Note 3.7

Z/L	P(lb)
0.3112	3859
0.3233	525
0.3385	1185
0.3455	1235
0.3705	3085
0.3765	3105
0.3915	2500
0.4195	1890
0.4535	1885
0.4845	1870
0.4925	1595
0.5325	1265
0.5325	0

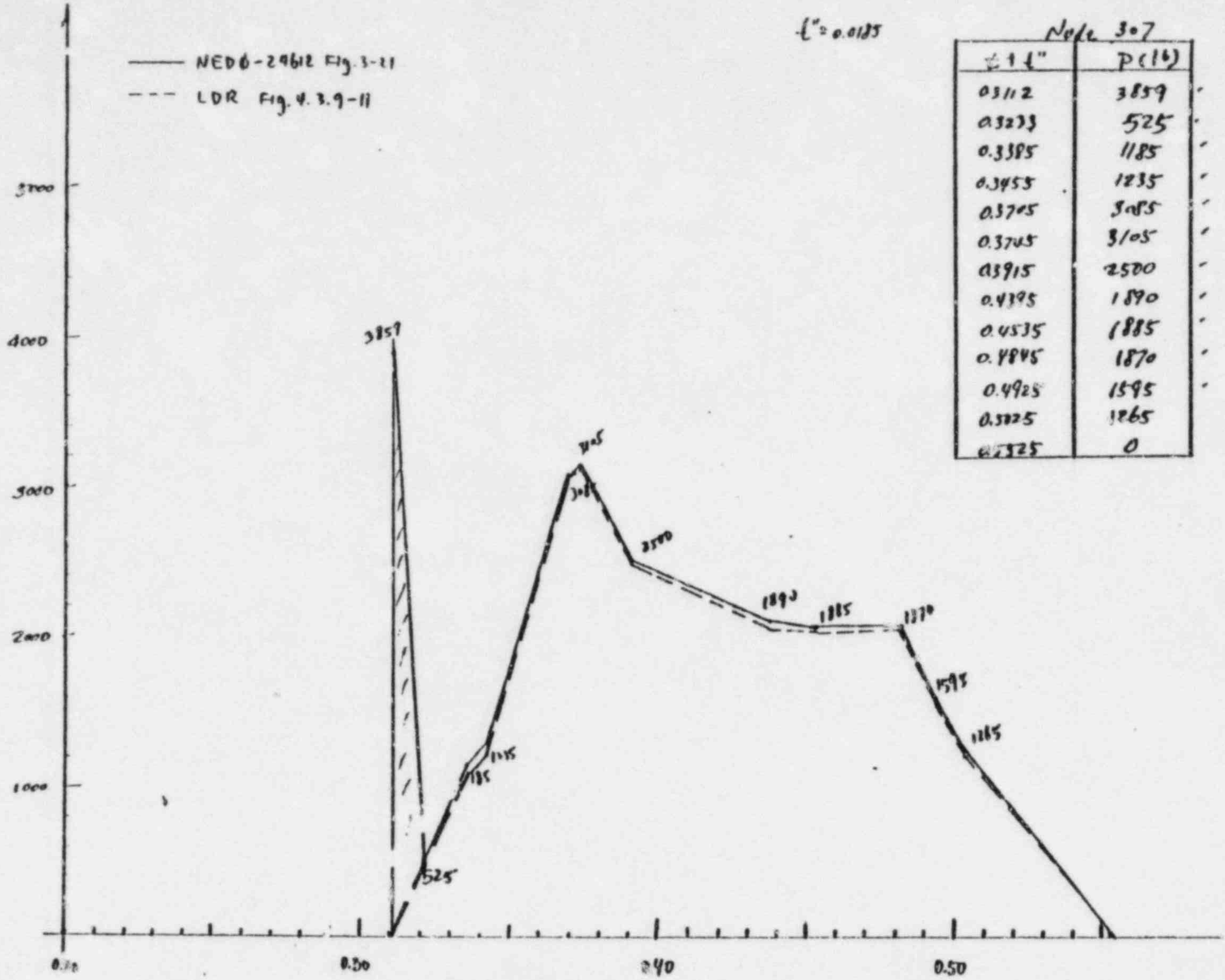

Fig. 15 Loads at Z/L = 0.521

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CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.		0	YG DATE 9-15-81	LFH DATE 11-17-81
FINAL	9527-E-SC-DV-FF			
VOID				
SHEET	4/a OF 217	1	YLT DATE 8-16-83	LFH DATE 8-22-83
J.O.	9527.040			

NAME OF COMPANY: BSEP UNIT/S 1&2

SUBJECT: Pool Swell Loads

Node 308

t+t"	P(lb)
0.3113	1789
0.3335	220
0.3386	540
0.3456	555
0.3706	1435
0.3746	1445
0.3916	1155
0.4396	865
0.4536	865
0.4846	865
0.4926	740
0.5026	580
0.5526	0

t" = 0.0986

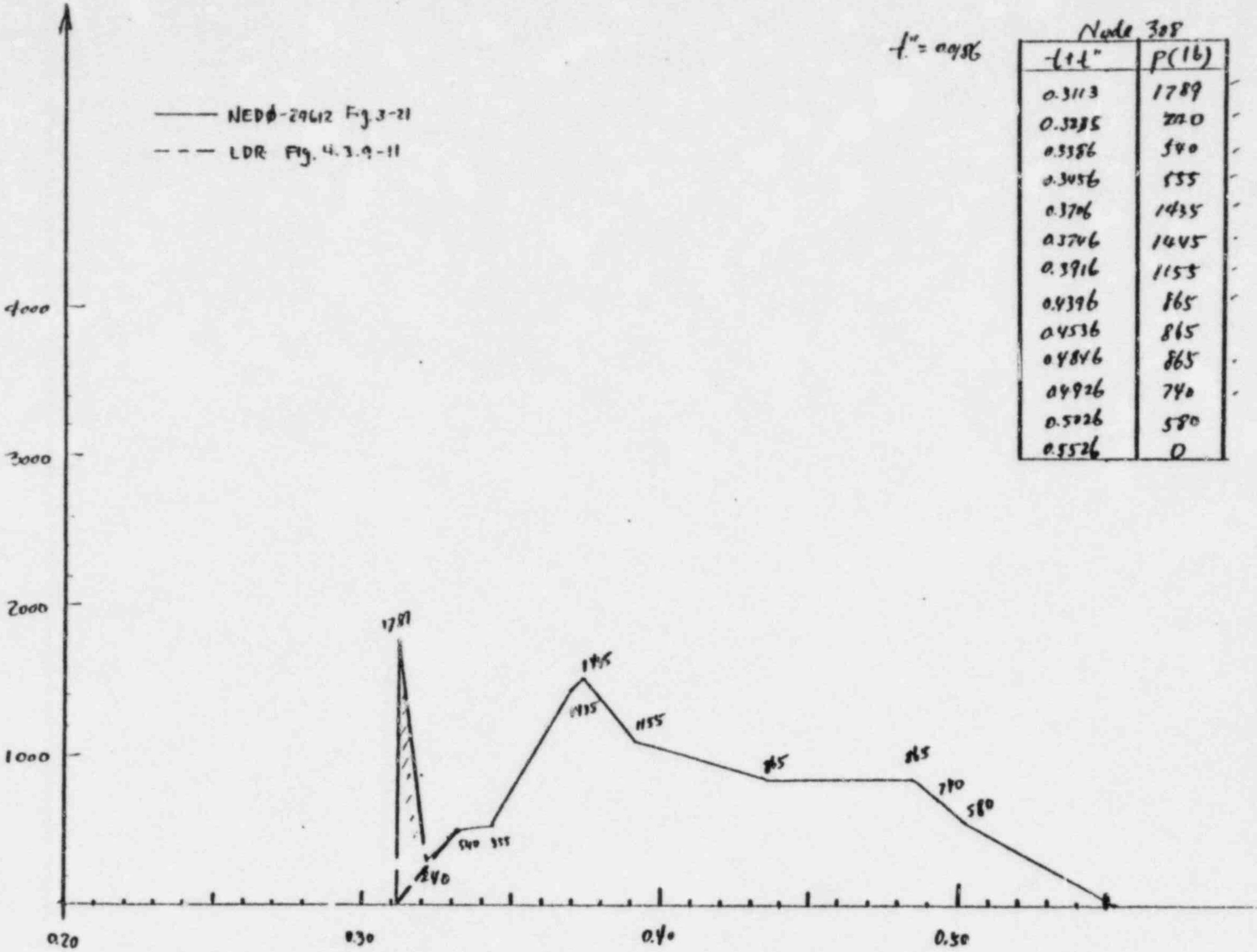

Fig. 16 Loads at Z/L = 0.5

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united engineers & constructors inc.

NAME OF COMPANY: BSEP UNIT/S: 1 & 2

SUBJECT: Pool Swell Loads

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.		0	YLT DATE 9-15-81	LFH DATE 11-17-81
FINAL	9527-E-SC-DU-1-F			
VOID				
SHEET	42 OF 217	1	YLT DATE 2-16-83	LFH DATE 2-21-83
J.O.	9527040			

$t^* = 0.0187$

Node 309

$t + t^*$	P (lb)
0.3117	2861
0.3280	390
0.3387	855
0.3457	880
0.3707	2245
0.3747	2290
0.3917	1875
0.4397	1390
0.4537	1380
0.4847	1380
0.4927	1180
0.5027	925
0.5527	0

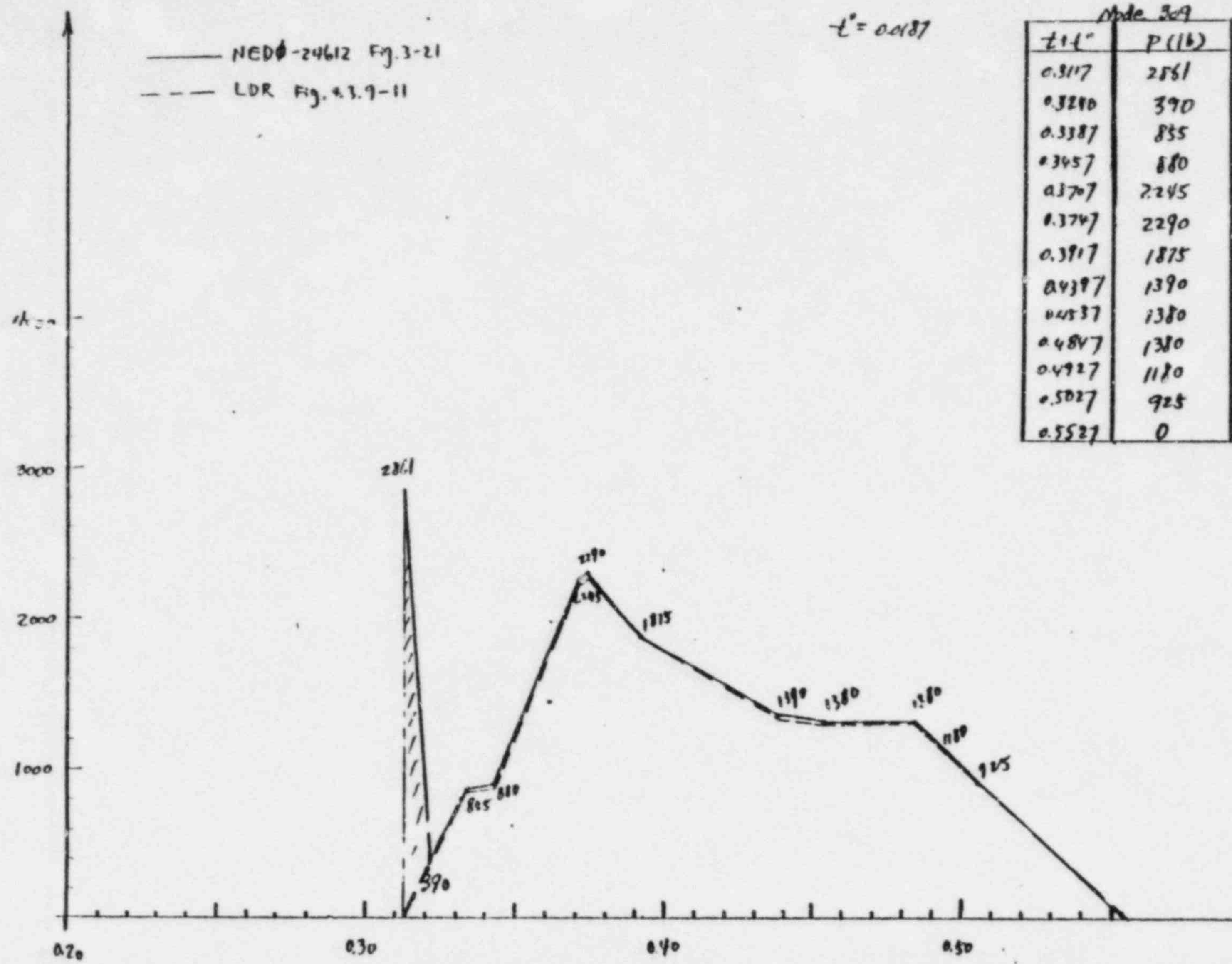

Fig. 17 Loads at $Z/L = 0.479$

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CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.		0	YLT DATE 9-15-81	HFH DATE 11-17-81
FINAL	9527-E-SC-DN-1-F			
VOID				
SHEET	43a OF 217	1	YLT DATE 8-16-83	HFH DATE 8-22-83
J.O.	9527040			

NAME OF COMPANY BSEP UNIT/S 1 & 2

SUBJECT Pool Swell Loads

Node 510

t + t"	P(lb)
0.3125	5222
0.3250	675
0.3391	1440
0.3461	1490
0.3711	3605
0.3751	3925
0.3921	3550
0.4401	2505
0.4501	2400
0.4851	2403
0.4931	2110
0.5031	1670
0.5641	0

t" = 0.0191

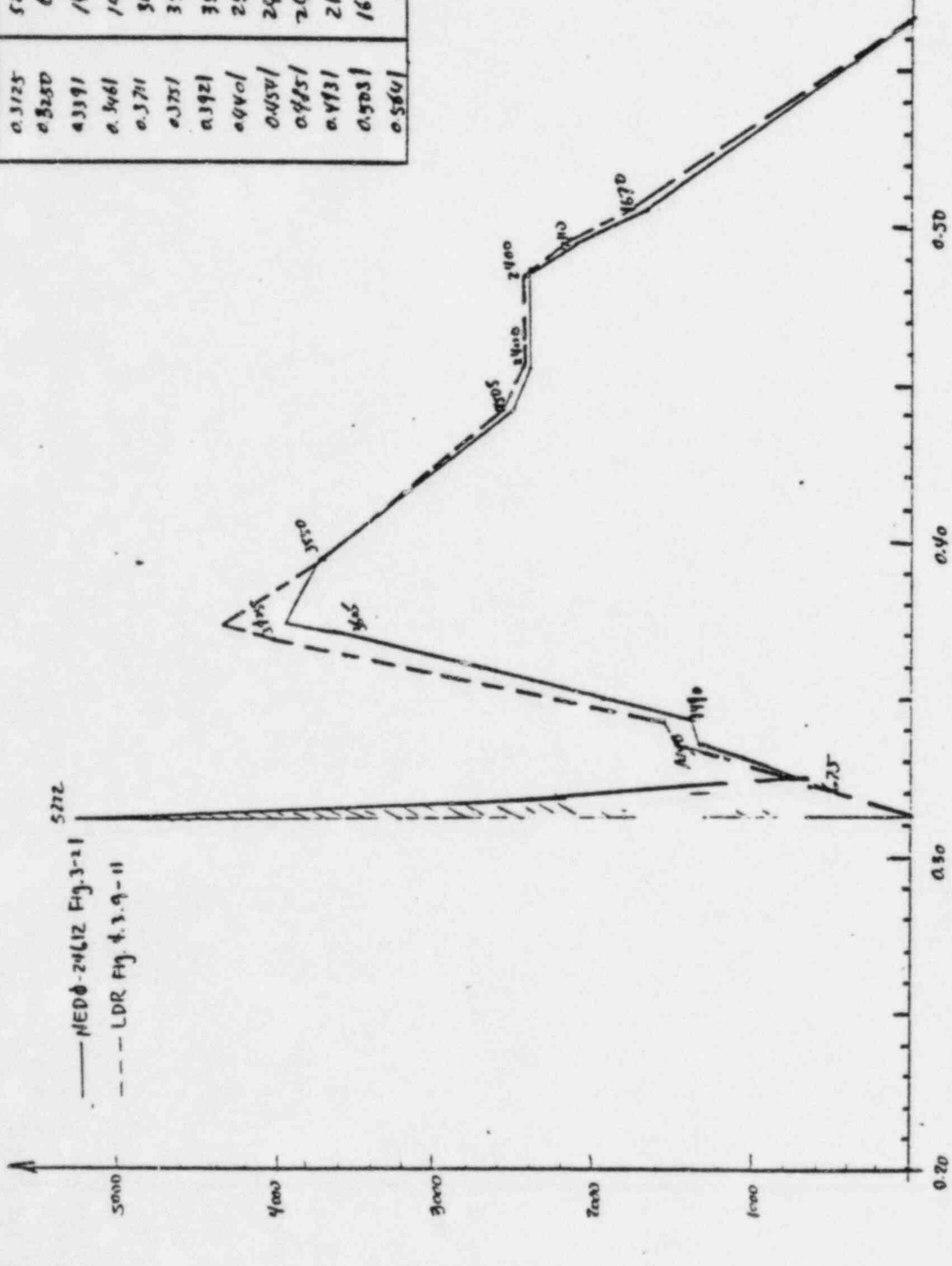

Fig. 18 Loads at Z/L = 0.431

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united engineers

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.		0	YLT	HFH
FINAL	9527-E-SC-DV-1-F		DATE 9-15-81	DATE 11-17-81
VOID				
SHEET	44a OF 217	1	YLT	HFH
J.O.	9527040		DATE 8-16-83	DATE 8-22-83

NAME OF COMPANY: BSEP UNIT/S: 1 & 2

SUBJECT: Pool Swell Loads

Node 311

$t+t''$	P (lb)
0.3141	4210
0.3370	785
0.3397	1560
0.3467	1610
0.3717	3565
0.3751	4330
0.3927	4500
0.4407	2980
0.4547	2700
0.4857	2700
0.4937	2460
0.5037	1990
0.5647	0

$t'' = 0.0197$

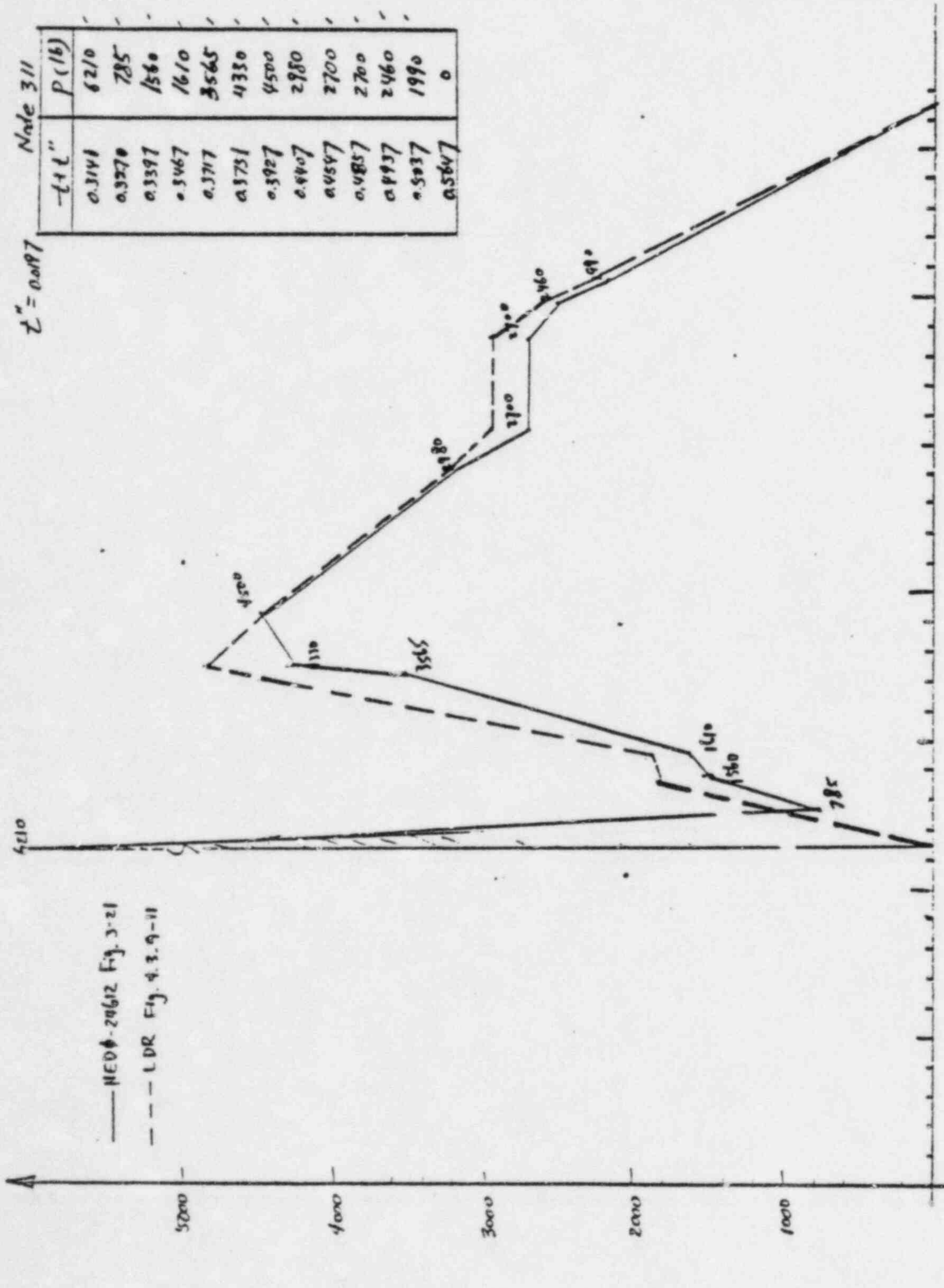

Fig. 19 Loads at Z/L = 0.348

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united engineers & constructors inc.

NAME OF COMPANY: BSEP UNIT/S: 1 & 2

SUBJECT: Pool Swell Loads

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.				
FINAL	9527-E-SC-DH-1-F	0	YLT DATE 0-15-81	LFH DATE 11-17-81
VOID				
SHEET	45a OF 217	1	YLT DATE 8-16-83	HFH DATE 8-22-83
J.O.	9527046			

$t^* = 0.0204$

Node 312

$t + t^*$	$p^{(L)}$
0.3158	5819
0.3292	730
0.3404	1335
0.3474	1395
0.3724	2765
0.3764	3810
0.3934	4500
0.4414	2820
0.4354	2430
0.4864	2430
0.4904	2290
0.5404	1880
0.5654	0

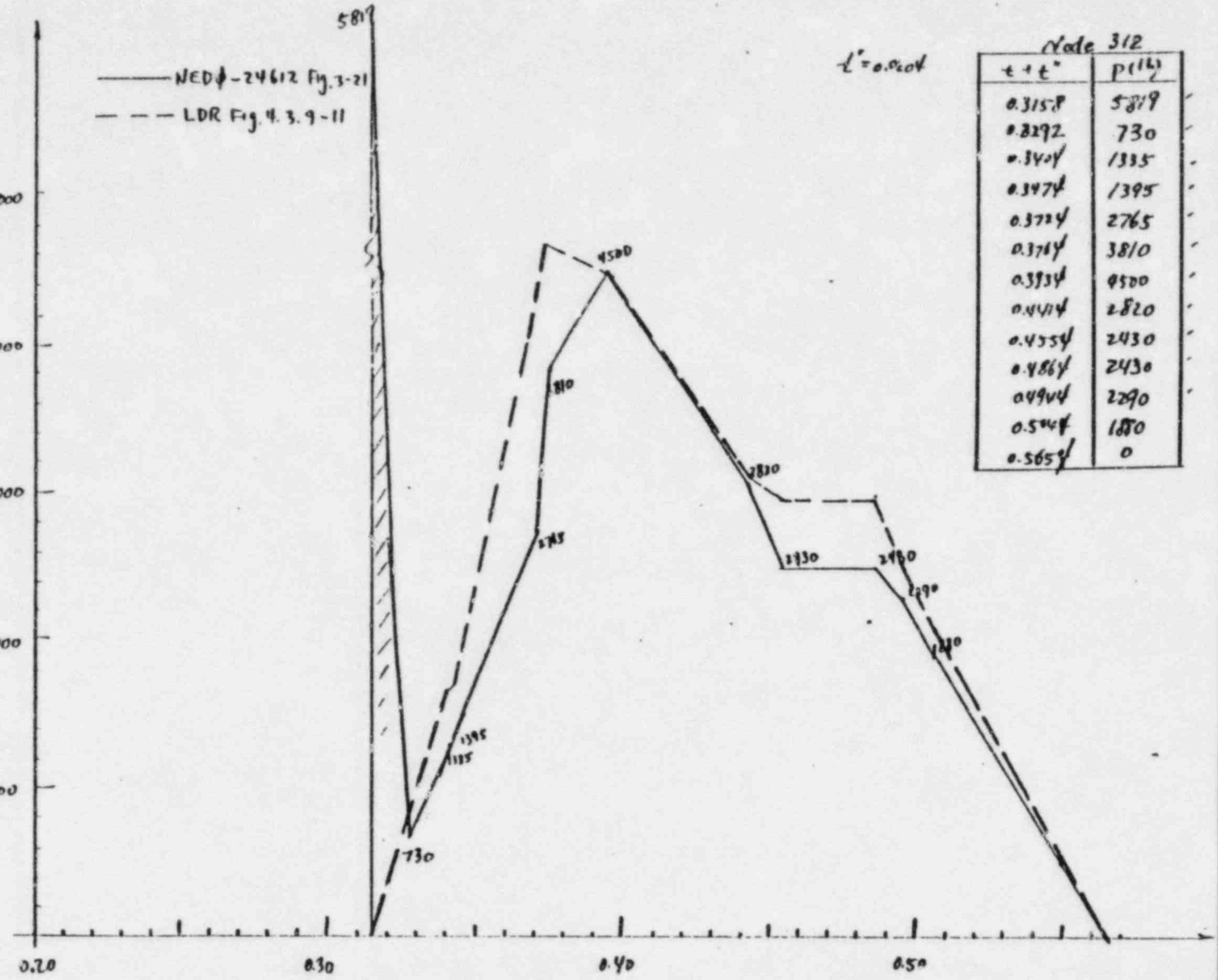

Fig. 20 Loads at Z/L = 0.265

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united engineers & constructors inc.

NAME OF COMPANY: BSEP UNIT/S: 1&2

SUBJECT: Pool Swell Loads

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.				
FINAL	9527-E-SC-DV-1-F	0	YCT DATE 9-15-81	HFH DATE 11-17-81
VOID				
SHEET	46a OF 217	1	YCT DATE 8-16-83	HFH DATE 8-22-83
J.O.	9527040			

$t'' = 0.0209$

Node 313

$t + t''$	P (lb)
0.3186	2760
0.3323	380
0.3409	615
0.3479	645
0.3729	1180
0.3769	1775
0.3939	2250
0.4419	1370
0.4359	1150
0.4869	1150
0.4949	1105
0.5049	915
0.5659	0

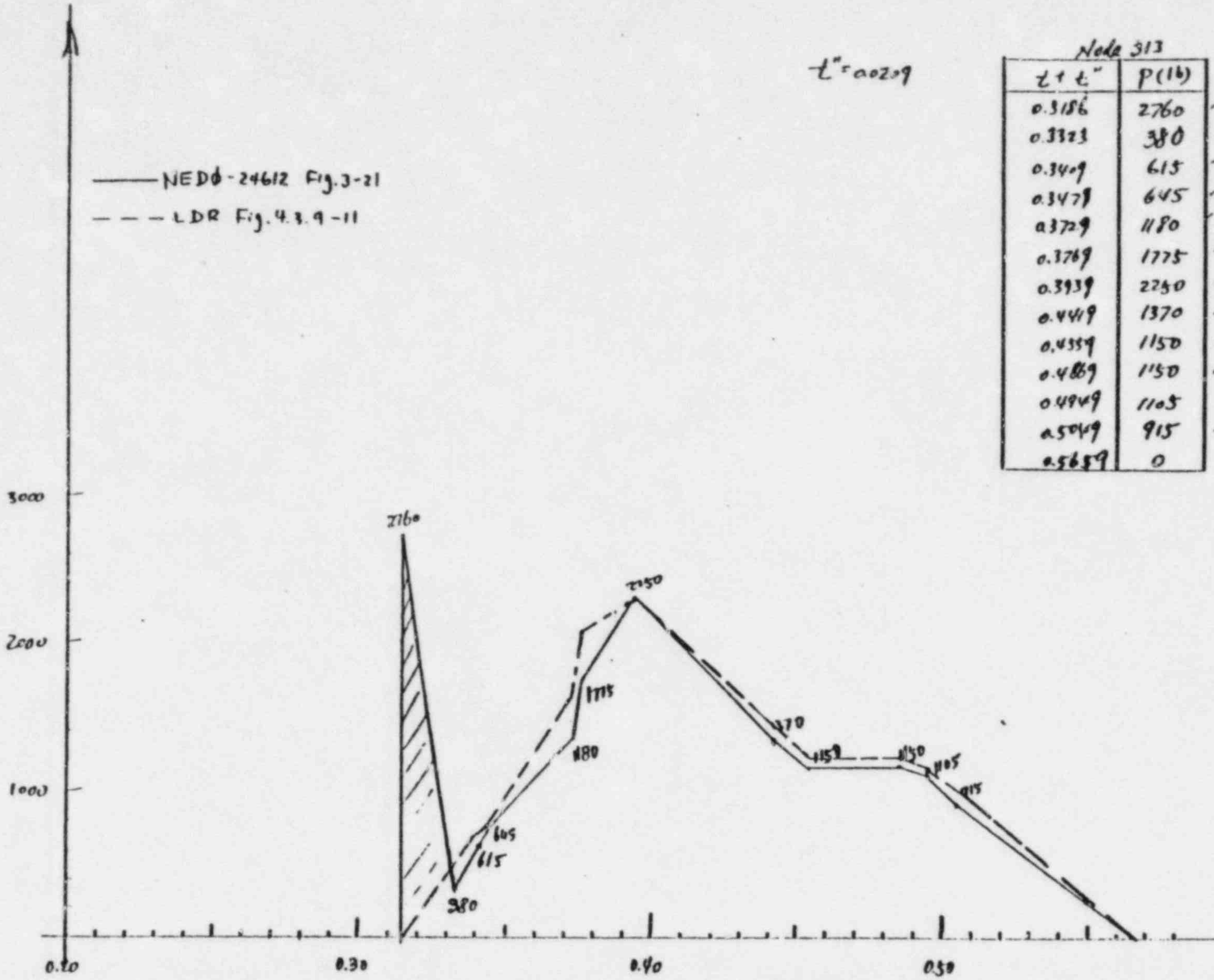

Fig. 21 Loads at Z/L = .182

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GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.		0	YLT	HFH
FINAL	9527-E-SC-DV-1-F		DATE 8-19-83	DATE 8-22-83
VOID				
SHEET	73a OF 217		DATE	DATE
J.O.	7453.119			

NAME OF COMPANY BSEP UNIT/S 1 & 2

SUBJECT Pool Swell Load applied "10" off Center (Run 108C)

Element Number	P(JA)	VA2	VA3	MA2	MA3	T(JA)	P(JB)	VB2	VB3	MB2	MB3	T(JB)
300	0.188 (c) -2.672 (T)	0.038 -0.479	0.123 -2.764	202 -2667	476 -42	0.429 -5.702	2.672 -0.188	0.478 -0.038	2.764 -0.123	2714 -204	43 -485	5.702 -0.429
301	0.189 -2.673	-1.438	-8.227	-2526	451	-5.702	2.673 -0.189	1.438	8.227	2667	-476	5.702
302				-2295	409		2.673 -0.189			2526	-451	
303	0.189 -2.673			-1975	351		2.673 -0.189			2295	-409	
304	0.187 -2.653	0.308 -4.142	1.077 -23.481	151 -1587	280 -27	3.219 -0.333		4.142 -0.308	23.481 -1.077	1975 -169	32.55 -351.29	0.333 -3.219
305	0.187 -2.647			-1123	196		2.647 -0.187			1587	-280	
306	0.186 -2.631	-5.782	-32.614	-553	92.8	3.425	2.631 -0.186	5.782	32.614	1122	-196	-3.425
307	0.186 -2.689	0.397 -6.306	1.468 -35.608	93.17 -368	61 -12	3.600 -0.374	2.689 -0.186	6.306 -0.397	35.608 -1.469	553 -103	14.21 -92.80	0.374 -3.600
308	0.167 -0.030	0.442 -7.076	1.486 -36.980	170.9 -203.02	34.6 -21.47	143.61 -36.76	0.030 -0.167	7.076 -0.442	36.998 -1.486	339.5 -87.8	12.01 -61.04	36.76 -143.61
309	0.181 -0.026	0.447 -7.457	1.495 -39.235	484 -4.5	2.9 -82.6	143.61 -36.76	0.026 -0.181	7.456 -0.447	39.235 -1.495	203.0 -120.9	21.47 -34.63	36.76 -143.61
310	0.078 -0.084	2.073	12.496	219	-36	143.61	0.084 -0.078	-2.073	-12.496	-484	79.7	-143.61
311	0.049 -0.048			57	-9		0.048 -0.049			-219	35.9	
312	0.016 -0.017			0	0		0.017 -0.016			-57	9.1	

matrix loads (Loads at Support)

310-1 55.84 k

310-2 0.105 k

310-3 10.218 k

310-4 3.707 in-k

310-5 143.61 in-k

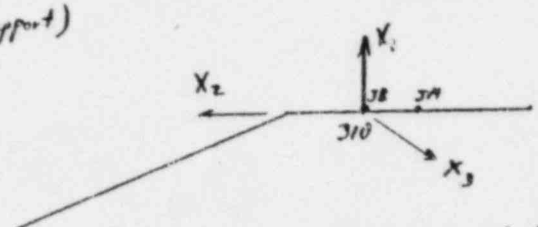

Fig. 22 Element Forces and Reactions Based on Loads from LDR Fig. 4.3.9-11

FORM 5007 REV. 7/79

(DISCIPLINE)

GENERAL COMPUTATION SHEET

united engineers

NAME OF COMPANY: BSEP UNIT/S: 1 & 2

SUBJECT: Pool Swell Loads applied +10° off center

(Run 108 B)

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM.				
FINAL	9527-E-SC-DV-1-F	0	YGT DATE 9-25-81	HFH DATE 11-17-81
VOID				
SHEET	73 OF 217		DATE	DATE
J.O.	9527040			

Element Number	P(JA)	VA2	VA3	MA2	MA3	T (JA)	P(JB)	VB2	VB3	MB2	MB3	T(JB)
300	1.966(c) -5.887(t)	0.760 -1.076	5.096 -5.516	1418 -4726	834 -259	3.02 -10.12	5.887 -1.966	1.076 -0.760	5.516 -5.096	4818 -1438	263 -849	10.12 -3.02
301	1.947 -5.882	-2.666	-15.248	-4454	787	-10.12	5.882 -1.947	2.666	15.248	4726	-834	10.12
302	1.910 -5.867			-4022	711		5.867 -1.910			4454	-787	
303	1.856 -5.844			-3523	609		5.844 -1.836			4022	-711	
304	1.794 -5.782	1.985 -7.098	9.387 -40.877	962 -2936	492 -163	6.283 -2.042		7.098 -1.985	40.877 -9.387	3522 -1123	197 -609	2.042 -6.283
305	1.714 -5.736			-2240	384		5.736 -1.714			2936	-492	
306	1.629 -5.675	-9.55	-52.05	-1368	256	6.581	5.675 -1.629	9.55	52.05	2240	-384	-6581
307	1.526 -5.697	2.728 -10.458	12.613 -54.713	694 -1076	213 -112	7.014 -2.295	5.697 -1.526	10.458 -2.728	54.713 -12.614	1367 -605	106 -256	2.295 -7.014
308	1.776 -2.434	3.134 -12.214	12.808 -56.416	694 -762	165 -118	418 -267	2.434 -1.776	12.21 -3.13	56.416 -12.808	992 -641	112 -213	267 -418
309	1.713 -2.218	3.21 -12.82	13.030 -59.230	826 -944	58 -159	418 -267	2.218 -1.713	12.82 -3.21	59.23 -13.03	762 -694	118 -165	267 -418
310	1.392 -1.878	3.914	19.394	408	-75	418	1.878 -1.392	-3.914	-19.394	-826	159	-418
311	0.926 -1.164			142	-24		1.164 -0.926			-407	75	
312	0.342 -0.391			0	0		0.391 -0.342			-142	24	

Matrix Loads (Loads at Support)

- 310-1 75.1 K
- 310-2 0.179 K
- 310-3 16.537 K
- 310-4 6.629 in-K
- 310-5 418 in-K

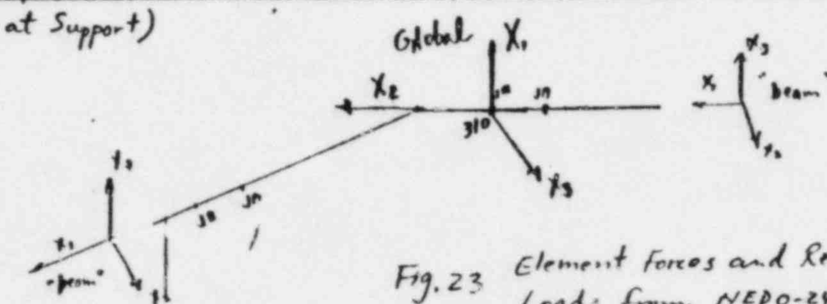

Fig. 23 Element Forces and Reactions Based on Loads from NEDO-24612 Fig. 3-21

RAI 8c - PUAR Section 3.3.2.3, AC Section 2.10.1

In addition, specify what the Z/L is for the typical pool swell impact and drag load given in Figure 3.3.2.3-1 of the PUAR.

RESPONSE

The Z/L for the typical pool swell impact and drag load given in Figure 3.3.2.3-1 of the PUAR is 0.792 as shown in Figure 11, Attachment RAI 8b-2.

RAI 8d - PUAR Tables 3.9.2.1-1 and 3.9.2.1-2

Indicate service levels for bolts and welds listed in Tables 3.9.2.1-1 and 3.9.2.1-2 of PUAR.

RESPONSE

The structural acceptance criteria used to evaluate the acceptability of the existing Mark I containment systems or to provide the basis for any modifications required to withstand LDR defined loads, are generally through the Summer 1977 Addenda to Section III, Division I, ASME Boiler and Pressure Vessel Code. The analysis showed that load combination No. 18, which consists of dead load, earthquake, LOCA thermal and LOCA pool swell loads, is the governing load case. Service Level D is specified for this load case. However, the bolts were conservatively designed by the allowables of Service Level A. As for the welds, the 1977 ASME Code lists only one set of allowables and is silent about its applicable service levels. As such, no service level was indicated for the welds in the PUAR.

RAI 9 - PUAR Section 3.3.2.5, AC Section 2.12.2

Describe what analyses were done to satisfy the AC requirement for multiple downcomer chugging synchronization. Indicate what exceedance probability was used to assess the statistical directional dependence and what the corresponding force per downcomer was.

RESPONSE

Two worst case load conditions were analyzed, 96 and 8 downcomers chugging synchronization. Quasistatic loads, including dynamic load factors, were applied to the 180^{o} beam model of the vent system. The mitered joints were reviewed per ASME Boiler and Pressure Vessel Code, 1981, Code Case N-319, "Alternate Procedure for Evaluation of Stresses in Butt Welding Elbows in Class 1 Piping Section III, Division 1". Stress indices (C_{22} = 9.0 for in-plane bending, C_{23} = 11.4 for out-of-plane bending and torsion) and maximum stress intensities were computed. The latter were within the code allowables.

The exceedance probability used to assess statistical directional dependence was 10^{-4} per LOCA. The corresponding plant unique force for Brunswick was 6.6 Kips per downcomer for the 8 downcomers for the 96 downcomers synchronization, depending upon direction.

RAl 10a - PUAR section 1.3.4, AC section 2.13

Provide more detailed information concerning the T-quencher utilized in the Brunswick plants.

RESPONSE:

The T-quencher utilized in the Brunswick Plant were compared to those used at Monticello and found to be identical, except that the Brunswick T-quencher does not have end cap holes".

References:

Brunswick: F.P. 9527-66038 (GE Dwg. No. 794E828)

Monticello: Tee-Quencher Stress Analysis
Report 22a6010
Fig. 4.2

RAI 10b - PUAR section 1.3.4, AC section 2.13

Specify any differences such as hole spacing, hole diameter, etc. between the Brunswick T-quencher and the T-quencher tested at Monticello.

RESPONSE:

There are no differences, the hole size and spacing of the two designs are identical, except as noted in "a".

References:

Brunswick:	F.P. 9527-66038 (G.E. Dwg. No. 794E828)
Monticello:	Tee Quencher Stress Analysis Report 22A6010 Fig. 4.2

RAI 11 - PUAR Section 2.2.1.8, AC Section 2.14.8

Provide the details of a post-chug submerged structure load calculation for a given segment of a vent header support column. Include numerical values of source strength and DLF as a function of frequency. In addition, provide the acceleration volume, drag coefficient, interference effect multiplier and pertinent geometric parameters and configuration used in the calculation.

RESPONSE

The post-chug load was calculated based on Application Guide 2 (Ref. 1). A rectangular cell model which includes 18 downcomers and the vent header columns was made. The submerged length of column A is 11.02 ft. which was divided into 20 sections. The length of each section is 0.551 ft. which is less than its diameter of 0.552 ft. as required by Application Guide 2. Inputs for section 1 which is near the water surface are shown below:

The location of the section centers are:

XSTR (1) = -2.267 ft.

YSTR (1) = -2.609 ft.

ZSTR (1) = 173.18 ft.

Orientations of structure section axes are:

SX (1) = 0.0

SY (1) = 1.0

SZ (1) = 0.0

Structure section acceleration drag volume (VOL) and projected area (AX) were determined as follows:

$$V\phi L\ (1) = 2\pi R^2 L = 2\pi \left(\frac{0.552}{2}\right)^2 (0.551) = 0.264$$

$$AX\ (1) = 2RL = 0.552 * 0.551 = 0.304$$

The drag coeficcient (CD) for cylinder in this case is:

CD (1) = 3.6

Standard drag is included conservatively without calculating the value for $U_m T/D$.

The column is adjacent to the center support of the T-Quencher, the interference effects between neighboring structure were calculated as follows:

$$r_{12} = 1.968 < 3\,\overline{D} = 4.008$$

$$\overline{D} = (0.552 + 2.12)/2 = 1.336$$

$$X_I = \frac{r_{12}}{\overline{D}} - 1 = 0.473$$

$$A_I = \frac{0.2}{X_I} \left(\frac{D_2}{D_1 + D_2} \right) = 0.3354$$

$$D_I = 0.2/X_I = 0.4228$$

The multiplier $(1 + A_I = 1.3354)$ was used to increase the acceleration drag and the multiplier $(1 + D_I = 1.4228)$ was used to increase the standard drag. These multiplies were applied to the acceleration drag volumn (VOL) and the drag coefficient (CD) respectively.

The drag force due to the source at 26.5 Hz. was calculated. The amplitude of the source function at frequency 26.5 Hz. is 377.83 ft^3/sec^2; hence

AMP (NB) = 377.83 NB = 1, 2

FREQ (NB) = 26.5 NB = 1, 2

Only the two downcomer vents nearest to the header column need to be considered in post-chug calculations. The downcomer vents and corresponding phases for calculating maximum loadings are given in Table 1, Attachment RAI 11-1. Using these relationships, maximum loadings in the X, Y and Z directions and the maximum moment were computed for a frequency of 26.5 Hz. The post-chug loads for other frequencies (Table 2, Attachment RAI 11-1) were obtained by ratioing the amplitude of the source function with respect to that of 26.5 Hz. A steady state analysis was conducted to determine the dynamic effects for each frequency. The dynamic effects were not output in terms of dynamic load factors (DLF). An absolute summation of the individual responses of all 50 frequencies was then combined with fluid-structure-interaction induced drag loads to form the post-chug design loads.

For more information, refer to the attached configuration, calculations (Attachment RAI 11-2) and computer output (Attachment RAI 11-3, 4).

Reference:

1. Mark I Containment Program, Application Guide 2, NEDE-24555-P.

Table 1 The Downcomer Vents and Corresponding Phases

Table 2 Amplitudes at Various Frequences for Post-chug Source Strength

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

BNL RAI 11-1

TABLE 1

The Downcomer Vents and Corresponding Phases

Loading Condition	Quadrants	Downcomer Vents	Phasing
Maximum Loading in X-Direction	I/IV II/III	11, 12	180° out of phase
Maximum Loading in Z-Direction	I/II III/IV	10, 12	180° out of phase
Maximum Loading in Y-Direction	I/II II/III III/IV I/IV	10, 12	In Phase
Maximum Moment	I/III II/IV	9, 12	180° out of phase

BNL RAI 11-1

TABLE 2

Amplitudes at Various Frequencies for

Post-Chug Source Strength

Frequency (HZ)	Amplitude (ft^3/sec^2)	Frequency (HZ)	Amplitude (ft^3/sec^2)
0.5	11.98	25.5	313.84
1.5	11.98	26.5	377.83
2.5	10.36	27.5	251.89
3.5	9.87	28.5	163.32
4.5	17.40	29.5	116.66
5.5	17.00	30.5	43.14
6.5	18.88	31.5	21.57
7.5	18.88	32.5	37.91
8.5	18.88	33.5	50.54
9.5	18.88	34.5	42.54
10.5	87.90	35.5	61.87
11.5	76.18	36.5	41.95
12.5	41.01	37.5	20.97
13.5	35.89	38.5	24.47
14.5	6.82	39.5	29.37
15.5	6.20	40.5	224.90
16.5	3.14	41.5	224.90
17.5	4.18	42.5	224.90
18.5	2.94	43.5	224.90
19.5	16.82	[illegible] 5	224.90
20.5	17.53	45.5	224.90
21.5	30.67	46.5	90
22.5	92.39	47.5	224.90
23.5	92.39	48.5	224.90
24.5	134.50	49.5	224.90

CALCULATION SET NO.

9527-E-SC-SL-3-F

Sheets 62 to 66 of 471
Sheets 61, 62 of 180
Sheets 159, 161, 163 and 164 of 471
Sheets 167 to 170 of 471

(Total 15 Pages)

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

Units 1 & 2

Attachment RAI 11-2

Form 5007 Rev. 3-77

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GENERAL COMPUTATION SHEET

united engineers & constructors inc.

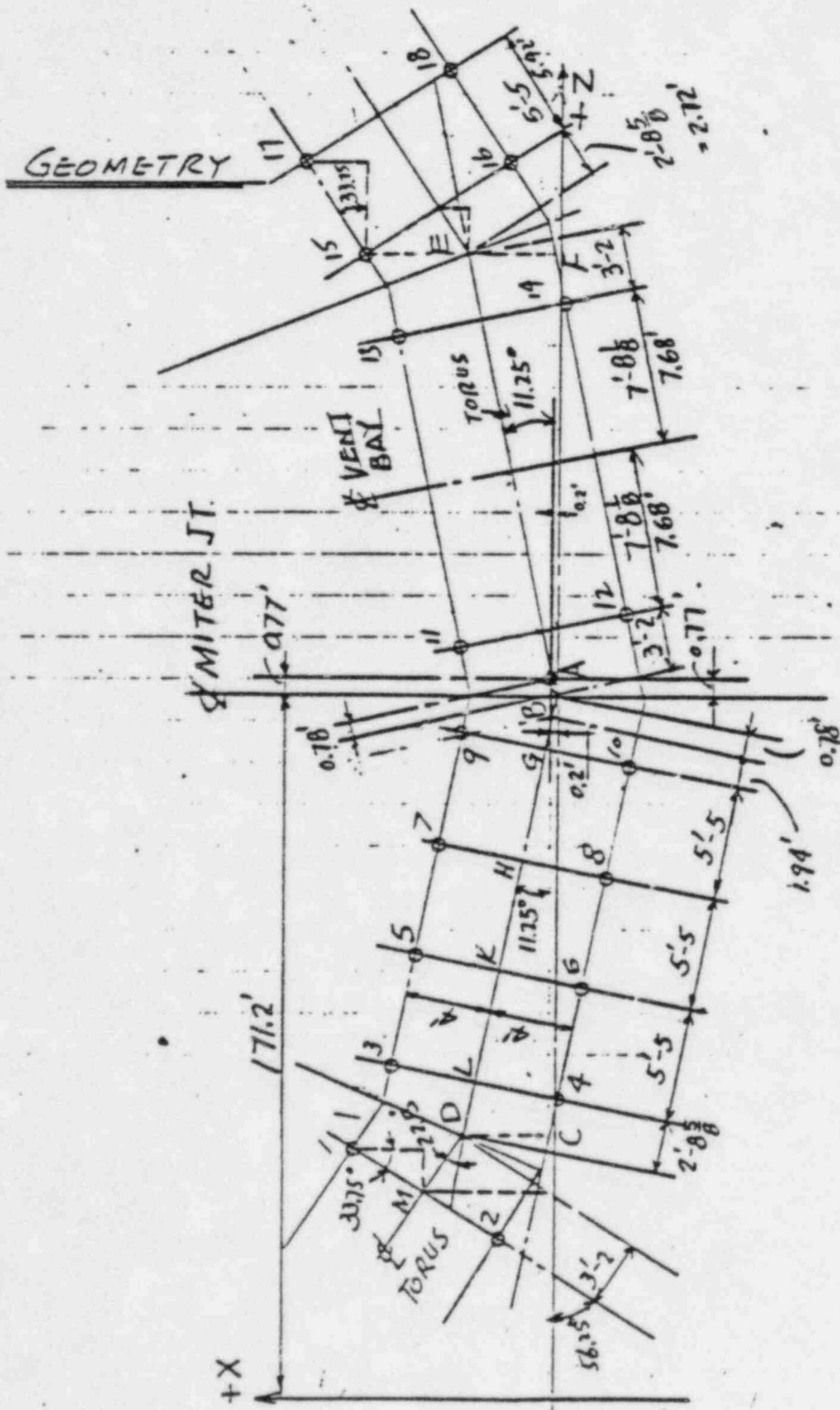
CALC. SET NO.	
PRELIM.	
FINAL	9527-E-SC-SL-3-F
VOID	
SHEET 62 OF 471	
J.O. 9527-040	

REV	COMP. BY	CHK'D BY
0	HFH DATE 5-25-79	YLT DATE 5-31-79
	DATE	DATE

NAME OF COMPANY C.P & L - BRUNSWICK UNIT/S 1 & 2

SUBJECT CONDFOR

GEOMETRY



DOWNCOMERS GEOMETRY

SCALE 1/8" = 1'-0

REF. { CB & I DWG. No. 206 REV. 6
{ T-9527-F-755 (DESIGN No. 3)

Form 5007 Rev. 3-77

(DISCIPLINE)

GENERAL COMPUTATION SHEET

united engineers & constructors inc.

NAME OF COMPANY C P & L - BRUNSWICK UNIT/S 1 & 2

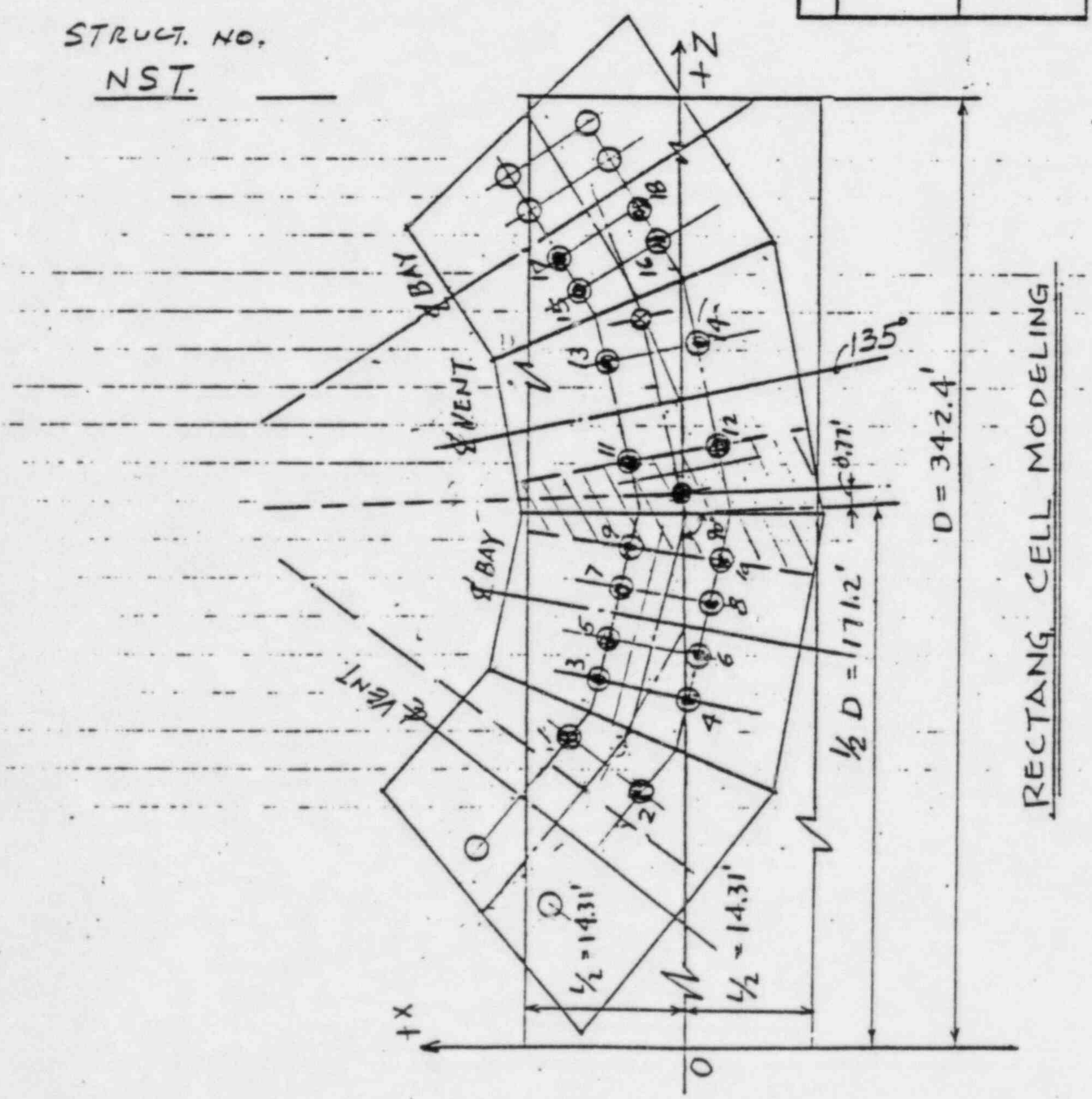
SUBJECT TEEQFOR

CALC. SET NO.		
PRELIM.		
FINAL	9527-E-SC-SL-3-F	
VOID		
SHEET 63 OF 471		
J.O. 9527-040		
REV	COMP. BY	CHK'D BY
0	HFH DATE 5-10-79	YLT DATE 5-31-79
	DATE	DATE

GEOMETRIC ℄ OF STRUCTURES

STRUCT. NO.

NST.



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NAME OF COMPANY C. P. & L - BRUNSWICK UNIT/S 1&2

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CALC. SET NO.	
PRELIM.	
FINAL	9527-E-SC-SL-3-F
VOID	
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J.O. 9527-040	

REV	COMP. BY	CHK'D BY
0	HFH DATE 5-29-79	YLT DATE 5-31-79
	DATE	DATE

GEOMETRY OF DOWNCOMERS

REF TO PREVIOUS SHT.

$\theta = 11.25°$

$BG = 2.72' - 0.78' = 1.94'$

$AB = 2 \times 0.77' = 1.54'$

$X_G = BG \sin\theta = 0.38'$

$Z_G = 171.2' - AB - BG \cos\theta = 171.2 - 1.54 - 1.94 \cos\theta = 167.8'$

DOWNCOMER NO. 9 $Y = -6.67'$ (TYP)

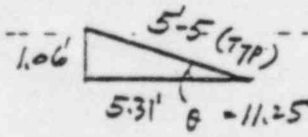
$X_9 = 4' \cos\theta + X_G \overset{+.02'}{} = 4 \cos\theta + 0.38' \overset{+.02'}{} = 3.92' + 0.38' \overset{+.02'}{} = 4.3'$

$Z_9 = -4 \sin\theta + Z_G \overset{+.77}{} = -0.78' + 167.8' \overset{+.77}{} = 168.6'$

NO. 10

$X_{10} = -4 \cos\theta + X_G \overset{+.02}{} = -3.92' + 0.38' \overset{+.02}{} = -3.34'$

$Z_{10} = Z_G - 4 \sin\theta \overset{+.77}{} = 167.8 - 0.78 \overset{+.77}{} = 167.8'$



NO. 7 $X_7 = X_9 + 1.06' \overset{+.02}{} = 4.3 + 1.06 \overset{+.02}{} = 5.56'$

$Z_7 = Z_9 - 5.31 \overset{+.77}{} = 168.6 - 5.31 \overset{+.77}{} = 164.3'$

NO. 8 $X_8 = X_{10} + 1.06' \overset{+.02}{} = -3.54' + 1.06' \overset{+.02}{} = -2.28'$

$Z_8 = Z_{10} - 5.31 \overset{+.77}{} = 167 - 5.31 \overset{+.77}{} = 162.5'$

NO. 5 $X_5 = X_9 + 2 \times 1.06 \overset{+.02}{} = 4.3 + 2 \times 1.06 \overset{+.02}{} = 6.62'$

$Z_5 = Z_9 - 2 \times 5.31 \overset{+.77}{} = 168.6 - 2 \times 5.31 \overset{+.77}{} = 158.8'$

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GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc.

CALC. SET NO.	
PRELIM.	
FINAL	9527-E-SC-SL-3-F
VOID	
SHEET 65 OF 471	
J.O. 9527-040	

REV	COMP. BY	CHK'D BY
0	HFH DATE 5-29-79	YLT DATE 5-31-79
	DATE	DATE

NAME OF COMPANY C P & L - BRUNSWICK UNIT/S 1 & 2

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(GEOM. / DNCOMERS)

No. 6
$X_6 = X_{10} + 2 \times 1.06' \pm .2 = -3.54 + 2 \times 1.06 \pm .2 = -1.22$
$Z_6 = Z_{10} - 2 \times 5.31 \pm .77 = 167 - 10.62 \pm .77 = 157.2'$

No. 3
$X_3 = X_9 + 3 \times 1.06' \pm .2 = 4.3' + 3 \times 1.06 \pm .2 = 7.68'$
$Z_3 = Z_9 - 3 \times 5.31' \pm .77 = 168.6 - 3 \times 5.31 \pm .77 = 153.5'$

No. 4
$X_4 = X_{10} + 3 \times 1.06' \pm .2 = -3.54 + 3 \times 1.06 \pm .2 = -0.76'$
$Z_4 = Z_{10} - 3 \times 5.31 \pm .77 = 167 - 3 \times 5.31 \pm .77 = 151.9'$

No. 1
$X_1 = BD \sin\theta + DM \sin 33.75° + 4' \cos 33.75° \pm .2$
$= 20.91 \sin\theta + 3.17 \sin 33.75° + 4 \cos 33.75° \pm .2 = 9.37'$
$Z_1 = 171.2 - 1.54 - 20.91 \cos\theta - 3.17 \cos 33.75 + 4 \sin 33.75° \pm .77 = 149.5'$

No. 2
$X_2 = X_1 - 8 \cos 33.75° \pm .2 = 9.17 - 8 \cos 33.75 \pm .2 = 2.72'$
$Z_2 = Z_1 - 8 \sin 33.75 \pm .77 = 145.3'$

No. 11
$X_{11} = (3.17 - 0.78) \sin\theta + 4 \cos\theta \pm .2 = 4.59'$
$Z_{11} = (3.17 - 0.78) \cos\theta - 4 \sin\theta + 171.2 \pm .77 = 173.65'$

No. 12
$X_{12} = X_{11} - 8 \cos\theta \pm .2 = 4.39 - 7.85 \pm .2 = -3.26'$
$Z_{12} = Z_{11} + 8 \sin\theta \pm .77 = 172.76 + 1.56 \pm .77 = 175.1'$

No. 13
$X_{13} = X_{11} + 2 \times 7.68 \sin\theta \pm .2 = 4.39 + 3 \pm .2 = 7.59'$
$Z_{13} = Z_{11} + 2 \times 7.68 \cos\theta \pm .77 = 172.76 + 15.06 \pm .77 = 188.6'$

No. 14
$X_{14} = X_{12} + 2 \times 7.68 \sin\theta \pm .2 = -3.46' + 3 \pm .2 = -0.26'$
$Z_{14} = Z_{12} + 2 \times 7.68 \cos\theta \pm .77 = 174.32 + 15.06 \pm .77 = 190.2'$

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GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc.

CALC. SET NO.		
PRELIM.		
FINAL	9527-E-SC-SL-3-F	
VOID		
SHEET 66 OF 471		
J.O. 9527-040		
REV	COMP. BY	CHK'D BY
0	HFH DATE 5-29-79	YLT DATE 5-31-79
	DATE	DATE

NAME OF COMPANY C P & L - BRUNSWICK UNIT/S 1 & 2

SUBJECT CONDFOR

(GEOM. / DNCOMERS)

NO. 15

$X_{15} = (2 \times 10.84 - 0.78) \sin\theta + 2.72 \sin 33.75^\circ + 4 \cos 33.75^\circ + .2 = 9.11'$

$Z_{15} = (2 \times 10.84 - 0.78) \cos\theta + 2.72 \cos 33.75^\circ - 4 \sin 33.75^\circ + .77 + 171.2 = 20.5 + 171.2 + .77 = 192.5$

NO. 16

$X_{16} = X_{15} - 8 \cos 33.75 + .2 = 8.91 - 6.65 + .2 = 2.46'$

$Z_{16} = 191.7 + 8 \sin 33.75 + .77 = 196.9'$

NO. 17

$X_{17} = X_{15} + 5.42 \sin 33.75 + .2 = 12.1'$

$Z_{17} = 191.7 + 5.42 \cos 33.75 + .77 = 197.2'$

NO. 18

$X_{18} = X_{17} - 8 \cos 33.75 + .2 = 5.45'$

$Z_{18} = 196.2 + 8 \sin 33.75 + .77 = 201.5'$

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GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc

NAME OF COMPANY CP&L- Brunswick UNIT/S 1 & 2

SUBJECT LOCAFOR – 6"φ Header Support

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM		0	YLT	HFH
FINAL	9527-E-SC-SL-1-E		DATE 12-6-79	DATE 1-3-80
VOID				
SHEET	61 OF 180		DATE	DATE
J.O.	9527-040			

Effects due to proximity of wall:

Element #20

$r = 0.551/2 = 0.2755 < 1.5 \times \frac{6.625}{12} = 1.5 \times 0.552 = 0.828$

$X_w = \frac{0.2755}{0.552} - 0.5 = -0.0009$

$A_w = 1.0$

$D_w = 2.4$

Element #19

$r = 1.5 \times 0.551 = 0.8265 < 0.828$

$X_w = \frac{0.8265}{0.552} - 0.5 = 0.9972$

$A_w = \frac{0.05}{0.9972} = 0.050$

$D_w = \frac{0.12}{0.9972} = 0.1203$

Element #18

$r = 2.5 \times 0.551 = 1.3775 > 0.828$

No effect

FORM 5007 REV 7/79

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc

NAME OF COMPANY CP & L - Brunswick UNIT/S 1 & 2

SUBJECT LOCAFOR - 6"ϕ Header Support

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM		0	YLT	HFH
FINAL	9527-E-SC-SL-1-F		DATE 12-7-79	DATE 1-3-80
VOID				
SHEET	62 OF 180		DATE	DATE
J.O.	9527-040			

Effect of neighbor structure (Main Beam Center Support):

$$r_{12} = \sqrt{(-2.267+.331)^2 + (8.864-9.22)^2} = 1.968 < 3\bar{D} = 4.008$$

$$\bar{D} = \frac{.552+2.12}{2} = 1.336$$

$$X_I = \frac{1.968}{1.336} - 1 = 0.473$$

$$A_I = \frac{0.2}{0.473} \cdot \frac{2.12}{0.552+2.12} = 0.3354$$

$$D_I = \frac{0.2}{0.473} = 0.4228$$

Total interference effects:

Element #1 thru #18

$$A_I = \underline{1.3354}, \quad D_I = 1.4228$$

Element #19

$$A_I = 1 + 0.05 + 0.3354 = \underline{1.3854}$$

$$D_I = 1 + 0.12 + 0.4228 = 1.5428$$

Element #20

$$A_I = 1 + 1.0 + 0.3354 = \underline{2.3354}$$

$$D_I = 1 + 2.4 + 0.4228 = 3.8228$$

FORM 5007 REV 7/79

(DISCIPLINE)

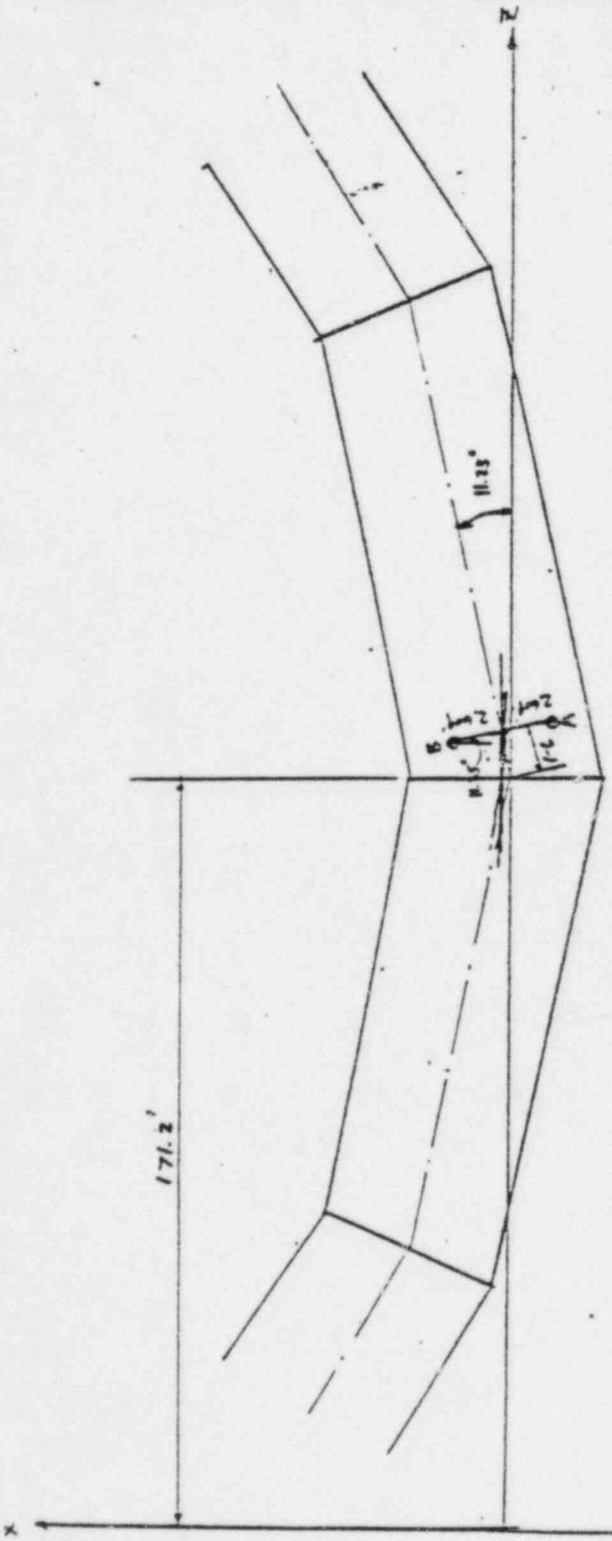
GENERAL COMPUTATION SHEET

united engineers & constructors inc

CALC SET NO.		REV	COMP BY	CHK'D BY
PRELIM.		0	YLT	HFH
FINAL	9527-E-SC-SL-2-2		DATE 12-17-79	DATE 7-2-80
VOID				
SHEET	159 OF 471		DATE	DATE
J.O.	9527-040			

NAME OF COMPANY: CP&L - Brunswick UNIT/S: 1 & 2

SUBJECT: CONDFOR - 6"ϕ Header Support Column



Ref: LOCAFOR

$1.5 \tan 11.25° = 0.298$

$2.609 + 0.298 = 2.907$ (Column B)

$2.609 - 0.298 = 2.311$ (Column A)

Submerged Column Length $= 14.083 - (2.75 - 1.5208) + 0.5 - 2.333 = 11.02$

Segment Length $= \frac{11.02}{20} = 0.551' < \frac{6.625}{12} = 0.552'$ ok.

Same Cell Model as T Quencher

FORM 5007 REV 7/79

(DISCIPLINE)

GENERAL COMPUTATION SHEET

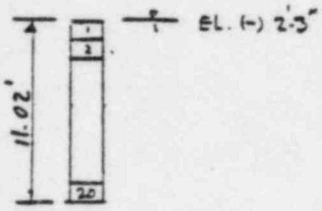
united engineers & constructors inc

NAME OF COMPANY CP&L- Brunswick UNIT/S 1 & 2

SUBJECT CONDFOR - 6"ϕ Header Support Column

CALC. SET NO.		REV	COMP BY	CHK'D. BY
PRELIM		0	YLT	
FINAL	9527-E-SC-SL-3-E		DATE 12-7-79	DATE
VOID				
SHEET	461 OF 471	1	YLT	HFH
JO	9527-040		DATE 5-27-80	DATE 7-2-80

(Run 510, 511)



Column A

Segment No.	XSTR	YSTR	ZSTR
1	−2.311 cos 11.25° = −2.267	$-2.333 - \frac{.551}{2} = -2.609$	171.2 + 1.5/cos 11.25 + 2.311 sin 11.25° = 173.18
2	−2.267	−3.160	173.18
3	−2.267	−3.711	173.18
4	−2.267	−4.262	173.18
5	−2.267	−4.813	173.18
6	−2.267	−5.364	173.18
7	−2.267	−5.915	173.18
8	−2.267	−6.466	173.18
9	−2.267	−7.017	173.18
10	−2.267	−7.568	173.18
11	−2.267	−8.119	173.18
12	−2.267	−8.670	173.18
13	−2.267	−9.221	173.18
14	−2.267	−9.772	173.18
15	−2.267	−10.323	173.18
16	−2.267	−10.874	173.18
17	−2.267	−11.425	173.18
18	−2.267	−11.976	173.18
19	−2.267	−12.527	173.18
20	−2.267	−13.078	173.18

VOL (NS) = $2\pi\left(\frac{.552}{2}\right)^2(.551)$ = 0.264 + 1.3354 = 0.3525, NS = 1,18 ; VOL (19) = 0.264 + 1.3854 = .3657; VOL(20) = .264 + 2.3354 = .6165 ;

AX (NS) = .552 (.551) = 0.304

CD (NS) = 3.6 + 1.4228 = 5.122, NS = 1,18 ; CD (19) = 3.6 + 1.5428 = 5.554 ; CD (20) = 3.6 + 3.8228 = 13.762 ;

SX = 0.0,

SY = 1.0,

SZ = 0.0,

Form 5007 Rev. 3-77

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc.

CALC. SET NO.	
PRELIM.	
FINAL	9527-E-SC-SL-3-I
VOID	
SHEET 163 OF 471	
J.O. 9527040	

REV	COMP. BY	CHK'D BY
0	YLT DATE 5-27-80	HFH DATE 7-2-80
	DATE	DATE

NAME OF COMPANY CPL- Brunswick UNITS: 1 & 2

SUBJECT Postchugging - Header Column

I 9	II 11
10 IV	12 III

Run 510A, 511A

D.C.	9	10	11	12
XVENT	4.5	-3.34	4.59	-3.26
YVENT	-6.67	-6.67	-6.67	-6.67
ZVENT	169.4	167.8	173.6	175.1

Maximum loading in x-direction

NBUB=2,

Downcomer #11 and #12 180° out of phase

XVENT = 4.59, -3.26,
YVENT = 2*-6.67,
ZVENT = 173.6, 175.1,
FREQ = 2*26.5,
AMP = 2*377.83,
TL= 0.0, 0.01887,

Maximum loading in y-direction

Downcomer #10 and #12 in phase

XVENT = -3.34, -3.26,
YVENT = 2*-6.67,
ZVENT = 167.8, 175.1,
FREQ = 2*26.5,
AMP = 2*377.83,
TL = 2*0.,

Form 5007 Rev. 3-77

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc.

NAME OF COMPANY CPL- Brunswick UNIT/S 1 & 2

SUBJECT Postchugging - Header Column

CALC. SET NO.		
PRELIM.		
FINAL	9527-E-SC-SC-2-2	
VOID		
SHEET 164 OF 471		
J.O. 9527040		
REV	COMP. BY	CHK'D BY
0	YLT DATE 5-27-80	HFH DATE 7-2-80
	DATE	DATE

Maximum loading in z-direction

Downcomer #10 and #12 180° out of phase

XVENT= -3.34, -3.26,
YVENT = 2 * -6.67,
ZVENT = 167.8, 175.1,
FREQ = 2 * 26.5,
AMP = 2 * 377.83,
TL = 0.0, 0.01887,

Maximum moment

Downcomer #9 and #12 180° out of phase

XVENT = 4.5, -3.26,
YVENT = 2 * -6.67,
ZVENT = 169.4, 175.1,
FREQ = 2 * 26.5,
AMP = 2 * 377.83,
TL = 0.0, 0.01887,

Form 5u07 Rev. 3-77

(DISCIPLINE)

GENERAL COMPUTATION SHEET

united engineers & constructors inc.

CALC. SET NO.	
PRELIM.	
FINAL	9527-E-SC-SL-3-2
VOID	
SHEET 167 OF 471	
J.O. 9527040	

REV	COMP. BY	CHK'D BY
0	YCT DATE 5-28-80	HFH DATE 7-2-80
	DATE	DATE

NAME OF COMPANY CPL- Brunswick UNIT/S 1 & 2

SUBJECT Postchugging - Header Column
Maximum loading in X direction

Run 510A, 511A

Frequency = 26.5
Amplitude = 377.83

Segment Number	Fx (LBF)	Fy (LBF)	Fz (LBF)	
1	1.084	0	-1.335	
2	3.336	0	-4.204	
3	5.946	0	-7.815	
4	9.224	0	-12.808	
5	13.528	0	-19.913	
6	19.029	0	-29.502	
7	24.998	0	-40.205	
8	29.076	0	-47.485	
9	28.711	0	-46.420	
10	24.389	0	-37.943	
11	18.952	0	-27.520	
12	14.358	0	-18.896	
13	11.026	0	-12.836	
14	8.721	0	-8.833	
15	7.122	0	-6.226	
16	5.993	0	-4.519	
17	5.180	0	-3.389	
18	4.589	0	-2.634	
19	4.318	0	-2.209	
20	6.759	0	-3.149	

Form 5007 Rev. 3-77

(DISCIPLINE)

GENERAL COMPUTATION SHEET

united engineers & constructors inc.

CALC. SET NO.	
PRELIM.	
FINAL	9527-E-SC-SL-3-F
VOID	
SHEET 168 OF 471	
J.O. 9527040	

REV	COMP. BY	CHK'D BY
0	YLT DATE 5-28-80	HFH DATE 7-2-80
	DATE	DATE

NAME OF COMPANY CPL- Brunswick UNIT/S 1 & 2

SUBJECT Postchugging - Header Column

Maximum Loading in y direction

(Not governing)

Run 510A, 511A

Frequency = 26.5

Amplitude = 377.83

Segment Number	Fx (LBF)	Fy (LBF)	Fz (LBF)
1	-0.836	0	0.745
2	-2.608	0	2.454
3	-4.759	0	4.927
4	-7.612	0	8.826
5	-11.537	0	14.924
6	-16.715	0	23.644
7	-22.425	0	33.674
8	-26.309	0	40.526
9	-25.817	0	39.304
10	-21.434	0	30.928
11	-15.996	0	20.824
12	-11.452	0	12.672
13	-8.213	0	7.168
14	-6.031	0	3.744
15	-4.573	0	1.694
16	-3.590	0	0.491
17	-2.918	0	-0.204
18	-2.455	0	-0.599
19	-2.217	0	-0.850
20	-3.365	0	-1.641

Form 5007 Rev. 3-77

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers & constructors inc.

CALC. SET NO.	
PRELIM.	
FINAL	9527-E-SC-SL-5-F
VOID	
SHEET 169 OF 471	
J.O. 9527040	

REV	COMP. BY	CHK'D BY
0	YLT DATE 5-29-80	HFH DATE 7-2-80
	DATE	DATE

NAME OF COMPANY CPL- Brunswick UNIT/S 1 & 2

SUBJECT Postchugging - Header Column
Maximum loading in Z direction

Run 516A, 511A
Frequency = 26.5
Amplitude = 377.83

Segment Number	Fx (LBF)	Fy (LBF)	Fz (LBF)	
1	0.581	0	-1.971	
2	1.849	0	-6.089	
3	3.504	0	-10.926	
4	5.883	0	-17.092	
5	9.370	0	-25.279	
6	14.167	0	-35.800	
7	19.577	0	-47.225	
8	23.263	0	-54.968	
9	22.686	0	-54.081	
10	18.324	0	-45.509	
11	12.997	0	-34.761	
12	8.628	0	-25.648	
13	5.602	0	-19.008	
14	3.643	0	-14.396	
15	2.402	0	-11.202	
16	1.615	0	-8.962	
17	1.114	0	-7.368	
18	0.791	0	-6.229	
19	0.606	0	-5.623	
20	0.794	0	-8.509	

Form 5007 Rev. 3-77

(DISCIPLINE)

GENERAL COMPUTATION SHEET

united engineers & constructors inc.

CALC. SET NO.	
PRELIM.	
FINAL	9527-E-SC-SL-3-F
VOID	
SHEET 170 OF 471	
J.O. 9527040	

REV	COMP. BY	CHK'D BY
0	YCT DATE 5-29-80	HFH DATE 7-2-80
	DATE	DATE

NAME OF COMPANY C P L - Brunswick UNIT/S 1 & 2

SUBJECT Postchugging - Header Column

Maximum Moment

Run 510A, 511A

Frequency = 26.5

Amplitude = 377.83

Segment Number	F_x (LBF)	F_y (LBF)	F_z (LBF)
1	0.949	0	-1.492
2	2.938	0	-4.667
3	5.293	0	-8.573
4	8.331	0	-13.842
5	12.419	0	-21.198
6	17.738	0	-31.003
7	23.570	0	-41.881
8	27.561	0	-49.293
9	27.163	0	-48.315
10	22.862	0	-39.881
11	17.490	0	-29.461
12	12.995	0	-20.806
13	9.785	0	-14.690
14	7.609	0	-10.613
15	6.140	0	-7.924
16	5.131	0	-6.133
17	4.425	0	-4.922
18	3.924	0	-4.094
19	3.703	0	-3.660
20	5.815	0	-5.511

COMPUTER PRINTOUT

BRUNSWICK CONDFOR

RUN 510A

HD COLUMN

POST CHUGGING

(Total 13 Pages)

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

Attachment RAI-11-3

BNL RAI II-3

BRUNSWICK
CONDFDR
RUN 5109
HD COLUMN
POST CH

```
NBUL    = 2.
NSECT   = 10.
NIMG    = 9.
NTIME   = 50.
NOPT    = 1.
NPRINT  = 0.
NPUNCH  = 0.
NST     = 1.
NCOND   = 1.
NVEL    = 0.
D       = .3424E+03,
L       = .2862E+02,
H       = .1717E+02,
VWATER  = -.233E+01,
XVENT   = .659E+01, -.326E+01, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,   0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0,
YVENT   = -.667E+01, -.667E+01, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,   0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0,
[illegible] = .1736E+03, .1791E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,   0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0,
GC      = .372E+02,
RHO     = .624E+02,
[illegible] = -.2267E+01, -.2267E+01, -.2267E+01, -.2267E+01, -.2267E+01,   -.2267E+01, -.2267E+01, -.2267E+01,
          -.2267E+01, -.2267E+01,
XSTR    = -.2609E+01, -.316E+01, -.3711E+01, -.4263E+01, -.4813E+01,   [illegible], [illegible], [illegible],
          -.7017E+01, -.7568E+01,
ZSTR    = .1731E+03, .1731E+03, .1731E+03, .1731E+03, .1731E+03,   .1731E+03, .1731E+03, .1731E+03,
          .1731E+03, .1731E+03,
SX      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
SY      = .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,   .1E+01, .1E+01,
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VOL     = .3525E+00, .3525E+00, .3525E+00, .3525E+00, .3525E+00, .3525E+00,   .3525E+00, .3525E+00, .3525E+00, .3525E+00,
AX      = .304E+00, .304E+00, .304E+00, .304E+00, .304E+00, .304E+00, .304E+00, .304E+00, .304E+00, .304E+00,
CD      = .5122E+01, .5122E+01, .5122E+01, .5122E+01, .5122E+01, .5122E+01,   .5122E+01, .5122E+01, .5122E+01, .5122E+01,
DT      = .5E-02,
AMP     = .17783E+03, .37783E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,   0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0,
FREQ    = .265E+02, .265E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0,
TIMW    = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
          0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
```

```
         0.0,
ZVENT    = .  .16E+03, .1751E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,   0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0,
GC       = .372E+02,
RHO      = .624E+02,
XSTR     = -.2267E+01, -.2267E+01, -.2267E+01, -.2267E+01, -.2267E+01,        -.2267E+01, -.2267E+01, -.2267E+01,
           -.2267E+01, -.2267E+01,
YSTR     = -.2604E+01, -.316E+01, -.3711E+01, -.4262E+01, -.4813E+01,         -.5364E+01, -.5910E+01, -.6466E+01,
           -.7017E+01, -.7568E+01,
ZSTR     = .17310E+03, .17310E+03, .17310E+03, .17310E+03, .17310E+03,        .17310E+03, .17310E+03, .17310E+03,
           .17310E+03, .17310E+03,
SX       = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
SY       = .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01, .1E+01,    .1E+01, .1E+01,
SZ       = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
[illegible] = .3525E+00, .3525E+00, .3525E+00, .3525E+00, .3525E+00, .3525E+00,    .3525E+00, .3525E+00, .3525E+00, .3525E+00,
AK       = .384E+00, .384E+00, .384E+00, .384E+00, .384E+00, .384E+00, .384E+00, .384E+00, .384E+00, .384E+00,
CD       = .5122E+01, .5122E+01, .5122E+01, .5122E+01, .5122E+01, .5122E+01,    .5122E+01, .5122E+01, .5122E+01, .5122E+01,
[illegible] = .5E-02,
[illegible] = .37783E+03, .37783E+03, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,   0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0,
FREQ     = .265E+02, .265E+02, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.1,
SIGMA    = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
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           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
SDI      = 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
TL       = 0.0, .1087E-01, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,      0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
           0.0,
FSOPT    = .1E+01,
TIME     = 0.0,
$END
```

CONDFOR VER 8.9 8/78 CODE TO CALCULATE SUBMERGED STRUCTURE LOADING DUE TO CONDENSATION OSCILLATION AND CHUGGING

***CP&L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAX. IN X

INPUT DATA

VENT EXIT LOCATIONS AND PHASE TIMES:

VENT #	X-AXIS (FT)	Y-AXIS (FT)	Z-AXIS (FT)	PHASE TIME (SEC)	AMP (FT**3/S**2)	FREQ (HZ)
1	4.59000	-5.67000	173.60000	0.00000	377.03000	20.00000
2	-3.2[illegible]000	-6.67000	176.10000	.01047	377.03000	26.00000

STRUCTURE INFORMATION:

NS	X-AXIS (FT)	Y-AXIS (FT)	Z-AXIS (FT)	VOL (CU FT)	AP (SQ FT)	CD	SX	SY	SZ
1	-2.26700	-2.60900	173.10000	.35250	.30400	1.122	0.00000	1.00000	0.00000
2	-2.26700	-3.16000	173.10000	.35250	.30400	1.122	0.00000	1.00000	0.00000
3	-2.26700	-3.71100	173.10000	.35250	.30400	1.122	0.00000	1.00000	0.00000
4	-2.26700	-4.26200	173.10000	.35250	.30400	1.122	0.00000	1.00000	0.00000
5	-2.26700	-4.81300	173.10000	.35250	.30400	1.122	0.00000	1.00000	0.00000
6	-2.26700	-5.36400	173.10000	.35250	.30400	1.122	0.00000	1.00000	0.00000
7	-2.26700	-5.91500	173.10000	.35250	.30400	1.122	0.00000	1.00000	0.00000
8	-2.26700	-6.46600	173.10000	.35250	.30400	1.122	0.00000	1.00000	0.00000
9	-2.26700	-7.01700	173.10000	.35250	.30400	1.122	0.00000	1.00000	0.00000
10	-2.26700	-7.56800	173.10000	.35250	.30400	1.122	0.00000	1.00000	0.00000

***CP&L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAX. IN X

TOTAL SECTION FORCES (LBF)

	SECTION 1			SECTION 2			SECTION 3		
TIME (SEC)	FX	FY	FZ	FX	FY	FZ	FX	FY	FZ
0.000000	-.009	0.000	.000	.001	0.000	-.001	.000	0.000	-.000
.005000	.002	0.000	-.907	2.460	0.000	-3.110	4.410	0.000	-8.761
.010000	1.070	0.000	-1.329	3.321	0.000	-4.106	5.920	0.000	-7.702
.015000	.651	0.000	-.802	2.002	0.000	-2.926	3.967	0.000	-4.090
.020000	-.283	0.000	.210	-.626	0.000	.709	-1.119	0.000	1.471
.025000	-.926	0.000	1.138	-2.045	0.000	3.905	-5.071	0.000	6.665
.030000	-1.043	0.000	1.292	-3.206	0.000	4.037	-6.710	0.000	7.906
.035000	-.477	0.000	.588	-1.467	0.000	1.049	-2.018	0.000	2.436
.040000	.399	0.000	-.431	1.229	0.000	-1.849	2.196	0.000	-2.003
.045000	1.016	0.000	-1.249	3.121	0.000	-3.933	5.963	0.000	-7.318
.050000	.966	0.000	-1.130	2.972	0.000	-3.746	5.297	0.000	-6.966
.055000	.286	0.000	-.352	.879	0.000	-1.100	1.966	0.000	-2.057
.060000	-.581	0.000	.715	-1.780	0.000	2.253	-3.190	0.000	4.198
.065000	-1.008	0.000	1.319	-3.286	0.000	4.141	-5.050	0.000	7.700
.070000	-.807	0.000	1.019	-2.636	0.000	3.322	-6.697	0.000	6.176
.075000	-.085	0.000	.105	-.260	0.000	.329	-.461	0.000	.607
.080000	.742	0.000	-.914	2.206	0.000	-2.070	4.073	0.000	-5.393
.085000	1.086	0.000	-1.335	3.336	0.000	-4.206	5.946	0.000	-7.019
.090000	.717	0.000	-.883	2.206	0.000	-2.780	3.938	0.000	-5.188
.095000	-.119	0.000	.146	-.367	0.000	.462	-.818	0.000	.866
.100000	-.877	0.000	1.030	-2.699	0.000	3.401	-6.012	0.000	6.320
.105000	-1.061	0.000	1.307	-3.267	0.000	4.117	-5.823	0.000	7.656
.110000	-.552	0.000	.610	-1.697	0.000	2.139	-3.023	0.000	3.979
.115000	.319	0.000	-.392	.982	0.000	-1.237	1.753	0.000	-2.306
.120000	.981	0.000	-1.208	3.019	0.000	-3.806	5.361	0.000	-7.073
.125000	1.001	0.000	-1.236	3.082	0.000	-3.806	5.493	0.000	-7.221
.130000	.367	0.000	-.452	1.129	0.000	-1.423	2.018	0.000	-2.868
.135000	-.507	0.000	.624	-1.562	0.000	1.968	-2.787	0.000	3.662
.140000	-1.050	0.000	1.293	-3.231	0.000	4.072	-5.760	0.000	7.571
.145000	-.946	0.000	1.116	-2.788	0.000	3.516	-4.969	0.000	6.532
.150000	-.170	0.000	.209	-.521	0.000	.657	-.929	0.000	1.217
.155000	.678	0.000	-.836	2.087	0.000	-2.629	3.721	0.000	-4.890
.160000	1.082	0.000	-1.332	3.338	0.000	-4.196	5.939	0.000	-7.801
.165000	.778	0.000	-.959	2.395	0.000	-3.019	4.268	0.000	-5.611
.170000	-.034	0.000	.042	-.106	0.000	.133	-.192	0.000	.290
.175000	-.826	0.000	1.018	-2.537	0.000	3.197	-4.526	0.000	5.946
.180000	-1.079	0.000	1.329	-3.310	0.000	4.171	-5.900	0.000	7.799
.185000	-.623	0.000	.766	-1.910	0.000	2.417	-3.416	0.000	4.491
.190000	.236	0.000	-.291	.720	0.000	-.910	1.302	0.000	-1.711
.195000	.941	0.000	-1.159	2.890	0.000	-3.692	5.166	0.000	-6.790
.200000	1.031	0.000	-1.270	3.173	0.000	-3.999	5.658	0.000	-7.436
.205000	.446	0.000	-.550	1.372	0.000	-1.729	2.443	0.000	-3.212
.210000	-.430	0.000	.530	-1.326	0.000	1.671	-2.366	0.000	3.109
.215000	-1.025	0.000	1.263	-3.196	0.000	3.977	-5.626	0.000	7.390
.220000	-.950	0.000	1.170	-2.923	0.000	3.686	-5.218	0.000	6.849
.225000	-.253	0.000	.312	-.778	0.000	.903	-1.383	0.000	1.019
.230000	.609	0.000	-.750	1.876	0.000	-2.364	3.346	0.000	-4.397
.235000	1.073	0.000	-1.322	3.303	0.000	-4.162	5.887	0.000	-7.738
.240000	.835	0.000	-1.029	2.570	0.000	-3.229	4.580	0.000	-6.021
.245000	.051	0.000	-.063	.186	0.000	-.197	.278	0.000	-.368

***CP&L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAX. IN X

CONDFOR VER 0.5 4/78 CODE TO CALCULATE SUBMERGED STRUCTURE LOADING DUE TO CONDENSATION OSCILLATION AND CHUGGING

***CP+L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAX. IN Y

INPUT DATA

VENT EXIT LOCATIONS AND PHASE TIMES:

VENT #	X-AXIS (FT)	Y-AXIS (FT)	Z-AXIS (FT)	PHASE TIME (SEC)	AMP (FT**3/S**2)	FREQ (HZ)
1	-3.34000	-6.67000	167.60000	0.00000	377.03000	19.90000
2	-3.26000	-6.67000	175.10000	0.00000	377.03000	20.50000

STRUCTURE INFORMATION:

NS	X-AXIS (FT)	Y-AXIS (FT)	Z-AXIS (FT)	VOL (CU FT)	AR (SQ FT)	OD	SX	SY	SZ
1	-2.26700	-2.60900	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
2	-2.26700	-3.16000	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
3	-2.26700	-3.71100	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
4	-2.26700	-4.26200	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
5	-2.26700	-4.81300	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
6	-2.26700	-5.36400	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
7	-2.26700	-5.91500	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
8	-2.26700	-6.46600	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
9	-2.26700	-7.01700	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
10	-2.26700	-7.56800	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000

CONDFOR VER 8.5 8/78 CODE TO CALCULATE SUBMERGED STRUCTURE LOADING DUE TO CONDENSATION OSCILLATION AND CHUGGING

***CP&L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAX. IN Y

TOTAL SECTION FORCES (LBF)

TIME (SEC)	SECTION 1 FX	SECTION 1 FY	SECTION 1 FZ	SECTION 2 FX	SECTION 2 FY	SECTION 2 FZ	SECTION 3 FX	SECTION 3 FY	SECTION 3 FZ
0.000000	-.000	0.000	.000	-.001	0.000	.001	-.006	0.000	.006
.005000	-.619	0.000	.951	-1.930	0.000	1.016	-3.080	0.000	3.446
.010000	-.675	0.000	.742	-2.807	0.000	2.444	-4.730	0.000	4.900
.015000	-.502	0.000	.447	-1.969	0.000	1.473	-2.055	0.000	2.916
.020000	.157	0.000	-.140	.490	0.000	-.401	.695	0.000	-.927
.025000	.713	0.000	-.635	2.225	0.000	-2.053	4.059	0.000	-4.201
.030000	.803	0.000	-.719	2.509	0.000	-2.307	4.970	0.000	-4.738
.035000	.360	0.000	-.320	1.147	0.000	-1.070	2.091	0.000	-2.169
.040000	-.308	0.000	.274	-.961	0.000	.900	-1.790	0.000	1.812
.045000	-.703	0.000	.697	-2.440	0.000	2.296	-4.452	0.000	4.610
.050000	-.745	0.000	.664	-2.324	0.000	2.107	-4.240	0.000	4.390
.055000	-.221	0.000	.197	-.687	0.000	.647	-1.252	0.000	1.297
.060000	.440	0.000	-.399	1.390	0.000	-1.316	2.553	0.000	-2.643
.065000	.824	0.000	-.734	2.570	0.000	-2.410	4.600	0.000	-4.654
.070000	.661	0.000	-.589	2.061	0.000	-1.939	3.750	0.000	-3.892
.075000	.066	0.000	-.058	.204	0.000	-.192	.370	0.000	-.303
.080000	-.573	0.000	.510	-1.786	0.000	1.681	-3.260	0.000	3.379
.085000	-.836	0.000	.745	-2.608	0.000	2.455	-4.759	0.000	4.927
.090000	-.593	0.000	.493	-1.725	0.000	1.623	-3.165	0.000	3.256
.095000	.092	0.000	-.082	.287	0.000	-.270	.526	0.000	-.549
.100000	.677	0.000	-.603	2.111	0.000	-1.986	3.892	0.000	-3.980
.105000	.819	0.000	-.730	2.555	0.000	-2.404	4.668	0.000	-4.825
.110000	.426	0.000	-.379	1.327	0.000	-1.249	2.420	0.000	-2.505
.115000	-.246	0.000	.219	-.768	0.000	.723	-1.403	0.000	1.451
.120000	-.757	0.000	.674	-2.360	0.000	2.221	-4.307	0.000	4.455
.125000	-.773	0.000	.588	-2.410	0.000	2.268	-4.396	0.000	4.552
.130000	-.283	0.000	.252	-.883	0.000	.831	-1.609	0.000	1.666
.135000	.392	0.000	-.349	1.221	0.000	-1.149	2.230	0.000	-2.309
.140000	.810	0.000	-.722	2.527	0.000	-2.378	4.610	0.000	-4.773
.145000	.659	0.000	-.623	2.188	0.000	-2.051	3.977	0.000	-4.117
.150000	.131	0.000	-.116	.407	0.000	-.383	.741	0.000	-.767
.155000	-.523	0.000	.466	-1.632	0.000	1.535	-2.970	0.000	3.083
.160000	-.839	0.000	.744	-2.603	0.000	2.450	-4.750	0.000	4.910
.165000	-.688	0.000	.535	-1.873	0.000	1.762	-3.416	0.000	3.537
.170000	.026	0.000	-.024	.083	0.000	-.078	.153	0.000	-.159
.175000	.636	0.000	-.567	1.984	0.000	-1.867	3.621	0.000	-3.749
.180000	.830	0.000	-.739	2.588	0.000	-2.435	4.728	0.000	-4.889
.185000	.481	0.000	-.428	1.499	0.000	-1.411	2.734	0.000	-2.831
.190000	-.183	0.000	.163	-.570	0.000	.536	-1.048	0.000	1.079
.195000	-.727	0.000	.547	-2.266	0.000	2.133	-4.139	0.000	4.281
.200000	-.786	0.000	.789	-2.481	0.000	2.334	-4.526	0.000	4.686
.205000	-.344	0.000	.387	-1.073	0.000	1.009	-1.959	0.000	2.029
.210000	.332	0.000	-.296	1.037	0.000	-.976	1.898	0.000	-1.960
.215000	.791	0.000	-.705	2.460	0.000	-2.318	4.808	0.000	-4.668
.220000	.733	0.000	-.653	2.286	0.000	-2.151	4.178	0.000	-4.317
.225000	.195	0.000	-.174	.600	0.000	-.572	1.107	0.000	-1.147
.230000	-.470	0.000	.419	-1.467	0.000	1.380	-2.670	0.000	2.772
.235000	-.828	0.000	.738	-2.582	0.000	2.430	-4.712	0.000	4.879
.240000	-.649	0.000	.574	-2.009	0.000	1.891	-3.668	0.000	3.799
.245000	-.039	0.000	.035	-.122	0.000	.119	-.220	0.000	.228

CONDFOR VER 8.5 8/78 CODE TO CALCULATE SUBMERGED STRUCTURE LOADING DUE TO CONDENSATION OSCILLATION AND CHUGGING

***CP&L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAX. IN Y

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CONDFOR    VER 0.5    8/78    CODE TO CALCULATE SUBMERGED STRUCTURE LOADING DUE TO CONDENSATION OSCILLATION AND CHUGGING

***CP&L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAXIMUM FORCES IN Z DIRECTION

  INPUT DATA

 VENT EXIT LOCATIONS AND PHASE TIMES)

VENT #    X-AXIS (FT)    Y-AXIS (FT)    Z-AXIS (FT)   PHASE TIME (SEC)  AMP (FT**3/S**2)   FREQ (HZ)
  1        -3.34000       -6.67000      167.00000        0.00000          377.03000        26.50000
  2        -3.26000       -6.67000      175.10000         .01667          377.03000        26.50000

 STRUCTURE INFORMATION)

NS        X-AXIS (FT)    Y-AXIS (FT)    Z-AXIS (FT)    VOL (CU FT)     AX-(SQ FT)    CD      SX        SY        SZ
  1        -2.26700       -2.60900      173.10000       .35250          .30400     5.122   0.00000   1.00000   0.00000
  2        -2.26700       -3.16000      173.10000       .35250          .30400     5.122   0.00000   1.00000   0.00000
  3        -2.26700       -3.71100      173.10000       .35250          .30400     5.122   0.00000   1.00000   0.00000
  4        -2.26700       -4.26200      173.10000       .35250          .30400     5.122   0.00000   1.00000   0.00000
  5        -2.26700       -4.81300      173.10000       .35250          .30400     5.122   0.00000   1.00000   0.00000
  6        -2.26700       -5.36400      173.10000       .35250          .30400     5.122   0.00000   1.00000   0.00000
  7        -2.26700       -5.91500      173.10000       .35250          .30400     5.122   0.00000   1.00000   0.00000
  8        -2.26700       -6.46600      173.10000       .35250          .30400     5.122   0.00000   1.00000   0.00000
  9        -2.26700       -7.01700      173.10000       .35250          .30400     5.122   0.00000   1.00000   0.00000
 10        -2.26700       -7.56800      173.10000       .35250          .30400     5.122   0.00000   1.00000   0.00000
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CONDFOR VER 4.5 8/78 CODE TO CALCULATE SUBMERGED STRUCTURE LOADS -- DUE TO CONDENSATION OSCILLATION AND CHUGGING

***CP&L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAXIMUM FORCES IN Z DIRECTION

TOTAL SECTION FORCES (LBF)

	SECTION 1			SECTION 2			SECTION 3		
TIME (SEC)	FX	FY	FZ	FX	FY	FZ	FX	FY	FZ
0.000000	-.000	0.000	-.000	.001	0.000	-.003	.003	0.000	-.018
.005000	.429	0.000	-1.456	1.360	0.000	-4.005	2.094	0.000	-8.007
.010000	.576	0.000	-1.962	1.041	0.000	-6.082	3.469	0.000	-10.079
.015000	.349	0.000	-1.103	1.110	0.000	-3.694	2.103	0.000	-6.590
.020000	-.109	0.000	.369	-.347	0.000	1.144	-.660	0.000	2.059
.025000	-.455	0.000	1.640	-1.576	0.000	5.192	-2.209	0.000	9.319
.030000	-.508	0.000	1.893	-1.776	0.000	5.040	-3.304	0.000	10.491
.035000	-.286	0.000	.867	-.013	0.000	2.677	-1.833	0.000	4.790
.040000	.214	0.000	-.726	.601	0.000	-2.264	1.298	0.000	-4.038
.045000	.543	0.000	-1.844	1.729	0.000	-5.696	3.279	0.000	-10.187
.050000	.518	0.000	-1.756	1.647	0.000	-5.425	3.123	0.000	-9.736
.055000	.183	0.000	-.528	.487	0.000	-1.694	.928	0.000	-2.878
.060000	-.311	0.000	1.086	-.993	0.000	3.269	-1.888	0.000	5.883
.065000	-.572	0.000	1.941	-1.821	0.000	5.990	-3.453	0.000	10.766
.070000	-.459	0.000	1.597	-1.461	0.000	4.811	-2.769	0.000	8.638
.075000	-.046	0.000	.159	-.144	0.000	.476	-.272	0.000	.848
.080000	.397	0.000	-1.349	1.266	0.000	-4.170	2.401	0.000	-7.486
.085000	.581	0.000	-1.971	1.849	0.000	-6.083	3.506	0.000	-10.926
.090000	.386	0.000	-1.303	1.223	0.000	-4.028	2.318	0.000	-7.278
.095000	-.064	0.000	.216	-.203	0.000	.671	-.380	0.000	1.211
.100000	-.478	0.000	1.594	-1.496	0.000	4.987	-2.836	0.000	8.843
.105000	-.569	0.000	1.938	-1.811	0.000	5.963	-3.432	0.000	10.708
.110000	-.296	0.000	1.003	-.941	0.000	3.090	-1.782	0.000	5.556
.115000	.171	0.000	-.588	.544	0.000	-1.793	1.036	0.000	-3.220
.120000	.525	0.000	-1.783	1.673	0.000	-5.510	3.178	0.000	-9.880
.125000	.537	0.000	-1.821	1.708	0.000	-5.626	3.238	0.000	-10.094
.130000	.197	0.000	-.668	.626	0.000	-2.060	1.186	0.000	-3.698
.135000	-.272	0.000	.922	-.866	0.000	2.852	-1.642	0.000	5.122
.140000	-.562	0.000	1.909	-1.791	0.000	5.890	-3.399	0.000	10.584
.145000	-.485	0.000	1.647	-1.549	0.000	5.083	-2.929	0.000	9.130
.150000	-.091	0.000	.308	-.289	0.000	.950	-.540	0.000	1.690
.155000	.363	0.000	-1.232	1.156	0.000	-3.809	2.193	0.000	-6.839
.160000	.588	0.000	-1.967	1.849	0.000	-6.077	3.508	0.000	-10.909
.165000	.417	0.000	-1.419	1.320	0.000	-4.372	2.516	0.000	-7.862
.170000	-.010	0.000	.062	-.059	0.000	.194	-.113	0.000	.359
.175000	-.441	0.000	1.490	-1.406	0.000	4.631	-2.666	0.000	8.313
.180000	-.576	0.000	1.955	-1.834	0.000	6.041	-3.477	0.000	10.851
.185000	-.334	0.000	1.133	-1.063	0.000	3.500	-2.013	0.000	6.278
.190000	.127	0.000	-.430	.404	0.000	-1.331	.768	0.000	-2.395
.195000	.506	0.000	-1.712	1.606	0.000	-5.290	3.049	0.000	-9.496
.200000	.552	0.000	-1.875	1.759	0.000	-5.791	3.333	0.000	-10.392
.205000	.230	0.000	-.811	.760	0.000	-2.503	1.440	0.000	-4.487
.210000	-.231	0.000	.783	-.735	0.000	2.421	-1.399	0.000	4.361
.215000	-.549	0.000	1.869	-1.749	0.000	5.761	-3.316	0.000	10.339
.220000	-.509	0.000	1.727	-1.620	0.000	5.336	-3.071	0.000	9.578
.225000	-.136	0.000	.460	-.431	0.000	1.419	-.819	0.000	2.561
.230000	.326	0.000	-1.100	1.040	0.000	-3.425	1.972	0.000	-6.150
.235000	.575	0.000	-1.951	1.830	0.000	-6.020	3.470	0.000	-10.818
.240000	.448	0.000	-1.519	1.429	0.000	-4.691	2.700	0.000	-8.418
.245000	.027	0.000	-.093	.086	0.000	-.284	.162	0.000	-.503

CONDFOR VER 4.5 8/78 CODE TO CALCULATE SUBMERGED STRUCTURE LOADING DUE TO CONDENSATION OSCILLATION AND CHUGGING

***CP&L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAXIMUM FORCES IN Z DIRECTION

CONDFOR VER 0.5 8/78 CODE TO CALCULATE SUBMERGED STRUCTURE LOADING DUE TO CONDENSATION OSCILLATION AND CHUGGING

***CP&L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAXIMUM MOMENT

INPUT DATA

VENT EXIT LOCATIONS AND PHASE TIMES:

VENT #	X-AXIS (FT)	Y-AXIS (FT)	Z-AXIS (FT)	PHASE TIME (SEC)	AMP (FT**3/S**2)	FREQ (HZ)
1	4.56000	-6.67000	169.40000	0.00000	377.03000	16.70000
2	-3.26000	-6.67000	179.10000	.01007	377.07000	16.00000

STRUCTURE INFORMATION:

NS	X-AXIS (FT)	Y-AXIS (FT)	Z-AXIS (FT)	VOL (CU FT)	AX (SQ FT)	CD	NX	NY	NZ
1	-2.26700	-2.68900	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
2	-2.26700	-3.16000	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
3	-2.26700	-3.71100	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
4	-2.26700	-4.26200	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
5	-2.26700	-4.81300	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
6	-2.26700	-5.36400	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
7	-2.26700	-5.91500	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
8	-2.26700	-6.46600	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
9	-2.26700	-7.01700	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000
10	-2.26700	-7.56800	173.10000	.35250	.30400	9.122	0.00000	1.00000	0.00000

CONDFOR VER 0.5 8/78 CODE TO CALCULATE SUBMERGED STRUCTU[illegible] DUE TO CONDENSATION OSCILLATION AND CHUGGING

*** BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAXIMUM MOMENT

TOTAL SECTION FORCES (LBF)

	SECTION 1			SECTION 2			SECTION 3		
TIME (SEC)	FX	FY	FZ	FX	FY	FZ	FX	FY	FZ
0.000000	-.000	0.000	.000	.001	0.000	-.002	.000	0.000	-.007
.005000	.782	0.000	-1.103	2.174	0.000	-3.493	3.917	0.000	-6.348
.010000	.945	0.000	-2.408	2.925	0.000	-4.647	8.278	0.000	-8.037
.015000	.970	0.000	-.896	1.764	0.000	-2.002	3.175	0.000	-9.144
.020000	-.178	0.000	.279	-.552	0.000	.076	-.996	0.000	1.614
.025000	-.809	0.000	1.272	-2.505	0.000	3.900	-6.516	0.000	7.318
.030000	-.912	0.000	1.433	-2.822	0.000	4.402	-5.003	0.000	8.234
.035000	-.418	0.000	.697	-1.297	0.000	2.092	-2.328	0.000	3.742
.040000	.348	0.000	-.548	1.083	0.000	-1.719	1.993	0.000	-3.143
.045000	.888	0.000	-1.396	2.748	0.000	-4.306	4.952	0.000	-6.821
.050000	.846	0.000	-1.338	2.618	0.000	-4.159	4.716	0.000	-7.439
.055000	.251	0.000	-.396	.774	0.000	-1.230	1.342	0.000	-2.236
.060000	-.589	0.000	.799	-1.979	0.000	2.902	-2.039	0.000	4.999
.065000	-.936	0.000	1.470	-2.896	0.000	4.898	-8.216	0.000	8.447
.070000	-.798	0.000	1.179	-2.321	0.000	3.600	-6.101	0.000	6.775
.075000	-.075	0.000	.117	-.229	0.000	.365	-.411	0.000	.665
.080000	.650	0.000	-1.021	2.012	0.000	-3.196	3.626	0.000	-5.073
.085000	.959	0.000	-1.452	2.938	0.000	-4.667	[illegible]	0.000	[illegible]
.090000	.620	0.000	-.907	1.963	0.000	-3.106	3.400	0.000	-5.667
.095000	-.106	0.000	.166	-.326	0.000	.816	-.906	0.000	.940
.100000	-.768	0.000	1.207	-2.372	0.000	3.776	-4.284	0.000	6.809
.105000	-.930	0.000	1.461	-2.877	0.000	4.571	-8.103	0.000	8.397
.110000	-.443	0.000	.760	-1.495	0.000	2.378	-2.691	0.000	4.360
.115000	.270	0.000	-.439	.865	0.000	-1.374	1.561	0.000	-2.528
.120000	.889	0.000	-1.390	2.659	0.000	-4.283	4.790	0.000	-7.799
.125000	.877	0.000	-1.379	2.719	0.000	-4.318	4.890	0.000	-7.921
.130000	.322	0.000	-.506	.996	0.000	-1.580	1.789	0.000	-2.890
.135000	-.444	0.000	.698	-1.376	0.000	2.185	-2.400	0.000	4.010
.140000	-.919	0.000	1.445	-2.846	0.000	4.521	-5.127	0.000	8.309
.145000	-.793	0.000	1.247	-2.456	0.000	3.901	-4.423	0.000	7.145
.150000	-.149	0.000	.234	-.459	0.000	.729	-.823	0.000	1.334
.155000	.593	0.000	-.933	1.838	0.000	-2.919	3.312	0.000	-5.365
.160000	.947	0.000	-1.409	2.932	0.000	-4.650	8.282	0.000	-8.557
.165000	.682	0.000	-1.072	2.118	0.000	-3.351	3.799	0.000	-6.155
.170000	-.030	0.000	.047	-.093	0.000	.140	-.171	0.000	.277
.175000	-.732	0.000	1.136	-2.238	0.000	3.549	-4.027	0.000	6.523
.180000	-.942	0.000	1.480	-2.918	0.000	4.631	-5.251	0.000	8.507
.185000	-.546	0.000	.858	-1.649	0.000	2.603	-3.041	0.000	4.926
.190000	.207	0.000	-.325	.642	0.000	-1.020	1.159	0.000	-1.877
.195000	.824	0.000	-1.296	2.552	0.000	-4.054	4.599	0.000	-7.449
.200000	.903	0.000	-1.419	2.796	0.000	-4.439	5.036	0.000	-8.155
.205000	.391	0.000	-.616	1.208	0.000	-1.920	2.174	0.000	-3.523
.210000	-.377	0.000	.592	-1.168	0.000	1.899	-2.106	0.000	3.411
.215000	-.898	0.000	1.431	-2.788	0.000	4.416	-5.004	0.000	8.117
.220000	-.832	0.000	1.308	-2.579	0.000	4.098	-4.638	0.000	7.518
.225000	-.222	0.000	.340	-.685	0.000	1.080	-1.231	0.000	1.990
.230000	.533	0.000	-.838	1.652	0.000	-2.624	2.970	0.000	-4.824
.235000	.940	0.000	-1.477	2.909	0.000	-4.621	5.240	0.000	-8.489
.240000	.731	0.000	-1.150	2.266	0.000	-3.596	4.077	0.000	-6.604
.245000	.069	0.000	-.078	.137	0.000	-.210	.248	0.000	-.397

CONDFOR VER 0.5 8/78 CODE TO CALCULATE SUBMERGED STRUCTURE LOADING DUE TO CONDENSATION OSCILLATION AND CHUGGING

***GPU1 BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAXIMUM MOMENT

TOTAL SECTION FORCES (LBF)

```
JOB,T7,...    ,P2,H11.
    (N1906NF.UECOP)
    FCI(*550*9527848YL0)
HEADING,X1BRUNSWICK
HEADING,X CONOFOR
HEADING,X RUN 518A
HEADING,X HD COLUMN
HEADING,X POST CH
HEADING,X1BRUNSWICK
HEADING,X CONOFOR
HEADING,X RUN 518A
HEADING,X HD COLUMN
HEADING,X POST CH
ATTACH,XZW000,GEOXAPPLIB,ID=APPUSER.
APPLIC,GEPROG,PROG=CONOFOR,LL=777777.
REWIND(INPUT)
COPYSBF(INPUT,OUTPUT)
EXIT.
REWIND(INPUT)
COPYSBF(INPUT,OUTPUT)
***CP&L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAX. IN X
 $IN
 NOUR= 2.
 NSECT= 10.
 NING =9.
 NTIME =50.
 NOPT=1.
 NPRINT=0.
 NPUNCH=0.
 NCOND=1.
 NST=1.
 D=342.4.
 L=28.62.
 H=17.17.
 YWATER=-2.33.
 XVENT=4.59,-3.26,
 YVENT= 2*-6.67,
 ZVENT=173.6,175.1,
 GC=32.2.
 RHO=62.4.
 FSOPT= 1.0.
 XSTR= 10*-2.267.
 YSTR= -2.609,-3.16,-3.711,-4.262,-4.813,-5.364,-5.915,-6.466,-7.017,-7.568,
 ZSTR= 10*173.18.
 SX= 10*0..
 SY= 10*1..
 SZ= 10*0.0.
 VOL=10*0.3525.
 AX= 10*0.304.
 CD=10*6.122.
 DT= 0.005.
 FREQ=2*26.5.
 AMP=2*377.03.
 TL=0.,0.01847.
 $
***CP&L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAX. IN Y
 $IN
 XVENT=-3.34,-3.26,
 YVENT=2*-6.67,
 ZVENT=167.8,175.1,
 TL=2*0..
 $
***CP&L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAXIMUM FORCES IN Z DIRECTION
 $IN
 XVENT=-3.34,-3.26,
 YVENT=2*-6.67,
 ZVENT=167.8,179.1,
 TL=0.,0.01847.
```

```
 .4,
L=4.62,
H=12.17,
YWATER=-2.33,
XVENT=4.59,-3.26,
YVENT= 2*-6.67,
ZVENT=173.6,175.1,
GC=32.2,
RHO=62.4,
FSOPI= 1.0,
XSTR= 10*-2.247,
YSTR= -2.609,-3.16,-3.711,-4.262,-4.813,-5.364,-5.915,-6.466,-7.017,-7.562,
ZSTR= 10*173.18,
SX= 10*0.,
SY= 10*1.,
SZ= 10*0.0,
VOL=10*0.3525,
AX= 10*0.304,
CD=10*5.122,
DT= 0.005,
FREQ=2*26.5,
AMP=2*377.83,
TL=0.,0.01847,
$
***CP+L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAX. IN Y
$IN
XVENT=-3.34,-3.26,
YVENT=2*-6.67,
ZVENT=167.4,175.4,
TL=2*0.,
$
***CP+L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAXIMUM FORCES IN Z DIRECTION
$IN
XVENT=-3.34,-3.26,
YVENT=2*-6.67,
ZVENT=167.8,175.1,
TL=0.,0.01847,
$
***CP+L BRUNSWICK MARK I PROGRAM
***POSTCHUGGING DRAG FORCES ON HEADER COLUMN
***MAXIMUM MOMENT
$IN
XVENT=4.5,-3.26,
YVENT=2*-6.67,
ZVENT=169.4,175.1,
TL=0.0,0.01847,
$
```

COMPUTER PRINTOUT

BRUNSWICK HEADER COL.

RUN 921 F1

POST CHUGGING

DYNRE 2

(Total 3 Pages)

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

Attachment RAI 11-4

BNL RAI 11-4

BRUNSWICK
HEADER COL
POSTCHUG
DYNRE2
RUN 321F1

3

NODE	X1	X2	X3	THETA 1	THETA 2	3
2	.3000000E-03	0.	-.1000000E-02	0.	0.	0.
4	.1200000E-02	0.	-.4000000E-02	0.	0.	0.
5	.2200000E-02	0.	-.8500000E-02	0.	0.	0.
6	.4700000E-02	0.	-.1400000E-01	0.	0.	0.
7	[illegible]	0.	[illegible]	0.	0.	0.
8	.1100000E-01	0.	[illegible]	0.	0.	0.
9	.1640000E-01	0.	-.4150000E-01	0.	0.	0.
10	.2190000E-01	0.	-.5110000E-01	0.	0.	0.
11	.2300000E-01	0.	-.5460000E-01	0.	0.	0.
12	.2050000E-01	0.	-.4500000E-01	0.	0.	0.
13	.1570000E-01	0.	-.4020000E-01	0.	0.	0.
14	.1000000E-01	0.	-.3000000E-01	0.	0.	0.
15	.7100000E-02	0.	-.2230000E-01	0.	0.	0.
16	.4600000E-02	0.	-.1670000E-01	0.	0.	0.
17	.3000000E-02	0.	-.1200000E-01	0.	0.	0.
18	.2000000E-02	0.	-.1010000E-01	0.	0.	0.
19	.1400000E-02	0.	-.8200000E-02	0.	0.	0.
20	.1000000E-02	0.	-.8000000E-02	0.	0.	0.
21	.7000000E-03	0.	-.6900000E-02	0.	0.	0.
22	.7000000E-03	0.	-.7100000E-02	0.	0.	0.
23	.6000000E-03	0.	[illegible]	0.	0.	0.

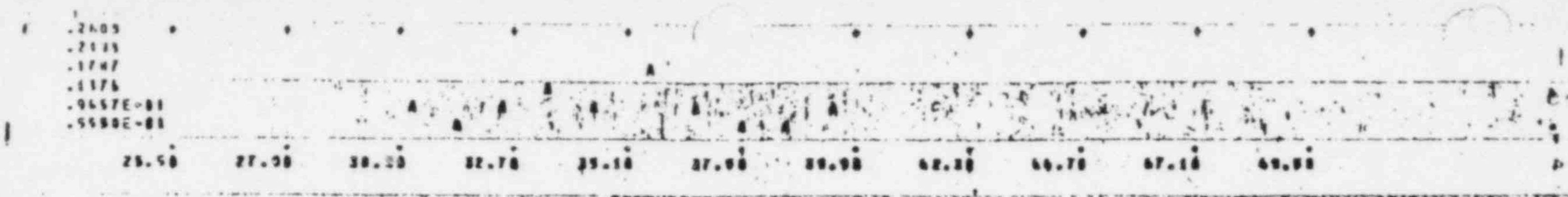
MAXIMUM X1 = .23000000E-01 AT NODE 11
MAXIMUM X3 = -.54600000E-01 AT NODE 11

DIRECTION NUMBER 1

AMPLITUDES WILL BE USED AS THEY ARE INPUT

FREQUENCY	AMPLITUDE	PHASE ANGLE
.5000000E+00	.3170000E-01	0.
.1500000E+01	.8170000E-01	0.
.2500000E+01	.7740000E-01	0.
.3500000E+01	.2610000E-01	0.
.4500000E+01	.4600000E-01	0.
.5500000E+01	.4490000E-01	0.
.6500000E+01	.4990000E-01	0.
.7500000E+01	.4990000E-01	0.
.8500000E+01	.4990000E-01	0.
.9500000E+01	.4990000E-01	0.
.1050000E+02	.1326000E+00	0.
.1100000E+02	.2640000E+00	0.
.1250000E+02	.1085000E+00	0.
.1350000E+02	.9490000E-01	0.
.1450000E+02	.1800000E-01	0.
.1550000E+02	.1640000E-01	0.
.1650000E+02	.6300000E-02	0.
.1750000E+02	.1100000E-01	0.
.1850000E+02	.7780000E-02	0.
.1950000E+02	.6450000E-01	0.
.2050000E+02	.4630000E-01	0.
.2150000E+02	.8110000E-01	0.
.2250000E+02	.2645000E+00	0.
.2350000E+02	.2445000E+00	0.
.2450000E+02	.3550000E+00	0.

.3500
.3408
.3296
.3169
.3082
.3000
.2651
.2699



DIRECTION NUMBER 3

AMPLITUDES WILL BE USED AS THEY ARE INPUT

FREQUENCY	AMPLITUDE	PHASE ANGLE
.255000E+02	.838600E+00	0.
.265000E+02	.100000E+01	0.
.275000E+02	.666600E+00	0.
.285000E+02	.432200E+00	0.
.295000E+02	.388700E+00	0.
.305000E+02	.116100E+00	0.
.315000E+02	.570000E-01	0.
.325000E+02	.130300E+00	0.
.335000E+02	.137700E+00	0.
.345000E+02	.112500E+00	0.
.355000E+02	.163700E+00	0.
.365000E+02	.111000E+00	0.
.375000E+02	.885000E-01	0.
.385000E+02	.647000E-01	0.
.395000E+02	.777000E-01	0.
.405000E+02	.448100E+00	0.
.415000E+02	.448100E+00	0.
.425000E+02	.448100E+00	0.
.435000E+02	.448100E+00	0.
.445000E+02	.448100E+00	0.
.455000E+02	.448100E+00	0.
.465000E+02	.448100E+00	0.
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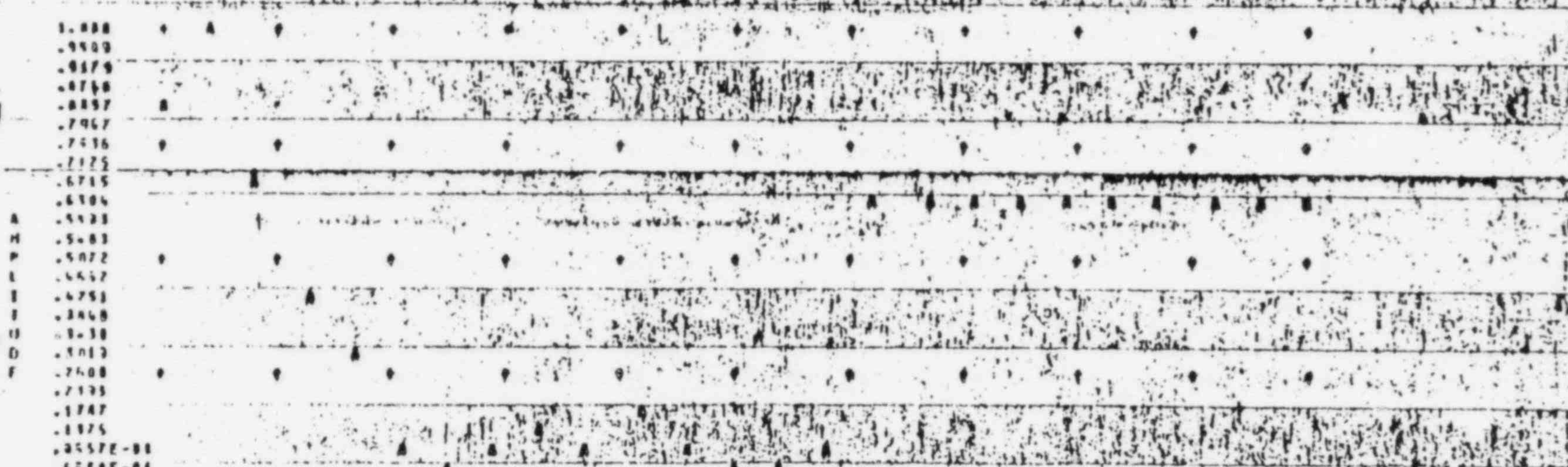
.485000E+02	.448100E+00	0.
.495000E+02	.448100E+00	0.



RAI 13 a - Provide the impact/drag load transients used in the analysis of the main vent, vent header, vacuum breaker and downcomers.

RESPONSE:

Due to the nature of analysis, the impact/drag load transients were divided into the following groups. 1) Main Vent and Vent Header, 2) Downcomers, and 3) Vacuum Breakers. The impact/drag load transients are provided in the form of nodal forces for use in the analysis of main vent, vent header, and downcomers.

The impact/drag load transients are:

1) Main Vent and Vent Header

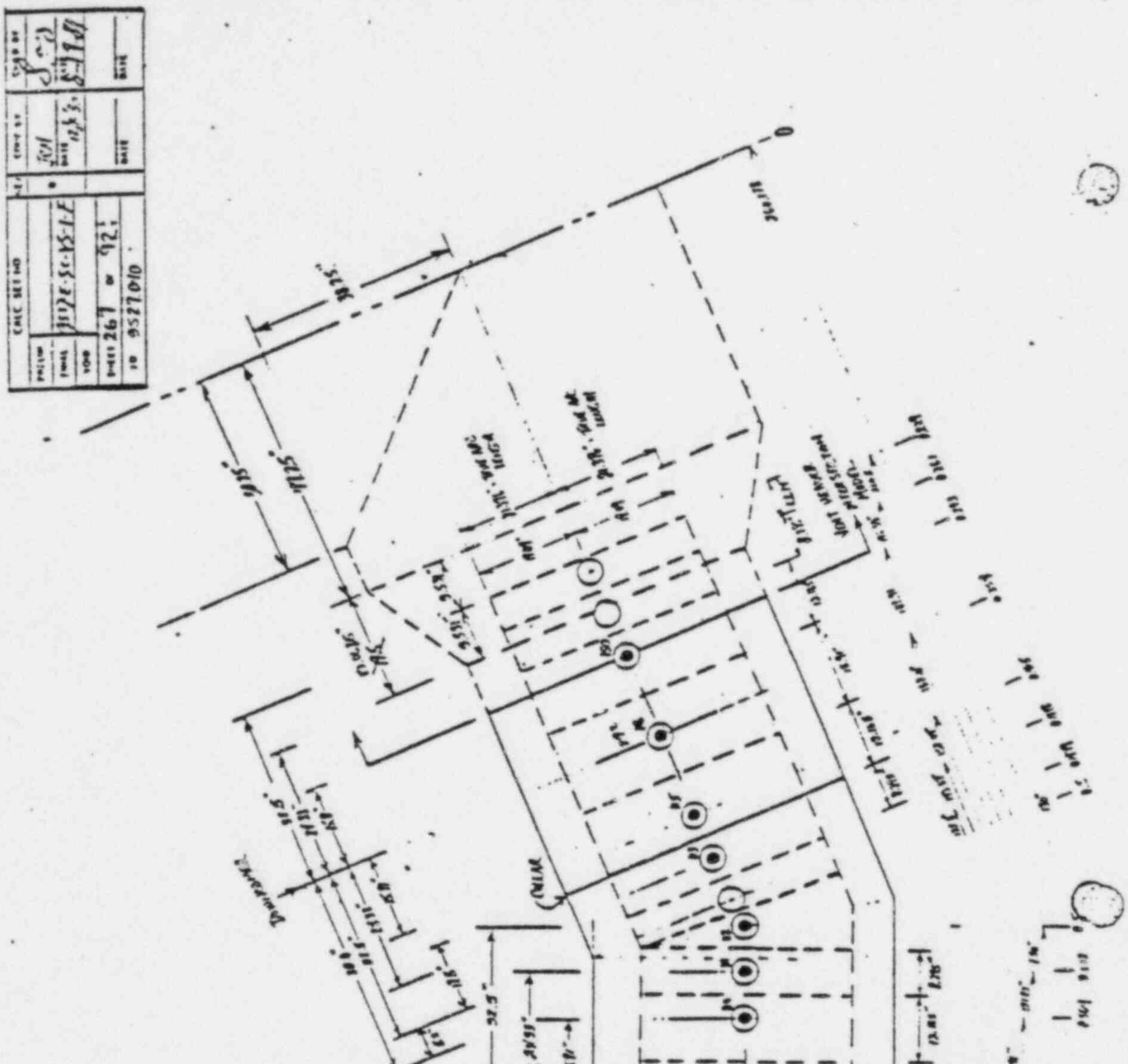
   Dynamic analyses were performed for the load of this group. Locations and load time-history for the vent header are shown on calculation sheets 267, 275 thru 286, and 292 thru 296 of 921, Attachment RAI-13a, and for the main vent on sheets 297 thru 301 of 921, Attachment RAI-13a.

2) Downcomers

   Static analyses for the downcomer impact with a dynamic load factor of two were performed in accordance with GE "Mark I Containment Program Load Definition Report" (NEDO-21888), these loads are shown on sheet 384 of 921, Attachment RAI-13a.

3) Vacuum Breakers

   Due to their specific locations, the vacuum breakers are not subjected to any impact/drag load transients during the pool swell event.



FORM 3077 REV. 7/79

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers

CALC. SET NO.		REV	COMP BY	CHKD BY
PRELIM.		0	JCM	[illegible]
FINAL	9527-E-SC-VS-1-F		DATE 12/4/80	DATE [illegible]
VOID				
SHEET 275 OF 921			DATE	DATE
J.O. 9527.040				

NAME OF COMPANY: Carolina Power & Light Company UNIT/S 1 & 2

SUBJECT: Brunswick - 22½° Beam Model Time History With Velocity Correction

TYPE D (T3, T8, T9, T12)

Node No. 100

Normalized Position, X/L = 1.0

Normalized Impact Velocity = 1.170

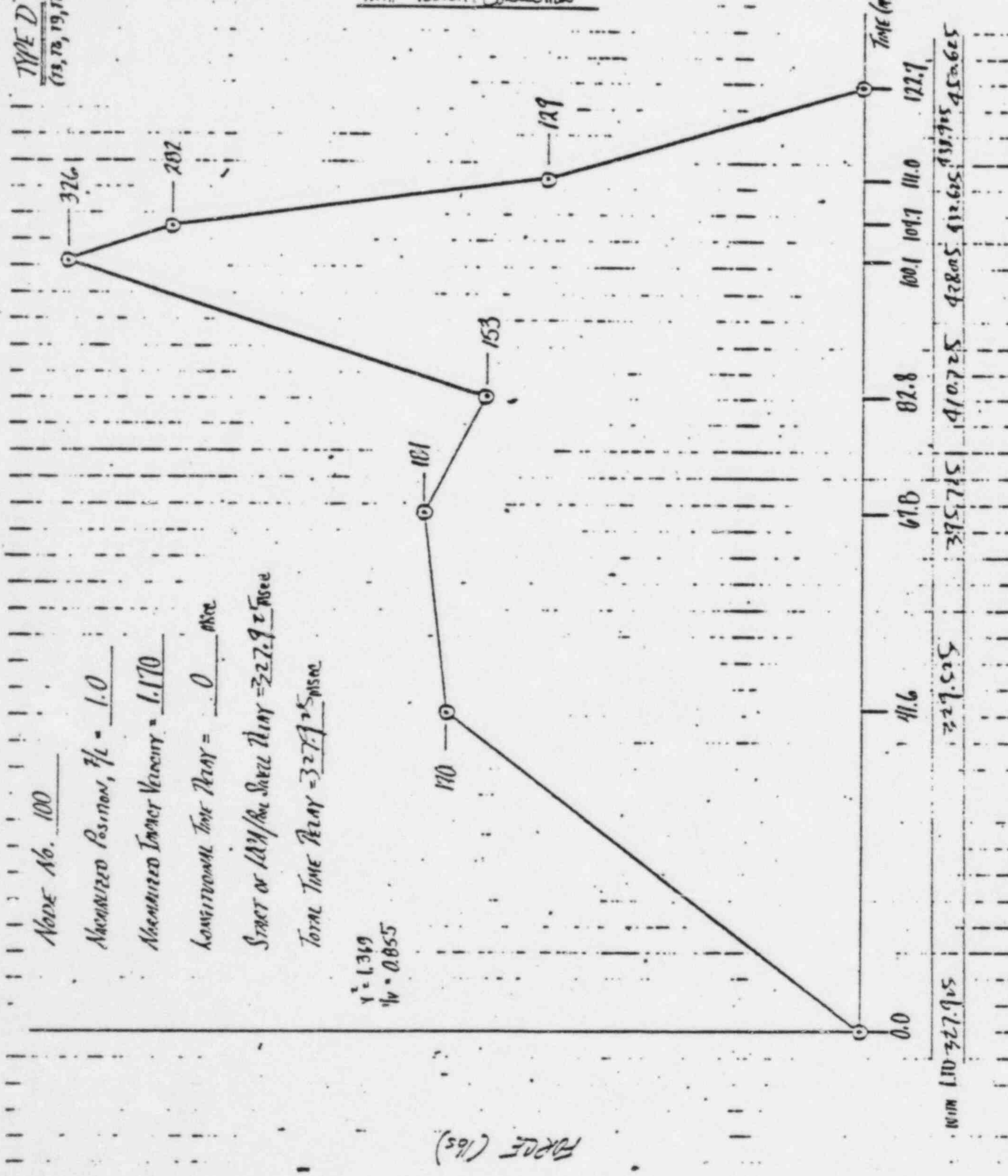
Longitudinal Time Delay = 0 msec

Start of LAM/Rel Shell Delay = 327.925 msec

Total Time Delay = 327.925 msec

Y^2 = 1.369

Y/V = 0.855



FORM 5007 REV. 7/79

GENERAL COMPUTATION SHEET

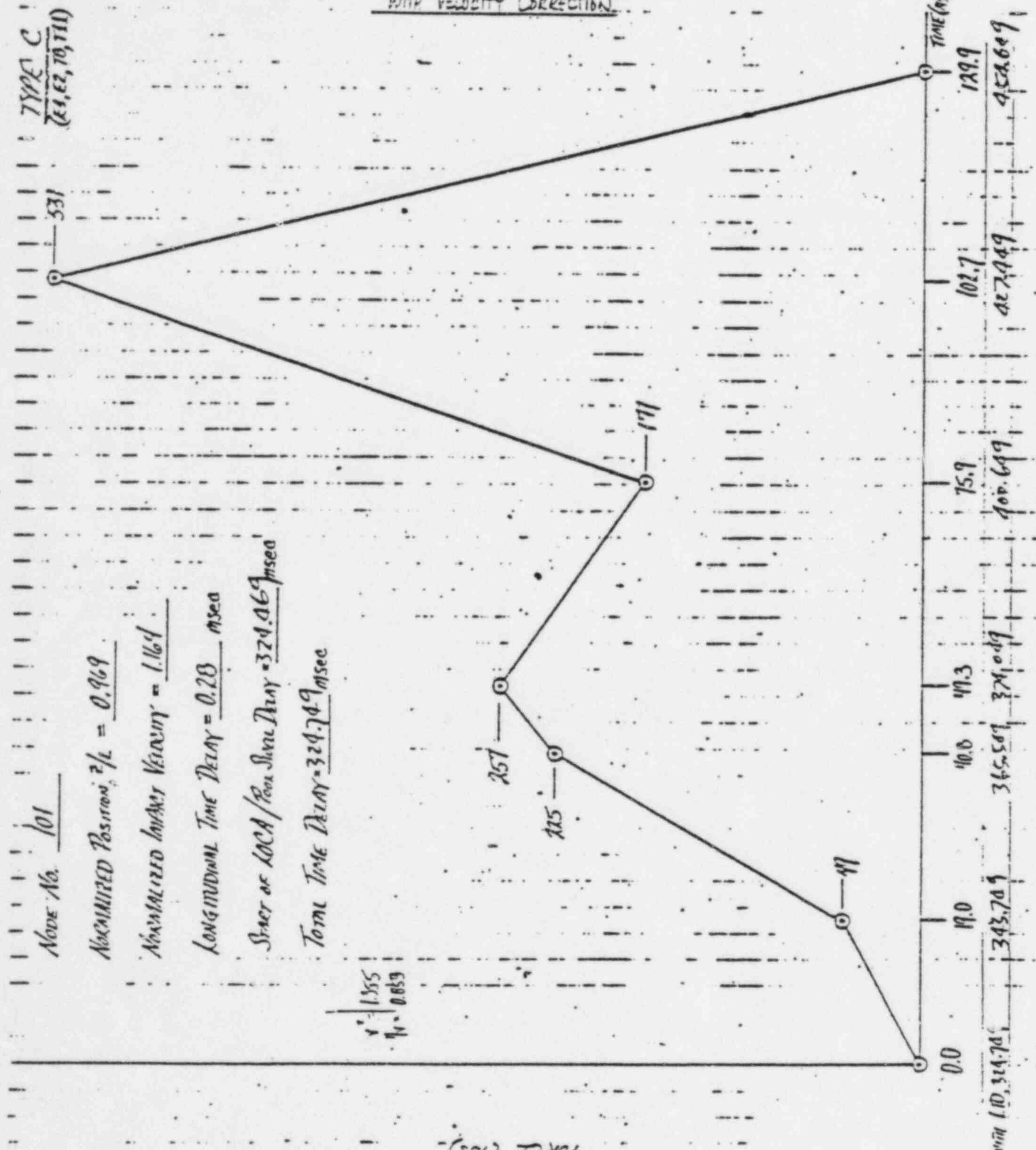
DISCIPLINE

United Engineers & Constructors Inc

CALC. SET NO.		REV	COMP BY	CHK'D. BY
PRELIM.		0	JCM	[signature]
FINAL	9527-ESC-VS-1-F		DATE 12/4/80	DATE 9-20-81
VOID				
SHEET 276 OF 921			DATE	DATE
J.O. 9527.040				

NAME OF COMPANY: CAROLINA POWER & LIGHT COMPANY UNIT/S 1 & 2

SUBJECT: BRUNSWICK – 22½° BEAM MODEL TIME HISTORY WITH VELOCITY CORRECTION.



FORM 5007 REV 7/79

GENERAL COMPUTATION SHEET

(DISCIPLINE)

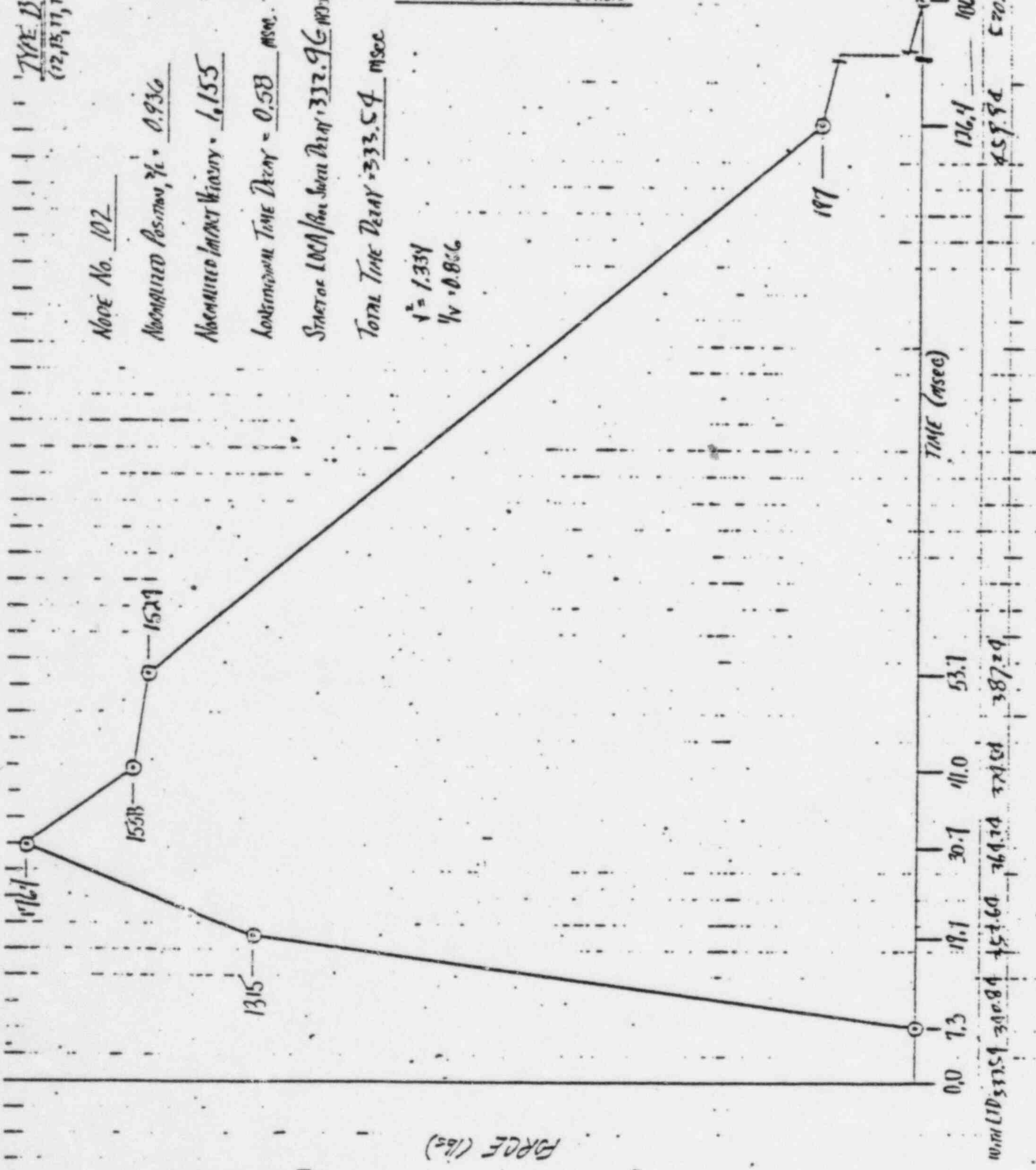
united engineers

	CALC. SET NO.	REV	COMP. BY	CHK'D BY
PRELIM.		0	JCM	[illegible]
FINAL	9527-E-SC-VS-1-F		DATE 12/4/80	DATE 8-20-81
VOID				
SHEET 277 OF 921			DATE	DATE
J.O. 9527.040				

NAME OF COMPANY Carolina Power & Light Company UNITS 1 & 2

SUBJECT Brunswick - 22½° Beam Model Time History

WITH VELOCITY CORRECTION



FORM 5007 REV 7/79

DISCIPLINE

GENERAL COMPUTATION SHEET

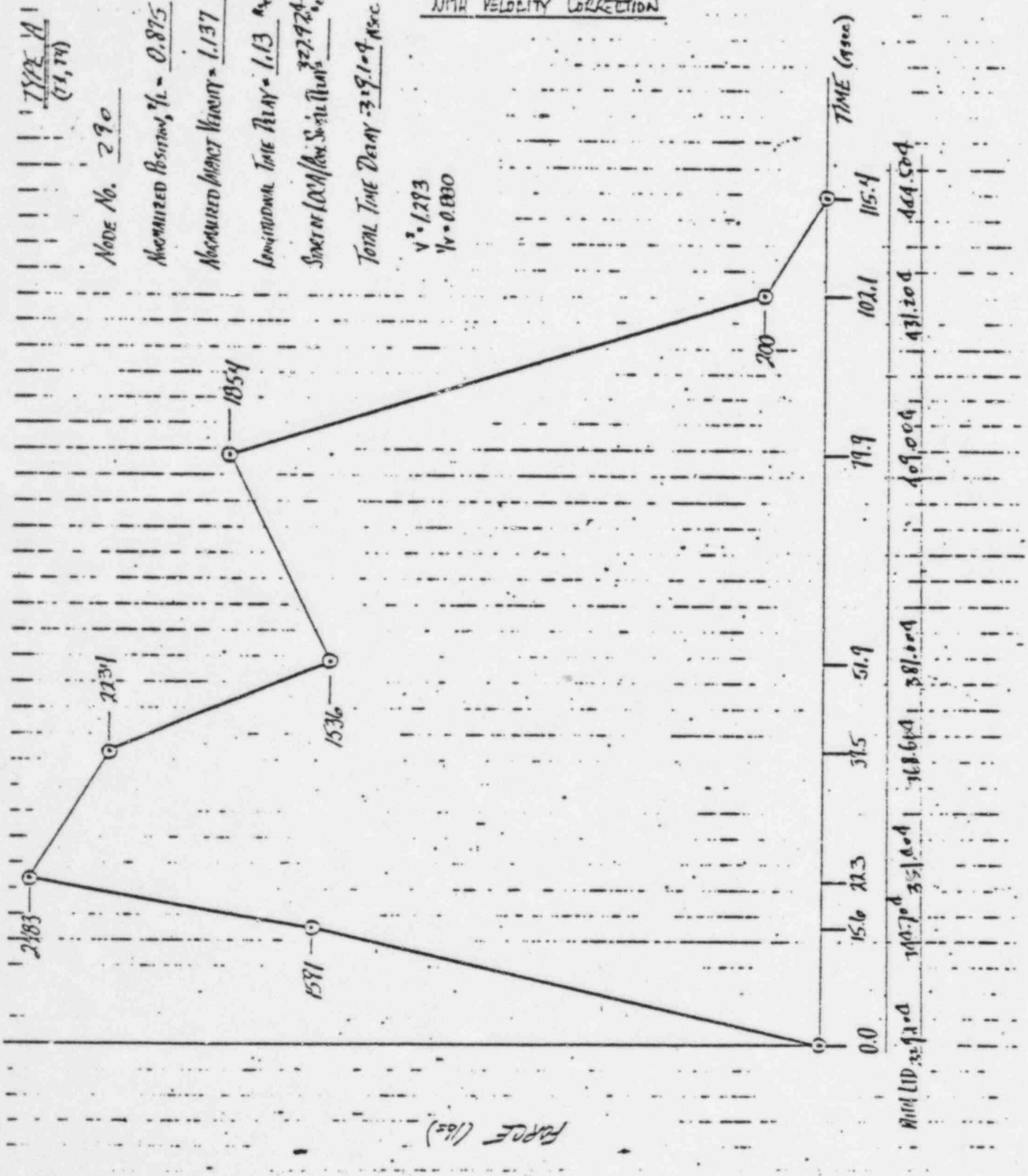
united engineers & constructors inc

CALC. SET NO.		REV	COMP BY	CHKD BY
PRELIM		D	JCM	[illegible]
FINAL	9527-E-SC-45-1-F		DATE 12/4/80	DATE 8-20-81
VOID				
SHEET	278 OF 921		DATE	DATE
ID	9527.040			

NAME OF COMPANY: Carolina Power & Light Company UNIT/S 1&2

SUBJECT: Brunswick - 22½" Beam Model Time History

With Velocity Correction



FORM 3007 REV 7/79

DISCIPLINE

GENERAL COMPUTATION SHEET

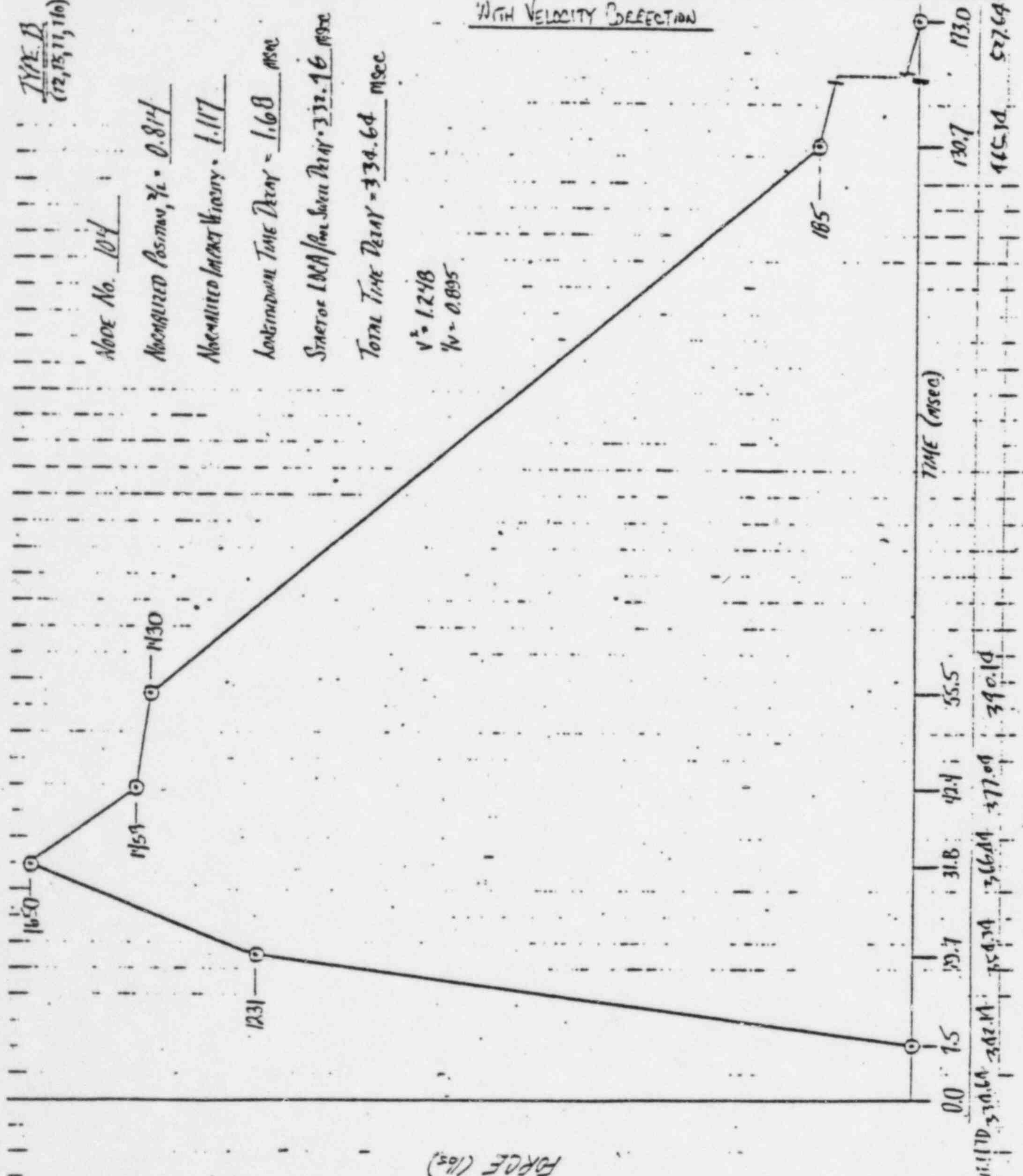
United Engineers

CALC SET NO		REV	COMP BY	CHKD BY
PRELIM		0	JCM	[illegible]
FINAL	9527-E-SC-VSH-F		DATE 12/4/80	DATE 8-20-81
VOID				
SHEET 279 OF 921			DATE	DATE
JO 9527.040				

NAME OF COMPANY: Carolina Power & Light Company UNIT/S 1 & 2

SUBJECT: Brunswick - 22½° Beam Model Time History

With Velocity Correction



FORM 5007 REV. 7/79

(DISCIPLINE)

GENERAL COMPUTATION SHEET

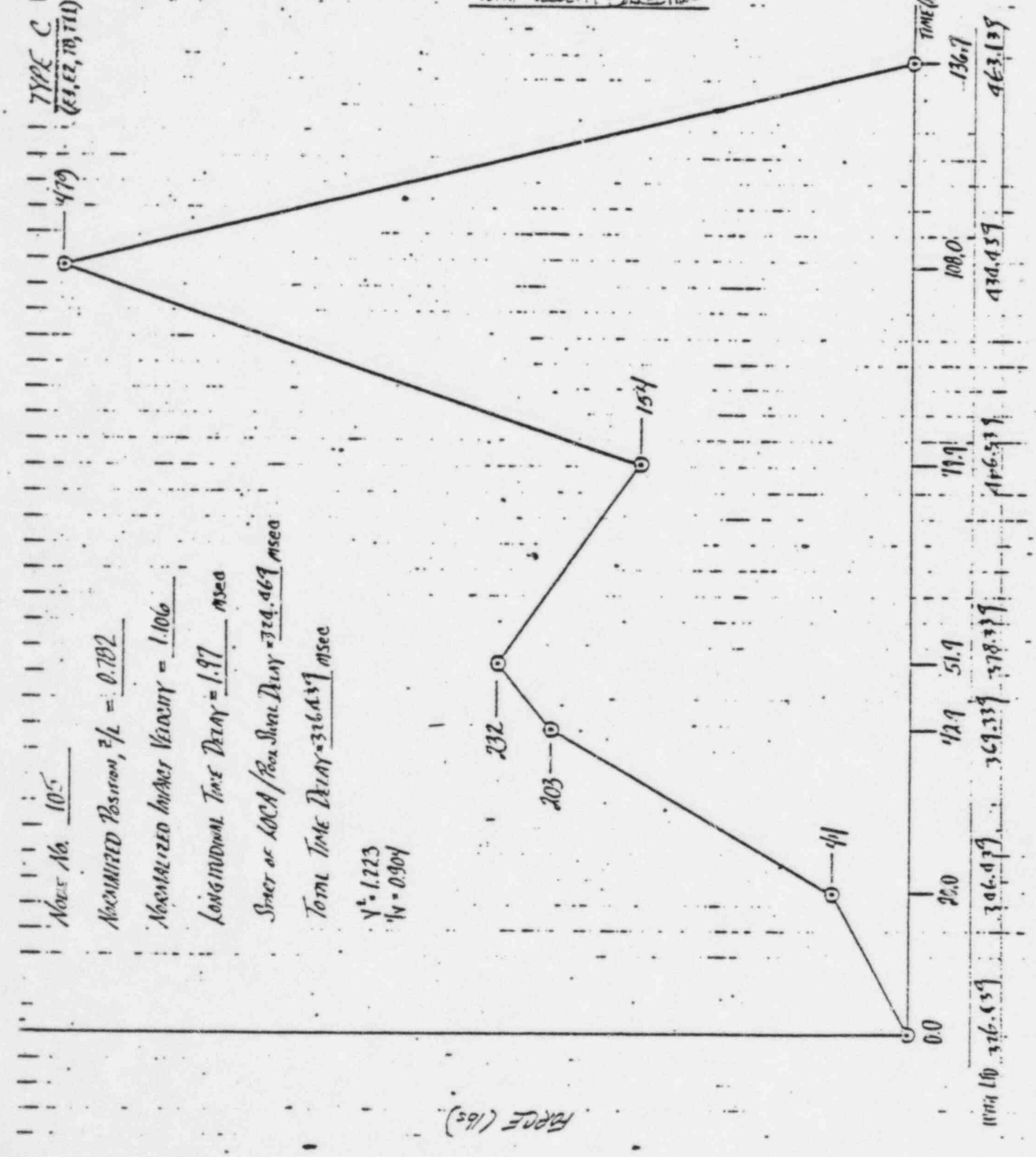
united engineers

CALC. SET NO.		REV	COMP. BY	CHK'D. BY
PRELIM		0	JLM	S. ...
FINAL	9527-F-SC-VS-1-F		DATE 12/4/80	DATE 8-20-81
VOID				
SHEET 280 OF 921			DATE	DATE
J.O. 9527.040				

NAME OF COMPANY Carolina Power & Light Company UNIT/S 1+2

SUBJECT Brunswick – 22½° Beam Model Time History

With Velocity Correction



FORM 5007 REV. 7/79

(DISCIPLINE)

GENERAL COMPUTATION SHEET

united engineers & constructors inc

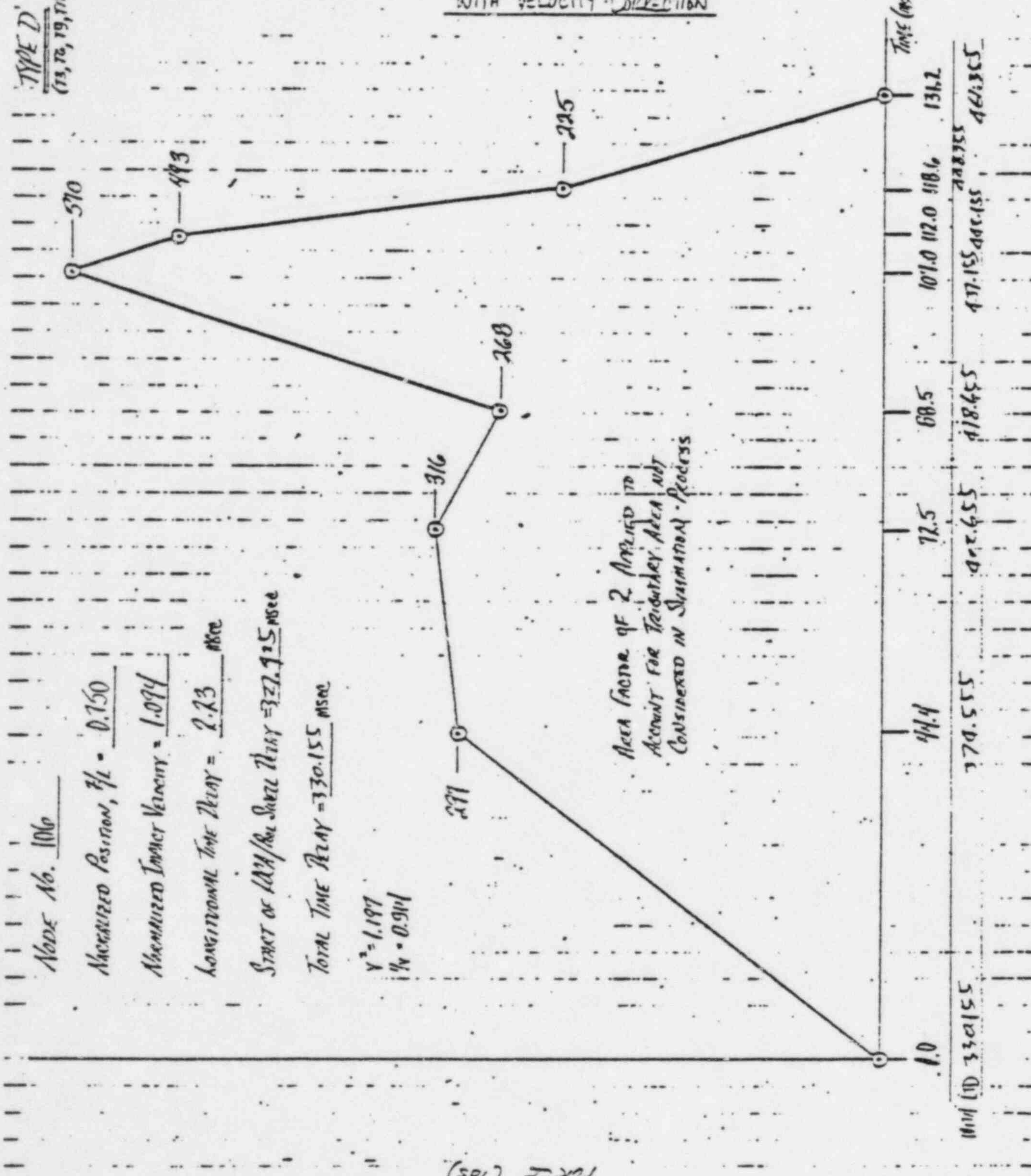
CALC. SET NO.		REV	COMP. BY	CHK'D BY
PRELIM.				
FINAL	9527-E-SC-VS-1-F	0	JCM DATE 12/4/80	DATE 5-20-81
VOID	0			
SHEET 281 OF 921			DATE	DATE
J.O.	9527.040			

NAME OF COMPANY: Carolina Power & Light Company UNITS 1 & 2

SUBJECT: Brunswick - 22½° Beam Model Time History

WITH VELOCITY CORRECTION

TYPE D' (T3, T6, T9, T12)



Node No. 106

Normalized Position, Y/L = 0.750

Normalized Impact Velocity = 1.094

Longitudinal Time Delay = 2.23 msec

Start of LOA/Rol Shell Delay = 327.925 msec

Total Time Delay = 330.155 msec

Y^2 = 1.197
V/V = 0.914

Area Factor of 2 Applied to Account for Tributary Area not Considered in Summation Process

FORM 5007 REV. 7/79

GENERAL COMPUTATION SHEET

(DISCIPLINE)

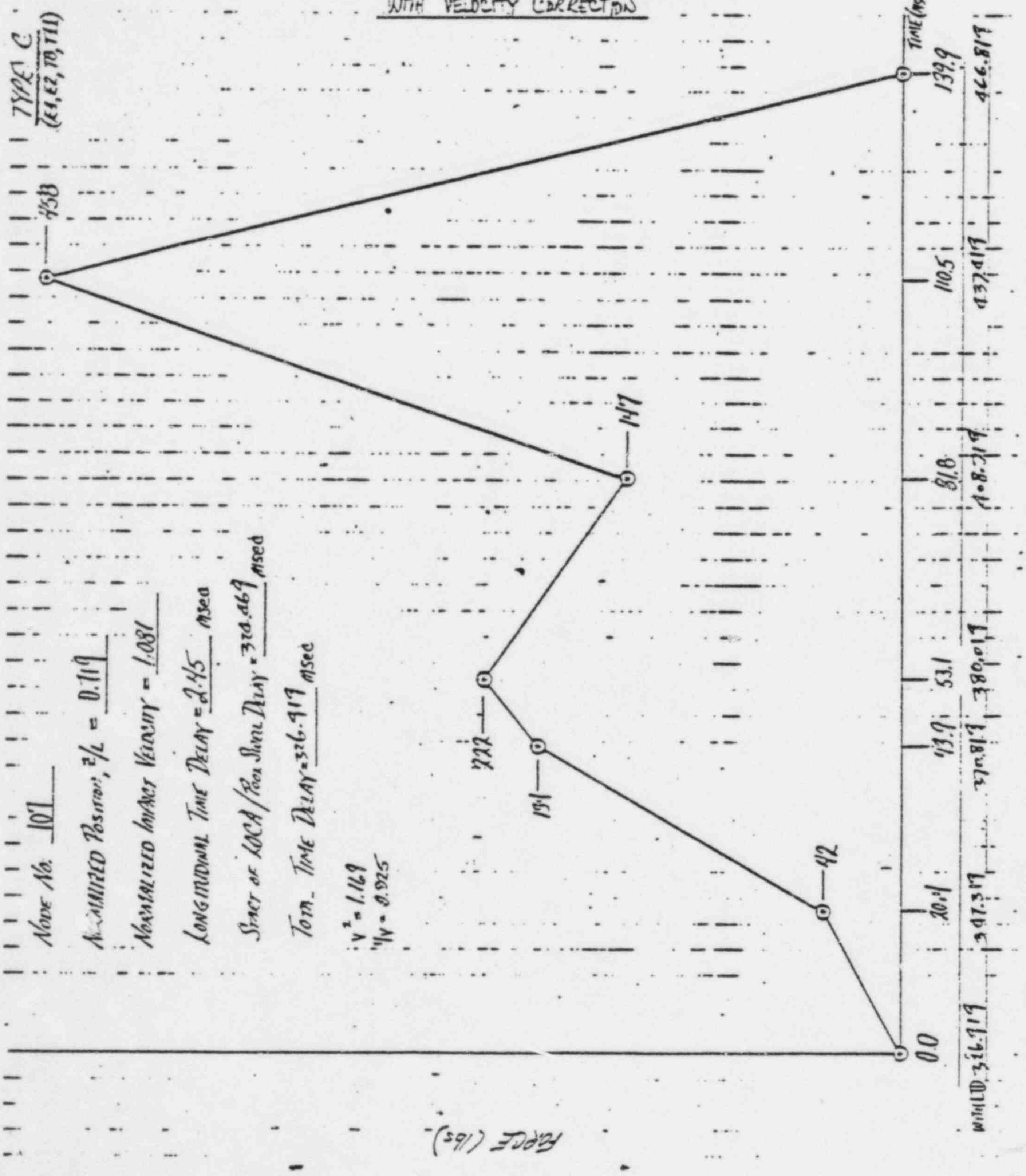
united engineers & constructors

CALC. SET NO.		REV	COMP. BY	CHKD. BY
PRELIM.		D	JCM	[illegible]
FINAL	9522-SC-AS-1-F		DATE 12/4/80	DATE 5-20-81
VOID				
SHEET 282 OF 921			DATE	DATE
J.O. 9527.040				

NAME OF COMPANY: CAROLINA POWER & LIGHT COMPANY UNITS 1 & 2

SUBJECT: BRUNSWICK - 22½° BEAM MODEL TIME HISTORY

WITH VELOCITY CORRECTION



FORM 5007 REV 7/79

DISCIPLINE

GENERAL COMPUTATION SHEET

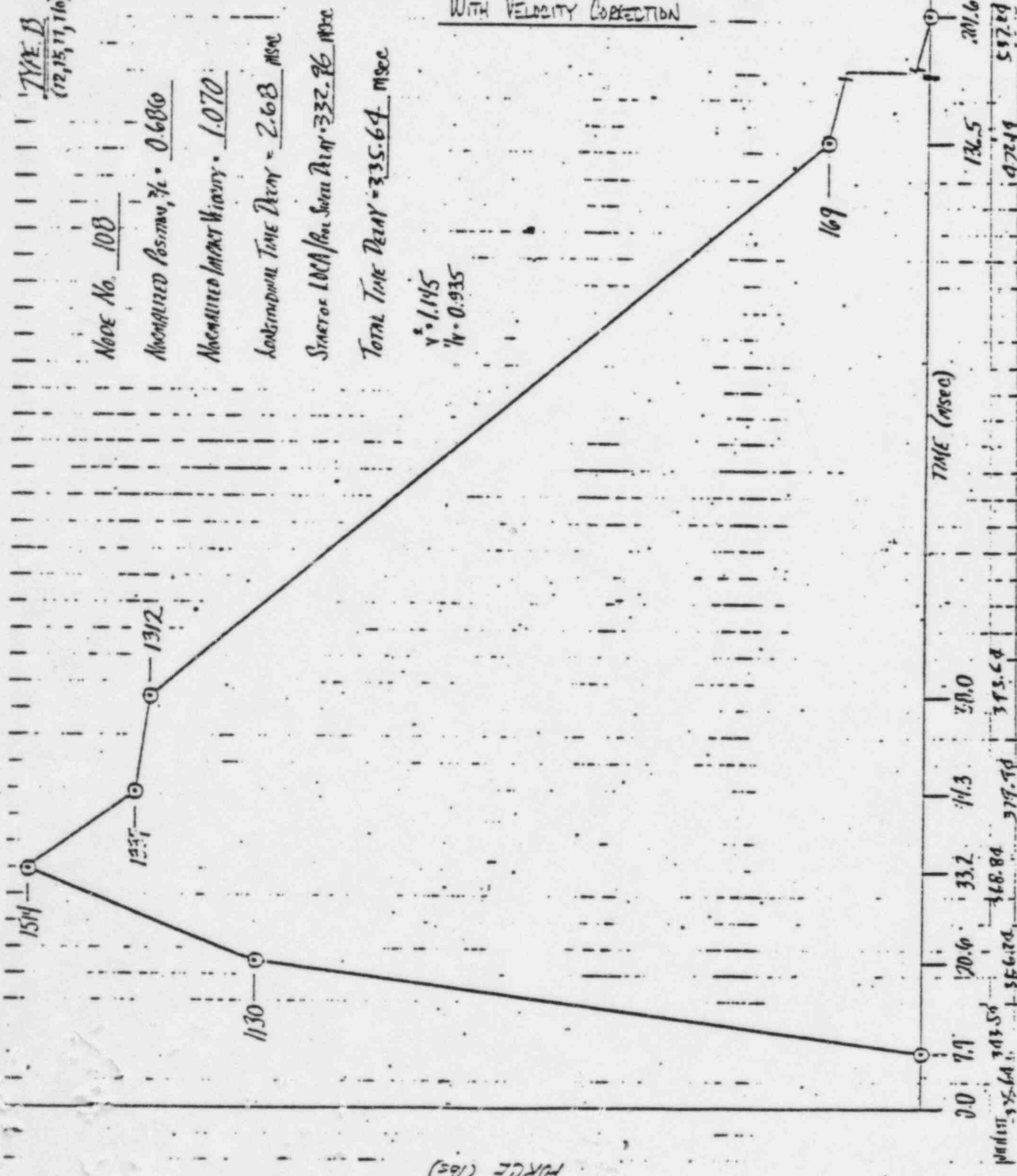
united engineers

CALC. SET NO.		REV	COMP. BY	CHKD. BY
PRELIM.		0	JCM	[illegible]
FINAL	9527-E-SC-V64-F		DATE 12/14/80	DATE 1-20-81
VOID				
SHEET 283 OF 921			DATE	DATE
J.O. 9527.040				

NAME OF COMPANY: CAROLINA POWER & LIGHT COMPANY UNITS 1 & 2

SUBJECT: BRUNSWICK - 22½° BEAM MODEL TIME HISTORY

WITH VELOCITY CORRECTION



FORM 5007 REV. 7/79

GENERAL COMPUTATION SHEET

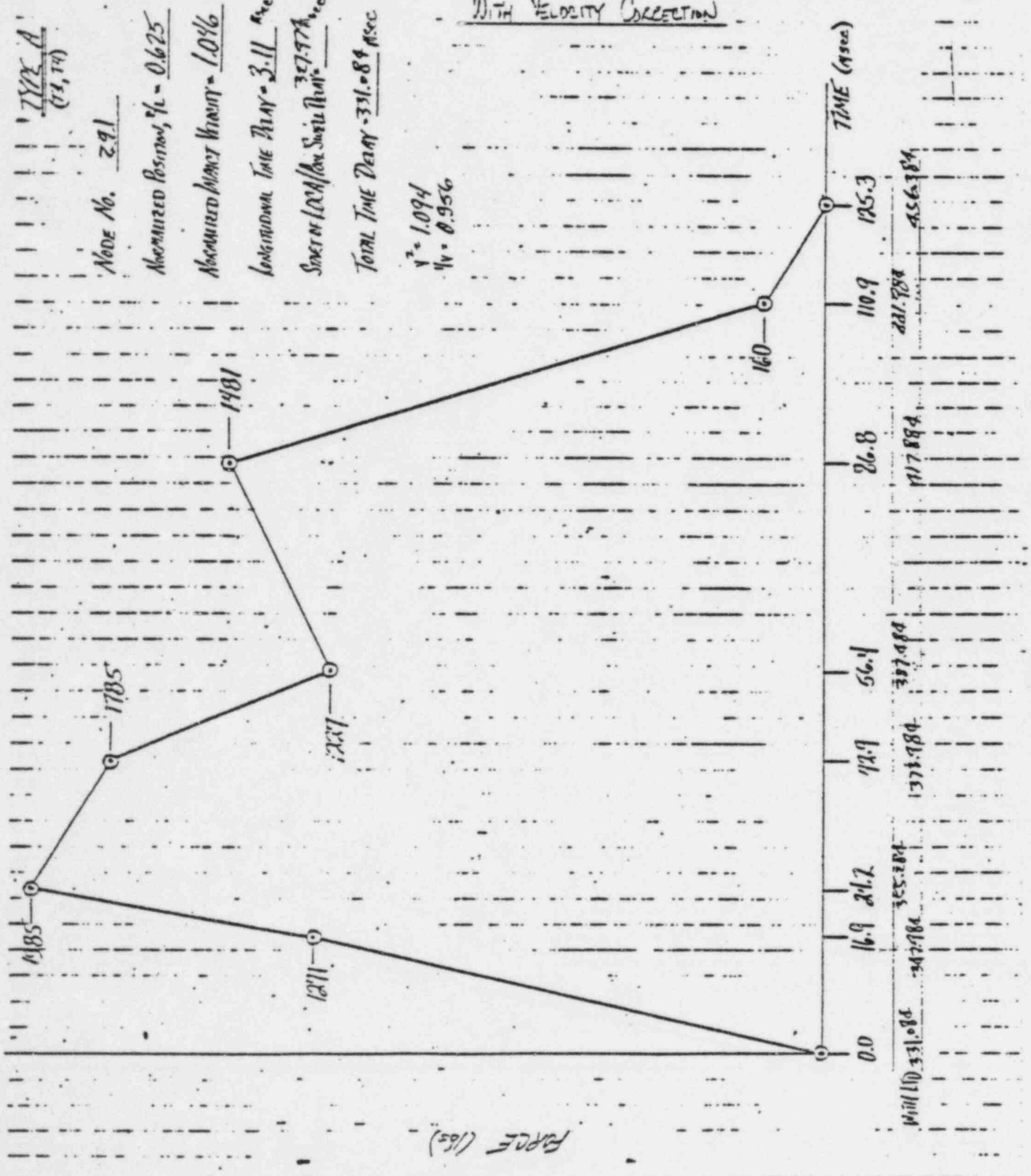
(DISCIPLINE)

united engineers

NAME OF COMPANY: Carolina Power & Light Company UNIT/S: 1&2

SUBJECT: Brunswick - 22½" Beam Model Time History

CALC. SET NO.		REV.	COMP. BY	CHKD. BY
PRELIM.		0	JCM	[signature]
FINAL	9527-SC-VS-1-F		DATE 12/4/81	DATE 8-20-81
VOID				
SHEET 284 OF 921			DATE	DATE
J.O. 9527.040				



FORM 5007 REV 7/79

(DISCIPLINE)

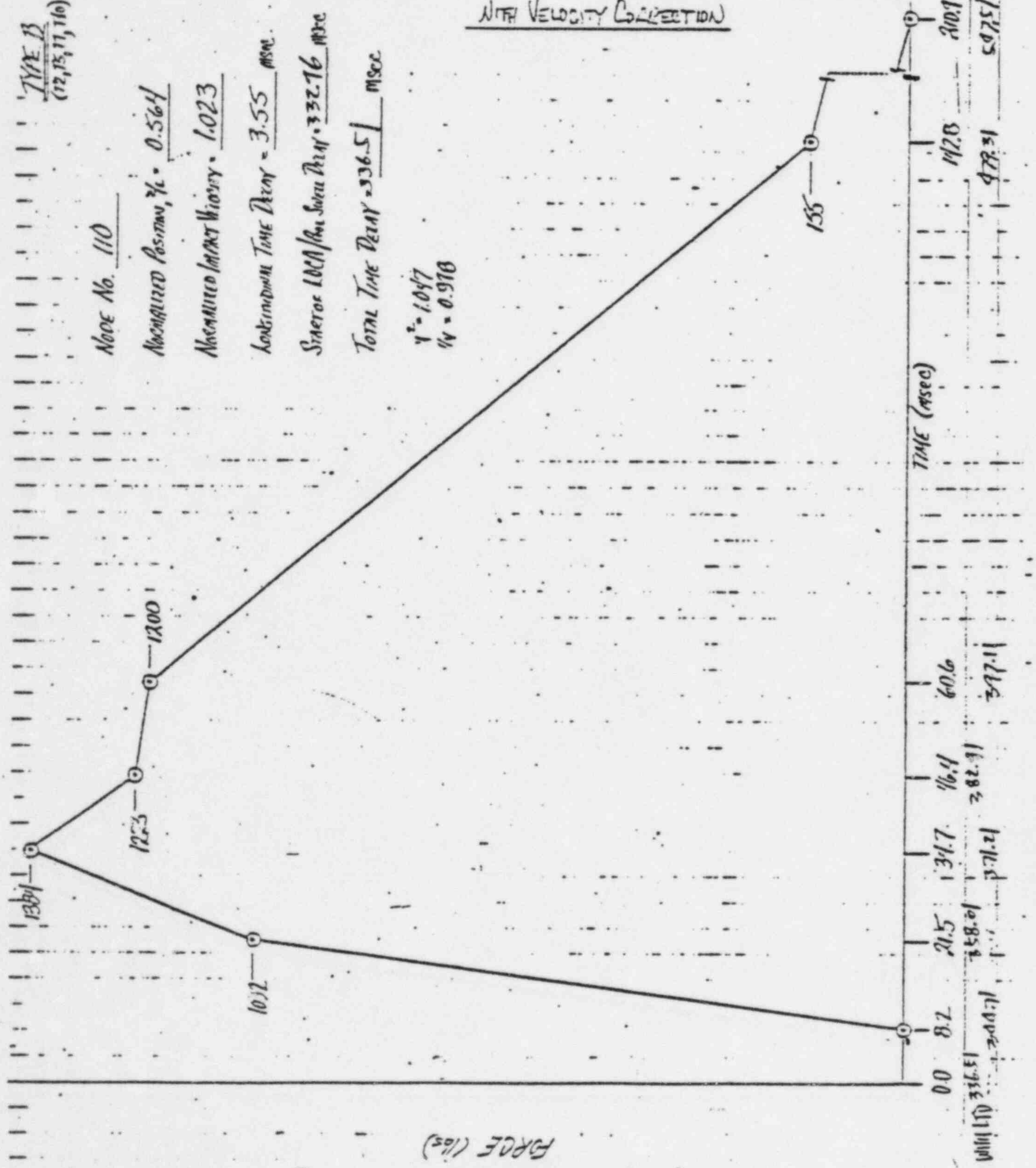
GENERAL COMPUTATION SHEET

united engineers

CALC. SET NO.		REV	COMP. BY	CHK'D BY
PRELIM.		0	JCM	[signature]
FINAL	9527-E-SC-VS-1-7		DATE 12/4/80	DATE 8-20-81
VOID				
SHEET 285 OF 921			DATE	DATE
J.O. 9527.040				

NAME OF COMPANY Carolina Power & Light Company UNIT/S 1&2

SUBJECT Brunswick - 22½° Beam Model Time History



FORM 5027 REV. 7/79

(DISCIPLINE)

GENERAL COMPUTATION SHEET

united engineers

CALC. SET NO.		REV	COMP BY	CHK'D BY
PRELIM.			JCM	[illegible]
FINAL	9527-E-SC-VSH-F	0	DATE 12/4/80	DATE 5-20-81
VOID				
SHEET 286 OF 921			DATE	DATE
J.O. 9527.040				

NAME OF COMPANY: Carolina Power & Light Company UNIT/S 1 & 2

SUBJECT: Brunswick - 22½° Beam Model Time History

With Velocity Correction

TYPE C (E1, E2, T8, T11)

Node No. 111

Normalized Position, z/L = 0.532

Normalized Impact Velocity = 1.013

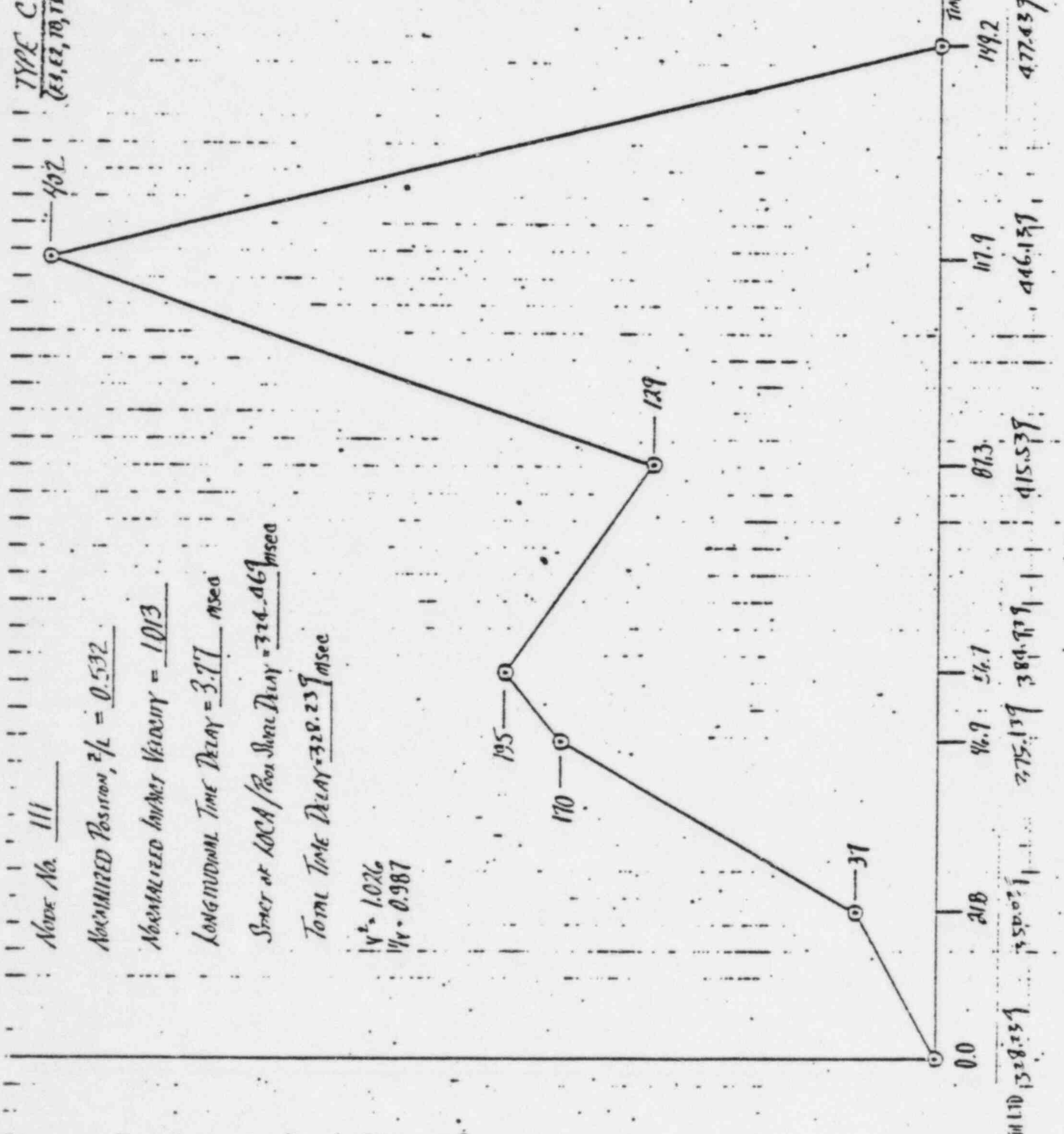
Longitudinal Time Delay = 3.77 msec

Start of LOCA/Pool Swell Delay = 324.469 msec

Total Time Delay = 328.239 msec

$V^2 = 1.026$

$1/V = 0.987$



FORM 5007 REV. 7/79

GENERAL COMPUTATION SHEET

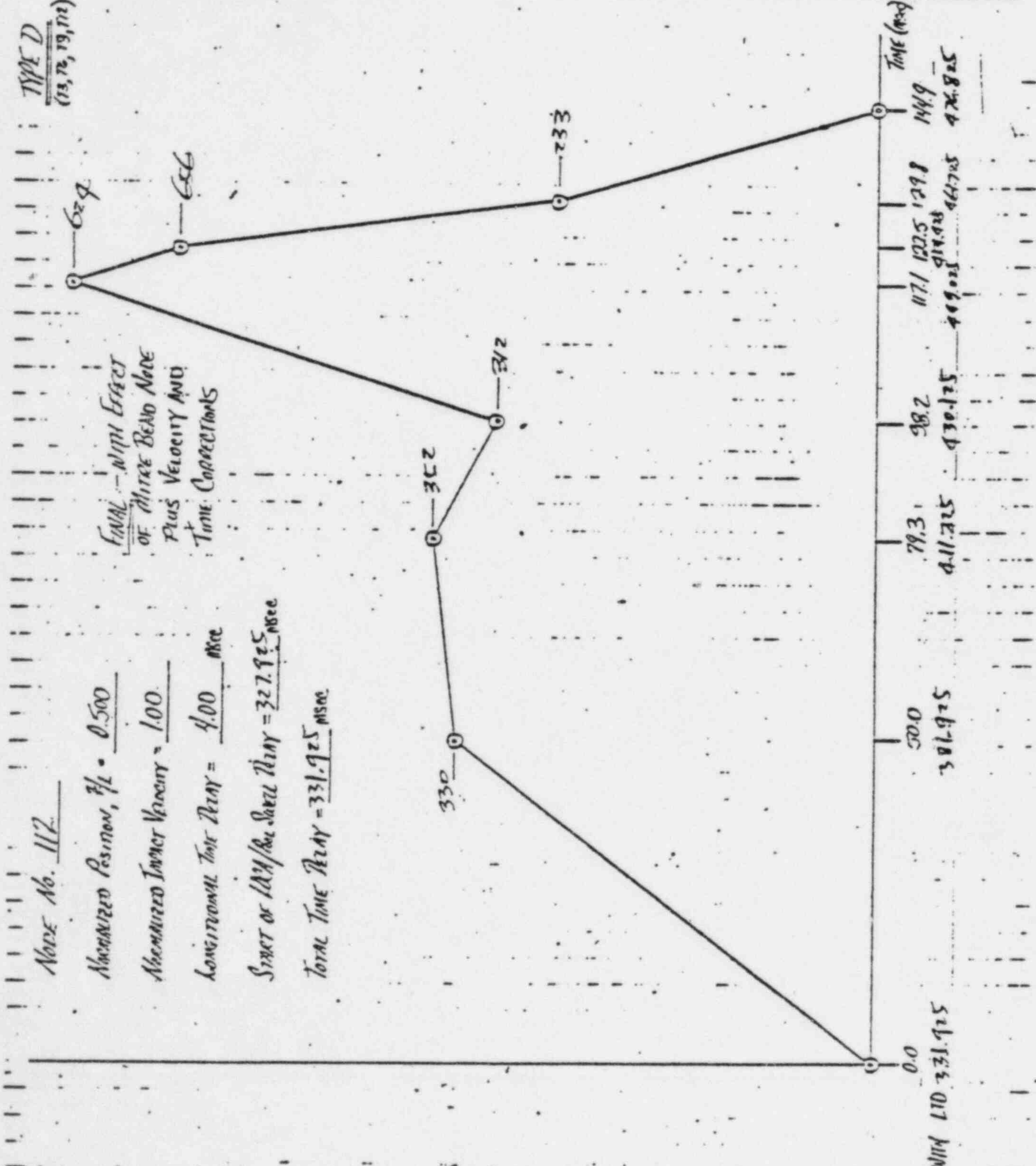
(DISCIPLINE)

united engineers & constructors inc.

NAME OF COMPANY: CAROLINA POWER & LIGHT COMPANY UNIT/S 1&2

SUBJECT: BRUNSWICK - 22½° BEAM MODEL TIME HISTORY

CALC. SET NO.		REV	COMP BY	CHK'D BY
PRELIM.				
FINAL	9527E-SC-VS-1-F	0	JCM DATE 12/5/80	Daej DATE 12-9-80
VOID				
SHEET 292 OF 921			DATE	DATE
J.O. 9527.040				



FORM 5007 REV. 7/79

GENERAL COMPUTATION SHEET

(DISCIPLINE)

united engineers

CALC. SET NO.	REV	COMP BY	CHK'D BY
PRELIM.			
FINAL 9527E-SC-V3-1	0	JCM DATE 12/5/80	[signature] DATE 2-9-81
VOID			
SHEET 293 OF 921		DATE	DATE
J.O. 9527.040			

NAME OF COMPANY Carolina Power & Light Company UNITS 1&2

SUBJECT Brunswick – 22½° Beam Model Time History

TYPE C (E1, E2, T8, T11)

Node No. 113

Normalized Position, z/L = 0.447

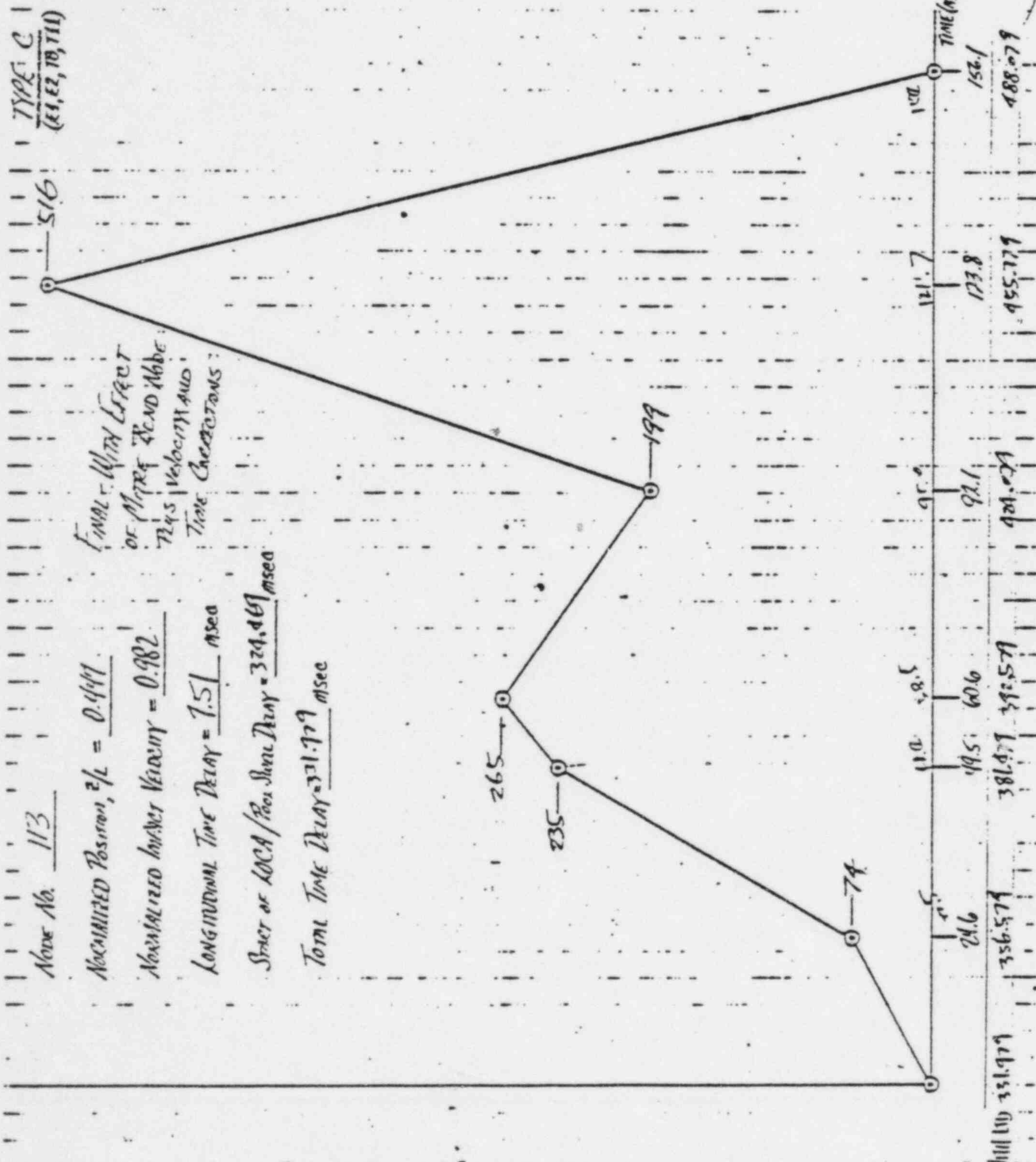
Normalized Impact Velocity = 0.982

Longitudinal Time Delay = 7.51 msec

Start of LOCA/To Pool Swell Delay = 324.469 msec

Total Time Delay = 331.979 msec

Final – With Effect of Mark Bend Node 7245 Velocity and Time Corrections.



FORM 3027 REV. 7/79

GENERAL COMPUTATION SHEET

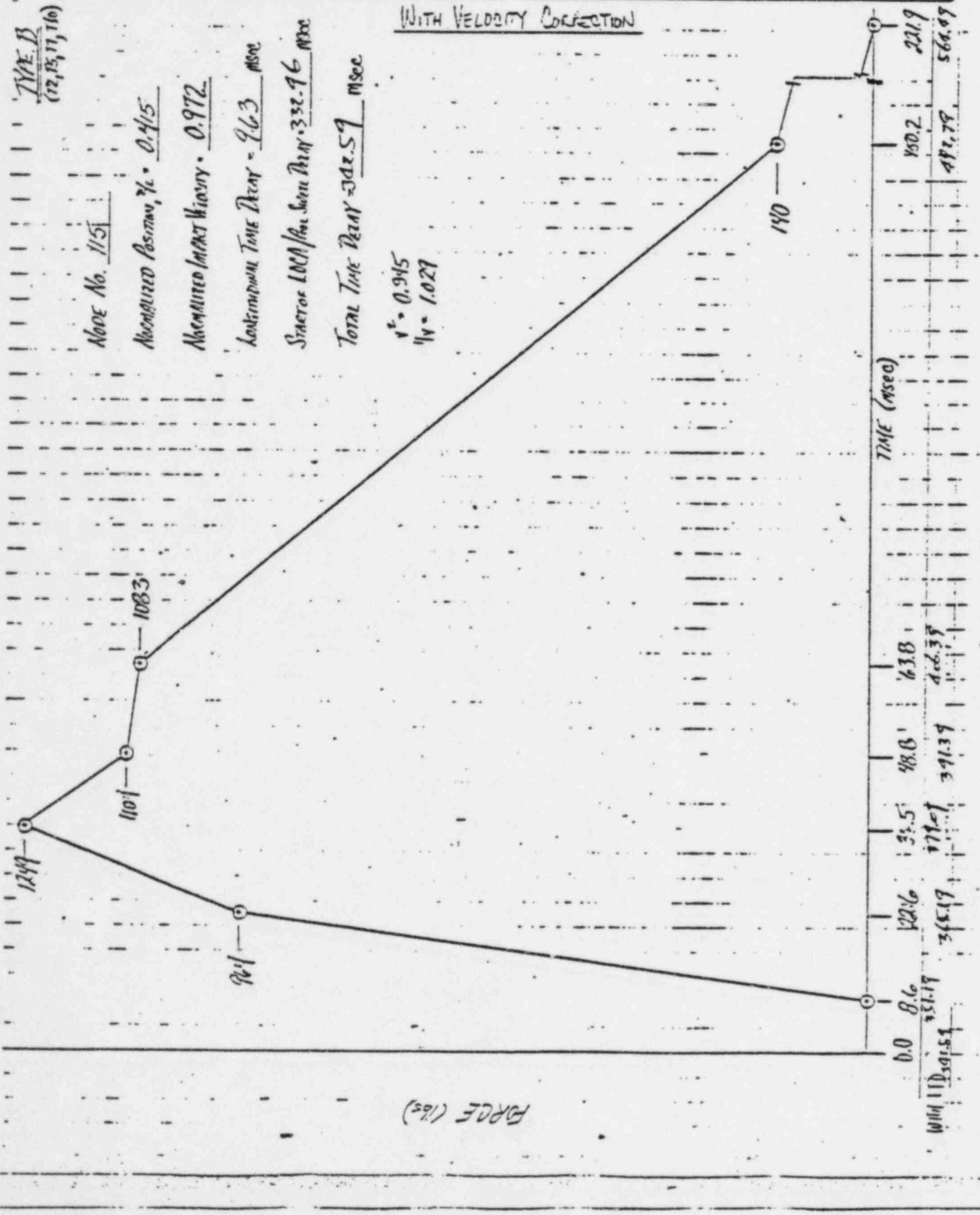
(DISCIPLINE)

united engineers

	CALC SET NO.	REV	COMP BY	CHKD BY
PRELIM.				
FINAL	9527-E-SCHR-1-F	0	JCM	[illegible]
VOID			DATE 12/4/80	DATE 1-7-81
SHEET	294 OF 921		DATE	DATE
J.O.	9527.040			

NAME OF COMPANY: Carolina Power & Light Company UNITS: 1 & 2

SUBJECT: Brunswick - 22½° Beam Model Time History



FORM 5007 REV. 7/79

GENERAL COMPUTATION SHEET

DISCIPLINE

united engineers & constructors inc

NAME OF COMPANY: Carolina Power & Light Company UNIT/S: 1 & 2

SUBJECT: Brunswick - 22½" Beam Model Time History

CALC. SET NO.		REV	COMP. BY	CHKD BY
PRELIM.		0	JCM	[signature]
FINAL	9SD-C-SC-VS-1-F		DATE 12/4/80	DATE 9-?-81
VOID				
SHEET 295 OF 921			DATE	DATE
J.O. 9527.040				

WITH VELOCITY CORRECTION

TYPE H (T1, T4)

Node No. 292

Normalized Position, x/L = 0.351

Normalized Impact Velocity = 0.956

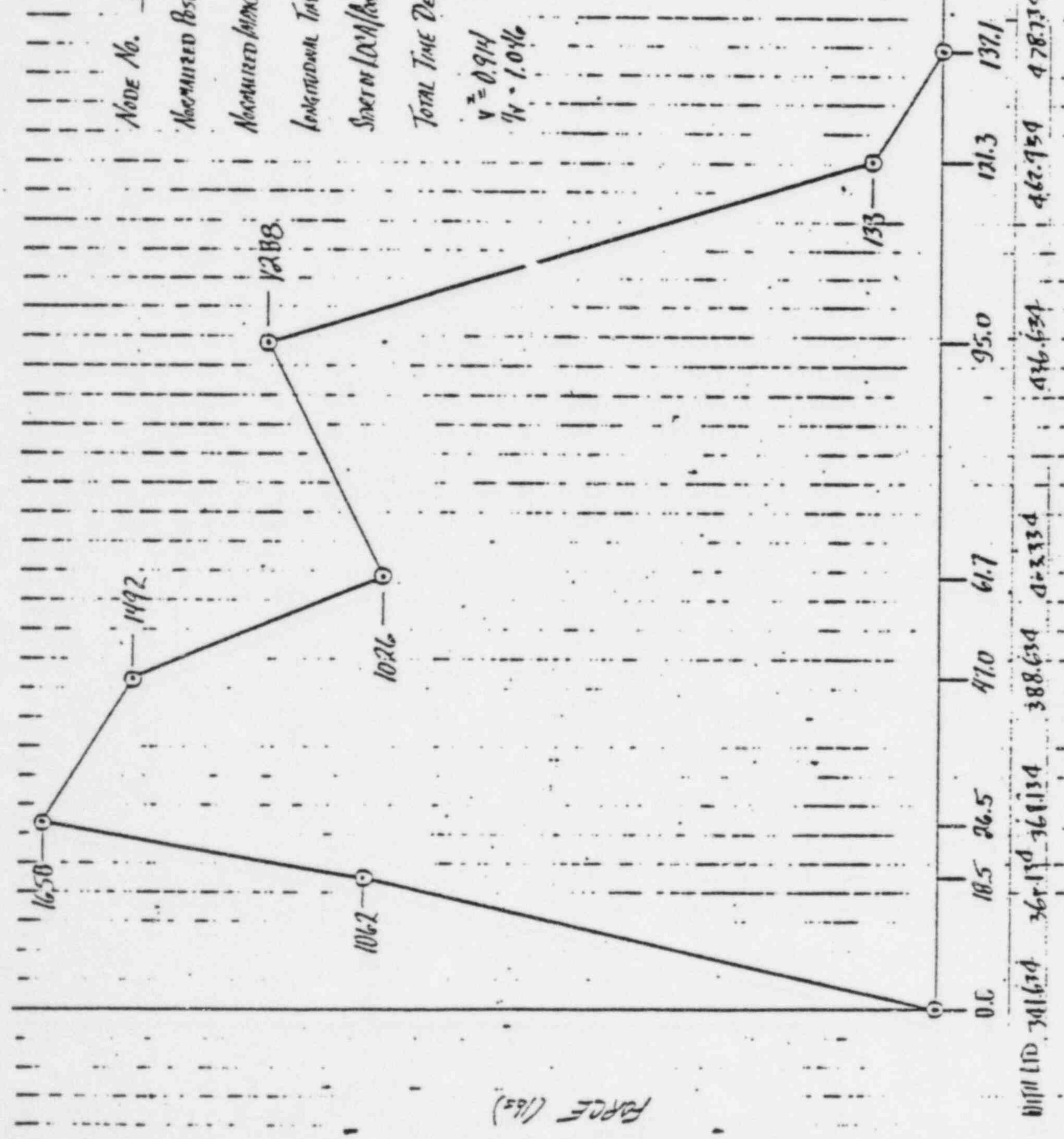
Longitudinal Time Delay = 13.66 msec

Start of LOCA/Pool Swell Delay = 327.974 msec

Total Time Delay = 341.634 msec

V² = 0.914

V/V = 1.046



FINAL – INCLUDING EFFECTS OF Pipes in [illegible] Velocity and Tar Corrections Has Been Applied. Nos. in Paren's are Uncorrected Values

NODE No 150

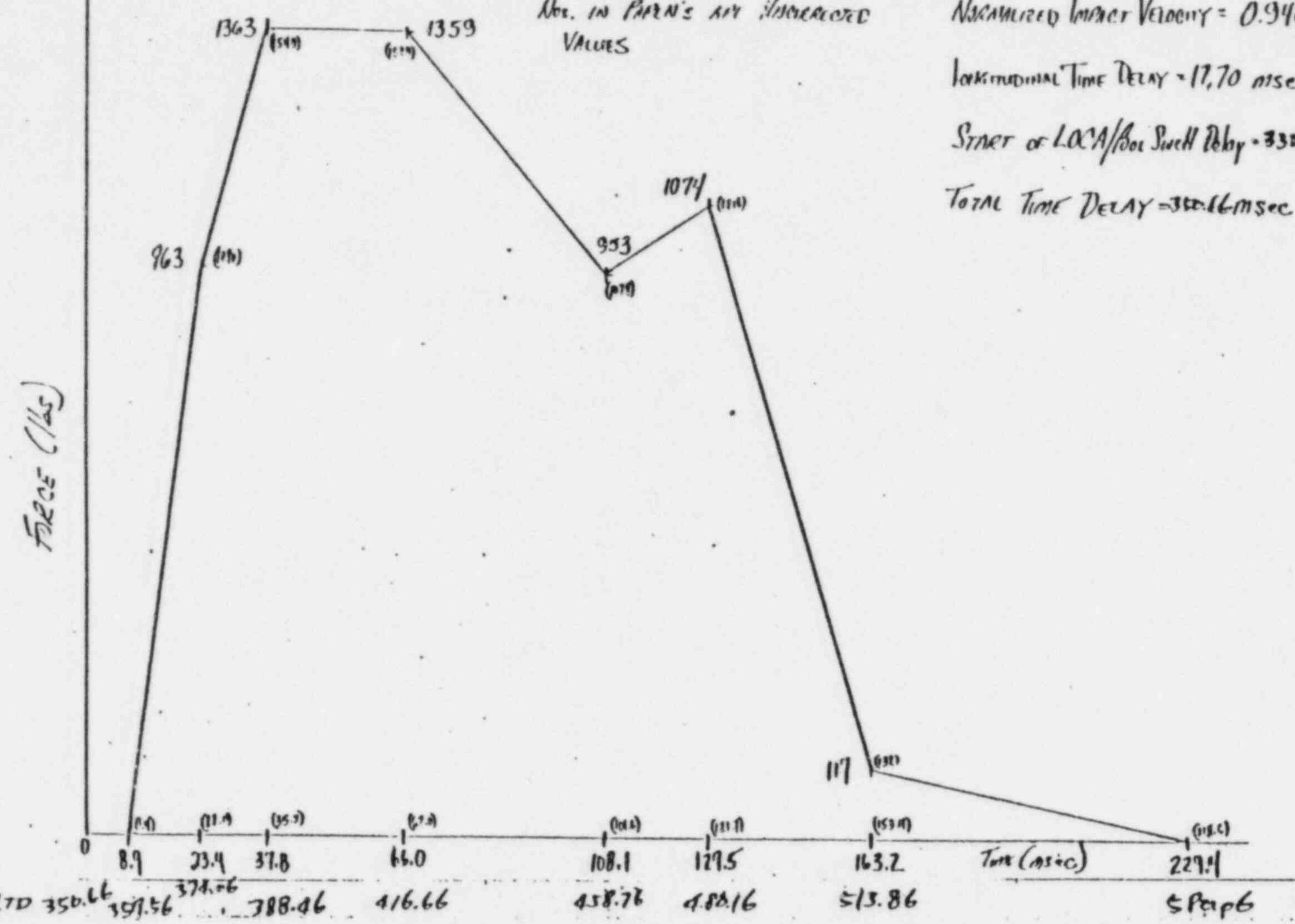
Normalized Position, Z/L = 0.293

Normalized Impact Velocity = 0.9400

Longitudinal Time Delay = 17.70 msec

Start of LOCA/Pool Swell Delay = 332.96 msec

Total Time Delay = 350.66 msec



FORM 8007 REV 7/79

(DISCIPLINE)

GENERAL COMPUTATION SHEET

united engineers

NAME OF COMPANY CP&L BSEP UNITS 1&2

SUBJECT Pool Swell Load

CALC SET NO.		REV	COMP. BY	CHK'D BY
PRELIM				
FINAL	[illegible]	0	JCM DATE 12/15/80	DATE
VOID			DATE	DATE
SHEET 296 OF 921				
JO 9527.040				

FORM 5015

GENERAL COMPUTATION SHEET

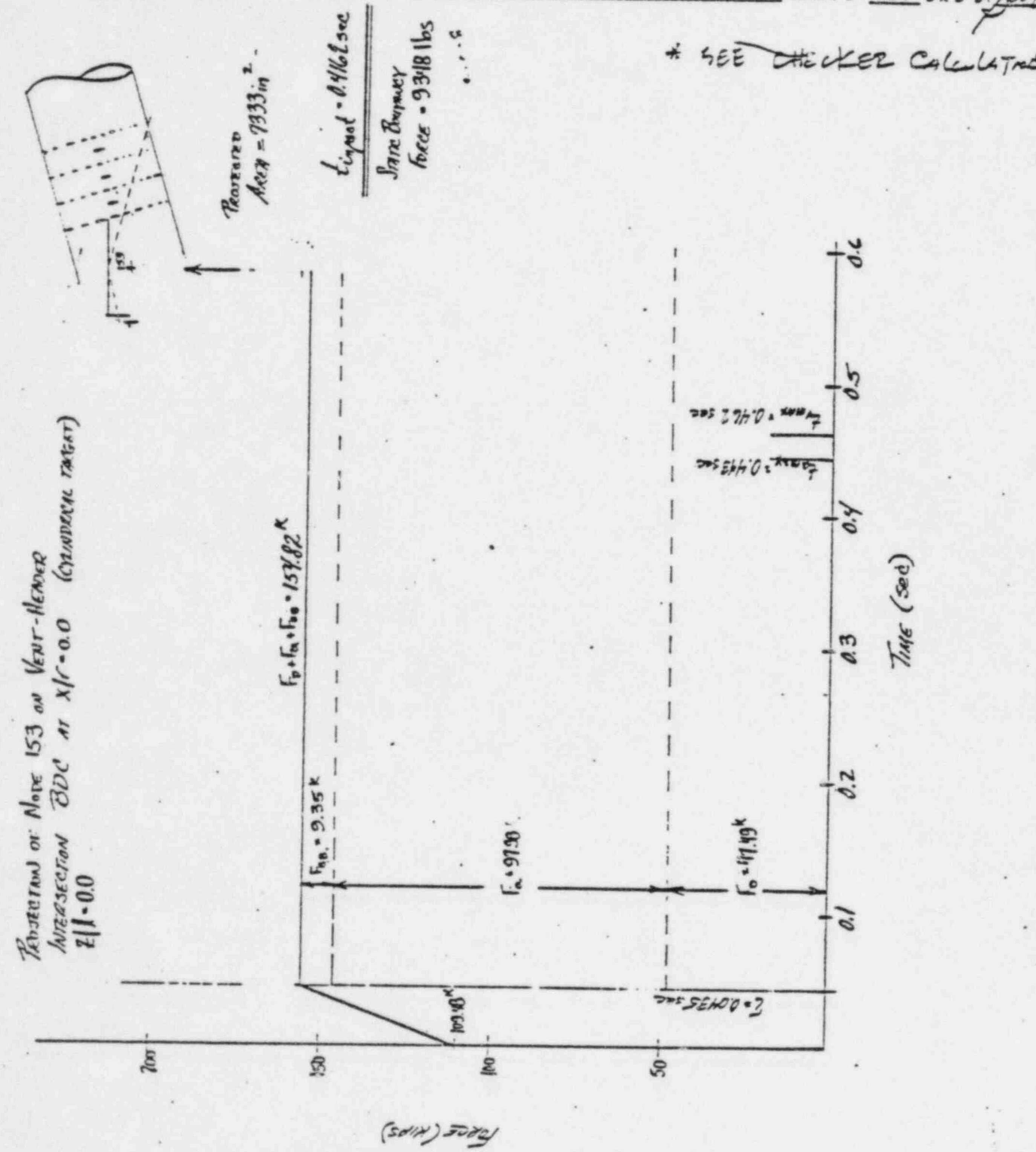
united engineers & constructors inc.

NAME OF COMPANY CP&L

SUBJECT 22½° BEAM MODEL VENT TIME HISTORIES

FILE NO. 9527-E-SC-VS-1-F
J.O. NO. 9527.040
SHEET NO. 297 OF 93'
DATE 2/10/81
COMP. BY JCM CHK'D BY [illegible]

* SEE CHECKER CALCULATNS



FORM 5013

GENERAL COMPUTATION SHEET

united engineers & constructors inc.

NAME OF COMPANY CP&L RSEP UNITS 1 & 2

SUBJECT Pool swell Load

FILE NO. 9527-I-SC-VSH-I

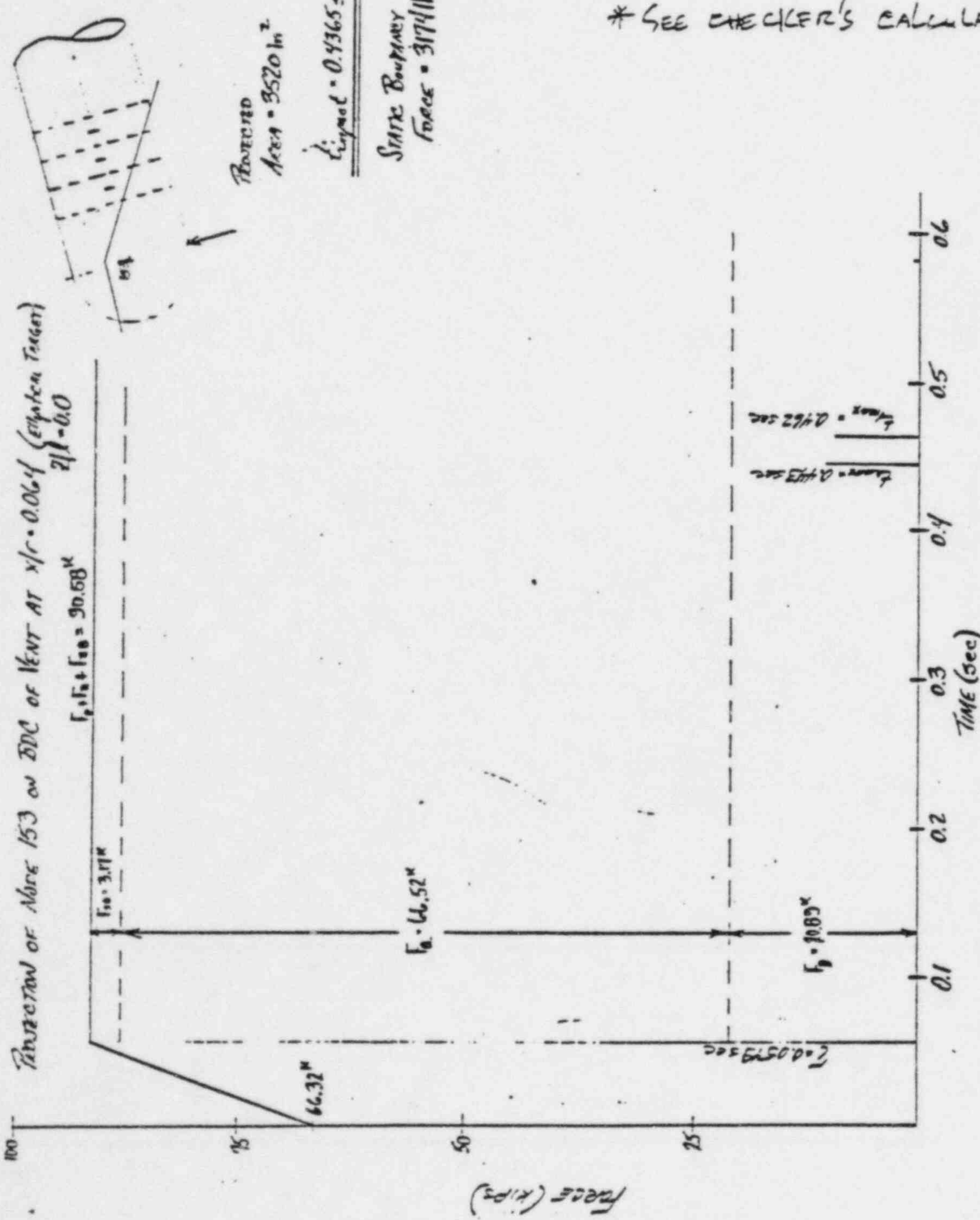
J.O. NO. 9527.040

SHEET NO. 298 OF 921

DATE 2/10/81

COMP. BY JCM CK'D BY [illegible] *

* SEE CHECKER'S CALCULATIONS



GENERAL COMPUTATION SHEET

FORM 5015

united engineers & constructors inc.

FILE NO. 9527-E-SC-VS-1-F

J.O. NO. 9527.040

NAME OF COMPANY CPSL RSEP Units 1 & 2

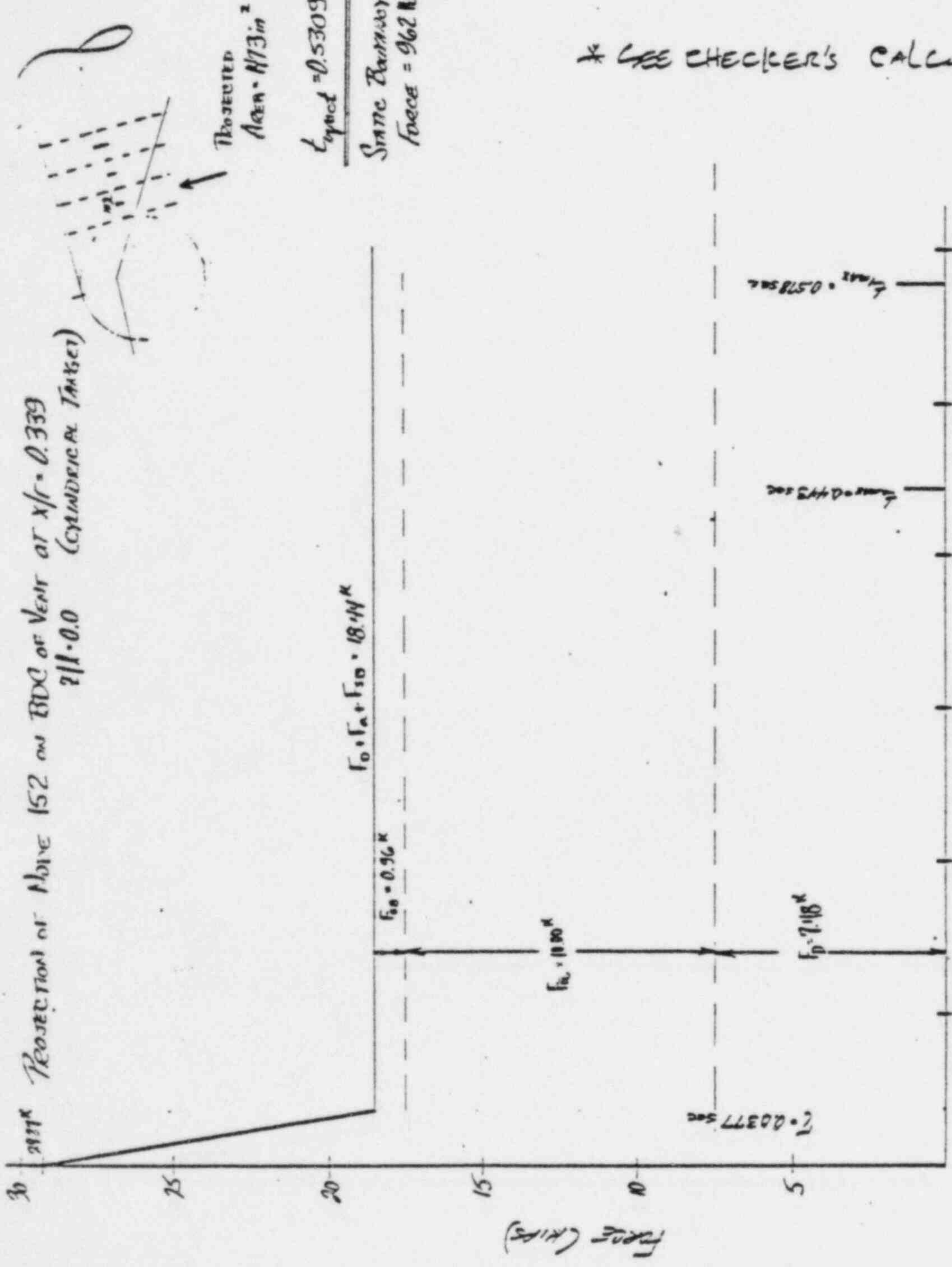
SHEET NO. 209 OF 921

DATE 2/10/81

SUBJECT Pool Swell Load

COMP. BY JRM CHK'D BY

* SEE CHECKER'S CALCULATIONS



GENERAL COMPUTATION SHEET

FORM 5015

united engineers & constructors inc.

FILE NO. 9527-E-SC-VS-1-7

J.O. NO. 9527.040

NAME OF COMPANY CP&L BSEP Units 1 & 2

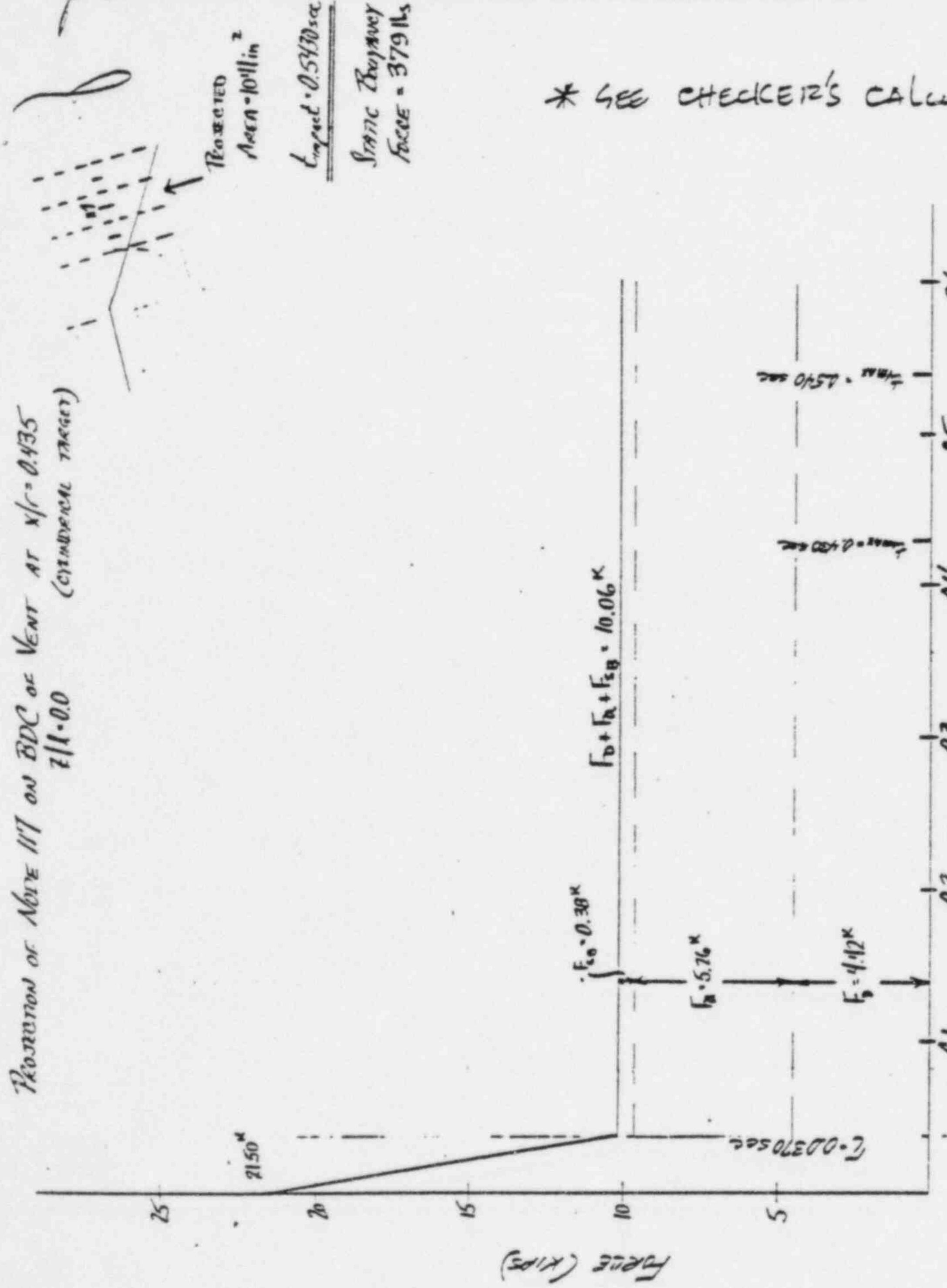
SHEET NO. 300 OF 921

DATE 2/10/81

SUBJECT Pool Swell Load

COMP. BY JCM CK'D BY

* SEE CHECKER'S CALCULATIONS



FORM 5015

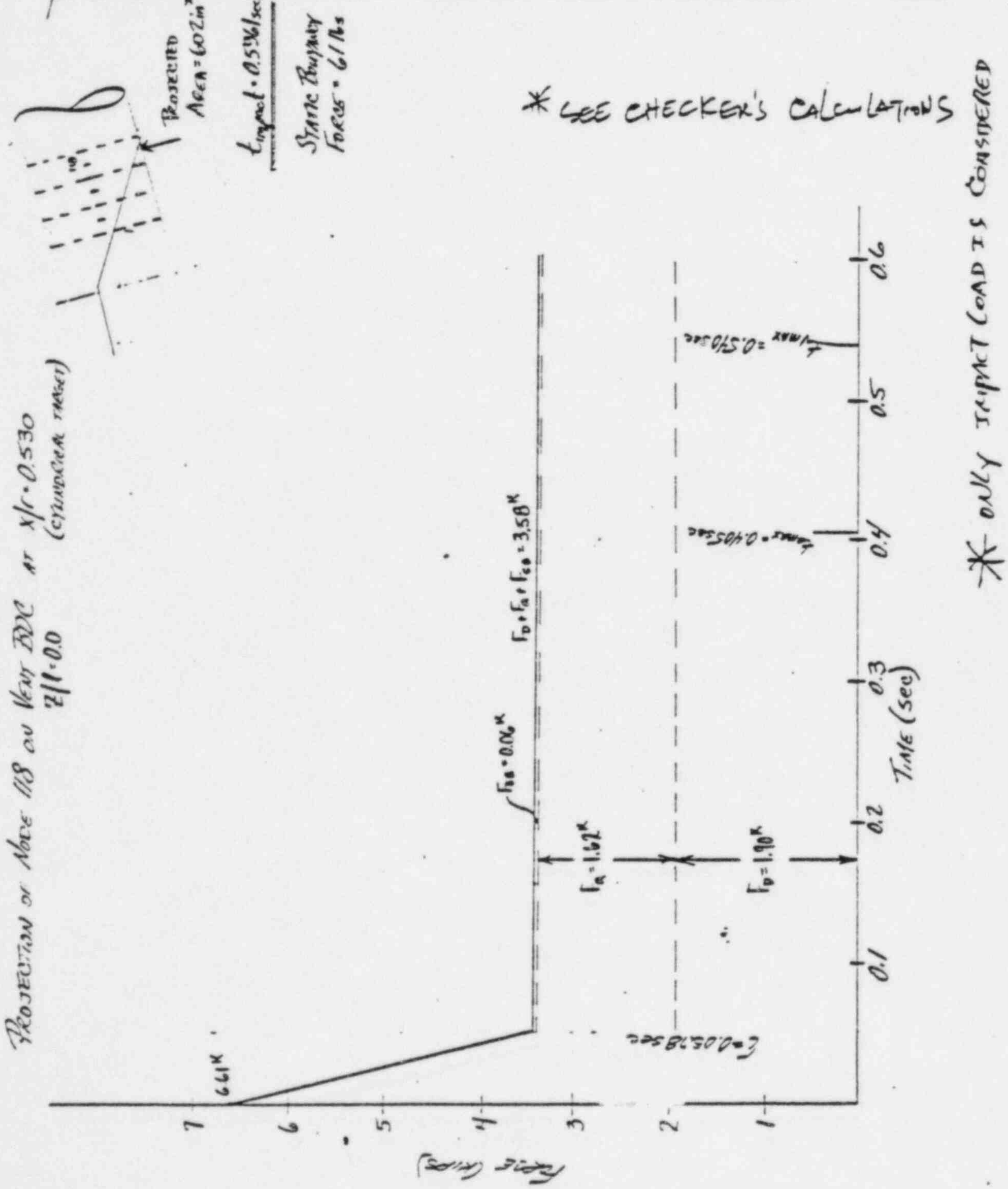
GENERAL COMPUTATION SHEET

united engineers & constructors inc.

NAME OF COMPANY CP&L BSEP Units 1&2

SUBJECT Pool swell Load

File No. 9527-E-SC-VS-1-F
J.O. NO. 9527.040
SHEET NO. 301 OF 921
DATE 2/10/81
COMP. BY JCM CK'D BY [illegible]



FORM 5007 REV 7/79

GENERAL COMPUTATION SHEET

(DISCIPLINE)

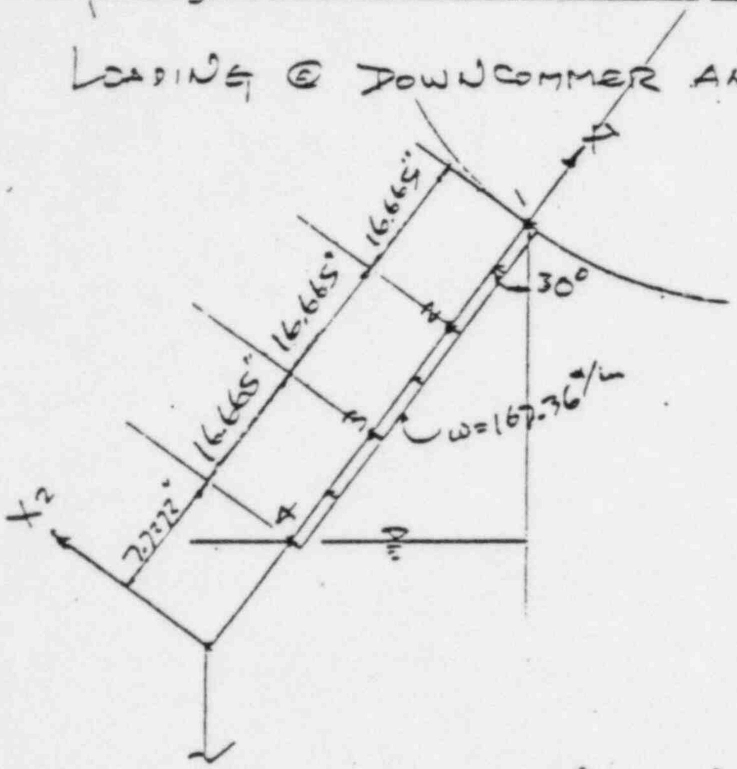
united engineers

NAME OF COMPANY CP&L BSEP UNIT/S 1 & 2

SUBJECT Pool Swell Load @ Downcomer

CALC. SET NO.		REV	COMP BY	CHK'D BY
PRELIM.		0	[illegible]	HFH
FINAL	9527-ESC-VS-1-F		DATE [illegible]	DATE 7-8-82
VOID				
SHEET	384 OF 921		DATE	DATE
J.O.	9527.060			

LOADING @ DOWNCOMER ANGLED PORTION.



NODE NO.	FX2. (Kips)*
1	1.395
2	2.789
3	2.789
4	1.395

* W/ DLF=2.0

RAI 13b - In addition, provide the position of the maximum pool swell height anbd its relation to the main vent.

RESPONSE

Figure 13-1, Attachment RAI-13b shows the position of the maximum pool swell height and its relation to the main vent.

FIG. 13.1

MAXIMUM POOL SWELL HEIGHT

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 & 2

Attachment RAI-13b

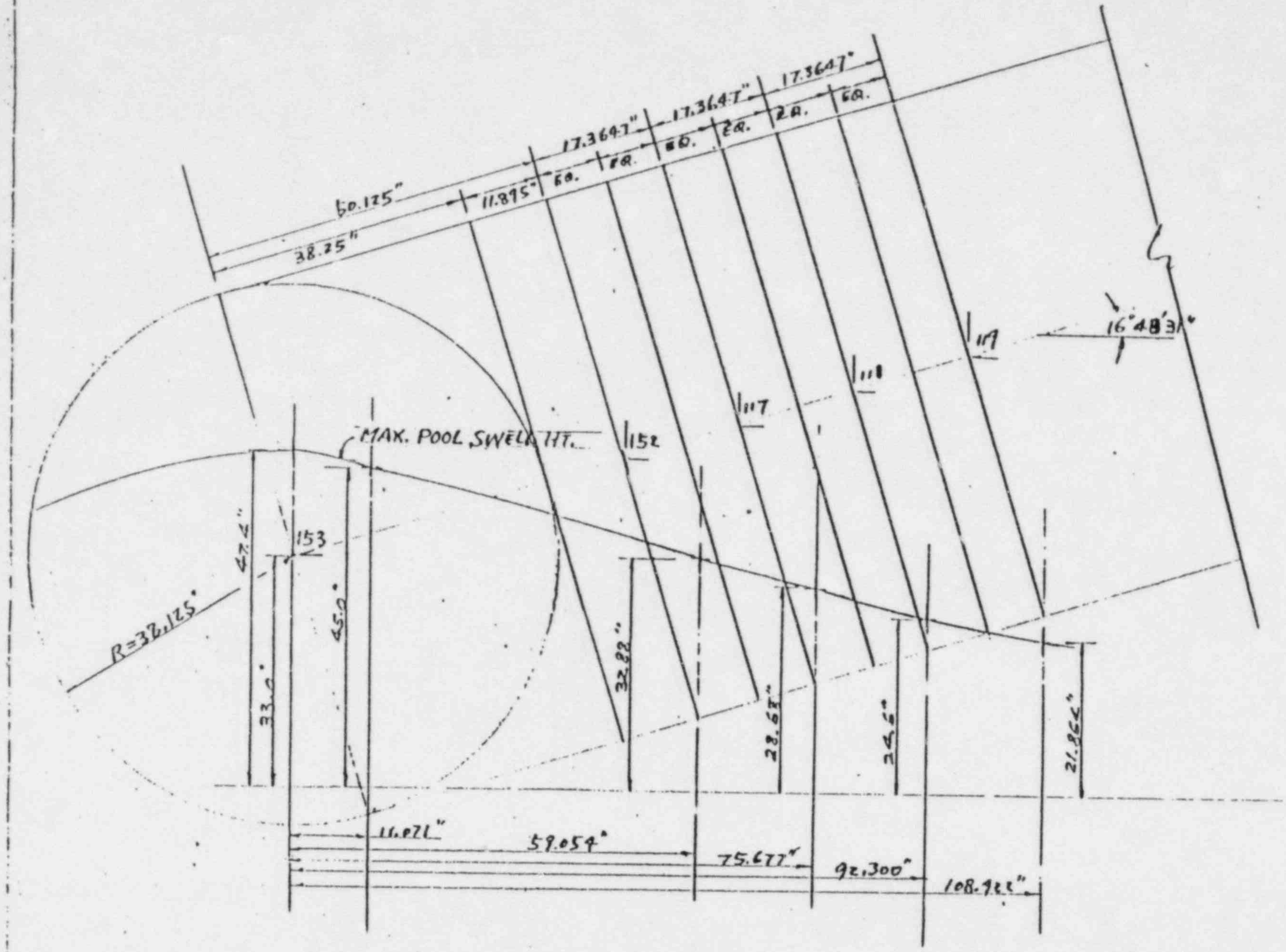


Figure 13-1 Maximum Pool Swell Height

RAI 14 - Provide the loads that were used in the Torus attached piping.

RESPONSE

This item is not applicable to Brunswick Units 1 and 2 because each has a massive concrete Torus. The anchor loads on Torus attached piping are negligible.