VOLUME 2

REACTOR COOLANT SYSTEM

ASYMMETRIC LOADS

FINAL REPORT

Prepared by

COMBUSTION ENGINEERING, INC.

for

CALVERT CLIFFS 1 & 2

FORT CALHOUN

MILLSTONE 2

PALISADES

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4.3 SUBCOMPARTMENT ANALYSIS

4.3.1 Design Bases

Subcompartment pressures in the steam generator compartment resulting from dispersion of fluid emanating from design basis pipe breaks were calculated. Methods for determination of characteristics of design basis pipe breaks are discussed in Section 4.2. Definitions of design basis pipe breaks are also stated in Section 4.2. The calculated subcompartment pressures constitute one of the forcing functions employed in the evaluation of the structural design.

4.3.2 Design Features

The steam generator compartment was subdivided into nodes to reflect physical plant characteristics with respect to components, structures, piping and other major obstructions. Millstone 2 plant arrangement drawings are shown in Figures 4.3.1 through 4.3.13, Calvert Cliffs 1 & 2 arrangement drawings in Figures 4.3.14 through 4.3.20, Palisades drawings in Figures 4.3.21 through 4.3.30, and Fort Calhoun arrangement drawings can be seen in Figures 4.3.31 through 4.3.41. The steam generator compartment layouts for Millstone 2, Calvert Cliffs 1 & 2, and Palisades are alike: the compartment contains the steam generator flanked by two reactor coolant pumps. In the Fort Calhoun compartment there are walls which extend back from the primary shield wall to the secondary shield wall between the steam generator and reactor coolant pumps.

The generic analysis nodal model is shown in Figures 4.3.42 and 4.3.43, and node and flow path information in Tables 4.3.1 and 4.3.2.

Tabulations of node and flow path parameters for the Millstone 2 and Calvert Cliffs 1 & 2 steam generator subcompartment analysis are given in Tables 4.3.1 and 4.3.2. Palisades parameters are in Tables 4.3.3 and 4.3.4, and Fort Calhoun node and flow path data are presented in Tables 4.3.5 and 4.3.6. The method by which the values in Tables 4.3.1 through 4.3.6 were determined for each specific plant from those calculated for the generic plant is explained in Section 4.3.3.7. All node and flow path tables correspond to the nodalization scheme of Figures 4.3.42 and 4.3.43.

The space occupied by piping and component insulation was deducted in determining volumes and vent areas in the steam generator compartment. There were no movable obstructions to vent flow that required treatment.

4.3.3 Design Evaluation

4.3.3.1 Method for Mass and Energy Releases

The modified CEFLASH-4 computer program was used to compute the pipe rupture release rates. The CEFLASH-4 program is described in Reference 3.5 and its acceptability is stated in Reference 3.6. The modification to this CEFLASH-4 code is the incorporation of a critical flow correlation subroutine which conservatively maximizes the blowdown rates. This is the same critical flow subroutine as discussed in Reference 3.7. The Henry/Fauske critical flow correlation is used for subcooled and low quality fluid conditions and the Moody critical flow correlation for the remainder of the saturation regime. A flow multiplier of 0.7 was used throughout. Appendix A discusses the selection of this flow multiplier.

Reactor coolant system nodalization shown in Figure 4.3.44 was used.

4.3.3.2 Results for Mass and Energy Releases

Blowdown release rates were generated for each pipe break postulated in the reactor cavity and steam generator compartment. Blowdown mass flow rate and energy release rate as functions of time are provided as follows:

Generic Analysis Postulated Pipe Break	Table Numbers
RV inlet 1414 in^2 break	4.3.7A and 4.3.7B
RV outlet 135 in^2 break	4.3.8A and 4.3.8B
SG inlet 1000 in^2 break	4.3.9A and 4.3.9B
SG outlet 1414 in^2 break	4.3.10A and 4.3.10B

These tables are for the generic mass and energy release analysis. Plant specific mass and energy releases are discussed in Section 4.3.3.3.

4.3.3.3 Application of Mass and Energy Release Results

This section discusses the determination of pipe break releases for the individual plants under consideration. A comparison of pertinent plant nominal design parameters is made in Table 4.3.15. Pipe break definitions are given in Section 4.2.

The Calvert Cliffs and Millstone Reactor Coolant Systems are essentially identical and served as the basis for the generic analysis. As is indicated in Table 4.3.15, the Palisades system is similar geometrically and thermodynamically to the generic, except the initial pressurizer pressure. Since the Palisades system pressure is initially less than that of the generic, this causes the generic system model to be conservative for the Palisades application.

Now, the generic analysis system model and pipe breaks are appropriate for Calvert Cliffs, Millstone, and Palisades, so the mass and energy releases of Tables 4.3.7A through 4.3.10B were used for these plants.

Fort Calhoun's Reactor Coolant System is considerably smaller than that selected for the generic analysis. The larger inventory and associated relatively slower de-pressurization rate following the postulated pipe break make the generic RCS model undesirable for predicting Fort Calhoun mass and energy releases. Therefore, a dedicated Fort Calhoun CEFLASH4 RCS input model was used. The Fort Calhoun mass and energy releases are given as indicated here.

Fort Calhoun Postulated Pipe Break	Table Numbers
RV inlet 905 in^2 break	4.3.11A and 4.3.11B
RV outlet 200 in^2 break	4.3.12A and 4.3.12B
SG inlet 1608 in^2 break	4.3.13A and 4.3.13B
SG outlet 905 in^2 break	4.3.14A and 4.3.14B

4.3.3.4 Method for Steam Generator Subcompartment Pressure Analysis

The DDIFF-1 MOD7 (Reference 3.8) computer program was used to perform the steam generator compartment subcompartment pressure analysis. A compartment multi-node, space-time pressure response analysis was made.

The steam generator compartment nodal model was developed following a detailed review of the geometric features. Significant spatial variations in pressure within a node because of geometric influences were precluded by the model selected. Advantage was taken of nodalization sensitivity studies previously performed. Guidance from results reported in SAR's and in Reference 3.17 were utilized. Additional nodalization sensitivity studies were not required.

4.3.3.5 Reactor Cavity Analyses

Independent reactor cavity analyses were performed for the Calvert Cliffs Units, Millstone 2, Fort Calhoun and Palisades. The Calvert Cliffs and Millstone cavities are very similar, differing essentially in the type of neutron streaming shield employed. The other two cavities are considerably different.

4.3.3.5.1 Description of the Cavities

a) Calvert Cliffs

The reactor cavity of the B.G.&E. Calvert Cliffs Units 1 and 2 is composed of two different sections(2). The support on the reactor vessel (RV) hot leg rests on a shelf at elevation 29'-4". The two discharge leg supports sit on shelves at elevation 30'-10". The lateral portions of each support are set against partial walls extending out into the reactor cavity. Thus, each leg is set in a "well" bounded on either side by partial walls and extending from elevation 29'-4" (or 30'-10") to the vessel seal elevation (44'-10").

Below the supports, the cavity walls take the shape of an irregular polyhedron. This shape is extended to the bottom of the cavity at elevation 8'-5½". In this lower region, insulation is placed against the walls of the cavity and around the excore neutron detectors. This placement restricts the free volume at several points. According to the insulation specifications(3), a minimum 15/16-inch gap exists at the narrowest section.

In the upper cavity, insulation is placed against the vessel, the nozzles and legs. A convection barrier of insulation at elevation 29'-4" is placed across the annular air space from the insulation on the wall of the lower cavity to the insulation on the vessel in the upper cavity. This convection barrier is held in place by stainless steel rivets and screws which attach stainless steel angles to the insulation. At the narrowest portions of the cavity, upper and lower insulation panels are so closely spaced as to block flow without an additional barrier.

The penetrations in the upper primary shield wall (PSW) are tapered to their widest diameter at the exterior face of the wall. Above the seal at elevation 48'-3½", there is a neutron shield consisting of water bags resting on a steel framework[4]. The framework is supported in the cavity at the seal elevation. The neutron shield water bags are designed to blow away if the cavity is pressurized by a LOCA -- the water bags tearing open as they are pushed away from the frame.

The pathways for flow out of the cavity are the pipe penetrations and the annular space between the reactor and the PSW at elevation 44'. Flow within the cavity is blocked by a combination of insulation and excore neutron detectors at several locations.

b) Millstone 2

The Millstone 2 cavity is essentially identical to that of Calvert Cliffs. However the neutron streaming shield configuration is drastically different. The streaming shield consists of a segmented cylindrical annulus composed of tanks containing water. The bottom and top of each shield segment are designed to rupture under the forces resulting from LOCA. The shield structure is clamped on the vessel flange. Differences in the vessel insulation placement were considered in the modelling of the cavity.

c) Palisades

The reactor cavity of the Consumers Power Palisades Plant is essentially a cylindrical annulus formed by the reactor vessel and the inner face of the primary shield wall (PSW) extending from elevation 590' to the refueling pool seal, el. 624'-6".(15) The reactor vessel is supported on one hot leg and two discharge legs. The supports rest on beams which extend across the cavity both vertically and laterally into the primary shield wall. Each support structure occupies about 9 feet vertically and 12 feet laterally within the volume of the cavity.

Insulation covers the reactor vessel in the region of the cavity above the supports and is placed against the PSW below the supports(3). At the interface at the support elevation, there is a convection barrier across the width of the annulus which prevents thermal contact between the two regions.

Concrete blocks are bolted in place in the openings for the legs in the primary shield wall between the legs and the wall. The blocks are shaped to prevent any flow through these penetrations. There is an open 30 inch access passage in the lower cavity just above elevation 590'. This passage leads into one of the steam generator (E-50A #1) compartments.

d) Fort Calhoun

The reactor cavity of the Ft Calh[illegible] Unit 1 NPP is essentially a series of stacked cylindrical annuli ex[illegible]ding from elevation 976'-6" to elevation 1013'-0" (13). The four reactor vessel supports sit on a ledge at elevation 1001'-6 7/8"; beneath this elevation, the cavity has an irregular shape as there are cutouts in the primary shield wall to accommodate excore neutron detectors. In the immediate area of the nozzles, the cavity takes the appearance of six interlocked pipe penetrations. Above the legs, the primary shield wall (PSW) is brought to within a few inches of the vessel up to the seal elevation. Within each of the pipe penetrations, a sand plug blocks an access passage into the refueling pool.

Insulation within the cavity is placed between the vessel and the PSW such that there are sizable gaps between the insulation and the vessel[14] above the legs. At the bottom of the RV, the insulation is "squared off" so that there is a 4 7/32" gap between the insulation and the tangent line of the RV. There is insulation placed around each of the nozzles and on the legs.

At the bottom of the cavity, a barrier door separates the cavity from an access tunnel. The tunnel opens into the containment at elevation 994'-0".

4.3.3.5.2 Derivation of the Subcompartment Model

The analysis of the pressure transient due to a pipe break in this compartment is performed using the RELAP4-MOD6 computer code(1). This code simulates the reactor cavity in a lumped parameter representation as a series of subcompartment volumes linked by junctions with particular flow properties. The program options used in this study include:

(a) the RELAP-4 CONTAINMENT option, to account for the presence of air in the volumes;

(b) the thermal homogeneous equilibrium model (HEM), for determining the critical flow for air-steam-water mixtures; and

(c) the compressible single-stream form of the momentum equation, as this break case produces relatively high pressures in the cavity subcompartments.

The effective inertia (l/A) for each junction is calculated in a manner consistent with the methods used by the RELAP-4 code for one-dimensional models. For a pair of volumes v_i and v_k, with cross-sectional areas, A_i and A_k, and lengths in the direction of flow l_i and l_k, and for a junction between v_i and v_k with area A_j and length l_j, where $l_j << l_i$ and l_k and may be zero, the inertia coefficient,

$$\frac{l}{A} = \frac{l_i}{2A_i} + \frac{l_j}{A_j} + \frac{l_k}{2A_k} \qquad (1)$$

Flow coefficients for friction and irreversible losses were also computed in a manner consistent with the calculations performed by RELAP-4. The junction "form loss coefficient" utilized in the analysis is a combination of the wall friction losses (K_F) and any irreversible friction losses due to area changes, turns, obstructions and gratings. The total wall friction loss is computed as:

$$K_F = K_{Fi} + K_{Fj} + K_{Fk} \tag{2}$$

$$= f \frac{l_i}{2D_{Hi}} \left(\frac{A_j}{A_i}\right)^2 + f' \frac{l_j}{D_{Hj}} + f'' \frac{l_k}{2D_{Hk}} \left(\frac{A_j}{A_k}\right)^2 \tag{3}$$

where $D_{Hi,j,k}$ are the hydraulic diameters of the system. Typical values of density and flow for the upper cavity were used to calculate the friction factor, to realistically model the maximum pressure drop due to friction, such that:

$$f = \frac{0.316}{Re^{1/4}} = \frac{0.316}{\left(\frac{\rho v D_H}{\mu}\right)^{1/4}} = \frac{0.010738}{D_H^{1/4}}, \quad (5) \tag{4}$$

where $\frac{\rho v}{\mu} = 7.5 \times 10^5 ft^{-1}$

This value was chosen for all junctions to realistically simulate the maximum pressure drop that could be seen at the junction.

For irreversible losses, the coefficient for a reduction in area in the direction of flow is computed as:

$$K_c = 0.5 \left(1 - \frac{A_j}{A_i}\right), \tag{5}$$

and the coefficient for an expansion in area is computed as:

$$K_e = (1 - \frac{Aj}{Ak})^2 \ . \ (5) \quad (6)$$

Additional losses due to turns in flow direction or other changes in area were included as:

$$K_I = K_{Ii} (\frac{Aj}{Ai})^2 + K_{Ij} + K_{Ik} (\frac{Aj}{Ak})^2 \quad (6) \quad (7)$$

Thus, the total loss coefficient for each junction is calculated from Equations 3, 5, 6 and 7 as:

$$K \text{ (RELAP-4)} = K_F + K_c + K_e + K_I \quad (8)$$

Loss coefficients for both forward and reverse flow through the junction (in the sense of the RELAP-4 definition) were modelled consistently.

A multi-volume model of the reactor cavity compartment is constructed by considering all the physical flow restrictions as division between subcompartments. A flow restriction is defined by the presence of an object in the flow path which alters the area of the cross-section, with the subdivision defined at the point of minimum flow area. This minimum flow area is the junction flow area used in the RELAP-4 analysis. By choosing volume boundaries at the various physical flow restrictions, a method consistent with the lumped-parameter model used by RELAP-4 as described above, calculated differential pressures will reflect the actual parameters for flow in the compartment, and the consequent external asymmetric loads on the RV can be realistically calculated.(7,8)

Figures 4.3-81 through 4.3-88 show a schematic of the subcompartment models employed for each of the cavities analyzed. For Calvert Cliffs (Figures 4.3-81 and 4.3-82), junctions in the model are defined in the upper cavity by the hot and cold legs, the partial shield wall pipe penetration entrances, the convection barrier and lowest elevation of the supports, and the reactor vessel flange. In the lower cavity, the subdivisions are defined by the presence of the excore neutron detectors and the angles made by the PSW that create a minimum flow ares in θ and z directions. Flow between volumes 1 and 13, 12 and 13, 4 and 15, and 9 and 17 are blocked by insulation and no flow is assumed through these junctions.

The actual values of volume and flow area used in the RELAP-4 analyses are given in Tables 4.3-21a and 4.3-21b. The calcuation of these parameters is based on detailed drawings and realistic "worst case" approximations were used where uncertainty existed. The upper cavity subdivision corresponds to that used on many other plants and which has been shown in sensitivity studies (7,8) to be conservative in calculating forces and moments on the reactor vessel due to a pipe break in the cavity. These studies suggest that there is no more than a ±10% uncertainty in the results obtained, and this figure is applied to the results given in this report. The break locations for this study were assumed to be the volumes over supported legs. Volumes 2 and 3 were the break locations for the discharge leg break, and volumes 6 and 7 were the break locations for the hot leg break. Total break flow was divided evenly between each set of volumes.

For Millstone 2 (Figures 4.3-83 and 4.3-84), junctions in the model are also defined in the upper cavity by the hot and cold legs, the lowest elevation of the supports and the reactor vessel flange; but also by the neutron streaming shield. Initially there is minimal flow between the volumes at the legs elevation, but the flow increases as the shield tanks are computed to rupture. The description of the analytical method employed to compute the time varying flow area across the neutron streaming shield is given in Section 4.3.3.5.3.

The actual values of volume and flow area used in the RELAP-4 analyses are given in Tables 4.3-22a and 4.3-22b. The calculation of these parameters is based on detailed drawings and consideration has been given to the bending of the insulation panels in the mid-region of the cavity under the influence of the significant pressure forces. The insulation was modelled as a plate simply supported at the edges. The deflection of the insulation against the concrete of the PSW has the effect of increasing the flow area between the volumes modelling the cavity mid-region. The break locations and modelling are identical to those employed for Calvert Cliffs.

For Palisades (Figures 4.3-85 and 4.3-86), volumes and junctions are defined as for the Calvert Cliffs and Millstone 2 Plants. Tables 4.3-23a and 4.3-23b give the values of the volume and flow area parameters employed. Volumes 1 and 2 were the break locations for the discharge leg break, and volumes 3 and 4 were the break locations for the hot leg break, with the flow being equally divided between each set of volumes.

Figures 4.3-87 and 4.3-88 show a schematic of the Fort Calhoun subcompartment model. Junctions are defined in the upper cavity by the hot and cold legs, pipe penetration entrances, the inset of the PSW, and the reactor vessel flange. In the lower cavity, the axial subdivisions are extended from the upper cavity and subcompartments are further defined by the tangent line and bottom of the reactor vessel.

The actual values of volume and flow area used in the RELAP-4 analysis are given in Table 4.3-2. The break location was chosen to be between volumes 1 and 2 for the discharge leg and bet[illegible]n volumes 3 and 4 for the hot leg, with the break flow geing divided evenly between the sets of volume.

The position of the insulation in cavity determines the cavity free volume and flow areas and thus will have siginificant effect on the differential pressure calculated by RELAP. The present regulatory position on the movement of i tion during asymmetric pressure loadings is that any assumption of movement must be justified analytically. Traditionally, insulation has been left in place during the transient, as it is not possible to predict with any certainty the movement of any piece of insulation during the pressure transient. A defensible yet realistic case assumes minimum insulation movement while acknowledging that in an arrangement of insulation such as that which exists in the plants analyzed, some panels will blow away or crush under any conceivable circumstances. The selection of assumptions is conditioned by the necessity of calculating a defensible yet realistic asymmetric load. This load will occur when the free volume and flow area are smallest and the surface area of the vessel that experiences the transient is the largest possible.

For Calvert Cliffs and Palisades, the insulation occupies approximately 133 ft^3 of the upper cavity, or about 8% of the available volume. The insulation in the lower cavity reduces the free volume by about one-third in most areas, especially where the excore detectors are located. The principal component of the insulation is the convection barrier that blocks flow from upper to lower cavity volumes. For the Calvert Cliffs cold leg break, for example, this flow obstruction maintains the pressure differentials (V7-V1) and (V10-V4) at constant high levels of about 60 psid, or about 600,000 lb_f laterally. The lack of an insulation barrier would have the effect of distributing the flow throughout the entire cavity during an early portion of the transient, reducing the lateral forces while enhancing the uplift force by an amount proportional to the added flow area. Results of the analysis also show that upper cavity volumes will be pressurized to well above 30 psia in all volumes of the upper cavity. Given the time history of the pressurization of the upper cavity, it is clear that the pressure differential between upper and lower cavity volumes will tear away the convection barrier where it possesses a cross-section. The plate of insulation will tear out of the bolts fastening it to the vertical sections of insulation and will be pushed into the bottom of the cavity or pressed against the vessel where it is not torn completely.

There is an average cross-sectional area of 900 in^2 for the convection barrier panels assumed to tear away in this analysis. The panels were assumed to begin tearing at three times their assumed weight, approximately 4317 lb_f, translating to a pressure on each section of 5.0 psid. Once this pressure differential was reached, the area was assumed to open at a linear rate to 95% free area in 50 msec, and to 99% free area by 0.1 sec, remaining at 99% free area thereafter. This model is typical of the movement of panels of this size and weight under this type of pressurization curve(9), and assumes that some insulation will remain attached at the barrier. Note that the area will open up only on a +5 psi differential between upper and lower cavities; for reverse differentials, the insulation is assumed to be trapped under the legs and no flow is permitted through this junction.

All other insulation in the Calvert Cliffs analysis has been assumed to remain in place during the transient. This is in conformance with present regulatory positions(10), and results in the most realistic, defensible model for insulation movement possible.

For Millstone 2, the insulation below the neutron streaming shield is assumed to tear away and blow through the shield panels as they rupture. The insulation in the cavity mid-region is computed to displace at the middle of the panels against the PSW.

For Palisades there is an average cross-sectional area of 12 ft^2 for the convection barrier panels assumed to tear away in the analysis. The panels are assumed to tear away at three times their assumed weight, translating in this instance to a pressure differential on each section of 12 psid. Once this pressure differential was reached, the area was assumed to open at a linear rate to 90% free area in 3 msec, remaining at 90% free area thereafter.

In Fort Calhoun Unit 1, the insulation cuts the free volume of the cavity in half (volumes 1 to 18). It can be realistically assumed that the asymmetric pressurization of the reactor cavity will tear off sections of insulation on some of the nozzles and legs and crush some of the panels of insulation on the vessel. The results of an initial analysis with the insulation in place show pressures of about 100 psia or above in the upper cavity volumes, and pressure differentials of from 220 to 240 psid across the legs adjacent to the purtured discharge leg. Given the time history of the pressure transients in the most realistic conceivable scenario, it is clear that the cavity pressures are likely to first collapse insulation nearest the break against the vessel, pulling it away from the rest of the insulation panels. As the pressure "waves" travel around the cavity in either direction, the insulation behind the "wave front" can be envisioned as being pushed into the vessel, with some deformation and tearing of the insulation on the side of the vessel opposite the break as this region of the cavity pressurizes. Insulation can be visualized to become pressed against the vessel in the lower cavity in a similar manner. At the bottom of the reactor vessel, pressures will built to 140 to 160 psia. The supports holding the insulation away from the vessel hemisphere in this region are not designed to withstand forces of this magnitude, and this insulation will also crush up against the vessel with considerable deformation.

Because of these considerations, and also because the asymmetric load cannot be transmitted to the vessel until the insulation contacts it (and possibly crushes against it), the insulation in the final analysis for Fort Calhoun was assumed to be pressed against the vessel. Moreover, in this analysis, the nozzle covers on the ruptured legs are assumed to be pushed off. In addition, insulation in the lower cavity is assumed to be crushed up against the vessel hemisphere.

The barrier door in the lower cavity in Fort Calhoun will partially blow out when the cavity is pressurized. The study assumed that 51.597 ft^2 of free area becomes available at a linear rate 2 msec after a 10 psi pressure differential is reached across the door. This area represents the sum of the area of several steel panels in the door, and the delay time was employed to enhance the numerical stability of the model.

A proposed general cavity model[10] includes a slightly different subdivision of volumes than has been used in this study or in any of the referenced studies[6,7,8,9]. The general cavity model seems to have been formulated for a regular, orthogonal cavity with no flow obstructions save changes in cavity cross-section at the legs and at a change in vessel radius. For such an unlikely arrangement, this subdivision is correct, as it accounts for all major flow obstructions within the cavity. In the case of the Calvert Cliffs Units 1 and 2 reactor cavity, however, these subdivisions are secondary, as the placement of insulation, the existence of partial walls and reactor vessel supports and the irregular lower cavity shape impose more severe restrictions in flow. In such cases the practice is to include the effect of the secondary flow area changes in the calculation of flow coefficients (e.g., K_F, K_c, K_e, K_I) at appropriate junctions, such as between volumes 2 and 14; and 2 and 31. The creation of additional volumes by the secondary subdivisions has been found to create numerical instabilities in the solution, as a subdivision at the legs would create from level 1 two sets of volumes, one small (about 30 ft^3 typically) and one large (90 ft^3 typically). This is a model that RELAP can use only with great difficulty, especially when the small volume has a time dependent junction as in this case.

In addition, the effect of such secondary subdivisions is usually small, assuming that a model can be created that is numerically stable and which splits the blowdown mass correctly. The subdivision will distribute the same flow among the "split" volumes, leading to similarly split pressure transients. The effect of these subdivisions is included in the ±10% multiplier described above; no study every seen by Ebasco has found a more significant change in results due to any change in the modelling system described in this report.

4.3.3.5.3 Effect of Neutron Streaming Shields

This section describes how the presence of Neutron Streaming Shields has been considered in the analysis. There is no neutron streaming shield for Palisades. In the Calvert Cliffs units, the neutron shield and frame are very similar to the shield used in Florida Power and Light's St. Lucie Unit 1 Plant. An analysis of shield movement for that plant design under similar pressurization(9) showed that for the cast of 1.0 ft^2 holes in the waterbags, the free area of the shield was made available 150 msec after the start of the accident. This assumption was used with a linear opening rate for the Calvert Cliffs neutron shield. Ths same St. Lucie Unit 1 study also showed that the presence of the shield had little effect on pressures or forces within the cavity, which is reasonable to suppose in the case as well as both shield designs elevate the shield above the seal elevation and thus do not directly block flow from the cavity.

The Millstone Unit 2 neutron shield consists of 16 water tanks, 1'-9" high filled to a 16" height with water. These tanks are arranged in an annulus around the vessel at the flange elevation and are supported as shown in Figure 4.3-89. Reference (11), Figure 4.1.2 provided the information relating to rotation angle of the slowest panel of a torn shield face as a function of time, from the instance at which the bottom or top plates begin to tear. The tearing is initiated when a 20 psid is applied across the plate. The notched plate then divides into 4 panels which rotate about their edges. This information was used to derive the area available for flow through the shield segments. First the angle vs. time curve from Reference (11) was used to jerive an area vs. time for the lower plate. This area vs. time curve showed almost no flow area for 20 msec, opening rapidly thereafter. This curve accounted for the flow through the holes in the inner ring of the shield structure, where the clamp is located, and also for the small lifting motion of the outer shell of the ring caused by rigid rotation of the entire annulus. Secondly, a model of the neutron shield was created in RELAP. This model consisted of 12 appropriately sized volumes (reflecting the total volume of the shield) with time dependent flow areas. Limitations on volumes, junctions and especially check valves inherent in RELAP-4, limited the detail with which the upper plates could be modelled. Hence, only the upper plates of the shield tanks nearest the break were simulated to open. Results of the analyses showed that the tanks rupture in a "wave like" manner; i.e., the tanks near the break open first, followed by tearing of the others in sequence around the RV, symmetrically about the break.

The results also show a "mixing" of the flow into the shield segment permitted by the tearing of the bottom plate, with the water and air contained in the shield segment. This results in a pressurization of the shield segment which in turn ruptures the upper plate.

This "mixing" phenomenon is considered "slower" than the real phenomenon which will cause the upper plate to tear; i.e., the slug motion of the water initially contained in the shield segment under the momentum acquired when the pressure wave hits the bottom plate. Thus, the derived flow area vs. time curves employed in the analyses are perceived to be conservative; i.e., overestimated the time required to open the flow area. Results are shown in Figure 4.3-90 for both cold leg and hot leg breaks. The figure shows that the area opening for cold legs occurs in two main steps. First the cavity pressure below the shield is sufficient to break the bottom plates of the shield. The pressure then remains virtually the same until the shield volume itself is pressurized and the top plate break.

In Fort Calhoun, the neutron streaming shield consists of sand plugs. The sand plugs were modelled as junctions between the pipe penetrations and the pool, volume 32. The junction trip was set at 2.64 psid, representing the force necessary to balance the estimated dead weight of the plug. Delay times were introduced at each junction to simulate that the flow area will not become available until the plug clears the hole completely, and that this event will occur at different times in different penetrations due to various position-dependent rates of pressurization. At the break (volumes 7, 8, 9), a 63 msec delay was computed. At 120° from the break (volumes 10, 12), a 110 msec delay was computed. A 161 msec delay was assumed for the penetration 180° from the break (volume 11). These times are based on a first-order solution of the nonlinear equation of motion of the sand plug using different pressure gradients.

The basic equation of motion can be derived as follows. Let the position dependent mass of the sand plug be given by:

$$M(z) = M_o - \rho A z = M(t) \qquad (9)$$

where M_o is the initial mass of the sand plug, and where $\rho A z$ is the mass of the sand pushed up and out into the pool. (ρ is the density of the sand {95 lb/ft^3} and A the cross sectional area.) Then, the basic equation of motion for the plug is given by:

$$\text{Force on the plug} = 144 \times \Delta p(t)A = \frac{d}{dt}\left(\frac{M(t)}{g_c}\frac{dz}{dt}\right) \qquad (10)$$

where Δp, the pressure differential across the plug, is given in psid. Substituting the expression in equation (9) for M(t), equation (10) becomes:

$$144\Delta p(t)A = \frac{d}{dt} \quad \frac{(M_o - \rho A z)}{g_c} \frac{dz}{dt}, \quad \text{or} \qquad (11)$$

$$144\, g_c \Delta p(t) A = -\rho A \left(\frac{dz}{dt}\right)^2 + (M_o - \rho A z)\frac{d^2 z}{dt^2} \quad . \tag{12}$$

Letting $z_o = M_o/\rho A$, and making the substitution that:

$$\frac{1}{2}\frac{d^2}{dt^2} z^2 = \left(\frac{dz}{dt}\right)^2 + z\frac{d^2 z}{dt^2} \quad . \tag{13}$$

The equation of motion of the plug becomes:

$$\frac{144 g_c}{\rho} \Delta p(t) = \frac{d^2}{dt^2}\left(z_o z - \frac{z^2}{2}\right) \quad (z < z_o), \tag{14}$$

with z, and dz/dt initially equal to zero.

Assuming $\Delta p(t) = \alpha + \beta t$, this equation can be integrated directly and the solution for z(t) becomes a cubic equation in t,

$$z_o z - z^2/2 = \frac{144 g_c}{\rho}\left(\frac{\alpha t^2}{2} + \frac{\beta t^3}{6}\right). \tag{15}$$

Solving for $z \approx z_o$, a cubic equation for t_o is obtained:

$$\frac{-z_o^2}{2} = \frac{144 g_c}{\rho}\left(\frac{\alpha t_o^2}{2} + \frac{\beta t_o^3}{6}\right), \tag{16}$$

or

$$t_o^3 + \frac{3\alpha}{\beta} t_o^2 + \frac{3\rho z_o^2}{144 g_c \beta} = 0. \tag{17}$$

$z_o = 4.0$ feet, and $\alpha = 2.64$ psid. β ranges between approximately 4100 psid/sec and 282.5 psid/sec. Thus, t_o ranges between about 0.063 and 0.161 seconds.

5.3.3.5.4 Results of Analysis

The models of the Calvert Cliffs, Millstone and Palisades cavities were run on RELAP4-MODE6 for two cases[12]:

a) 135 in^2 hot leg guillotine break (see Tables 4.3.8A and 4.3.8B)

b) 1414 in^2 discharge leg guillotine break (see Tables 4.3.7A and 4.3.7B)

Figures 4.3-82, 84 and 86 show a coordinate system for calculating forces on the reactor vessel. The +x axis is defined pointed towards the ruptured discharge leg, with +z pointed upwards. The origin of the coordinate system lies at the centerline of the reactor vessel, at the centerline of the hot and cold legs. A set of "projected areas" and lever arms is defined for the vessel in this coordinate syste, with values given in Tables 4.3-25a, b and c. The pressure differentials were then applied to these areas to produce the reactor vessel forces and moments shown in Figures 4.3.91 to 4.3.97 for the hot leg break; and 4.3.98 to 4.3.104 for the discharge leg break.

Figures in Appendices B, C, D, and E for each break show the pressure differential across the legs. These differentials are not included in the force and moment results described above. Following these figures, the time history of the pressure differentials used to calculate the forces and moments is given, as well as the pressure differentials across the primary shield wall in various locations. Finally, the absolute pressures for every volume within the reactor cavity are presented.

The model for the Fort Calhoun reactor cavity was run on the RELAP4-MOD6 for two cases:

a) in^2 hot leg guillotine break (see Tables 4.3.12A and 4.3.12B)

b) 905 in^2 discharge leg guillotine break (see Tables 4.3.11A and 4.3.11B)

The set of "projected areas" and lever arms is given in Table 4.3.25d.

4.3.3.5.5 Sensitivity of Results

Although, as previously stated, the various cavities have been modelled in such a manner as to produce results which by past experience are "realistic" and relatively insensitive to more changes in the modelling, an additional model of the reactor cavity was constructed for the one cavity which is reasonably regular; namely, Palisades, to further test the sensitivity of the results to modelling changes.

An additional model of the reactor cavity was constructed to test the sensitivity of the results to modelling changes. The reactor cavity was further subdivided in elevation by the vertical centerline of the legs. This division follows the subdivision of the general model described in proposed CSB guidelines for subcompartment analysis[10]. For this case, where a convection barrier just beneath the legs blocks flow completely, the legs offer a "secondary" flow obstruction in the z direction. This obstruction has been accounted for implicitly in the calculation of flow parameters for the junctions at the convection barrier in the original model.

The modification for the "CSB type" model is schematically illustrated in Figure (1). The remainder of the model remains as shown. The additional volume and area parameters are given in Table (7). The break flow subdivision follows the previous model and subdivides the total flow evenly into fourths.

The new forces and moments for the 1414 in^2 discharge leg guillotine break are shown in Figures 4.3.105 to 4.3.111. Comparison of the figures for FSUM (Figures 4.3.101C and 4.3.108) show that for the original model, the total F_x was 375 x 10^4 lb_f, and about 350 x 10^4 lb_f for the "CSB" model. Peak uplift is 275 x 10^4 lb_f for the original and 285 x 10^4 lb_f for the "CSB" model.

Comparison of the moments is very difficult; however, it is possible to see a maximum y-axis total moment of about 375 x 10^4 ft-lb_f for the original model compared to about 400 x 10^4 ft-lb_f for the "CSB" model. The x-axis moment is greatly reduced in the "CSB" model, reduced from the original by about a factor of three. Thus, even the added conservatism of additional levels affects the results by much less than the 10% uncertainty described in a previous section.

References for Section 4.3.3.5

1. E.G.&G. Idaho, Inc., "RELAP4/MOD6 - A COMPUTER CODE FOR TRANSIENT THERMAL-HYDRAULIC ANALYSIS OF NUCLEAR REACTORS AND RELATED SYSTEMS", User's Manual, CDAP TR 003, January 1978.

2. B.G.&E. Drawings: 60-337, 338, 340, 342
   61-757, 758, 761, 766, 771 (latest revisions)

   CE Drawings: 3836-10 (R3), B, D: -11, -12 (RO)

3. Bechtel Specification for B.G.&.E. Calvert Cliffs Units 1 and 2 6750-M-339, R1, dated May 18, 1970, page 4.

4. B.G.&.E. Drawings: 5MA1022; 61-759, 762;
   63-853, 855 (latest revisions)

5. Idel'Chik, I. E., "Handbook of Hydraulic Resistance - Coefficients of Local Resistance and Friction", AEC-tr-6630, U.S.D. of C., 1966.

   "Flow of Fluids Through Valves, Fittings and Pipes", (17th Edition), Crane Company, New York 1978.

6. Louisiana Power and Light Company, Waterford Unit Number 3, FSAR Chapter 6, Section 6.2.1.2.

7. Carolina Power and Light Company, Shearon Harris Unit 1, PSAR Chapter 5, Section 5.1.2.3.7.

8. Northeast Utilities, Millstone Nuclear Power Station, Unit No. 2, letter to NRC dated February 23, 1978 (Doc. No. 50-336), Subject: Neutron Shielding.

9. Florida Power and Light Company, St. Lucie Unit 1, letter to NRC (L-76-406, Doc. No. 50-335), dated November 29, 1976, Subject: Neutron Shielding.

10. Letter to Ebasco from B.G.&E., dated August 20, 1979 containing CSB draft guidelines for PWR Subcompartment Analysis.

11. Neutron Streaming Shield (EDS).

12. CE letter to B.G.&E. (B.G.&E.-10577-64) dated January 11, 1979.

13. OPPD Drawing Nos. 11405-S-20, 21, -M-79, 82, -A-13.

References for Section 4.3.3.5 (Cont'd)

14. Transco Inc., drawings for CE/OPPD Nos. 3742-1 to -9.

15. Consumer Power Drawings: C-154(RW5), C-157(RW6), M-3(RW8), M-7(RW5)
CE Drawing E-232-111(RW3).

Table 4.3-11a

OPPD - Ft Calhoun Unit 1

Mass/Energy Release Rates

905 Square Inch Discharge Leg Guillotine Break
at Reactor Vessel Nozzle

(Flow From Pump Side)

Time (Seconds)	Flow Rate (lb/sec)	Enthalpy (Btu/lb)	Energy Rate (Btu/sec)
0.00000	0.0	544.70	0.
.00100	2284.0	544.60	1243866.
.00200	4446.0	544.30	2419958.
.00300	6403.0	543.90	3482592.
.00400	7825.0	543.20	4250540.
.00500	8865.0	542.50	4809203.
.00600	9523.0	541.70	5158609.
.00700	9701.0	541.00	5248241.
.00800	9649.0	540.40	5214320.
.00900	9477.0	539.90	5116632.
.01000	9464.0	539.60	5106774.
.01200	11190.0	539.60	6038124.
.01400	13050.0	539.60	7041780.
.01600	14920.0	539.60	8050832.
.01800	16780.0	539.60	9054488.
.02000	18640.0	539.60	10058144.
.02200	20510.0	539.60	11067196.
.02400	21430.0	539.60	11563628.
.02600	21430.0	539.70	11565771.
.02800	21420.0	539.70	11560374.
.03000	21420.0	539.70	11560374.
.03200	21420.0	539.70	11560374.
.03400	21420.0	539.80	11562516.
.03600	21420.0	539.80	11562516.
.03800	21420.0	539.80	11562516.

Table 4.3-11a (cont.)

OPPD - Ft Calhoun Unit 1

Mass/Energy Release Rates

905 Square Inch Discharge Leg Guillotine Break at Reactor Vessel Nozzle

(Flow From Pump Side)

Time (Seconds)	Flow Rate (lb/sec)	Enthalpy (Btu/lb)	Energy Rate (Btu/sec)
.04000	21430.0	539.80	11567914.
.04200	21430.0	539.90	11570057.
.04400	21440.0	539.90	11575456.
.04600	21440.0	539.90	11575456.
.04800	21440.0	539.90	11575456.
.05000	21450.0	539.90	11580855.
.05500	21450.0	540.00	11583000.
.06000	21450.0	540.00	11583000.
.06500	21450.0	540.00	11583000.
.07000	21450.0	540.10	11585145.
.07500	21450.0	540.10	11585145.
.08000	21450.0	540.10	11585145.
.08500	21430.0	540.10	11574343.
.09000	21390.0	540.10	11552739.
.09500	21350.0	540.10	11531135.
.10000	21320.0	540.20	11517064.
.11000	21240.0	540.20	11473848.
.12000	21170.0	540.20	11436034.
.13000	21100.0	540.30	11400330.
.14000	21050.0	540.30	11373315.
.15000	21000.0	540.30	11346300.
.16000	20940.0	540.40	11315976.
.17000	20870.0	540.40	11278148.
.18000	20800.0	540.40	11240320.
.19000	20740.0	540.40	11207896.

Table 4.3-11a (cont.)

OPPD - Ft Calhoun Unit 1

Mass/Energy Release Rates

905 Square Inch Discharge Leg Guillotine Break
at Reactor Vessel Nozzle

(Flow From Pump Side)

Time (Seconds)	Flow Rate (lb/sec)	Enthalpy (Btu/lb)	Energy Rate (Btu/sec)
.20000	20680.0	540.50	11177540.
.22000	20560.0	540.50	11112680.
.24000	20450.0	540.60	11055270.
.26000	20350.0	540.70	11003245.
.28000	20240.0	540.70	10943768.
.30000	20150.0	540.80	10897120.
.32000	20070.0	540.80	10853856.
.34000	19990.0	540.90	10812591.
.36000	19920.0	541.00	10776720.
.38000	19850.0	541.00	10738850.
.40000	19800.0	541.10	10713780.
.42000	19750.0	541.20	10688700.
.44000	19700.0	541.30	10663610.
.46000	19670.0	541.30	10647371.
.48000	19630.0	541.40	10627682.
.50000	19610.0	541.50	10618815.
.55000	19580.0	541.70	10606486.
.60000	19580.0	542.00	10612360.
.65000	19620.0	542.20	10637964.
.70000	19680.0	542.50	10676400.
.75000	19770.0	542.80	10731156.
.80000	19890.0	543.20	10804248.
.85000	20020.0	543.50	10880870.
.90000	20170.0	543.90	10970463.
.95000	20340.0	544.20	11069028.

Table 4.3-11a (cont.)

OPPD - Ft Calhoun Unit 1

Mass/Energy Release Rates

905 Square Inch Discharge Leg Guillotine Break at Reactor Vessel Nozzle

(Flow From Pump Side)

Time (Seconds)	Flow Rate (lb/sec)	Enthalpy (Btu/lb)	Energy Rate (Btu/sec)
1.00000	20520.0	544.60	11175192.
1.10000	20910.0	545.40	11404314.
1.20000	21340.0	546.30	11658042.
1.30000	21810.0	547.10	11932251.
1.40000	24600.0	548.30	13488180.
1.50000	24750.0	549.20	13592700.
1.60000	24860.0	550.10	13675486.
1.70000	24990.0	551.00	13769490.
1.80000	25140.0	551.90	13874786.
1.90000	25350.0	552.80	14013480.
2.00000	25500.0	553.70	14119350.
2.50000	26140.0	557.90	14583506.
3.00000	26860.0	561.80	15089948.

Table 4.3-11b

OPPD - Ft Calhoun Unit 1

Mass/Energy Release Rates

905 Square Inch Discharge Leg Guillotine Break at Reactor Vessel Nozzle

(Flow From RV Side)

Time (Seconds)	Flow Rate (lb/sec)	Enthalpy (Btu/lb)	Energy Rate (Btu/sec)
0.00000	0.0	544.70	0.
.00100	2184.0	544.10	1188314.
.00200	3765.0	543.00	2044395.
.00300	5138.0	542.20	2785824.
.00400	6769.0	542.10	3669475.
.00500	8766.0	542.40	4754678.
.00600	10720.0	542.60	5816672.
.00700	12230.0	542.40	6633552.
.00800	13320.0	542.00	7219440.
.00900	14110.0	541.00	7641976.
.01000	15070.0	541.40	815889[illegible].
.01200	17320.0	541.20	9373584.
.01400	19780.0	541.10	10702958.
.01600	22160.0	541.10	11990776.
.01800	24420.0	541.10	13213662.
.02000	26600.0	541.20	14395920.
.02200	28710.0	541.20	15537852.
.02400	32550.0	541.70	17632335.
.02600	34860.0	542.10	18897606.
.02800	36520.0	542.50	19812100.
.03000	37740.0	542.70	20481498.
.03200	38610.0	542.80	20957508.
.03400	39290.0	543.00	21334470.
.03600	39780.0	543.10	21604518.
.03800	40150.0	543.10	21805465.

Table 4.3-11b (cont.)

OPPD - Ft Calhoun Unit 1

Mass/Energy Release Rates

905 Square Inch Discharge Leg Guillotine Break
at Reactor Vessel Nozzle

(Flow From RV Side)

Time (Seconds)	Flow Rate (lb/sec)	Enthalpy (Btu/lb)	Energy Rate (Btu/sec)
.04000	40400.0	543.10	21941240.
.04200	40550.0	543.20	22028760.
.04400	40600.0	543.10	22049860.
.04600	40570.0	543.10	22033587.
.04800	40450.0	543.00	21964350.
.05000	40280.0	543.00	21872040.
.05500	39740.0	542.80	21570872.
.06000	39250.0	542.60	21297050.
.06500	38830.0	542.50	21065275.
.07000	38220.0	542.30	20726706.
.07500	37070.0	542.10	20095647.
.08000	35350.0	541.80	19152630.
.08500	33340.0	541.30	18046942.
.09000	31380.0	541.00	16976580.
.09500	29890.0	540.70	16161523.
.10000	29310.0	540.70	15847917.
.11000	31010.0	541.00	16776410.
.12000	33060.0	541.40	17898684.
.13000	33490.0	541.50	18134835.
.14000	33250.0	541.50	18004875.
.15000	33750.0	541.60	18279000.
.16000	34090.0	541.60	18463144.
.17000	33070.0	541.40	17904098.
.18000	3[illegible]860.0	541.20	17242632.
.19000	30860.0	541.00	16695260.

Table 4.3-11b (cont.)

OPPD - Ft Calhoun Unit 1

Mass/Energy Release Rates

905 Square Inch Discharge Leg Guillotine Break at Reactor Vessel Nozzle

(Flow From RV Side)

Time (Seconds)	Flow Rate (lb/sec)	Enthalpy (Btu/lb)	Energy Rate (Btu/sec)
.20000	30660.0	541.00	16587080.
.22000	33190.0	541.50	17972385.
.24000	33140.0	541.40	17941996.
.26000	32290.0	541.30	17478577.
.28000	31250.0	541.10	16909375.
.30000	31810.0	541.20	17215572.
.32000	32670.0	541.40	17687538.
.34000	32290.0	541.30	17478577.
.36000	31430.0	541.10	17006773.
.38000	31600.0	541.20	17101920.
.40000	31800.0	541.20	17231808.
.42000	31900.0	541.20	17264280.
.44000	31570.0	541.20	17085684.
.46000	31440.0	541.20	17015328.
.48000	31700.0	541.20	17156040.
.50000	31860.0	541.20	17134392.
.55000	31140.0	541.10	16849854.
.60000	31030.0	541.10	16790333.
.65000	30930.0	541.10	16736223.
.70000	30640.0	541.10	16579304.
.75000	30520.0	541.10	16514372.
.80000	30360.0	541.10	16427796.
.85000	30240.0	541.10	16362864.
.90000	30150.0	541.10	16314165.
.95000	30000.0	541.10	16233000.

Table 4.3-11b (cont.)

OPPD - Ft Calhoun Unit 1

Mass/Energy Release Rates

905 Square Inch Discharge Leg Guillotine Break at Reactor Vessel Nozzle

(Flow From RV Side)

Time (Seconds)	Flow Rate (lb/sec)	Enthalpy (Btu/lb)	Energy Rate (Btu/sec)
1.00000	29830.0	541.10	16141013.
1.10000	29460.0	541.10	15940806.
1.20000	29180.0	541.10	15789298.
1.30000	28960.0	541.10	15670256.
1.40000	28670.0	541.20	15516204.
1.50000	28510.0	541.30	15432463.
1.60000	28340.0	541.40	15343276.
1.70000	28130.0	541.40	15229582.
1.80000	27880.0	541.60	15099808.
1.90000	27640.0	541.70	14972588.
2.00000	27510.0	541.80	14904918.
2.50000	26630.0	542.80	14454764.
3.00000	26180.0	544.10	14244538.

Table 4.3-21a

Baltimore Gas & Electric

Calvert Cliffs Units 1 and 2

Volumes

Volume Number	Volume (ft^3)	Height (ft)	Elevation (ft)
1	179.98	13.1671	30.833
2	122.63	13.1671	30.833
3	122.63	13.1671	30.833
4	130.65	13.1671	30.833
5	130.65	13.1671	30.833
6	147.02	14.6671	29.333
7	147.02	14.6671	29.333
8	130.65	13.1671	30.833
9	130.65	13.1671	30.833
10	122.63	13.1671	30.833
11	122.63	13.1671	30.833
12	179.98	13.1671	30.833
13	30.277	13.3331	17.5
14	174.94	13.3331	17.5
15	52.792	13.3331	17.5
16	170.85	13.3331	17.5
17	52.792	13.3331	17.5
18	169.98	13.3331	17.5
19	265.09	9.4171	8.083
20	265.89	9.4171	8.083
21	175.08	9.4171	8.083
22	262.86	9.4171	8.083
23	175.08	9.4171	8.083
24	262.20	9.4171	8.083
25	87.26	7.667	33.5
26	171.52	6.5	34.083

Table 4.3-21a (cont.)

Baltimore Gas & Electric

Calvert Cliffs Units 1 and 2

Volumes

Volume Number	Volume (ft^3)	Height (ft)	Elevation (ft)
27	129.62	6.5	34.083
28	87.26	7.667	33.5
29	171.52	6.5	34.083
30	129.62	6.5	34.083
31	1594.0	4.292	44.0
32	51350.0	74.0	10.0
33	51350.0	74.0	10.0
34	12380.0	35.0	34.0
35	12400.0	20.709	48.292
36	16560.0	39.5	29.5
37	1.0E+6	145.0	10.0

Note: All volumes are initially at 14.7 psia, 120°F, 0.5% RH, except volumes 13 to 24 which are at 14.7 psia, 550°F, 0.01% RH.

Table 4.3-21b

Baltimore Gas & Electric

Calvert Cliffs Units 1 and 2

Junctions

Junction Number	From Vol	To Vol	Area (ft^2)	Elevation (ft)	Inertia Coeff L/A (ft^{-1})	Irreversible Loss Coeff (Forward Flow)	Irreversible Loss Coeff (Reverse Flow)
1	1	2	27.069	30.833	0.1934	0.04099	0.04099
2	2	3	18.236	30.833	0.1934	0.32063	0.32063
3	3	4	27.069	30.833	0.1934	0.06277	0.06277
4	4	5	29.978	30.833	0.1934	0.06037	0.06037
5	5	6	27.069	30.833	0.1934	0.08218	0.06750
6	7	6	11.318	29.333	0.1934	0.67558	0.67558
7	8	7	27.069	30.833	0.1934	0.06341	0.06341
8	9	8	29.978	30.833	0.1934	0.03597	0.03597
9	10	9	27.069	30.833	0.1934	0.04699	0.06167
10	11	10	18.326	30.833	0.1934	0.32063	0.32063
11	12	11	27.069	30.833	0.1934	0.04163	0.04163
12	1	12	15.719	30.833	0.1934	0.09442	0.09442
13	1	31	15.719	44.0	0.43447	1.53688	1.02602
14	2	31	15.719	44.0	0.43447	1.53688	1.02602
15	3	31	15.719	44.0	0.43447	1.53688	1.02602
16	4	31	15.719	44.0	0.43447	1.53688	1.02602
17	5	31	15.719	44.0	0.43447	1.53688	1.02602
18	6	31	15.719	44.0	0.43447	1.53688	1.02602
19	7	31	15.719	44.0	0.43447	1.53688	1.02602
20	8	31	15.719	44.0	0.43447	1.53688	1.02602
21	9	31	15.719	44.0	0.43447	1.53688	1.02602
22	10	31	15.719	44.0	0.43447	1.53688	1.02602
23	11	31	15.719	44.0	0.43447	1.53688	1.02602
24	12	31	15.719	44.0	0.43447	1.53688	1.02602
25	1	13	1.19511	30.833	3.73168	0.67942	0.92339
26	2	14	7.16425	30.833	1.34418	0.273	0.26519

Table 4.3-21b (cont)

Baltimore Gas & Electric

Calvert Cliffs Units 1 and 2

Junctions

Junction Number	From Vol	To Vol	Area (ft^2)	Elevation (ft)	Inertia Coeff L/A (ft^{-1})	Irreversible Loss Coeff (Forward Flow)	(Reverse Flow)
27	3	14	6.647	30.833	1.35757	0.32877	0.2847
28	4	15	1.71659	30.833	2.27927	0.75813	0.94844
29	5	15	2.45106	30.833	1.89705	0.66886	1.01407
30	6	16	6.54764	30.833	1.98100	0.39477	0.38728
31	7	16	6.94033	30.833	1.82643	0.51717	0.5431
32	8	17	2.45106	30.833	1.89705	0.66886	1.01407
33	9	17	1.71659	30.833	2.27927	0.75813	0.94844
34	10	18	6.647	30.833	1.35757	0.32877	0.2847
35	11	18	6.77156	30.833	1.35757	0.52886	0.55658
36	12	13	1.19511	30.833	3.73168	0.67942	0.92339
37	1	25	3.752	33.5	0.18587	1.09336	1.24467
38	2	27	3.185	34.083	0.71249	1.0857	1.26414
39	3	27	3.185	34.083	0.71249	1.0857	1.26414
40	4	29	3.185	34.083	0.46262	1.09823	1.31339
41	5	29	3.185	34.083	0.46262	1.09823	1.31339
42	6	28	3.752	33.5	0.18955	1.08961	1.31339
43	7	28	3.752	33.5	0.18955	1.08961	1.23095
44	8	30	3.185	34.083	0.69717	1.09894	1.31411
45	9	30	3.185	34.083	0.69717	1.09894	1.31411
46	10	26	3.165	34.083	0.47795	1.08498	1.26343
47	11	26	3.185	34.083	0.47795	1.08498	1.26343
48	12	25	3.752	33.5	0.18587	1.09336	1.24467
49	15	16	13.538	17.5	0.61076	0.16704	0.22299
50	16	17	13.538	17.5	0.61076	0.22299	0.16704
51	13	19	2.3902	17.5	2.83561	0.92712	0.55973
52	14	20	13.811	17.5	0.64387	0.23159	0.25144

Table 4.3-21b (cont.)

Baltimore Gas & Electric

Calvert Cliffs Units 1 and 2

Junctions

Junction Number	From Vol	To Vol	Area (ft^2)	Elevation (ft)	Inertia Coeff L/A (ft^{-1})	Irreversible Loss Coeff (Forward Flow)	Irreversible Loss Coeff (Reverse Flow)
53	15	21	4.1677	17.5	1.80105	0.62717	0.43873
54	16	22	13.488	17.5	0.657	0.24302	0.26012
55	17	23	4.1677	17.5	1.80105	0.62751	0.43907
56	18	24	13.419	17.5	0.65988	0.24271	0.25920
57	19	20	110.47	8.083	0.08104	0.01608	0.04975
58	20	21	118.02	8.083	0.08104	0.04919	0.04081
59	21	22	112.54	8.083	0.08091	0.06443	0.07208
60	23	22	110.47	8.083	0.08091	0.02528	0.06
61	24	23	112.54	8.083	0.08104	0.04993	0.02239
62	19	24	118.02	8.083	0.08104	0.01021	0.01859
63	25	32	28.447	33.5	0.15247	1.11594	0.63724
64	27	32	23.332	34.083	0.67885	1.15864	0.67613
65	26	32	23.332	34.083	0.44430	1.14352	0.66101
66	28	33	28.447	33.5	0.15247	1.11594	0.63724
67	29	33	23.332	34.083	0.44430	1.14352	0.66101
68	30	33	23.332	34.083	0.67885	1.15864	0.67613
69	31	35	415.6	48.292	0.02294	0.17829	0.17829
70	31	34	77.2	44.0	0.10822	0.86502	0.46714
71	31	36	77.2	44.0	0.10870	0.88345	0.47216
72	35	34	385.5	48.292	0.05087	0.32120	0.28796
73	35	36	385.5	48.292	0.05135	0.37986	0.31303
74	34	37	404.0	69.0	0.04675	0.96696	0.49035
75	36	37	428.0	69.0	0.04947	0.96367	0.48992
76	32	37	1071.6	10.0	0.00805	0.97556	0.62312
77	32	37	126.95	84.0	0.06204	1.39058	1.16223
78	33	37	1071.6	10.0	0.00805	0.97556	0.62312

Table 4.3-21b (cont.)

Baltimore Gas & Electric

Calvert Cliffs Units 1 and 2

Junctions

Junction Number	From Vol	To Vol	Area (ft^2)	Elevation (ft)	Inertia Coeff L/A (ft^{-1})	Irreversible Loss Coeff (Forward Flow)	(Reverse Flow)
79	33	37	126.95	84.0	0.06204	1.39058	1.16223
80	13	14	0.85766	17.5	1.04504	1.33455	1.1871
81	13	18	0.85766	17.5	1.04504	1.33455	1.1871
82	14	15	0.85766	17.5	0.62330	1.35513	1.38091
83	18	17	0.85766	17.5	0.62330	1.35513	1.38091

Notes: Junctions 25 to 36 are a convection barrier.

Junctions 25, 28, 33 and 36 do not open during the transient.

Junctions 26, 27, 29, 30, 31, 32, 34 and 35 open at 5 psid with a linear opening rate: 95 percent open in 50 msec, 99 percent open at 100 msec.

Junction 69 is a neutron shield trip at 10 msec, 25 percent open at 100 msec, 100 percent open at 150 msec.

Table 4.3-22a

Northeast Utilities

Millstone NPS Unit 2

Volumes

Volume Number	Volume (ft^3)	Height (ft)	Elevation (ft)
1	103.1	10.4584	2.0
2	110.4	10.4584	2.0
3	110.4	10.4584	2.0
4	94.3	10.4584	2.0
5	94.3	10.4584	2.0
6	91.0	10.4584	2.0
7	91.0	10.4584	2.0
8	94.3	10.4584	2.0
9	94.3	10.4584	2.0
10	110.4	10.4584	2.0
11	110.4	10.4584	2.0
12	103.1	10.4584	2.0
13	49.56	15.8751	-13.875
14	271.1	15.8751	-13.875
15	102.22	15.8751	-13.875
16	267.18	15.8751	-13.875
17	102.22	15.8751	-13.875
18	255.22	15.8751	-13.875
19	179.8	9.6251	-23.5
20	314.12	9.6251	-23.5
21	211.73	9.6251	-23.5
22	311.74	9.6251	-23.5
23	211.73	9.6251	-23.5
24	304.5	9.6251	-23.5
25	86.293	4.7917	3.4375
26	113.1	4.333	3.667
27	132.7	4.333	3.667

Table 4.3-22a (cont.)

Northeast Utilities

Millstone NPS Unit 2

Volumes

Volume Number	Volume (ft^3)	Height (ft)	Elevation (ft)
28	86.293	4.7917	3.4375
29	113.1	4.333	3.667
30	132.7	4.333	3.667
31	1613.0	40.51	12.4583
32	6323.0	85.51	-22.5
33	6323.0	85.51	-22.5
34	1590.0	40.51	-2.0
35	1590.0	34.01	2.5
36	1.0E+6	175.0	-22.5

Note: Volumes 1 to 24 are initially at 14.7 psia, 550°F, 0.01% RH, all other volumes are at 14.7 psia, 120°F, 0.5% RH.

Table 4.3-22b

Northeast Utilities

Millstone NPS Unit 2

Junctions

Junction Number	From Vol	To Vol	Area (ft^2)	Elevation (ft)	Inertia Coeff L/A (ft^{-1})	Irreversible Loss Coeff (Forward Flow)	(Reverse Flow)
1	1	2	19.898	2.0	0.19988	0.21097	0.21097
2	2	3	10.543	2.0	0.19988	0.68684	0.68684
3	3	4	19,898	2.0	0.19988	0.21097	0.21097
4	4	5	15.241	2.0	0.19988	0.41759	0.41759
5	5	6	19.898	2.0	0.19988	0.21097	0.21097
6	7	6	8.602	2.0	0.19988	0.80289	0.80289
7	8	7	19.898	2.0	0.19988	0.21097	0.21097
8	9	8	15.241	2.0	0.19988	0.41759	0.41759
9	10	9	19.898	2.0	0.19988	0.21097	0.21097
10	11	10	10.543	2.0	0.19988	0.68684	0.68684
11	12	11	19.898	2.0	0.19988	0.21097	0.21097
12	1	12	11.359	2.0	0.19988	0.64155	0.64155
13	1	31	16.533	12.45833	0.654673	1.215	0.54740
14	2	31	16,533	12.45833	0.556561	1.244	0.60456
15	3	31	16,533	12.45833	0.556561	1.244	0.60456
16	4	31	16,533	12.45833	0.654673	1.215	0.54740
17	5	31	16.533	12.45833	0.654673	1.215	0.54740
18	6	31	16.533	12.45833	0.855375	1.343	0.61386
19	7	31	16.533	12.45833	0.855375	1.343	0.61386
20	8	31	16.533	12.45833	0.654673	1.215	0.54740
21	9	31	16,533	12.45833	0.654673	1.215	0.54740
22	10	31	16.533	12.45833	0.556561	1.244	0.60456
23	11	31	16.533	12.45833	0.556561	1.244	0.60456
24	12	31	16.533	12.45833	0.654673	1.215	0.54740
25		13	1.4442	2.0	3.37795	0.7162	1.04147
26		14	8.7526	2.0	1.12266	0.27534	0.27430
27		14	8.8253	2.0	1.10611	0.25768	0.25632

Table 4.3-22b (cont.)

Northeast Utilities

Millstone NPS Unit 2

Junctions

Junction Number	From Vol	To Vol	Area (ft^2)	Elevation (ft)	Inertia Coeff L/A (ft^{-1})	Irreversible Loss Coeff (Forward Flow)	(Reverse Flow)
28	3	15	1.5484	2.0	1.79478	1.0087	1.12775
29	2	15	4.8316	2.0	1.79478	0.37941	0.48441
30	1	16	8.1989	2.0	1.16834	0.30074	0.28675
31	12	16	9.1189	2.0	1.16834	0.4189	0.3685
32	11	17	4.8316	2.0	1.79478	0.37941	0.48441
33	10	17	1.5484	2.0	1.79478	1.0087	1.12775
34	9	18	8.8253	2.0	1.10611	0.25768	0.25632
35	8	18	7.7	2.0	1.10611	0.38191	0.30933
36	7	13	1.4442	2.0	3.37795	0.7162	1.04147
37	1	25	0.3105	3.4375	0.22136	1.45764	1.47107
38	2	27	2.0926	3.667	0.53543	1.11458	1.28635
39	3	27	2.0926	3.667	0.53543	1.11458	1.28635
40	4	29	2.0926	3.667	0.70509	1.11128	1.28788
41	5	29	2.0926	3.667	0.70509	1.11128	1.28788
42	6	28	0.3105	3.4375	0.23067	1.45665	1.46745
43	7	28	0.3105	3.4375	0.23067	1.45665	1.46745
44	8	30	2.0926	3.667	0.70509	1.11128	1.28788
45	9	30	2.0926	3.667	0.70509	1.11128	1.28788
46	10	26	2.0926	3.667	0.53543	1.11458	1.28635
47	11	26	2.0926	3.667	0.53543	1.11458	1.28635
48	12	25	0.3105	3.4375	0.22136	1.45764	1.47107
49	15	16	25.136	-13.875	0.36732	0.0993	0.16106
50	16	17	25.136	-13.875	0.36732	0.16106	0.0993
51	13	19	2.8883	-13.875	3.17907	0.8189	0.5371
52	14	20	17.578	-13.875	0.63919	0.20754	0.23713
53	15	21	6.38	-13.875	1.55266	0.53593	0.40139
54	16	22	17.318	-13.875	0.64756	0.20972	0.23777
55	17	23	6.38	-13.875	1.55266	0.53923	0.41039

Table 4.3-22b (cont.)

Northeast Utilities

Millstone NPS Unit 2

Junctions

Junction Number	From Vol	To Vol	Area (ft^2)	Elevation (ft)	Inertia Coeff L/A (ft^{-1})	Irreversible Loss Coeff (Forward Flow)	(Reverse Flow)
56	18	24	16.525	-13.875	0.67464	0.2282	0.25127
57	19	20	128.99	-23.5	0.06551	0.05372	0.07293
58	20	21	129.79	-23.5	0.06541	0.06987	0.05089
59	21	22	134.6	-23.5	0.06541	0.02668	0.05062
60	23	22	137.81	-23.5	0.06541	0.01169	0.03911
61	24	23	129.79	-23.5	0.06541	0.06987	0.05089
62	19	24	128.99	-23.5	0.06551	0.05372	0.07293
63	25	32	34.975	3.4375	0.17436	1.25505	0.78605
64	27	32	16.547	3.667	0.49171	1.15026	0.66504
65	26	32	16.547	3.667	0.66409	1.1619	0.67668
66	28	33	34.975	3.4375	0.17436	1.25505	0.78605
67	29	33	16.547	3.667	0.49171	1.15026	0.66504
68	30	33	16.547	3.667	0.66409	1.1619	0.67668
69	31	35	173.58	12.45833	0.11544	0.73169	0.44946
70	31	34	173.58	12.45833	0.1128	0.68053	0.43389
71	35	36	525.0	36.5	0.04453	0.95066	0.48807
72	34	36	400.0	38.5	0.04808	0.97197	0.49246
73	32	36	1198.5	-22.5	0.00536	1.37504	1.22161
74	33	36	1198.5	-22.5	0.00536	1.37504	1.22161
75	32	36	237.84	63.0	0.04724	1.35648	1.10046
76	33	36	237.84	63.0	0.04724	1.35648	1.10046
77	13	14	1.13144	-13.875	0.2935	1.42338	1.4023
78	13	18	2.398	-13.875	0.25863	1.42338	1.4023
79	14	15	2.398	-13.875	0.33317	1.39332	1.42108
80	18	17	2.398	-13.875	0.33317	1.39332	1.42108

Note: Junctions 13 to 24 are the neutron shield tank interface. See text for discussion of these junctions.

Table 4.3-23a

Consumers Power
Palisades Plant
Reactor Cavity Subcompartment Analysis
Volumes

Volume Number	Volume (ft^3)	Height (ft)	Elevation (ft)
1	198.33	9.6276	614.8724
2	209.86	9.6276	614.8724
3	198.68	9.6276	614.8724
4	198.68	9.6276	614.8724
5	209.86	9.6276	614.8724
6	198.33	9.6276	614.8724
7	409.44	15.8255	599.0469
8	409.44	15.8255	599.0469
9	408.67	15.8255	599.0469
10	408.67	15.8255	599.0469
11	409.44	15.8255	599.0469
12	409.44	15.8255	599.0469
13	621.26	7.7240	591.3229
14	621.26	7.7240	591.3229
15	621.26	7.7240	591.3229
16	621.26	7.7240	591.3229
17	621.26	7.7240	591.3229
18	621.26	7.7240	591.3229
19	472.9	1.323	590.0
20	2.9071×10^4	24.5	624.5
21	39.27	2.5	591.33
22	5.1345×10^4	70.0	590.0
23	1.0742×10^6	130.0	649.0

Table 4.3-23b

Consumers Power
Palisades Plant
Reactor Cavity Subcompartment Analysis
Junctions

Junction Number	From Vol.	To Vol.	Area (ft^2)	Elevation (ft)	L/A (ft^{-1})	Irreversible Loss Coefficie[nt] Forward K	Reverse K
1	1	2	11.28	614.8724	0.44773	0.5684	0.5684
2	2	3	12.655	614.8724	0.4381	0.4828	0.4828
3	3	4	9.377	614.8724	0.4657	0.6960	0.6960
4	5	4	12.655	614.8724	0.4381	0.4828	0.4828
5	6	5	11.28	614.8724	0.44773	0.5684	0.5684
6	1	6	10.283	614.8724	0.4563	0.6327	0.6327
7	1	20	20.155	624.5	0.2016	1.09704	0.55987
8	2	20	20.155	624.5	0.2016	1.09704	0.55987
9	3	20	20.155	624.5	0.2016	1.09704	0.55987
10	4	20	20.155	624.5	0.2016	1.09704	0.55987
11	5	20	20.155	624.5	0.2016	1.09704	0.55987
12	6	20	20.155	624.5	0.2016	1.09704	0.55987
13	1	7	12.87	614.8724	0.71995	0.58129	0.57491
14	2	8	12.406	614.8724	0.7292	0.60842	0.60187
15	3	9	12.87	614.8724	0.71995	0.58129	0.57491
16	4	10	12.87	614.8724	0.71995	0.58129	0.57491
17	5	11	12.406	614.8724	0.7292	0.60842	0.60187
18	6	12	12.87	614.8724	0.71995	0.58129	0.57491
19	7	8	24.81	599.0469	0.32119	0.44426	0.44426
20	8	9	44.185	599.0469	0.18012	0.02851	0.02851
21	9	10	23.42	599.0469	0.32956	0.48977	0.48977
22	11	10	44.185	599.0469	0.18012	0.02851	0.02851
23	12	11	24.81	599.0469	0.32119	0.44426	0.44426
24	7	12	44.185	599.0469	0.18012	0.02851	0.02851
25	7	13	25.36	599.0469	0.42815	0.3123	0.2988
26	8	14	25.36	599.0469	0.42815	0.3123	0.2988
27	9	15	25.36	599.0469	0.42815	0.3123	0.2988

Table 4.3-23b (cont.)

Consumers Power
Palisades Plant
Reactor Cavity Subcompartment Analysis
Junctions

Junction Number	From Vol.	To Vol.	Area (ft^2)	Elevation (ft)	L/A (ft^{-1})	Irreversible Loss Coefficie Forward K	Reverse K
28	10	16	25.36	599.0469	0.42815	0.3123	0.2988
29	11	17	25.36	599.0469	0.42815	0.3123	0.2988
30	12	18	25.36	599.0469	0.42815	0.3123	0.2988
31	13	14	35.53	591.3229	0.27325	0.02713	0.02713
32	14	15	35.53	591.3229	0.27325	0.02713	0.02713
33	15	16	35.53	591.3229	0.27325	0.02713	0.02713
34	17	1[illegible]	35.53	591.3229	0.27325	0.02713	0.02713
35	18	17	35.53	591.3229	0.27325	0.02713	0.02713
36	13	18	35.53	591.3229	0.27325	0.02713	0.02713
37	13	19	59.58	591.3229	0.13812	1.0275	0.7497
38	14	19	59.58	591.3229	0.13812	1.0275	0.7497
39	15	19	59.58	591.3229	0.13812	1.0275	0.7497
40	16	19	59.58	591.3229	0.13812	1.0275	0.7497
41	17	19	59.58	591.3229	0.13812	1.0275	0.7497
42	18	19	59.58	591.3229	0.13812	1.0275	0.7497
43	13	21	2.455	591.33	0.8602	0.7337	1.18571
44	18	21	2.455	591.33	0.8602	0.7337	1.18571
45	21	22	4.909	591.33	0.82186	1.0268	0.5307
46	20	23	1186.6	649.0	0.01819	0.7414	0.4362
47	22	23	120.6	660.0	0.06128	1.378	1.1585

Note: Junctions 13 to 18 are a convection barrier. They are assumed to open at a +12 psid pressure differential. See text.

Table 4.3-24a

OPPD

Ft Calhoun Unit 1

Reactor Cavity Subcompartment Analysis

Volumes

Volume Number	Volume (ft^3)	Height (ft)	Elevation (ft)
1	47.55	7.9171	1002.333
2	50.14	7.9171	1002.333
3	47.55	7.9171	1002.333
4	47.55	7.9171	1002.333
5	50.14	7.9171	1002.333
6	47.55	7.9171	1002.333
7	90.02	2.084	1003.667
8	43	3.855	1004.75
9	43	3.855	1004.75
10	90.02	2.084	1003.667
11	43	3.855	1004.75
12	43	3.855	1004.75
13	20.981	2.75	1010.25
14	20.981	2.75	1010.25
15	20.981	2.75	1010.25
16	20.981	2.75	1010.25
17	20.981	2.75	1010.25
18	20.981	2.75	1010.25
19	144.1	15.4219	987.0912
20	145.4	15.4219	987.0912
21	144.1	15.4219	987.0912
22	144.1	15.4219	987.0912
23	145.4	15.4219	987.0912
24	144.1	15.4219	987.0912
25	135.49	6.4063	980.685
26	142.85	6.4063	980.685
27	135.49	6.4063	980.685

Table 4.3-24a (cont.)

OPPD

Ft Calhoun Unit 1

Reactor Cavity Subcompartment Analysis

Volumes

Volume Number	Volume (ft^3)	Height (ft)	Elevation (ft)
28	135.49	6.4063	980.685
29	142.85	6.4063	980.685
30	135.49	6.4063	980.685
31	809.6	4.1851	976.5
32	67126.0	43.01	995.5
33	1039.3	17.51	976.5
34	37347.4	62.51	994.0
35	37347.4	62.51	994.0
36	6.0E+5	125.5	994.0

Table 4.3-24b

OPPD

Ft Calhoun Unit 1

Reactor Cavity Subcompartment Analysis

Junctions

Junction Number	From Vol	To Vol	Area (ft^2)	Elevation (ft)	L/A (ft^{-1})	Irreversible Loss Coefficient Forward K	Reverse K
1	1	7	6.046	1003.667	0.68014	0.56272	1.01034
2	1	8	4.097	1004.75	0.94722	1.31567	1.43152
3	2	8	4.097	1004.75	0.94703	1.31616	1.43346
4	2	9	4.097	1004.75	0.94703	1.31616	1.43346
5	3	9	1.1095	1004.75	0.94722	1.31567	1.43152
6	3	10	4.0135	1003.667	0.68014	0.5627	1.01034
7	4	10	4.0135	1003.667	0.68014	0.5627	1.01034
8	4	11	1.1095	1004.75	0.94722	1.31567	1.43152
9	5	11	1.1095	1004.75	0.94703	1.31616	1.43346
10	5	12	1.1095	1004.75	0.94703	1.31616	1.43346
11	6	12	1.1095	1004.75	0.94722	1.31567	1.43152
12	6	7	4.0135	1003.667	0.68014	0.56272	1.01034
13	1	19	8.12	1002.333	1.567	1.530	1.483
14	2	20	8.12	1002.333	1.494	1.144	1.096
15	3	21	8.12	1002.333	1.567	1.530	1.483
16	4	22	8.12	1002.333	1.567	1.530	1.483
17	5	23	8.12	1002.333	1.494	1.144	1.096
18	6	24	8.12	1002.33	1.567	1.530	1.483
19	1	13	8.12	1010.25	1.056	0.0827	0.0827
20	2	14	8.12	1010.25	0.980	0.0832	0.0832
21	3	15	8.12	1010.25	1.056	0.0827	0.0827
22	4	16	8.12	1010.25	1.056	0.0827	0.0827
23	5	17	8.12	1010.25	0.980	0.0832	0.0832
24	6	18	8.12	1010.25	1.056	0.0827	0.0827
25	1	2	4.41	1002.333	1.712	0.3988	0.3988
26	2	3	4.41	1002.333	1.712	0.3988	0.3988

Table 4.3-24b (Cont'd)

OPPD

Ft Calhoun Unit 1

Reactor Cavity Subcompartment Analysis

Junctions

Junction Number	From Vol	To Vol	Area (ft^2)	Elevation (ft)	L/A (ft^{-1})	Irreversible Loss Coefficient Forward K	Reverse K
27	3	4	3.65	1002.333	2.079	0.5291	0.5291
28	5	4	4.41	1002.333	1.712	0.3988	0.3988
29	6	5	4.41	1002.333	1.712	0.3988	0.3988
30	1	6	3.65	1002.333	2.079	0.5291	0.5291
31	13	32	3.399	1013.0	0.40819	1.03017	0.53222
32	14	32	3.399	1013.0	0.40819	1.03017	0.53222
33	15	32	3.399	1013.0	0.40819	1.03017	0.53222
34	16	32	3.399	1013.0	0.40819	1.03017	0.53222
35	17	32	3.399	1013.0	0.40819	1.03017	0.53222
36	18	32	3.399	1013.0	0.40819	1.03017	0.53222
37	13	14	2.66	1010.25	2.96	0.0814	0.0814
38	14	15	2.66	1010.25	2.96	0.0814	0.0814
39	15	16	2.66	1010.25	2.96	0.0814	0.0814
40	17	16	2.66	1010.25	2.96	0.0814	0.0814
41	18	17	2.66	1010.25	2.96	0.0814	0.0814
42	13	18	2.66	1010.25	2.96	0.0814	0.0814
43	19	20	20.04	987.0912	0.4014	0.0619	0.0619
44	20	21	20.04	987.0912	0.4014	0.0619	0.0619
45	21	22	20.04	987.0912	0.4014	0.0619	0.0619
46	23	22	20.04	987.0912	0.4014	0.0619	0.0619
47	24	23	20.04	987.0912	0.4014	0.0619	0.0619
48	19	24	20.04	987.0912	0.4014	0.0619	0.0619
49	19	25	11.33	987.0912	0.817	0.517	0.517
50	20	26	11.33	987.0912	0.817	0.517	0.517

Table 4.3-24b (Cont'd)

OPPD

Ft Calhoun Unit 1

Reactor Cavity Subcompartment Analysis

Junctions

Junction Number	From Vol	To Vol	Area (ft^2)	Elevation (ft)	L/A (ft^{-1})	Irreversible Loss Coefficient Forward K	Reverse K
51	21	27	11.33	987.0912	0.817	0.517	0.517
52	22	28	11.33	987.0912	0.817	0.517	0.517
53	23	29	11.33	987.0912	0.817	0.517	0.517
54	24	30	11.33	987.0912	0.817	0.517	0.517
55	25	26	20.619	980.685	0.39784	0.01176	0.01176
56	26	27	20.619	980.685	0.39784	0.01176	0.01176
57	27	28	20.619	980.685	0.39784	0.01176	0.01176
58	29	28	20.619	980.685	0.39784	0.01176	0.01176
59	30	29	20.619	980.685	0.39784	0.01176	0.01176
60	25	30	20.619	980.685	0.39784	0.01176	0.01176
61	25	31	35.422	980.685	0.10016	0.70304	0.42311
62	26	31	34.652	980.685	0.10217	0.7107	0.42657
63	27	31	35.422	980.685	0.10016	0.70304	0.42311
64	28	31	35.422	980.685	0.10016	0.70307	0.42311
65	29	31	34.652	980.685	0.10217	0.7107	0.42657
66	30	31	35.422	980.685	0.10217	0.70307	0.42311
67	31	33	57.33	976.5	0.22413	0.0914	0.03534
68	33	36	50.31	994.0	0.20699	0.9955	0.51124
69	7	34	6.1617	1003.667	0.50616	1.00197	0.51452
70	8	34	6.8874	1004.75	0.27292	1.0174	0.50907
71	9	35	6.8874	1004.75	0.27292	1.0174	0.50907
72	10	35	6.1617	1003.667	0.50616	1.00197	0.51452
73	11	35	6.8874	1004.75	0.27292	1.0174	0.50907
74	12	34	6.8874	1004.75	0.27292	1.0174	0.50907
75	32	36	2315.9	1013.0	0.01698	0.26588	0.25932
76	34	36	611.14	1056.5	0.05923	0.83722	0.47356

Table 4.3-24b (cont.)

OPPD

Ft Calhoun Unit 1

Reactor Cavity Subcompartment Analysis

Junctions

Junction Number	From Vol	To Vol	Area (ft^2)	Elevation (ft)	L/A (ft^{-1})	Irreversible Loss Coefficient Forward K	Reverse K
77	35	36	611.14	1056.5	0.05923	0.83722	0.47356
78	7	32	8.125	1005.75	0.57[illegible]3	1.35641	0.9817
79	8	32	8.75	1008.6	0.4[illegible]4	1.37775	1.05337
80	9	32	8.75	1008.6	0.49134	1.3775	1.05337
81	10	32	8.125	1005.75	0.57373	1.35641	0.9817
82	11	32	8.75	1008.6	0.49134	1.3775	1.05337
83	12	32	8.75	1008.6	0.49134	1.3775	1.05337

Note: Junctions 78 to 83 are the sand plugs. See text.

Table 4.3-25a

B. G. & E. - Calvert Cliffs Units 1 and 2

Table of "Projected Areas" and Lever Arms

Level Number	Pressure Differential (Vol #	- Vol #)	Projected Area (in.^{2})	Lever Arm (ft.)
x-direction				
1	8	2	7383.0	0.33335
	9	3	7383.0	
	7	1	5163.3	
	10	4	5404.8	
	6	12	1889.9	
	11	5	1978.3	
2	16	13	7599.8	-13.1665
	18	15	7599.8	
	17	14	15200.0	
3	22	19	3544.1	-23.7913
	24	21	3544.1	
	23	20	7088.2	
y-direction				
1	8	2	1978.3	
	9	3	-1978.3	
	7	1	5163.3	
	10	4	-5404.8	
	6	12	7053.2	
	11	5	-7383.0	
2	16	13	13163.0	
	18	15	-13163.0	
3	22	19	6138.6	
	24	21	-6138.6	

Table 4.3-25a (cont.)

B. G. & E. - Calvert Cliffs Units 1 and 2

Table of "Projected Areas" and Lever Arms

Level Number	Pressure Differential (Vol #	- Vol #)	Projected Area (in.^{2})
z-direction			
1	1	31	417.24
	2	31	417.24
	3	31	417.24
	4	31	417.24
	5	31	417.24
	6	31	417.24
	7	31	417.24
	8	31	417.24
	9	31	417.24
	10	31	417.24
	11	31	417.24
	12	31	417.24
3	19	31	4725.5
	20	31	4725.5
	21	31	4725.5
	22	31	4725.5
	23	31	4725.5
	24	31	4725.5

Table 4.3.25b

NORTHEAST UTILITIES
MILLSTONE NPS #2
Table of Projected Areas and Level Arms

Level Number	Pressure Differential (Vol #	- Vol #)	Projected Area (in^2)	Lever Arm (ft)
X-Direction				
1	8	2	5372.0	- 0.604164
	9	3	5372.0	
	7	1	3692.9	
	10	4	3932.6	
	6	12	1351.7	
	11	5	1439.4	
2	16	13	9048.8	-11.7708
	18	15	9048.8	
	17	14	18098.0	
3	22	19	3544.1	-23.5833
	24	21	3396.5	
	23	20	6792.9	
Y-Direction				
1	8	2	1439.4	
	9	3	- 1439.4	
	7	1	3692.9	
	10	4	- 3932.6	
	6	12	5044.6	
	11	5	- 5372.0	
2	16	13	15673.0	
	18	15	-15673.0	
3	22	19	5882.8	
	24	21	- 5882.8	
Z-Direction				
1	1	31	601.88	
	2	31	601.88	
	3	31	601.88	
	4	31	601.88	
	5	31	601.88	
	6	31	601.88	
	7	31	601.88	

Table 4.3.25b

NORTHEAST UTILITIES
MILLSTONE NPS #2
Table of Projected Areas and Level Arms
(Continued)

Level Number	Pressure Differential (Vol #	- Vol #)	Projected Area (in^2)	Lever Arm (ft)
Z-Direction				
	8	31	601.88	
	9	31	601.88	
	10	31	601.88	
	11	31	601.88	
	12	31	601.88	
3	19	31	4528.6	
	20	31	4528.6	
	21	31	4528.6	
	22	31	4528.6	
	23	31	4528.6	
	24	31	4528.6	
	22	19	4528.6	
	24	21	4528.6	
	23	20	4528.6	

TABLE 4.3-25c

CONSUMERS POWER
PALISADES PLANT
TABLE OF "PROJECTED AREAS" AND LEVER ARMS

Lever Number	Pressure Differential (Vol No. - Vol No.) (psid)		Projected Area (in.^{2})	Lever Arm (ft)
X-direction				
1	4	1	6991.917	1.47787
	5	2	7380.721	
2	10	7	15541.79	-11.2487
	11	8	15541.79	
3	16	13	5843.363	-23.02343
	17	14	5843.363	
Y-direction				
1	4	1	4036.785	
	5	2	-4261.262	
	6	3	8073.570	
2	10	7	8973.059	
	11	8	-8973.059	
	9	12	17946.12	
3	16	13	3373.667	
	17	14	-3373.667	
	15	18	6747.334	
Z-direction				
1	1	20	282.0888	
	2	20	282.0888	
	3	20	282.0888	
	4	20	282.0888	
	5	20	282.0888	
	6	20	282.0888	
3	13	20	4498.223	
	14	20	4498.223	
	15	20	4498.223	
	16	20	4498.223	
	17	20	4498.223	
	18	20	4498.223	
	16	13	4498.223	
	17	14	4498.223	
	15	18	4498.223	

Table 4.3-25d

OPPD - Ft Calhoun Unit 1

Table of "Projected Areas" and Lever Arms

Level Number	Pressure Differential (Vol # - Vol #) (psid)		Projected Area (in.^{2})	Lever Arm (ft)
x-direction				
1	17	14	2411.34	5.25
	16	13	2411.34	
2	5	2	5319.06	-0.08365
	4	1	5011.92	
3	23	20	13523	-11.753
	22	19	13523	
4	29	26	4019.7	-22.667
	28	25	4019.7	
y-direction				
1	17	14	-1392.19	
	16	13	+1392.19	
	15	18	2784.38	
2	5	2	-2385.12	
	4	1	2077.99	
	3	6	6067.99	
3	23	20	-7807.3	
	22	19	7807.3	
	21	24	15615	
4	29	26	-2320.8	
	28	25	2320.8	
	27	30	4641.5	
z-direction				
4	25	32	3094.3	
	26	32	3094.3	
	27	32	3094.3	
	28	32	3094.3	

Table 4.3-25d (cont.)

OPPD - Ft Calhoun Unit 1

Table of "Projected Areas" and Lever Arms

Level Number	Pressure Differential (Vol # -	Vol #) (psid)	Projected Area ($in.^2$)	Lever Arm (ft)
	29	32	3094.3	
	30	32	3094.3	
	28	25	3094.3	
	29	26	3094.3	
	27	30	3094.3	

TABLE 4.3-26

CONSUMERS POWER
PALISADES PLANT
TABLE OF MODIFICATIONS FOR "CSB TYPE" MODEL

A - Revisions to Volumes (See Table 1a)

Volumes 1 to 6 divided into:

Volume No.	Volume (ft^3)	Height (ft)	Elevation (ft)
1	135.06	6.2917	618.2083
2	140.87	6.2917	618.2083
3	135.06	6.2917	618.2083
4	135.06	6.2917	618.2083
5	140.87	6.2917	618.2083
6	135.06	6.2917	618.2083
24	63.263	3.3359	614.8724
25	69.073	3.3359	614.8724
26	63.637	3.3359	614.8724
27	63.637	3.3359	614.8724
28	69.073	3.3359	614.8724
29	63.263	3.3359	614.8724

CONSUMERS POWER
PALISADES PLANT
TABLE OF MODIFICATIONS FOR "CSB TYPE" MODEL

B - Revisions to Junctions (See Table 1b)

Junction Number	From Vol	To Vol	Area (ft^2)	Elevation (ft)	L/A (ft^{-1})	Irreversible Loss Coeff Forward K	Irreversible Loss Coeff Reverse K
1	1	2	11.404	620.0417	0.59391	0.301366	0.301366
2	2	3	11.404	620.0417	0.59391	0.301366	0.301366
3	3	4	10.218	620.625	0.60409	0.385131	0.385131
4	5	4	11.404	620.0417	0.59391	0.301366	0.301366
5	6	5	11.404	620.0417	0.59391	0.301366	0.301366
6	1	6	10.218	620.625	0.60409	0.385131	0.385131
7	1	20	20.155	624.5	0.13856	1.09331	0.55614
8	2	20	20.155	624.5	0.13856	1.09331	0.55614
9	3	20	20.155	624.5	0.13856	1.09331	0.55614
10	4	20	20.155	624.5	0.13856	1.09331	0.55614
11	5	20	20.155	625.5	0.13856	1.09331	0.55614
12	6	20	20.155	624.5	0.13856	1.09331	0.55614
13	24	7	12.87	614.8724	0.60238	0.57336	0.56152
14	25	8	12.406	614.8724	0.60238	0.57336	0.56152
15	26	9	12.87	614.8724	0.60238	0.57336	0.56152
16	27	10	12.87	614.8724	0.60238	0.57336	0.56152
17	28	11	12.406	614.8724	1.60238	0.57336	0.56152
18	29	12	12.87	614.8724	0.60238	0.57336	0.56152
48	1	24	13.666	618.2083	0.21833	0.48365	0.48876
49	2	25	14.852	618.2083	0.21248	0.42007	0.42452
50	3	26	13.666	618.2083	0.21833	0.48365	0.48876
51	4	27	13.666	618.2083	0.21833	0.48365	0.48876
52	5	28	14.852	618.2083	0.21248	0.42007	0.42452
53	6	29	13.666	618.2083	0.21833	0.48365	0.48876
54	24	25	1.51324	614.8724	1.66333	1.12831	1.12831
55	25	26	1.70224	614.8724	1.58996	1.08197	1.08197
56	26	27	0.79954	614.8724	2.2532	1.31182	1.31182
57	28	27	2.88824	614.8724	1.34873	0.81280	0.81280
58	29	28	1.51324	614.8724	1.66333	1.12831	1.12831
59	24	29	2.88824	614.8724	1.34873	0.81280	0.81280

TABLE 4.3-26 (cont.)

CONSUMERS POWER
PALISADES PLANT
TABLE OF MODIFICATIONS FOR "CSB TYPE" MODEL

C - Revisions to "Projected Areas" and Lever Arms

X-direction	Pressure Differential (Vol No. -	Vol No.)	Area ($in.^2$)	Lever Arm (ft)
New Level 1	27	24	1948.564	+3.14585
	28	25	2124.966	
New Level 2	4	1	5043.321	-1.66795
	5	2	5237.724	

Y-direction New Levels	Pressure Differential (Vol No. -	Vol No.)	Area (ft^2)	Lever Arm (ft)
1	27	24	1125.004	
	28	25	-1237.242	
	26	29	2250.007	
2	4	1	2911.[illegible]63	
	5	2	-3024.001	
	3	6	5823.526	

Previous level 2 is now level 3; previous level 3 is now level 4.

Figure 4.3-81

Baltimore Gas And Electric
Calvert Cliffs Units 1 And 2
Reactor Cavity Subcompartment Model
SCHEMATIC SECTION SHOWING VOLUME NUMBERS

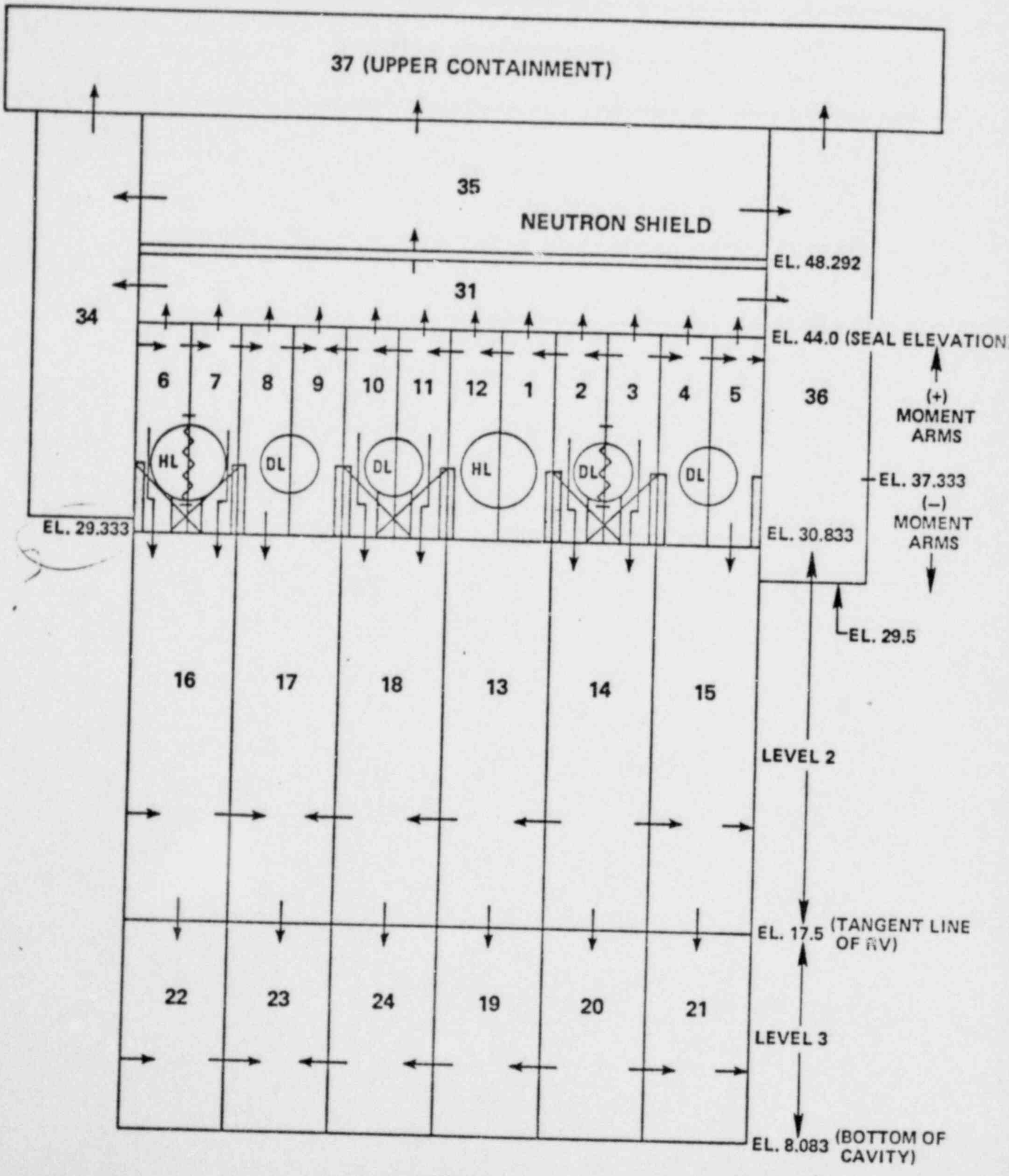
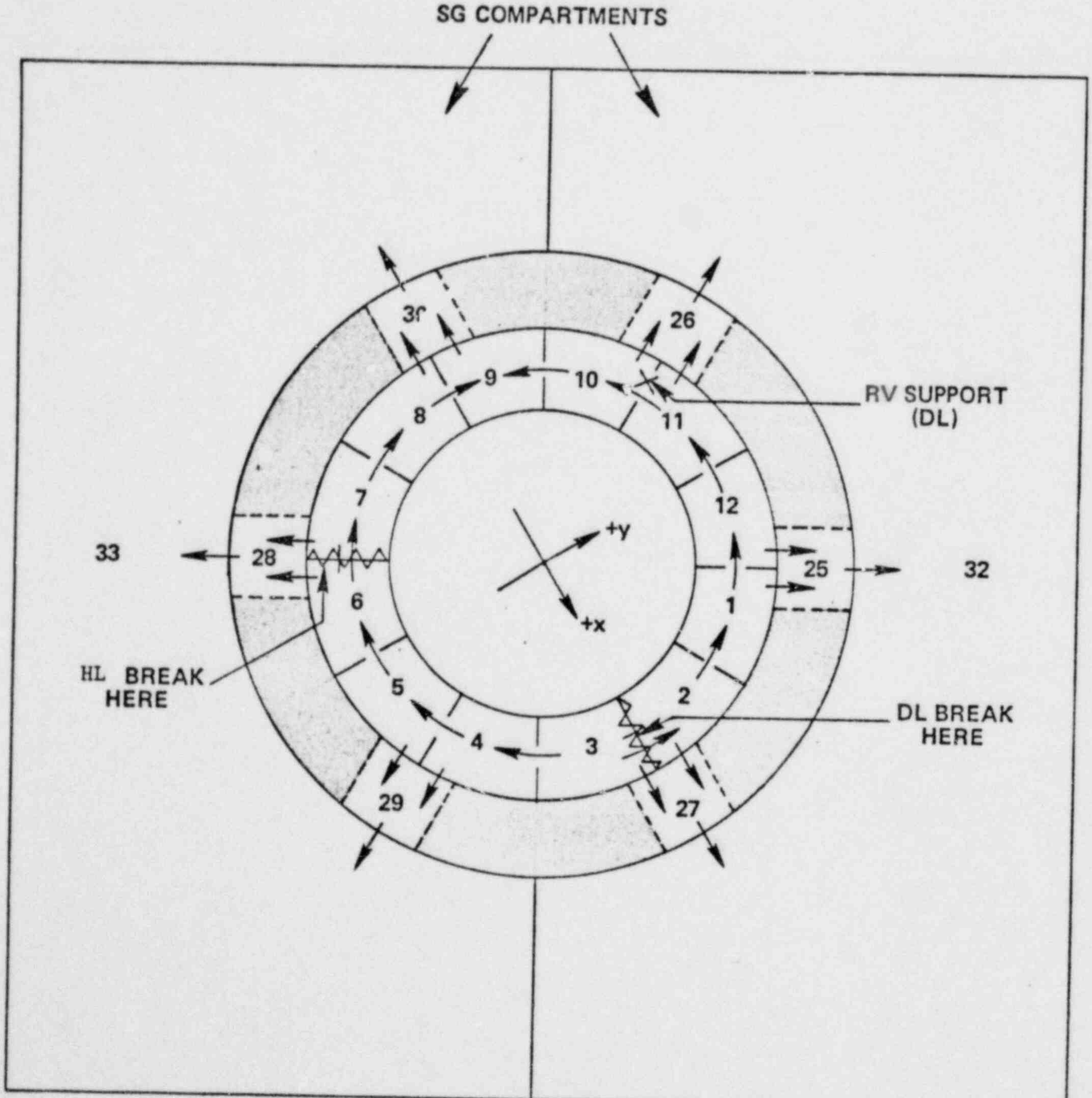


Figure 4.3-82

Baltimore Gas And Electric
Reactor Cavity Subcompartment Model
Calvert Cliffs Units 1 And 2
SCHEMATIC ELEVATION SHOWING VOLUME NUMBERS



V32 AND 33 VENT TO V37

Figure 4.3-83

MILLSTONE 2

Reactor Cavity Subcompartment Model
SCHEMATIC SECTION SHOWING VOLUME NUMBERS

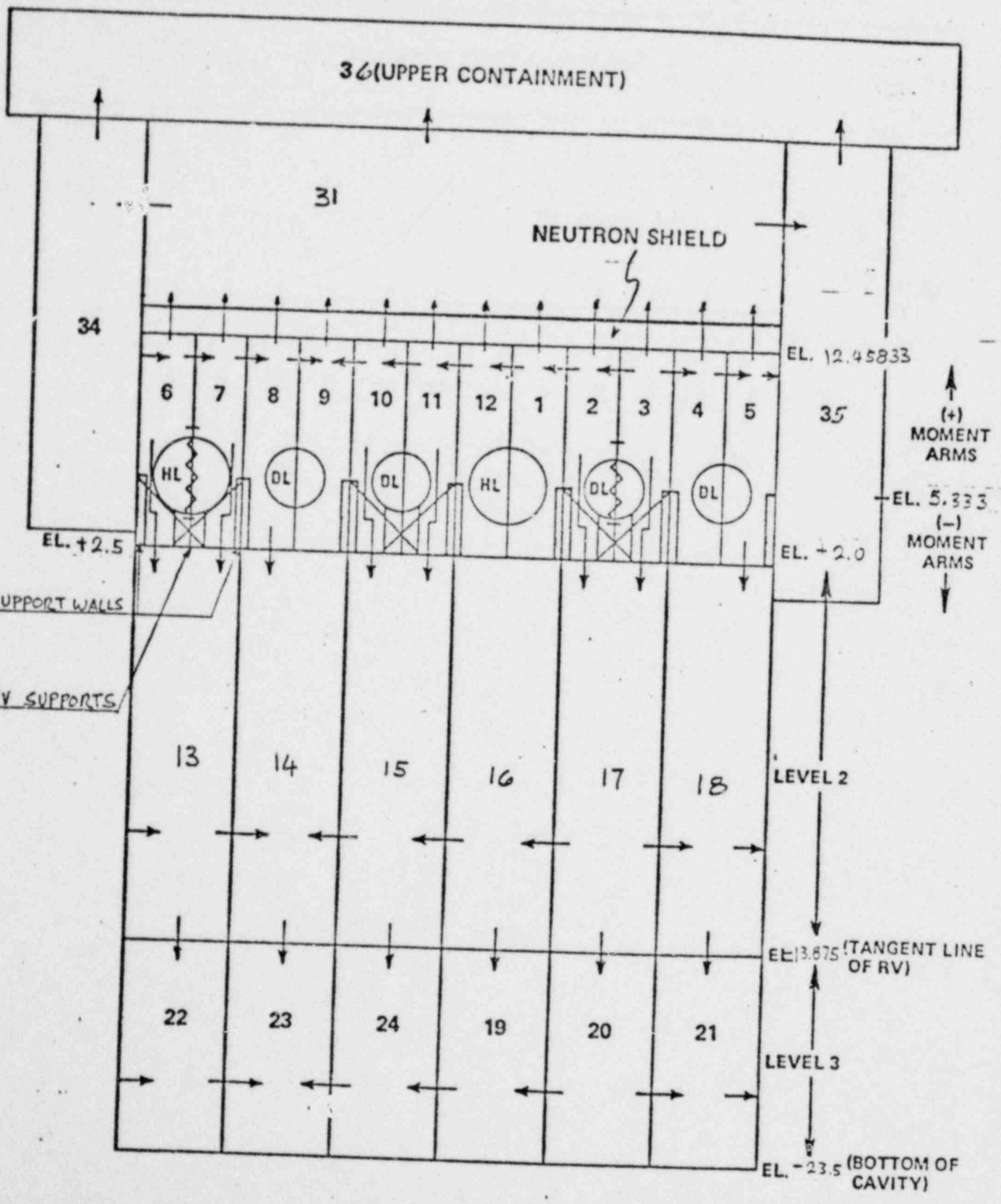


Figure 4.3-83

MILLSTONE 2

Reactor Cavity Subcompartment Model
SCHEMATIC SECTION SHOWING VOLUME NUMBERS

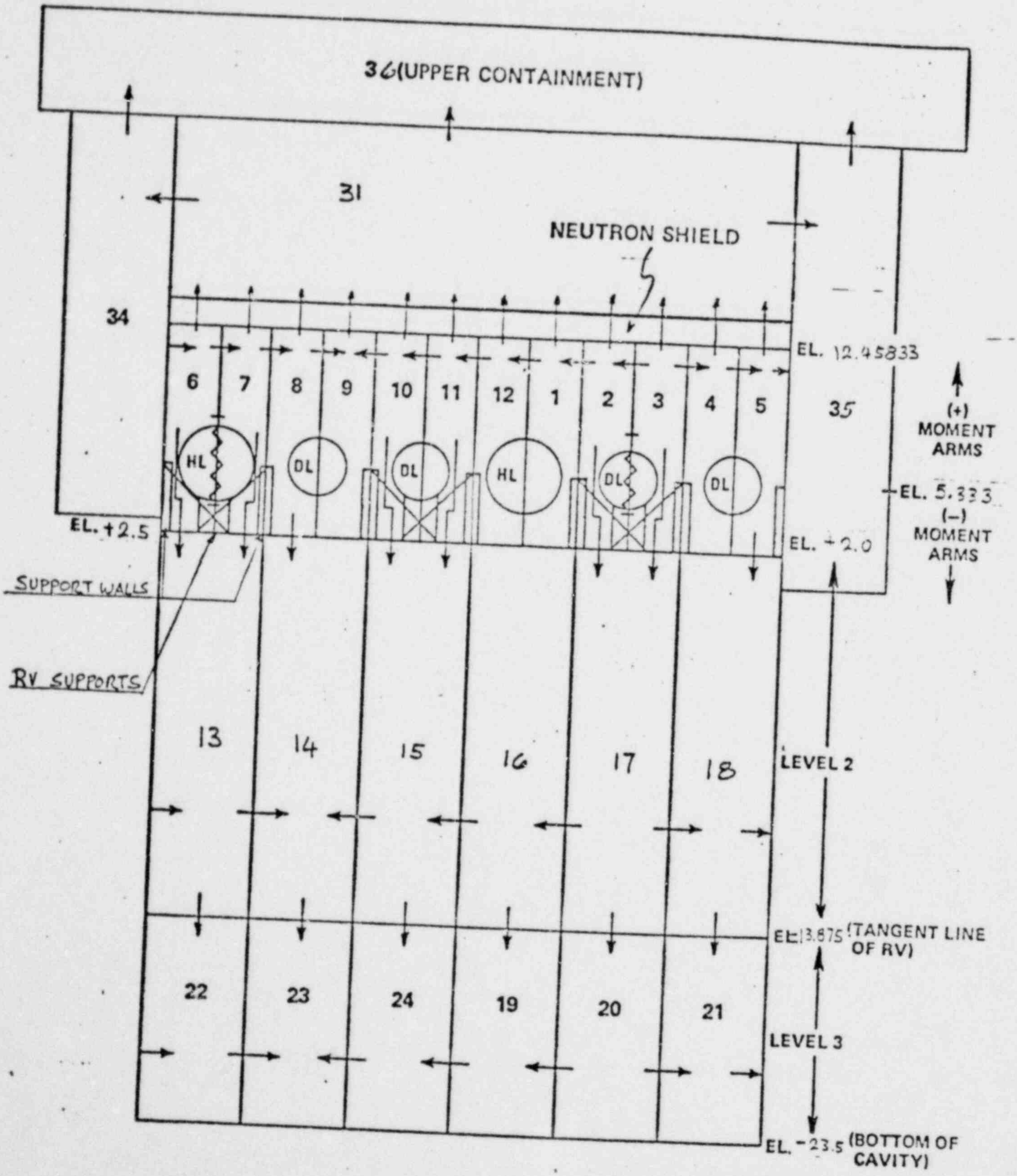
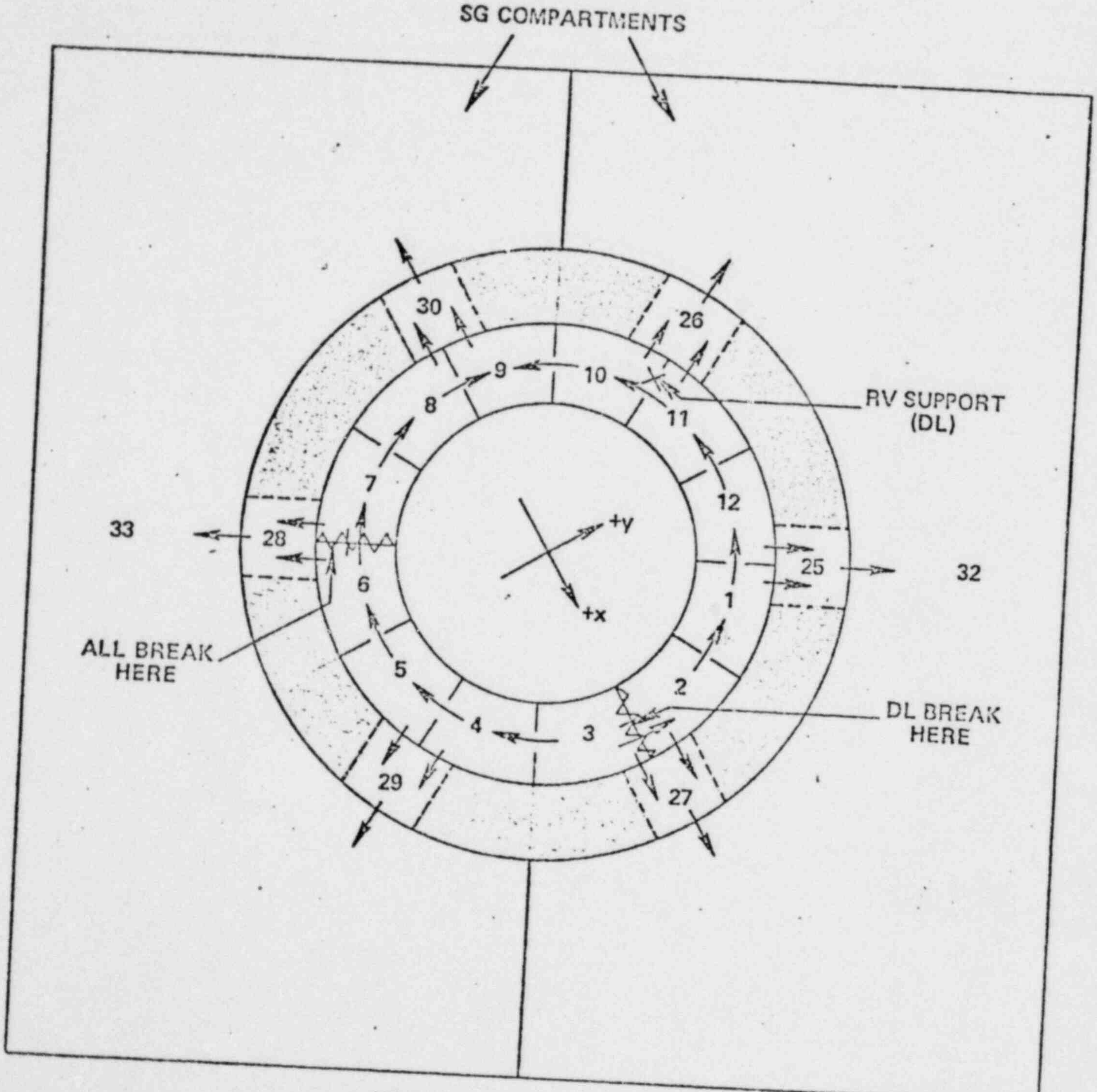


FIGURE 4.3-84 SCHEMATIC ELEVATION SHOWING VOLUME NUMBERS



V32 AND 33 VENT TO V37

Figure 4.3-85

CONSUMERS POWER
PALISADES

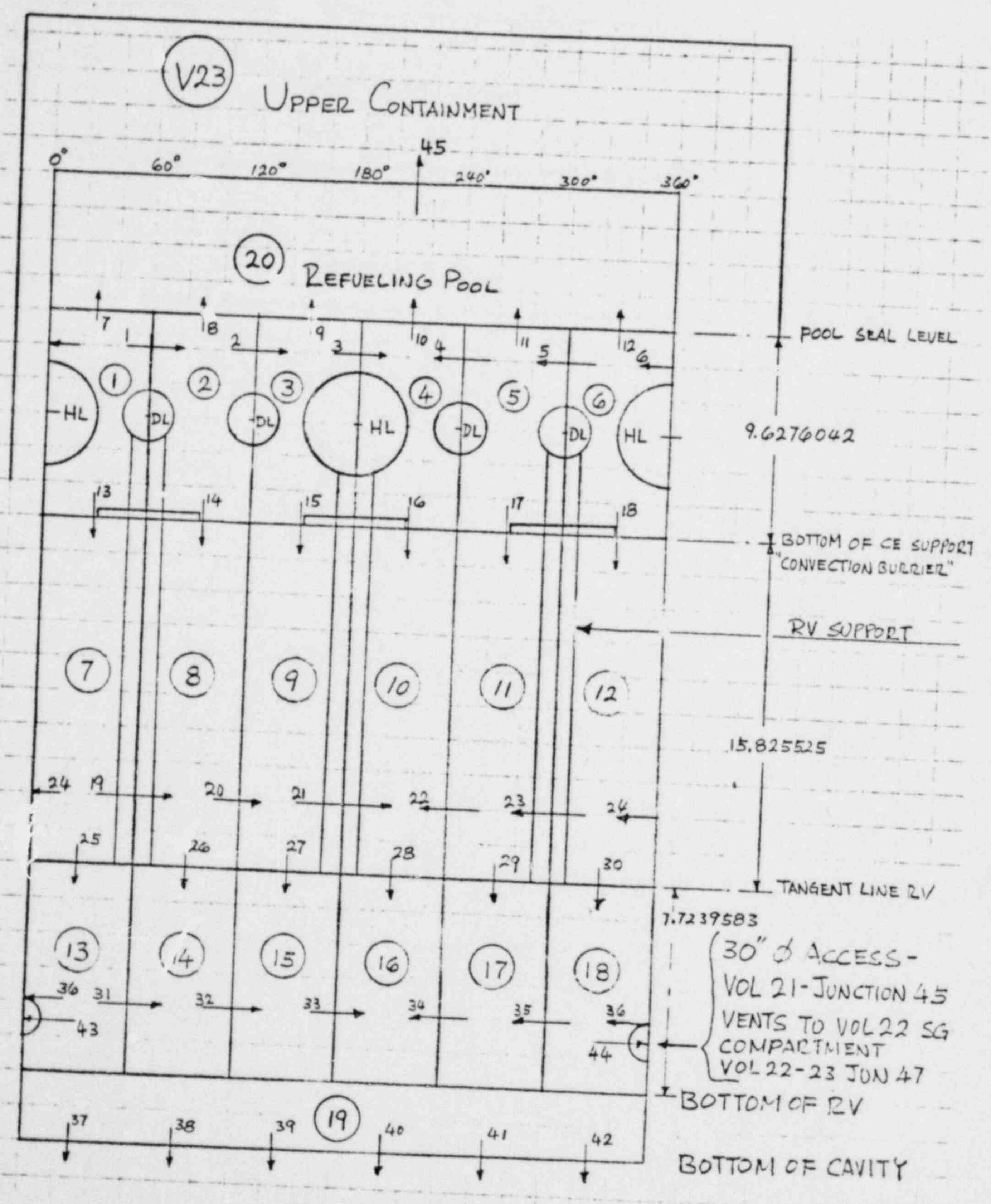


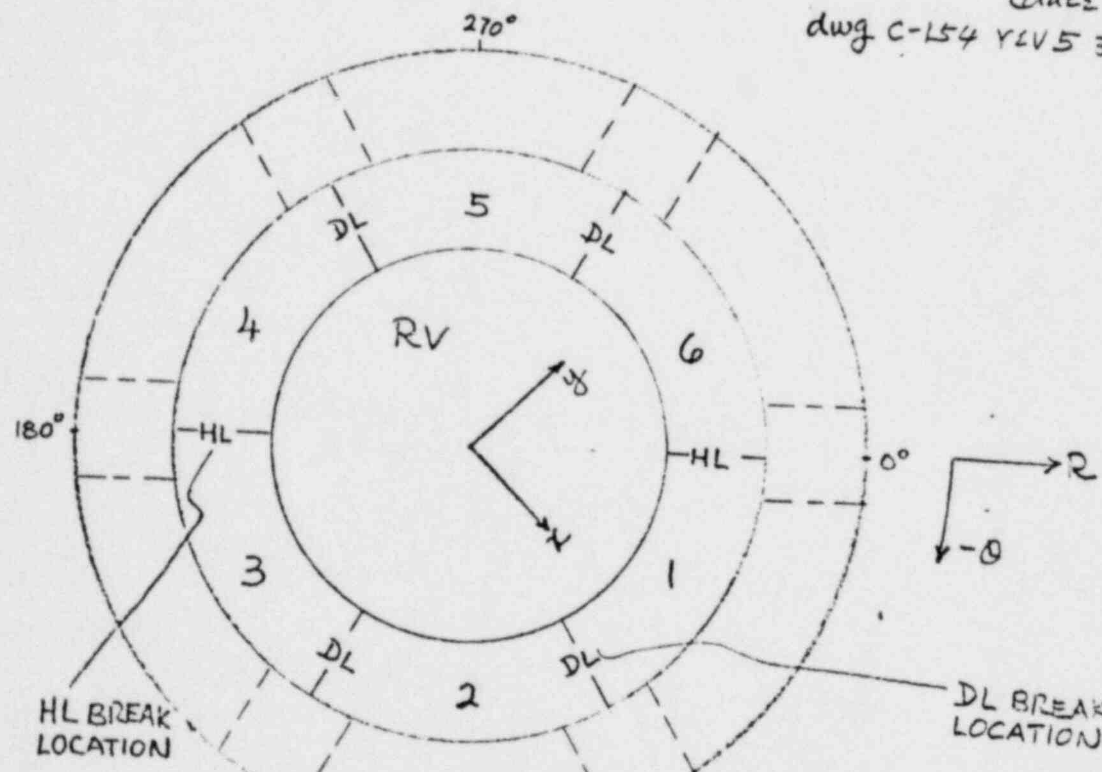
Figure 4.3-86

CONSUMERS POWER

PALISADES

MODLE SCHEMATIC
SHOWING VOLUME + JUNCTION NUMBERS

ref: dwg M-7, M-3
M-7 rev 5 10/22/74
M-3 rev 8 8/31/78
CE GA dwg E-232-111
rev 3
(date unclear)
dwg C-154 rev 5 3/24/72



Note: CONCRETE BLOCKS BLOCK
FLOW IN TO PENETRATIONS
NO NEUTRON SHIELDS
ref: telecon w/Gary Pratt
consumers power 8/13/79

Figure 4.3-87

O.P.P.D.

FT. CALHOUN UNIT 1 REACTOR CAVITY SUBCOMPARTMENT MODEL
SCHEMATIC SECTION SHOWING VOLUME NUMBERS

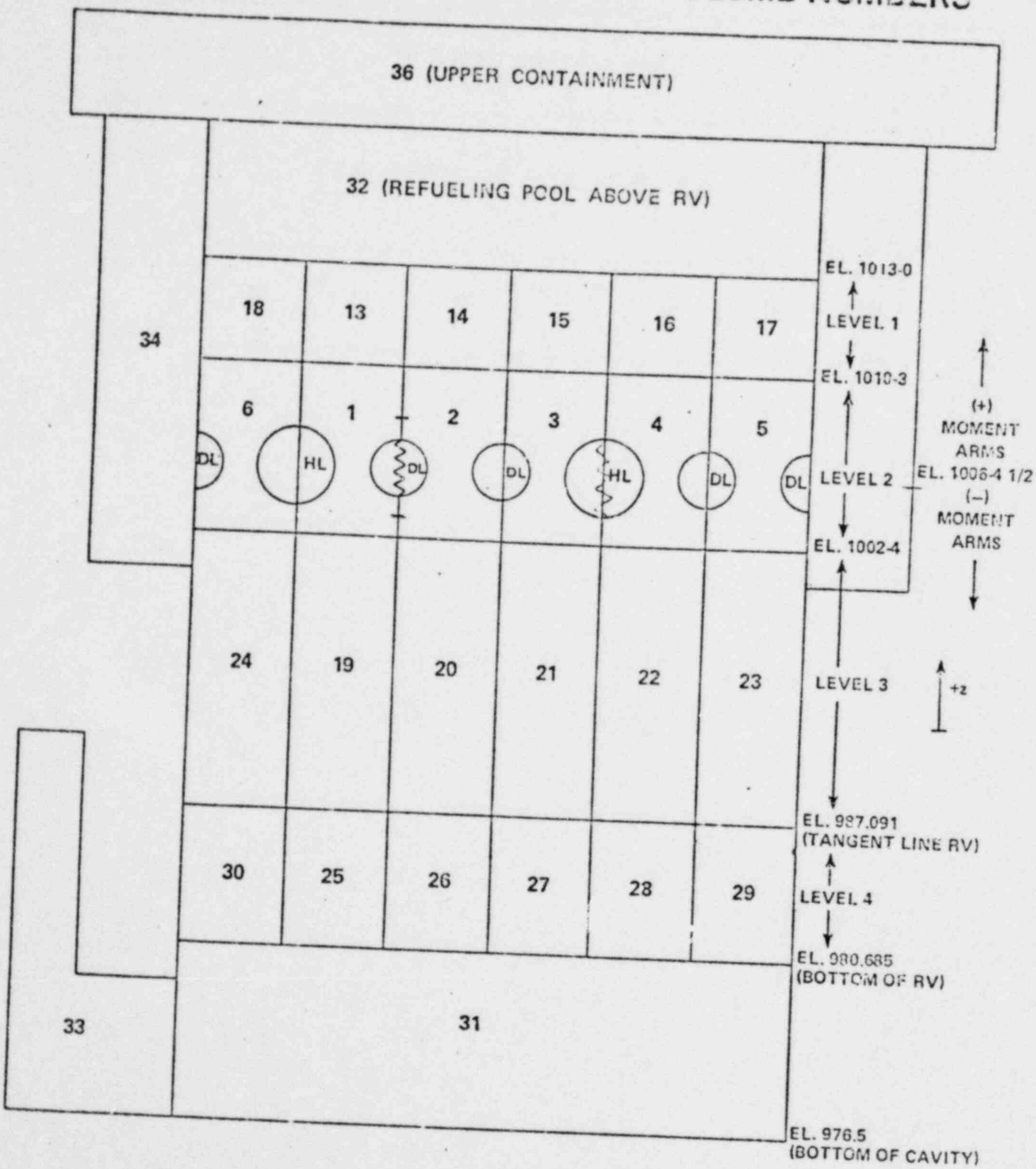
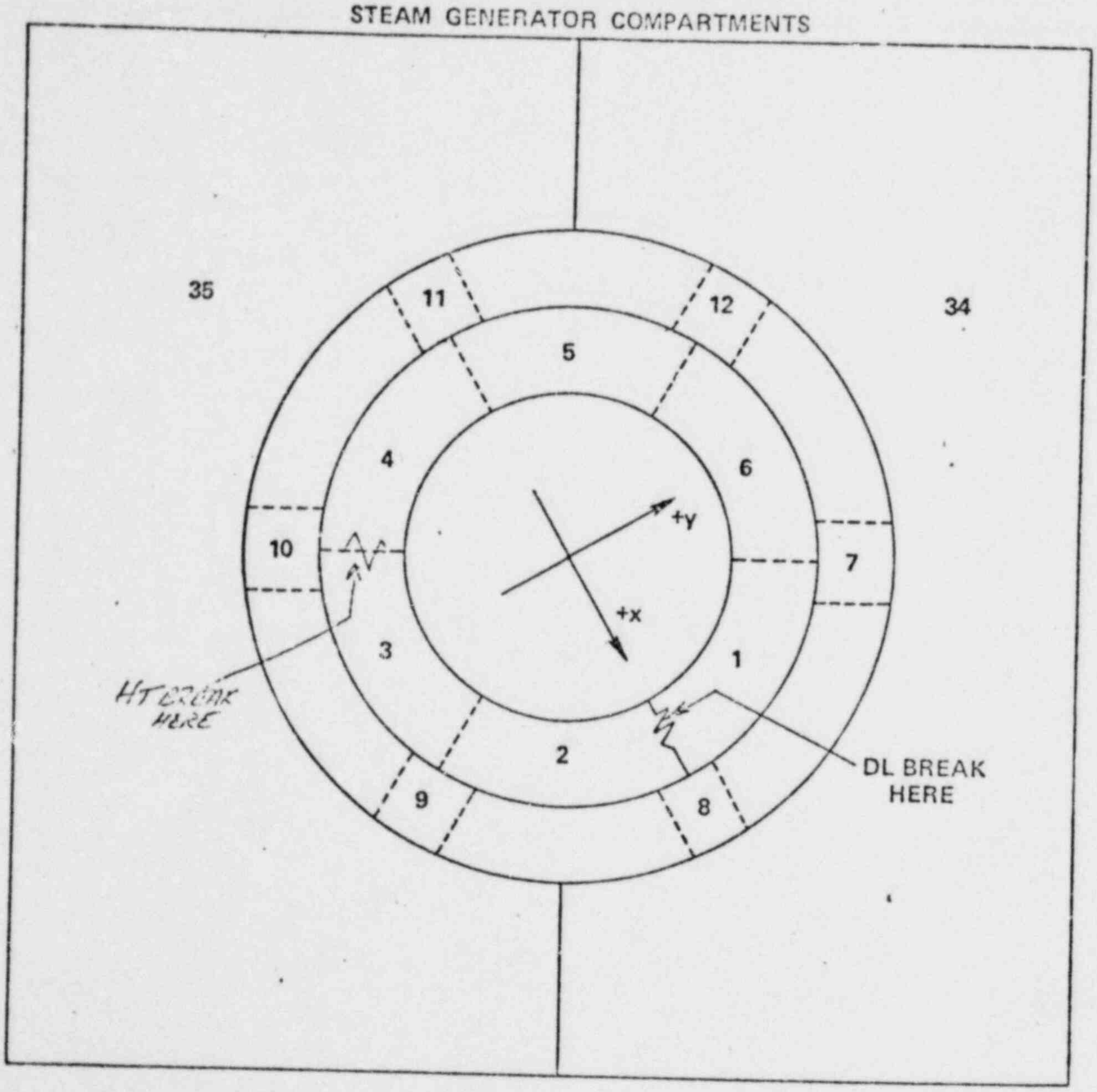


Figure 4.3-88

O.P.P.D.

FT. CALHOUN UNIT 1 REACTOR CAVITY SUBCOMPARTMENT MODEL SCHEMATIC ELEVATIONSHOWING VOLUME NUMBERS



VOLS. 7, 8, 9, 10, 11 AND 12 BLOWOUT TO V32.

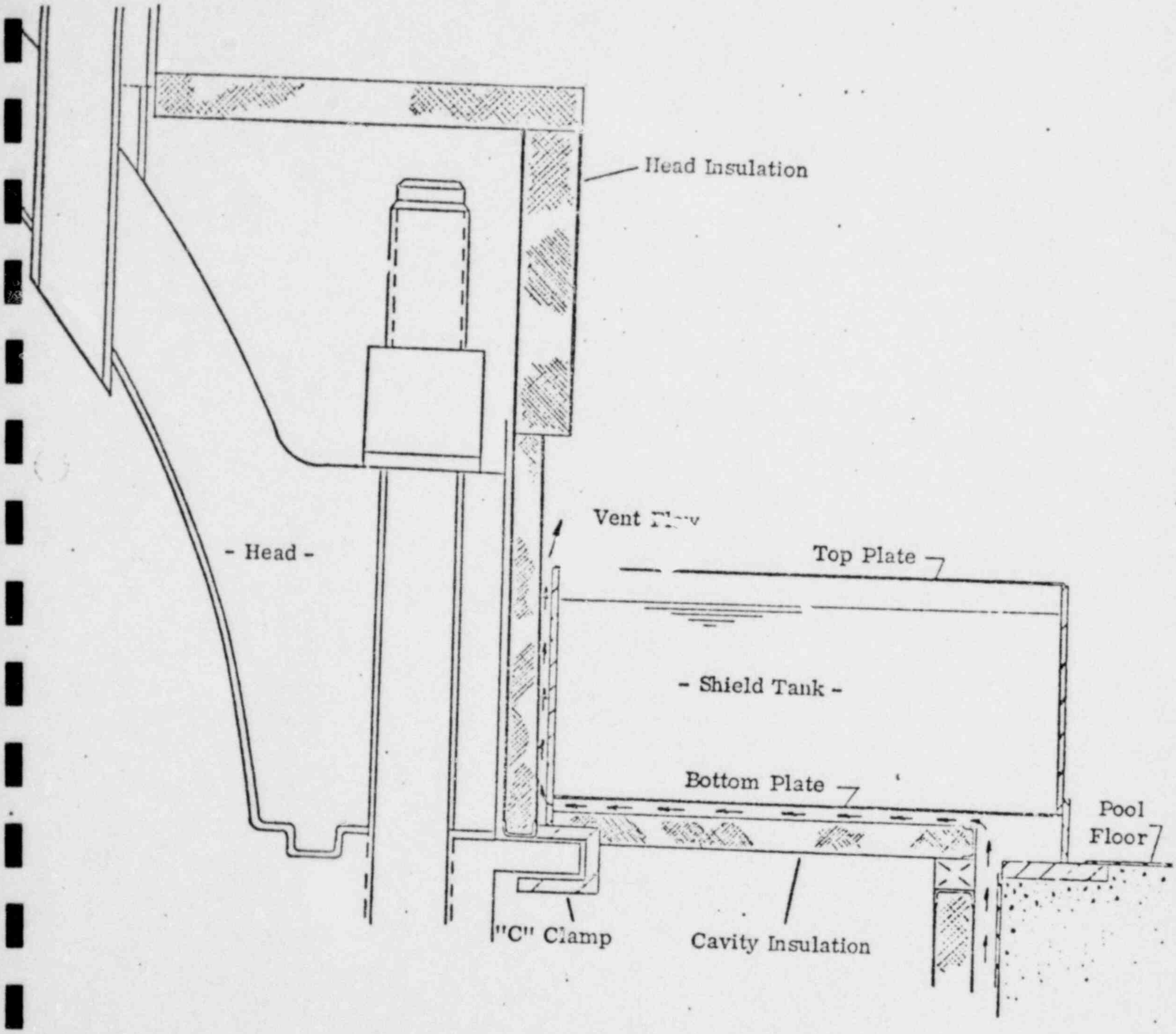
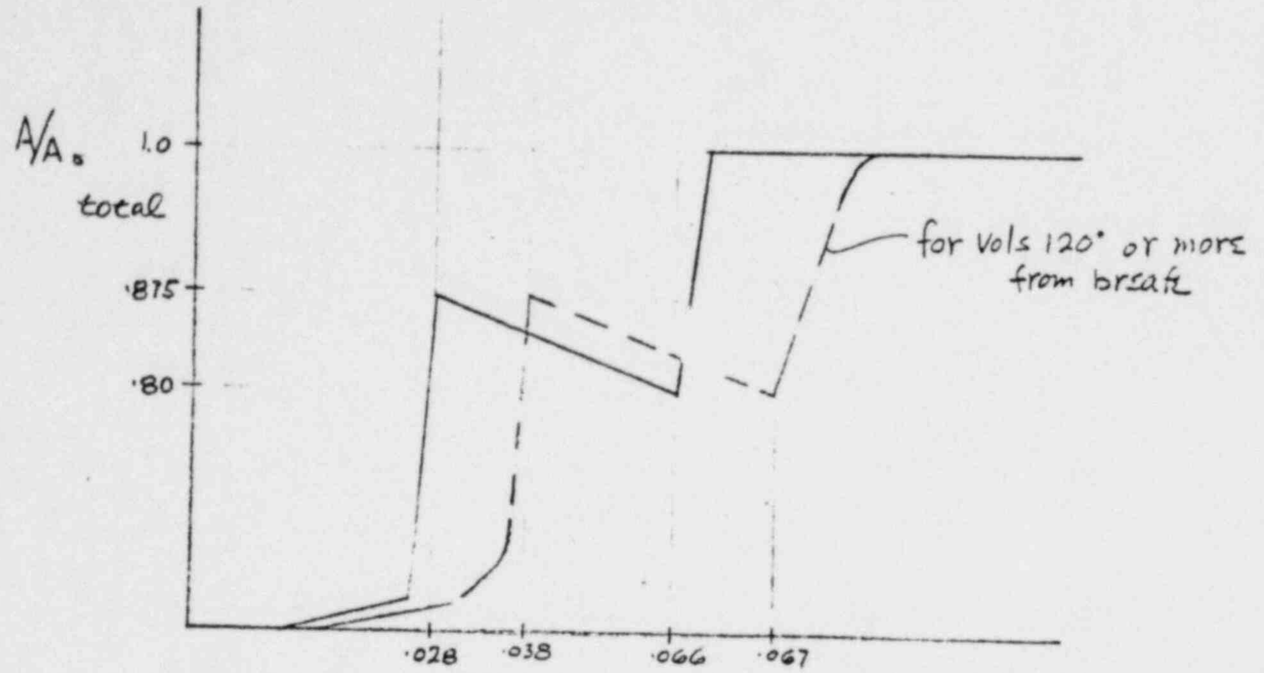


FIGURE 4.3-89 SHIELD TANK CROSS SECTION ARRANGEMENT

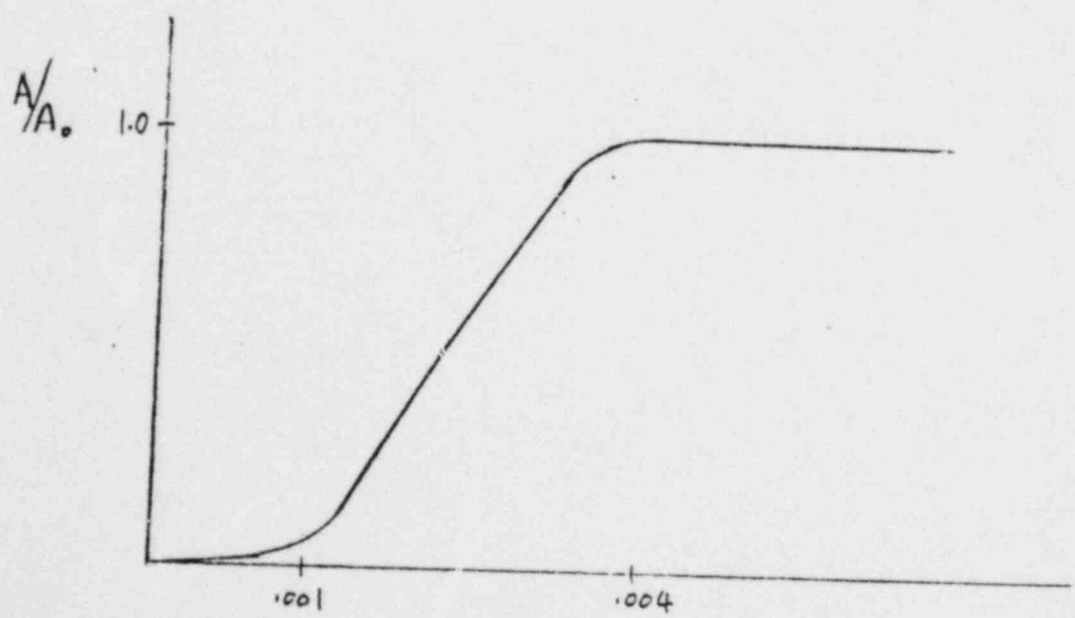
Figure 4.3-90

MILLSTONE 2

NEUTRON STREAMING SHIELD AREA OPENING VS. TIME



Cold Leg Break



Hot Leg Break

4.3.3.6 Steam Generator Compartment Analysis

The steam generator compartment was modelled to obtain the blowdown spatial pressure-time history response to determine the differential pressures on the steam generator. Postulated ruptures in the steam generator inlet and outlet pipes were evaluated.

Figures 4.3.42 and 4.3.43 present the nodal model for the generic analysis, while the node and flow path information is given in Tables 4.3.1 and 4.3.2. The Millstone 2 steam generator compartment served as the basis for this generic model.

Using the generic mass and energy data (Tables 4.3.9A through 4.3.10B) and the model described above, the steam generator compartment pressure responses were computed for the steam generator inlet and outlet pipe breaks. Pressure response histories for the 1000 square inch hot leg break are in Figures 4.3.45 through 4.3.50 and in Figures 4.3.51 through 4.3.56 for the 1414 square inch suction leg break. In the hot leg break analysis 50% of the blowdown was assumed to go into node 6 and the other 50% into node 7; for the suction leg break 45% of the blowdown was assumed into node 9 and 55% into node 8. These percentages were determined based on the location of the pipe break and the projection of blowdown from the break into the surrounding nodes.

Tables 4.3.16A and 4.3.16B present maximum calculated pressure differentials across the steam generator as well as time of occurrence for this generic analysis.

Generic analysis pressure-time histories were provided for evaluation of component supports.

Section 4.3.3.7 discusses plant specific analyses and presents those results.

4.3.3.7 Application of Subcompartment Pressure Analysis

This section explains how the generic steam generator compartment analysis was applied to the plant specific analyses.

A comparison of steam generator compartment parameters is made in Table 4.3.17. The plant civil arrangements can be seen in the Figures stated in Section 4.3.2. The Millstone 2 compartment was chosen as the basis for doing the generic analysis.

Millstone 2 and Calvert Cliffs 1 and 2 have very similar layouts. The Millstone upper compartment walls extend higher-up around the steam generator than do those for Calvert Cliffs. The effect of higher shield walls surrounding the Millstone steam generator is to include additional pressure differentials across the upper portion of this component versus Calvert Cliffs. In one corner of the compartment the primary shield wall extends further beyond the reactor coolant pump in Millstone versus Calvert Cliffs. The analysis of the suction leg break was performed on the other side of the compartment where the layouts are alike and pressures would be greater (due to more limited space). The differences on the one corner of the compartment have inconsequential effects on the results. The conclusion is that the generic (Millstone 2) steam generator compartment model is directly applicable to Calvert Cliffs. Since the generic mass and energy releases are also those for Millstone and Calvert Cliffs, the generic analysis and results of Section 4.3.3.6 are valid for these plants.

While the Palisades steam generator compartment configuration is like the generic, adjustments were made to the generic model to more closely reflect the Palisades plant. The generic model nodalization scheme was left as is (see Figures 4.3.42 and 4.3.43). Changes to node volumes and vent areas were made in the following way.

The generic model steam generator compartment total net volume was computed. The Palisades steam generator compartment total net volume was calculated and divided by the generic model total volume to give the value of 1.02. This is the Palisades normalized volume number of Table 4.3.17. Generic model volumes of nodes 1-25 and 30-35 were each multiplied by the Palisades normalized volume value to give node volumes for the Palisades analysis.

Generic model vent areas out of the steam generator compartment were changed for the Palisades analysis. The total vent area out

out of the generic steam generator compartment was calculated. This was also done for the Palisades compartment, and the Palisades total vent area was divided by the generic analysis vent area to result in a normalized vent area of 0.87 (See Table 4.3.17). Each vent area out of the generic analysis steam generator compartment was multiplied by the normalized vent area to produce a model which reflected the actual Palisade plant vent area.

Then, using the node volumes and vent areas described above, the Palisades compartment code input model was created and with the mass and energy releases of Tables 4.3.9A through 4.3.10B the pressure response histories were determined. Pressure-time histories for the 1000 square inch hot leg break are in Figures 4.3.57 through 4.3.62 while pressures for the 1414 square inch suction leg break are presented in Figures 4.3.63 through 4.3.68. Maximum differential pressures across the steam generator along with their times of occurrence are given in Tables 4.3.18A and 4.3.18B.

Fort Calhoun's steam generator compartment has walls between the steam generator and reactor coolant pumps. This difference versus the generic analysis configuration was accounted for by using the following approach to calculate normalized volume and vent area. Since differential pressures across the steam generator are of interest, the total net compartment volume was calculated for the region bounded by the walls surrounding the steam generator, but exclusive of the regions containing the main coolant pumps. Total compartment vent area was determined from the same region which defined total compartment volume. The Fort Calhoun normalized volume was obtained by dividing its total volume by the generic compartment total volume. In a similar fashion the Fort Calhoun normalized vent area was calculated. These normalized volumes and areas are stated in Table 4.3.17.

Then, as was done for Palisades, the generic model compartment interior node volumes were multiplied by the Fort Calhoun normalized volume and each vent area out of the generic compartment was multiplied by the Fort Calhoun normalized area. The Fort Calhoun steam generator compartment code input model was created using these node volumes and the vent areas. The nodalization scheme of Figures 4.3.42 and 4.3.43 remained the same.

The pressure analyses were accomplished using the hot leg break and suction leg break data of Tables 4.3.13A and 4.3.13B and Tables 4.3.14A and 4.3.14B, respectively. Pressure response histories for the hot leg break are in Figures 4.3.69 through 4.3.74 while the Fort Calhoun suction leg break pressure response transients are in Figures 4.3.75 through 4.3.80. Steam generator maximum pressure differentials are in Tables 4.3.19A and 4.3.19B.

Steam generator differential pressure scaling factors were determined and specified for evaluation of steam generator supports for each plant specific analysis. These scaling factors were computed from results of the generic and the plant specific analyses by using the method described below. Scaling factors were calculated for the horizontal and vertical directions for the pump suction leg and the hot leg pipe break cases.

There are four levels of nodes along the height of the steam generator as shown in Figure 4.3.42. From the subcompartment pressure analysis a maximum differential pressure across the steam generator was obtained for each of the four node levels. The maximum pressure differentials for each of the levels were weighted by nodal height on the steam generator and summed to yield an overall maximum horizontal differential pressure. For each break on each plant this value was divided by its counterpart determined from the generic analysis to produce the scaling factor. An analogous approach was used to obtain the vertical direction scaling factors.

Steam generator compartment analysis scaling factors are given in Table 4.3.20. The Millstone and Calvert Cliffs scaling factors are 1.0 because their analyses are one and the same as the generic ones. These scaling factors were provided for evaluation of the steam generator supports.

TABLE 4.3.1

MILLSTONE 2 / CALVERT CLIFFS 1,2
STEAM GENERATOR COMPARTMENT ANALYSIS
NODE DESCRIPTION

NODE NUMBER	VOLUME (FT**3)	DESCRIPTION
1	1253.46	EL -3.5 FT TO -.593 FT
2	212.59	EL -3.5 FT TO -.593 FT
3	1048.12	EL -3.5 FT TO -.593 FT
4	1890.52	EL -.593 FT TO 2.5 FT
5	1671.93	EL -.593 FT TO 2.5 FT
6	1885.99	EL 2.5 FT TO 20.0 FT
7	1923.57	EL 2.5 FT TO 20.0 FT
8	3165.71	EL 2.5 FT TO 20.0 FT
9	1385.73	EL 2.5 FT TO 20.0 FT
10	3165.33	EL 2.5 FT TO 20.0 FT
11	2831.49	EL 2.5 FT TO 20.0 FT
12	1190.12	EL 2.5 FT TO 20.0 FT
13	1899.17	EL 20.0 FT TO 35.5 FT
14	1899.17	EL 20.0 FT TO 35.5 FT
15	3052.49	EL 20.0 FT TO 35.5 FT
16	1112.05	EL 20.0 FT TO 35.5 FT
17	3045.13	EL 20.0 FT TO 35.5 FT
18	2465.11	EL 20.0 FT TO 35.5 FT
19	1043.47	EL 20.0 FT TO 35.5 FT
20	702.19	EL 35.5 FT TO 50.6 FT
21	702.19	EL 35.5 FT TO 50.6 FT
22	571.34	EL 35.5 FT TO 50.6 FT
23	852.27	EL 35.5 FT TO 50.6 FT
24	852.27	EL 35.5 FT TO 50.6 FT
25	571.34	EL 35.5 FT TO 50.6 FT
26	71.55	PIPE TUNNEL
27	73.27	PIPE TUNNEL
28	116.90	PIPE TUNNEL
29	4185.47	REACTOR CAVITY
30	559.69	EL 50.6 FT TO 63.0 FT
31	559.68	EL 50.6 FT TO 63.0 FT
32	446.43	EL 50.6 FT TO 63.0 FT
33	682.32	EL 50.6 FT TO 63.0 FT
34	682.32	EL 50.6 FT TO 63.0 FT
35	446.43	EL 50.6 FT TO 63.0 FT
36	1900000.00	CONTAINMENT VOLUME

TABLE 4.3.2

MILLSTONE 2 / CALVERT CLIFFS 1,2
STEAM GENERATOR COMPARTMENT ANALYSIS
FLOW PATH DESCRIPTION

FLOW PATH NO.	FROM VOLUME NODE NO.	TO VOLUME NODE NO.	AREA FT**2	L/A FT**-1	HEAD LOSS K FRICTION K	FORWARD GEOM K	REVERSE GEOM K
0405	4	5	51.31	.4133	.100	5.545	5.545
0410	4	10	120.51	.0600	.100	.600	.998
0409	4	9	36.10	.1866	.100	.510	1.410
0509	5	9	36.10	.1870	.100	.878	1.257
0508	5	8	150.77	.0469	.100	.920	1.420
1017	10	17	187.98	.0834	.100	.022	.022
0916	9	16	71.75	.2184	.100	.007	.000
0815	8	15	188.46	.0832	.100	.022	.030
0910	9	10	124.57	.1633	.100	.418	.396
0908	9	8	124.57	.1633	.100	.418	.396
1716	17	16	88.35	.1720	.100	.398	.354
1516	15	16	88.35	.1720	.100	.398	.354
0102	1	2	8.28	1.4265	.100	2.250	2.250
0203	2	3	8.28	1.0247	.100	2.250	2.250
0402	4	2	36.58	.0401	.100	.470	.862
0502	5	2	36.58	.0405	.100	.466	.867
0401	4	1	431.30	.0056	.100	.142	.081
0503	5	3	360.64	.0066	.100	.161	.103
0136	1	36	431.30	.0032	.100	1.000	.500
0236	2	36	73.15	.0189	.100	1.000	.500
0336	3	36	360.64	.0038	.100	1.000	.500
1104	11	4	130.16	.0681	.100	.919	.621
0604	6	4	106.03	.0833	.100	.627	.679
0705	7	5	106.03	.0852	.100	1.002	.864
1205	12	5	70.79	.1332	.100	1.155	.941
1106	11	6	58.19	.1105	.100	.872	.903
0607	6	7	128.16	.0916	.100	.239	.239
0708	7	8	89.37	.0574	.100	.841	.785
0610	6	10	89.37	.0574	.100	.841	.785
0712	7	12	58.19	.0985	.100	.785	.798
0812	8	12	94.21	.0854	.100	.660	.558
1011	10	11	110.84	.0733	.100	.632	.632
0626	6	26	7.69	.7683	.100	.485	.939
0627	6	27	4.72	.6009	.100	.491	.963
0727	7	27	4.72	.6009	.100	.491	.963
0728	7	28	3.84	1.2975	.100	.485	.939
1228	12	28	3.84	1.7236	.100	.487	.949
2629	26	29	4.15	1.3910	.100	1.000	.500
2729	27	29	1.22	1.5692	.100	1.000	.500
2829	28	29	7.69	.7533	.100	1.000	.500
1118	11	18	162.70	.0963	.100	.004	.033
0613	6	13	114.33	.1371	.100	.008	.044
0714	7	14	114.33	.1371	.100	.008	.044
1219	12	19	70.78	.2215	.100	.020	.071
1813	18	13	13.57	.1246	.100	.872	.903
1314	13	14	113.51	.1035	.100	.239	.239
1415	14	15	79.16	.0669	.100	.841	.785

(CONTINUED)

TABLE 4.3.2 (CONT.)

FLOW PATH NO.	FROM VOLUME NODE NO.	TO VOLUME NODE NO.	AREA FT**2	L/A FT**-1	HEAD LOSS K FRICTION K	FORWARD GEOM K	REVERSE GEOM K
1317	13	17	79.16	.0669	.100	.841	.785
1419	14	19	51.54	.1111	.100	.785	.798
1519	15	19	83.45	.0963	.100	.660	.558
1718	17	18	98.17	.0827	.100	.632	.632
1836	18	36	51.87	.0419	.100	1.771	1.413
1336	13	36	12.16	.0578	.100	1.872	1.736
1436	14	36	12.16	.0578	.100	1.872	1.736
1536	15	36	21.19	.0367	.100	1.867	1.719
1736	17	36	25.18	.0368	.100	1.857	1.684
1936	19	36	50.54	.0863	.100	1.613	1.070
1421	14	21	51.33	.1947	.100	.308	.380
1320	13	20	51.33	.1947	.100	.308	.380
1422	14	22	2.95	2.4940	.100	1.395	1.432
1325	13	25	2.95	2.4940	.100	1.395	1.432
1522	15	22	39.95	.2230	.100	.404	.652
1725	17	25	39.95	.2230	.100	.404	.652
1523	15	23	13.92	.1709	.100	1.065	1.257
1724	17	24	13.92	.1709	.100	1.065	1.257
1623	16	23	35.88	.2265	.100	.500	.500
1624	16	24	35.88	.2265	.100	.500	.500
2021	20	21	47.77	.2272	.100	.545	.545
2122	21	22	44.18	.1674	.100	.316	.422
2025	20	25	44.18	.1674	.100	.316	.422
2223	22	23	44.18	.1546	.100	.353	.265
2524	25	24	44.18	.1546	.100	.353	.265
2324	23	24	65.69	.1565	.100	.244	.244
2336	23	36	.30	11.1275	.100	1.498	1.492
2436	24	36	.30	11.1275	.100	1.498	1.492
2030	20	30	44.10	.2962	.100	.061	.123
2131	21	31	44.10	.2962	.100	.061	.123
2232	22	32	35.43	.3687	.100	.083	.144
2535	25	35	35.43	.3687	.100	.083	.144
2333	23	33	54.31	.2405	.100	.044	.105
2434	24	34	54.31	.2405	.100	.044	.105
3031	30	31	51.49	.2205	.100	.444	.444
3132	31	32	48.54	.1677	.100	.273	.327
3035	30	35	48.54	.1677	.100	.273	.327
3233	32	33	48.54	.1536	.100	.265	.241
3534	35	34	48.54	.1536	.100	.265	.241
3334	33	34	66.22	.1581	.100	.200	.200
3036	30	36	38.40	.1535	.100	1.000	.500
3136	31	36	38.40	.1535	.100	1.000	.500
3236	32	36	24.98	.2359	.100	1.000	.500
3536	35	36	24.98	.2359	.100	1.000	.500
3336	33	36	48.61	.1212	.100	1.000	.500
3436	34	36	48.61	.1212	.100	1.000	.500
2936	29	36	12.41	.9907	.100	1.000	.500

TABLE 4.3.3

PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
NODE DESCRIPTION

NODE NUMBER	VOLUME (FT**3)	DESCRIPTION
1	1281.91	EL -3.5 FT TO -.593 FT
2	217.42	EL -3.5 FT TO -.593 F
3	1071.91	EL -3.5 FT TO -.593 FT
4	1933.43	EL -.593 FT TO 2.5 FT
5	1709.89	EL -.593 FT TO 2.5 FT
6	1928.50	EL 2.5 FT TO 20.0 FT
7	1957.57	EL 2.5 FT TO 20.0 FT
8	3237.57	EL 2.5 FT TO 20.0 FT
9	1417.19	EL 2.5 FT TO 20.0 FT
10	3237.19	EL 2.5 FT TO 20.0 FT
11	2895.75	EL 2.5 FT TO 20.0 FT
12	1217.14	EL 2.5 FT TO 20.0 FT
13	1942.28	EL 20.0 FT TO 35.5 FT
14	1942.28	EL 20.0 FT TO 35.5 FT
15	3121.78	EL 20.0 FT TO 35.5 FT
16	1137.29	EL 20.0 FT TO 35.5 FT
17	3114.25	EL 20.0 FT TO 35.5 FT
18	2524.14	EL 20.0 FT TO 35.5 FT
19	1067.16	EL 20.0 FT TO 35.5 FT
20	715.13	EL 35.5 FT TO 50.6 FT
21	715.13	EL 35.5 FT TO 50.6 FT
22	584.31	EL 35.5 FT TO 50.6 FT
23	871.62	EL 35.5 FT TO 50.6 FT
24	871.62	EL 35.5 FT TO 50.6 FT
25	584.31	EL 35.5 FT TO 50.6 FT
26	71.55	PIPE TUNNEL
27	73.27	PIPE TUNNEL
28	116.90	PIPE TUNNEL
29	4185.47	REACTOR CAVITY
30	572.38	EL 50.6 FT TO 63.0 FT
31	572.38	EL 50.6 FT TO 63.0 FT
32	455.56	EL 50.6 FT TO 63.0 FT
33	597.81	EL 50.6 FT TO 63.0 FT
34	597.61	EL 50.6 FT TO 63.0 FT
35	455.56	EL 50.6 FT TO 63.0 FT
36	1900000.00	CONTAINMENT VOLUME

TABLE 4.3.4

PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
FLOW PATH DESCRIPTION

FLOW PATH NO.	FROM VOLUME NODE NO.	TO VOLUME NODE NO.	AREA FT**2	L/A FT**-1	HEAD LOSS K: FRICTION K	HEAD LOSS K: FORWARD GEOM K	HEAD LOSS K: REVERSE GEOM K
0405	4	5	51.31	.4133	.100	5.545	5.545
0410	4	10	105.10	.0000	.100	.800	.998
0409	4	9	31.48	.1360	.100	.510	1.410
0509	5	9	31.48	.1870	.100	.878	1.257
0508	5	8	131.49	.0469	.100	.920	1.420
1017	10	17	187.98	.0834	.100	.022	.022
0916	9	16	71.75	.2184	.100	.007	.000
0815	8	15	188.46	.0832	.100	.022	.030
0910	9	10	124.57	.1633	.100	.418	.396
0908	9	8	124.57	.1633	.100	.418	.396
1716	17	16	88.35	.1720	.100	.398	.354
1516	15	16	88.35	.1720	.100	.398	.354
0102	1	2	8.28	1.4265	.100	2.250	2.250
0203	2	3	8.28	1.0247	.100	2.250	2.250
0402	4	2	36.58	.0401	.100	.470	.802
0502	5	2	36.58	.0405	.100	.466	.807
0401	4	1	431.30	.0056	.100	.142	.081
0503	5	3	360.04	.0000	.100	.161	.103
0136	1	36	431.30	.0032	.100	1.000	.500
0236	2	36	73.15	.0189	.100	1.000	.500
0336	3	36	360.04	.0038	.100	1.000	.500
1104	11	4	113.51	.0061	.100	.919	.821
0604	6	4	92.47	.0833	.100	.627	.879
0705	7	5	92.17	.0852	.100	1.002	.864
1205	12	5	61.74	.1332	.100	1.155	.941
1106	11	6	58.19	.1105	.100	.872	.903
0607	6	7	128.16	.0916	.100	.239	.239
0708	7	8	89.37	.0574	.100	.841	.785
0610	6	10	89.37	.0574	.100	.841	.785
0712	7	12	58.19	.0985	.100	.785	.798
0812	8	12	94.21	.0854	.100	.660	.558
1011	10	11	110.84	.0733	.100	.032	.632
0626	6	26	0.71	.7083	.100	.485	.939
0627	6	27	4.12	.6007	.100	.491	.963
0727	7	27	4.12	.6009	.100	.491	.963
0729	7	29	3.35	1.2975	.100	.485	.939
1228	12	28	3.35	1.7236	.100	.487	.949
2629	26	29	4.13	1.3910	.100	1.000	.500
2729	27	29	1.22	1.5002	.100	1.000	.500
2829	28	29	7.09	.7533	.100	1.000	.500
1118	11	18	162.70	.0963	.100	.004	.033
0613	6	13	114.33	.1371	.100	.008	.044
0714	7	14	114.33	.1371	.100	.008	.044
1219	12	19	70.73	.2215	.100	.020	.071
1813	18	13	13.57	.1240	.100	.872	.903
1314	13	14	113.51	.1035	.100	.239	.239
1415	14	15	79.16	.0069	.100	.841	.785

(CONTINUED) 4. 3. 85

TABLE 4.3.4 (CONT.)

FLOW PATH NO.	FROM VOLUME NODE NO.	TO VOLUME NODE NO.	AREA FT**2	L/A FT**-1	HEAD LOSS K FRICTION K	FORWARD GEOM K	REVERSE GEOM K
1317	13	17	79.16	.0669	.100	.841	.785
1419	14	19	51.54	.1111	.100	.785	.798
1519	15	19	83.45	.0963	.100	.660	.558
1718	17	18	98.17	.0827	.100	.632	.632
1836	18	36	45.24	.0419	.100	1.771	1.413
1336	13	36	10.60	.0578	.100	1.872	1.736
1436	14	36	10.60	.0578	.100	1.872	1.736
1536	15	36	18.48	.0367	.100	1.867	1.719
1736	17	36	21.96	.0368	.100	1.857	1.684
1936	19	36	44.08	.0863	.100	1.613	1.070
1421	14	21	51.33	.1947	.100	.308	.380
1320	13	20	51.33	.1947	.100	.308	.380
1422	14	22	2.95	2.4940	.100	1.395	1.432
1325	13	25	2.95	2.4940	.100	1.395	1.432
1522	15	22	39.95	.2230	.100	.404	.652
1725	17	25	39.95	.2230	.100	.404	.652
1523	15	23	13.92	.1709	.100	1.065	1.257
1724	17	24	13.92	.1709	.100	1.065	1.257
1623	16	23	35.88	.2265	.100	.500	.500
1624	16	24	35.88	.2265	.100	.500	.500
2021	20	21	47.77	.2272	.100	.545	.545
2122	21	22	44.18	.1674	.100	.316	.422
2025	20	25	44.18	.1674	.100	.316	.422
2223	22	23	44.18	.1546	.100	.353	.285
2524	25	24	44.18	.1546	.100	.353	.285
2324	23	24	65.09	.1565	.100	.244	.244
2336	23	36	.26	11.1275	.100	1.498	1.492
2436	24	36	.26	11.1275	.100	1.498	1.492
2030	20	30	44.10	.2962	.100	.061	.123
2131	21	31	44.10	.2962	.100	.061	.123
2232	22	32	35.43	.3687	.100	.083	.144
2535	25	35	35.43	.3687	.100	.083	.144
2333	23	33	54.31	.2405	.100	.044	.105
2434	24	34	54.31	.2405	.100	.044	.105
3031	30	31	51.49	.2205	.100	.444	.444
3132	31	32	48.54	.1677	.100	.273	.327
3035	30	35	48.54	.1677	.100	.273	.327
3233	32	33	48.54	.1536	.100	.265	.241
3534	35	34	48.54	.1536	.100	.265	.241
3334	33	34	60.22	.1541	.100	.200	.200
3036	30	36	33.49	.1535	.100	1.000	.500
3136	31	36	33.49	.1535	.100	1.000	.500
3236	32	36	21.79	.2359	.100	1.000	.500
3536	35	36	21.79	.2359	.100	1.000	.500
3336	33	36	42.39	.1212	.100	1.000	.500
3436	34	36	42.39	.1212	.100	1.000	.500
2936	29	36	12.41	.9907	.100	1.000	.500

TABLE 4.3.5

FORT CALHOUN STEAM GENERATOR
COMPARTMENT ANALYSIS NODE DESCRIPTION

NODE NUMBER	VOLUME (FT**3)	DESCRIPTION
1	558.79	EL -3.5 FT TO -.593 FT
2	91.77	EL -3.5 FT TO -.593 FT
3	467.25	EL -3.5 FT TO -.593 FT
4	842.80	EL -.593 FT TO 2.5 FT
5	745.35	EL -.593 FT TO 2.5 FT
6	840.78	EL 2.5 FT TO 20.0 FT
7	357.00	EL 2.5 FT TO 20.0 FT
8	1411.28	EL 2.5 FT TO 20.0 FT
9	617.75	EL 2.5 FT TO 20.0 FT
10	1411.11	EL 2.5 FT TO 20.0 FT
11	1262.28	EL 2.5 FT TO 20.0 FT
12	530.50	EL 2.5 FT TO 20.0 FT
13	840.65	EL 20.0 FT TO 35.5 FT
14	840.65	EL 20.0 FT TO 35.5 FT
15	1360.30	EL 20.0 FT TO 35.5 FT
16	495.75	EL 20.0 FT TO 35.5 FT
17	1357.52	EL 20.0 FT TO 35.5 FT
18	1100.29	EL 20.0 FT TO 35.5 FT
19	465.18	EL 20.0 FT TO 35.5 FT
20	313.04	EL 35.5 FT TO 50.6 FT
21	313.04	EL 35.5 FT TO 50.6 FT
22	254.70	EL 35.5 FT TO 50.6 FT
23	377.94	EL 35.5 FT TO 50.6 FT
24	377.94	EL 35.5 FT TO 50.6 FT
25	254.70	EL 35.5 FT TO 50.6 FT
26	71.55	PIPE TUNNEL
27	73.27	PIPE TUNNEL
28	116.90	PIPE TUNNEL
29	4135.47	REACTOR CAVITY
30	249.51	EL 50.6 FT TO 63.0 FT
31	249.51	EL 50.6 FT TO 63.0 FT
32	199.02	EL 50.6 FT TO 63.0 FT
33	304.18	EL 50.6 FT TO 63.0 FT
34	304.18	EL 50.6 FT TO 63.0 FT
35	199.02	EL 50.6 FT TO 63.0 FT
36	1900000.00	CONTAINMENT VOLUME

TABLE 4.3.6

FORT CALHOUN
STEAM GENERATOR COMPARTMENT ANALYSIS
FLOW PATH DESCRIPTION

FLOW PATH NO.	FROM VOLUME NODE NO.	TO VOLUME NODE NO.	AREA FT**2	L/A FT**-1	HEAD LOSS K FRICTION K	HEAD LOSS K FORWARD GEOM K	HEAD LOSS K REVERSE GEOM K
0405	4	5	51.31	.4133	.100	5.545	5.545
0410	4	10	173.08	.0600	.100	.800	.998
0409	4	9	51.85	.1866	.100	.510	1.410
0509	5	9	51.85	.1870	.100	.873	1.257
0508	5	8	216.54	.0469	.100	.920	1.420
1017	10	17	187.98	.0834	.100	.022	.022
0916	9	16	71.75	.2184	.100	.007	.000
0815	8	15	188.46	.0832	.100	.022	.030
0910	9	10	124.57	.1633	.100	.418	.396
0908	9	8	124.57	.1633	.100	.418	.396
1716	17	16	88.35	.1720	.100	.398	.354
1516	15	16	88.35	.1720	.100	.398	.354
0102	1	2	8.28	1.4265	.100	2.250	2.250
0203	2	3	8.28	1.0247	.100	2.250	2.250
0402	4	2	36.58	.0401	.100	.470	.882
0502	5	2	36.58	.0405	.100	.466	.867
0401	4	1	431.30	.0056	.100	.142	.081
0503	5	3	300.64	.0066	.100	.161	.103
0136	1	36	431.30	.0032	.100	1.000	.500
0236	2	36	73.15	.0187	.100	1.000	.500
0336	3	36	300.64	.0038	.100	1.000	.500
1104	11	4	186.99	.0081	.100	.919	.821
0604	6	4	152.28	.0333	.100	.627	.879
0705	7	5	152.28	.0852	.100	1.002	.864
1205	12	5	101.67	.1332	.100	1.155	.941
1106	11	6	58.19	.1105	.100	.872	.903
0607	6	7	128.16	.0716	.100	.239	.239
0708	7	8	89.37	.0574	.100	.841	.785
0610	6	10	89.37	.0574	.100	.841	.785
0712	7	12	58.19	.0985	.100	.785	.798
0812	8	12	94.21	.0854	.100	.661	.558
1011	10	11	110.84	.0733	.100	.632	.632
0626	6	26	11.04	.7683	.100	.485	.939
0627	6	27	6.78	.6009	.100	.491	.963
0727	7	27	6.78	.6009	.100	.491	.963
0728	7	28	5.52	1.2975	.100	.485	.939
1228	12	28	5.52	1.7236	.100	.487	.949
2629	26	29	4.15	1.3910	.100	1.000	.500
2729	27	29	1.22	1.5692	.100	1.000	.500
2829	28	29	7.69	.7533	.100	1.000	.500
1118	11	18	162.70	.0963	.100	.004	.033
0613	6	13	114.33	.1371	.100	.008	.044
0714	7	14	114.33	.1371	.100	.008	.044
1219	12	19	76.78	.2215	.100	.020	.071
1813	18	13	13.57	.1246	.100	.872	.903
1314	13	14	113.51	.1035	.100	.239	.239
1415	14	15	79.16	.0669	.100	.841	.785

(CONTINUED)

TABLE 4.3.6 (CONT.)

FLOW PATH NO.	FROM VOLUME NODE NO.	TO VOLUME NODE NO.	AREA FT**2	L/A FT**-1	HEAD LOSS K FRICTION K	FORWARD GEOM K	REVERSE GEOM K
1317	13	17	79.16	.0669	.100	.841	.785
1419	14	19	51.54	.1111	.100	.785	.738
1519	15	19	83.45	.0763	.100	.660	.558
1718	17	18	95.17	.0827	.100	.632	.632
1836	18	36	74.50	.0419	.100	1.771	1.413
1336	13	36	17.46	.0578	.100	1.872	1.736
1436	14	36	17.46	.0578	.100	1.872	1.736
1536	15	36	30.43	.0367	.100	1.867	1.719
1736	17	36	36.16	.0368	.100	1.857	1.684
1936	19	36	72.59	.0863	.100	1.613	1.070
1421	14	21	51.33	.1947	.100	.308	.380
1320	13	20	51.33	.1947	.100	.308	.380
1422	14	22	2.95	2.4940	.100	1.395	1.432
1325	13	25	2.95	2.4940	.100	1.395	1.432
1522	15	22	39.95	.2230	.100	.404	.652
1725	17	25	39.95	.2230	.100	.404	.652
1523	15	23	13.92	.1709	.100	1.065	1.257
1724	17	24	13.92	.1709	.100	1.065	1.257
1623	16	23	35.88	.2265	.100	.500	.500
1624	16	24	35.88	.2265	.100	.500	.500
2021	20	21	47.77	.2272	.100	.545	.545
2122	21	22	44.18	.1674	.100	.316	.422
2025	20	25	44.18	.1674	.100	.316	.422
2223	22	23	44.18	.1546	.100	.353	.285
2524	25	24	44.18	.1546	.100	.353	.285
2324	23	24	65.62	.1505	.100	.244	.244
2336	23	36	.43	11.1275	.100	1.498	1.492
2436	24	36	.43	11.1275	.100	1.498	1.492
2030	20	30	44.10	.2962	.100	.061	.123
2131	21	31	44.10	.2962	.100	.061	.123
2232	22	32	35.43	.3087	.100	.083	.144
2535	25	35	35.43	.3087	.100	.083	.144
2333	23	33	54.31	.2405	.100	.044	.105
2434	24	34	54.31	.2405	.100	.044	.105
3031	30	31	51.49	.2205	.100	.444	.444
3132	31	32	48.54	.1677	.100	.273	.327
3035	30	35	48.54	.1677	.100	.273	.327
3233	32	33	48.54	.1536	.100	.265	.241
3534	35	34	48.54	.1536	.100	.265	.241
3334	33	34	66.22	.1581	.100	.200	.200
3036	30	36	55.15	.1535	.100	1.000	.500
3136	31	36	55.15	.1535	.100	1.000	.500
3236	32	36	35.88	.2359	.100	1.000	.500
3536	35	36	35.88	.2359	.100	1.000	.500
3336	33	36	69.82	.1212	.100	1.000	.500
3436	34	36	69.82	.1212	.100	1.000	.500
2936	29	36	12.41	.9707	.100	1.000	.500

TABLE 4.3.7A

MASS/ENERGY RELEASE DATA
1414 SQ. IN. DISCHARGE LEG GUILLOTINE
BREAK AT REACTOR VESSEL NOZZLE
FOR RCS ASYMMETRIC LOAD EVALUATION
(FLOW FROM PUMP SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	544.70	0.
.00100	3549.0	544.60	1932785.
.00200	6823.0	544.10	3712394.
.00300	9466.0	543.40	5143824.
.00400	11140.0	542.50	6043450.
.00500	11980.0	541.50	6487170.
.00600	11750.0	540.50	6350875.
.00700	10850.0	539.70	5855745.
.00800	11650.0	539.50	6285175.
.00900	13100.0	539.50	7067450.
.01000	14550.0	539.60	7851180.
.01200	17440.0	539.60	9410624.
.01400	20330.0	539.60	10970068.
.01600	23190.0	539.60	12513324.
.01800	26030.0	539.60	14045788.
.02000	28860.0	539.60	15572856.
.02200	31660.0	539.60	17083736.
.02400	33000.0	539.60	17806800.
.02600	32920.0	539.60	17763632.
.02800	32840.0	539.70	17723748.
.03000	32760.0	539.70	17680572.
.03200	32680.0	539.70	17637396.
.03400	32610.0	539.70	17599617.
.03600	32550.0	539.80	17570490.
.03800	32480.0	539.80	17532704.
.04000	32420.0	539.80	17500316.
.04200	32370.0	539.80	17473326.
.04400	32310.0	539.80	17440938.
.04600	32250.0	539.90	17411775.
.04800	32180.0	539.90	17373982.
.05000	32120.0	539.90	17341588.
.05500	31940.0	539.90	17244406.
.06000	31760.0	539.90	17147224.
.06500	31580.0	540.00	17053200.
.07000	31400.0	540.00	16956000.
.07500	31210.0	540.00	16853400.
.08000	30980.0	540.00	16729200.
.08500	30730.0	540.00	16594200.
.09000	30480.0	540.00	16459200.
.09500	30220.0	540.00	16318800.
.10000	29970.0	540.00	16183800.
.11000	29460.0	540.00	15908400.
.12000	28960.0	540.10	15641296.
.13000	28490.0	540.10	15387449.
.14000	28060.0	540.20	15158012.

(CONTINUED)

TABLE 4.3.7A (CONT.)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	27630.0	540.20	14925726.
.16000	27160.0	540.20	14671832.
.17000	26670.0	540.20	14407134.
.18000	26180.0	540.20	14142436.
.19000	25710.0	540.20	13888542.
.20000	25570.0	540.30	13815471.
.22000	25380.0	540.30	13712814.
.24000	25150.0	540.40	13591060.
.26000	24880.0	540.40	13445152.
.28000	24540.0	540.50	13263870.
.30000	24150.0	540.60	13055490.
.32000	23680.0	540.60	12801408.
.34000	23180.0	540.70	12533426.
.36000	22970.0	540.80	12422176.
.38000	22790.0	540.90	12327111.
.40000	22620.0	541.00	12237420.
.42000	22450.0	541.10	12147695.
.44000	22270.0	541.20	12052524.
.46000	22110.0	541.30	11968143.
.48000	21940.0	541.40	11878316.
.50000	21820.0	541.50	11815530.
.55000	21490.0	541.80	11643282.
.60000	21280.0	542.20	11538016.
.65000	21110.0	542.60	11454286.
.70000	20930.0	543.00	11364990.
.75000	20750.0	543.40	11275550.
.80000	20520.0	543.70	11156724.
.85000	20280.0	544.10	11034348.
.90000	19980.0	544.50	10879110.
.95000	19630.0	544.90	10696387.
1.00000	19240.0	545.20	10489648.
1.10000	18310.0	545.90	9995429.
1.20000	17340.0	546.60	9478044.
1.30000	16480.0	547.40	9021152.
1.40000	15800.0	548.20	8661560.
1.50000	15350.0	548.90	8425615.
1.60000	14870.0	549.60	8172552.
1.70000	14430.0	550.30	7940829.
1.80000	14020.0	550.90	7723618.
1.90000	13710.0	551.50	7561065.
2.00000	13440.0	552.00	7418880.
2.50000	12490.0	554.30	6923207.
3.00000	13170.0	556.50	7329105.

TABLE 4.3.7B

MASS/ENERGY RELEASE DATA
1414 SQ. IN. DISCHARGE LEG GUILLOTINE
BREAK AT REACTOR VESSEL NOZZLE
FOR RCS ASYMMETRIC LOAD EVALUATION
(FLOW FROM R.V. SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	544.70	0.
.00100	3330.0	543.80	1810854.
.00200	5361.0	542.20	2906734.
.00300	6879.0	541.30	3723603.
.00400	9233.0	541.30	4997823.
.00500	12170.0	541.70	6592489.
.00600	14680.0	541.70	7952156.
.00700	16440.0	541.40	8900616.
.00800	17800.0	541.10	9631580.
.00900	19260.0	541.00	10419660.
.01000	20920.0	540.90	11315628.
.01200	24350.0	540.80	13168480.
.01400	27690.0	540.80	14974752.
.01600	30860.0	540.80	16689088.
.01800	33880.0	540.80	18322304.
.02000	36790.0	540.90	19899711.
.02200	39580.0	541.00	21412780.
.02400	40100.0	541.00	21694100.
.02600	43360.0	541.40	23475104.
.02800	45990.0	541.80	24917382.
.03000	48140.0	542.10	26096694.
.03200	49880.0	542.30	27049924.
.03400	51280.0	542.40	27814272.
.03600	52390.0	542.50	28421575.
.03800	53260.0	542.60	28898876.
.04000	53920.0	542.60	29256992.
.04200	54380.0	542.70	29512026.
.04400	54670.0	542.60	29663942.
.04600	54820.0	542.60	29745332.
.04800	54850.0	542.60	29761610.
.05000	54790.0	542.50	29723575.
.05500	54400.0	542.30	29501120.
.06000	53910.0	542.20	29230002.
.06500	53290.0	542.00	28883180.
.07000	52280.0	541.80	28325304.
.07500	50720.0	541.60	27469952.
.08000	48890.0	541.30	26464157.
.08500	47150.0	541.00	25508150.
.09000	45680.0	540.90	24708312.
.09500	44640.0	540.70	24136848.
.10000	44400.0	540.70	24007080.
.11000	46870.0	541.20	25366044.
.12000	49470.0	541.60	26792952.
.13000	49460.0	541.50	26782590.
.14000	48600.0	541.40	26312040.

(CONTINUED)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	49490.0	541.50	26798835.
.16000	49730.0	541.60	26933768.
.17000	47710.0	541.20	25820652.
.18000	45770.0	541.00	24761570.
.19000	45410.0	541.00	24566810.
.20000	46590.0	541.20	25214508.
.22000	48770.0	541.50	26408955.
.24000	47860.0	541.30	25906618.
.26000	47510.0	541.30	25717163.
.28000	46150.0	541.10	24971765.
.30000	47080.0	541.30	25484404.
.32000	47180.0	541.30	25538534.
.34000	46500.0	541.20	25165800.
.36000	[illegible]	541.20	24895200.
.38000	46050.0	541.20	24922260.
.40000	46350.0	541.30	25089255.
.42000	45710.0	541.20	24738252.
.44000	45270.0	541.10	24495597.
.46000	45490.0	541.20	24619188.
.48000	45760.0	541.20	24765312.
.50000	45640.0	541.20	24700368.
.55000	44920.0	541.20	24310704.
.60000	44650.0	541.20	24164580.
.65000	44660.0	541.30	24174458.
.70000	44250.0	541.30	23952525.
.75000	43940.0	541.30	23784722.
.80000	43630.0	541.40	23621282.
.85000	43420.0	541.40	23507588.
.90000	42870.0	541.50	23214105.
.95000	42570.0	541.50	23051655.
1.00000	41890.0	541.60	22687624.
1.10000	41210.0	541.70	22323457.
1.20000	40900.0	541.90	22163710.
1.30000	41100.0	542.10	22280310.
1.40000	40650.0	542.30	22044495.
1.50000	40120.0	542.50	21765100.
1.60000	39660.0	542.70	21523482.
1.70000	39230.0	542.90	21297967.
1.80000	38850.0	543.20	21103320.
1.90000	38490.0	543.40	20915466.
2.00000	38130.0	543.70	20731281.
2.50000	36800.0	545.10	20059680.
3.00000	36110.0	546.80	19744948.

TABLE 4.3.8A

MASS/ENERGY RELEASE DATA
135 SQ. IN. HOT LEG GUILLOTINE BREAK
AT REACTOR VESSEL NOZZLE
FOR RCS ASYMMETRIC LOAD EVALUATION
(FLOW FROM R.V. SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	609.10	0.
.00100	318.1	609.10	193755.
.00200	632.3	609.00	385071.
.00300	944.6	609.00	575261.
.00400	1260.0	609.00	767340.
.00500	1578.0	609.00	961002.
.00600	1893.0	609.00	1152837.
.00700	2197.0	608.90	1337753.
.00800	2494.0	608.90	1518597.
.00900	2795.0	608.80	1701596.
.01000	3107.0	608.80	1891542.
.01200	3739.0	608.90	2276677.
.01400	4329.0	608.80	2635495.
.01600	4940.0	608.80	3007472.
.01800	5573.0	608.80	3392842.
.02000	6146.0	608.80	3741685.
.02200	6174.0	608.80	3758731.
.02400	6183.0	608.80	3764210.
.02600	6126.0	608.70	3728896.
.02800	6147.0	608.80	3742294.
.03000	6155.0	608.80	3747164.
.03200	6117.0	608.70	3723418.
.03400	6118.0	608.70	3724027.
.03600	6116.0	608.70	3722809.
.03800	6083.0	608.70	3702722.
.04000	6073.0	608.60	3696028.
.04200	6071.0	608.60	3694811.
.04400	6052.0	608.60	3683247.
.04600	6045.0	608.60	3678987.
.04800	6044.0	608.60	3678378.
.05000	6031.0	608.60	3670467.
.05500	6008.0	608.50	3655868.
.06000	5969.0	608.50	3632137.
.06500	5921.0	608.40	3602336.
.07000	5873.0	608.30	3572546.
.07500	5813.0	608.20	3535467
.08000	5744.0	608.10	3492926.
.08500	5697.0	608.10	3464346.
.09000	5676.0	608.00	3451008.
.09500	5652.0	608.00	3436416.
.10000	5620.0	607.90	3416398.
.11000	5546.0	607.80	3370859.
.12000	5452.0	607.70	3313180.
.13000	5363.0	607.60	3258559.
.14000	5285.0	607.50	3210638.

(CONTINUED)

TABLE 4.3.8A (CONT.)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	5232.0	607.40	3177917.
.16000	5187.0	607.30	3150065.
.17000	5136.0	607.30	3119093.
.18000	5049.0	607.20	3065753.
.19000	4969.0	607.10	3016680.
.20000	4884.0	607.00	2964588.
.22000	4808.0	606.90	2917975.
.24000	4750.0	606.80	2882300.
.26000	4668.0	606.60	2831609.
.28000	4582.0	606.50	2778983.
.30000	4547.0	606.50	2757756.
.32000	4504.0	606.40	2731226.
.34000	4465.0	606.40	2707576.
.36000	4445.0	606.40	2695448.
.38000	4396.0	606.30	2665295.
.40000	4386.0	606.30	2659232.
.42000	4404.0	606.30	2670145.
.44000	4390.0	606.30	2661657.
.46000	4374.0	606.30	2651956.
.48000	4379.0	606.30	2654988.
.50000	4366.0	606.30	2647106.
.55000	4357.0	606.40	2642085.
.60000	4345.0	606.40	2634808.
.65000	4325.0	606.40	2622680.
.70000	4356.0	606.50	2641914.
.75000	4399.0	606.60	2668433.
.80000	4420.0	606.70	2681614.
.85000	4421.0	606.70	2682221.
.90000	4436.0	606.80	2691765.
.95000	4452.0	606.90	2701919.
1.00000	4451.0	606.90	2701312.
1.10000	4450.0	607.00	2701150.
1.20000	4439.0	607.10	2694917.
1.30000	4424.0	607.20	2686253.
1.40000	4399.0	607.30	2671513.
1.50000	4376.0	607.40	2657982.
1.60000	4401.0	607.60	2674048.
1.70000	4396.0	607.80	2671889.
1.80000	4387.0	607.90	2666857.
1.90000	4385.0	608.10	2666519.
2.00000	4369.0	608.20	2657226.
2.50000	4277.0	609.00	2604693.
3.00000	4147.0	610.00	2529670.

TABLE 4.3.8B

MASS/ENERGY RELEASE DATA
135 SQ. IN. HOT LEG GUILLOTINE BREAK
AT REACTOR VESSEL NOZZLE
FOR RCS ASYMMETRIC LOAD EVALUATION
(FLOW FROM S.G. SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	609.10	0.
.00100	318.7	609.10	194120.
.00200	635.4	609.00	386959.
.00300	948.3	609.00	577515.
.00400	1256.0	608.90	764778.
.00500	1558.0	608.90	948666.
.00600	1856.0	608.80	1129933.
.00700	2149.0	608.70	1308096.
.00800	2442.0	608.70	1486445.
.00900	2737.0	608.70	1666012.
.01000	3033.0	608.60	1845884.
.01200	3638.0	608.60	2214087.
.01400	4259.0	608.70	2592453.
.01600	4882.0	608.70	2971673.
.01800	5487.0	608.70	3339937.
.02000	6068.0	608.60	3692985.
.02200	6041.0	608.60	3676553.
.02400	6052.0	608.60	3683247.
.02600	6099.0	608.70	3706983.
.02800	6124.0	608.70	3727679.
.03000	6142.0	608.70	3735635.
.03200	6139.0	608.70	3730869.
.03400	6115.0	608.70	3720953.
.03600	6082.0	608.70	3702113.
.03800	6060.0	608.60	3688116.
.04000	6051.0	608.60	3682639.
.04200	6056.0	608.60	3685662.
.04400	6069.0	608.70	3694200.
.04600	6079.0	608.70	3700287.
.04800	6079.0	608.70	3700287.
.05000	6069.0	608.70	3694200.
.05500	6017.0	608.60	3661946.
.06000	5967.0	608.50	3630920.
.06500	5908.0	608.40	3594427.
.07000	5848.0	608.40	3557923.
.07500	5778.0	608.30	3514757.
.08000	5685.0	608.10	3457049.
.08500	5648.0	608.10	3434549.
.09000	5675.0	608.10	3449751.
.09500	5683.0	608.10	3455832.
.10000	5680.0	608.10	3454008.
.11000	5617.0	608.00	3415136.
.12000	5490.0	607.90	3337371.
.13000	5323.0	607.60	3234255.
.14000	5257.0	607.50	3193628.

(CONTINUED)

TABLE 4.3.8B (CONT.)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	5190.0	607.50	3152925.
.16000	5138.0	607.40	3120821.
.17000	5125.0	607.40	3112925.
.18000	5021.0	607.30	3049253.
.19000	4975.0	607.20	3020820.
.20000	4913.0	607.10	2982682.
.22000	4831.0	607.00	2932417.
.24000	4734.0	606.90	2873065.
.26000	4653.0	606.70	2822975.
.28000	4550.0	606.60	2760030.
.30000	4557.0	606.60	2764276.
.32000	4519.0	606.50	2740774.
.34000	4446.0	606.40	2696054.
.36000	4452.0	606.40	2699693.
.38000	382.0	606.30	2656807.
.40000	4362.0	606.30	2644681.
.42000	4408.0	606.40	2673011.
.44000	4395.0	606.30	2664689.
.46000	4375.0	606.30	2652563.
.48000	4393.0	606.30	2663476.
.50000	4345.0	606.30	2634374.
.55000	4367.0	606.30	2647712.
.60000	4341.0	606.30	2631948.
.65000	4325.0	606.30	2622248.
.70000	4352.0	606.40	2639053.
.75000	4404.0	606.40	2670586.
.80000	4424.0	606.50	2683156.
.85000	4421.0	606.50	2681337.
.90000	4438.0	606.60	2692091.
.95000	4455.0	606.70	2702849.
1.00000	4455.0	606.70	2702849.
1.10000	4455.0	606.80	2703294.
1.20000	4444.0	606.90	2697064.
1.30000	4429.0	606.90	2687960.
1.40000	4404.0	607.00	2673228.
1.50000	4380.0	607.10	2659098.
1.60000	4407.0	607.30	2676371.
1.70000	4402.0	607.40	2673775.
1.80000	4393.0	607.50	2668748.
1.90000	4392.0	607.70	2669018.
2.00000	4376.0	607.80	2659733.
2.50000	4286.0	608.50	2608031.
3.00000	4159.0	609.30	2534079.

TABLE 4.3.9A

MASS/ENERGY RELEASE RATES.
1000-80 IN HOT LEG GUILLOTINE BREAK AT
STEAM GENERATOR NOZZLE.
FOR RCS ASYMMETRIC LOADS EVALUATION.
(FLOW FROM RV SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	609.10	0.
.00100	1959.0	609.00	1193031.
.00200	3850.0	608.90	2344205.
.00300	5600.0	608.60	3408160.
.00400	7201.0	608.30	4380308.
.00500	8660.0	608.00	5265280.
.00600	9940.0	607.70	6044184.
.00700	11130.0	607.50	6761475.
.00800	12250.0	607.20	7438200.
.00900	13400.0	607.10	8135140.
.01000	14580.0	606.90	8848692.
.01200	16930.0	606.70	10271431.
.01400	19050.0	606.50	11553825.
.01600	20850.0	606.30	12641355.
.01800	22350.0	606.10	13546335.
.02000	23810.0	605.90	14426479.
.02200	25480.0	605.80	15435784.
.02400	27750.0	605.80	16810950.
.02600	28310.0	605.90	17153029.
.02800	29480.0	606.20	17870776.
.03000	30170.0	606.30	18292071.
.03200	30170.0	606.30	18292071.
.03400	29800.0	606.30	18067740.
.03600	30450.0	606.40	18464880.
.03800	30970.0	606.50	18783305.
.04000	30880.0	606.50	18728720.
.04200	30530.0	606.50	18516445.
.04400	30110.0	606.40	18258704.
.04600	29800.0	606.40	18070720.
.04800	29630.0	606.40	17967632.
.05000	29890.0	606.40	18125296.
.05500	32510.0	606.90	19730319.
.06000	31010.0	606.60	18810606.
.06500	31050.0	606.40	18222320.
.07000	29450.0	606.30	17855535.
.07500	27950.0	606.00	16937700.
.08000	279[illegible]0.0	606.00	16949820.
.08500	28130.0	606.00	17045780.
.09000	27900.0	605.90	16904610.
.09500	27870.0	605.90	16880433.
.10000	27800.0	605.90	16880374.
.11000	27910.0	605.90	16910609.
.12000	27950.0	606.00	17004300.
.13000	27750.0	605.80	16810950.
.14000	27830.0	605.70	16856631.

(CONTINUED)

TABLE 4.3.9A (CONT.)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	27740.0	605.70	16802118.
.16000	27730.0	605.70	16790901.
.17000	27710.0	605.70	16783947.
.18000	27650.0	605.70	16747605.
.19000	27360.0	605.60	16690335.
.20000	27130.0	605.60	16511608.
.22000	27130.0	605.60	16427928.
.24000	26790.0	605.50	16221345.
.26000	26390.0	605.50	15979145.
.28000	25970.0	605.50	15724835.
.30000	25610.0	605.50	15506855.
.32000	25320.0	605.50	15331260.
.34000	25040.0	605.50	15161720.
.36000	24720.0	605.50	14967960.
.38000	24400.0	605.50	14774200.
.40000	24110.0	605.50	14598605.
.42000	23860.0	605.60	14449616.
.44000	23600.0	605.60	14292160.
.46000	23360.0	605.60	14140816.
.48000	23200.0	605.70	14052240.
.50000	23170.0	605.80	14030386.
.55000	23150.0	605.90	14026535.
.60000	22920.0	606.10	13891812.
.65000	22760.0	606.30	13799358.
.70000	22640.0	606.60	13733424.
.75000	22470.0	606.80	13634796.
.80000	22240.0	607.10	13501904.
.85000	21970.0	607.30	13342381.
.90000	21670.0	607.50	13164525.
.95000	21330.0	607.70	12962241.
1.00000	20980.0	607.90	12753742.
1.10000	20230.0	608.30	12305909.
1.20000	19900.0	608.70	12113130.
1.30000	19730.0	609.10	12017543.
1.40000	19570.0	609.60	11929872.
1.50000	19420.0	610.10	11848142.
1.60000	19290.0	610.60	11778474.
1.70000	19190.0	611.00	11694540.
1.80000	18970.0	611.40	11598258.
1.90000	18820.0	611.80	11514076.
2.00000	18660.0	612.20	11423652.
2.25000	18230.0	612.70	11169521.
2.50000	17820.0	612.70	10918314.
2.75000	17480.0	612.50	10706500.
3.00000	17210.0	612.30	10537683.

TABLE 4.3.9B

MASS/ENERGY RELEASE RATE.
1000 SQ IN HOT LEG GUILLOTINE BREAK AT
STEAM GENERATOR NOZZLE.
FOR RCS ASYMMETRIC LOADS EVALUATION.
(FLOW FROM SG SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	609.10	0.
.00100	1920.0	608.90	1169088.
.00200	3770.0	608.70	2294799.
.00300	5688.0	608.80	3462854.
.00400	7350.0	608.50	4472475.
.00500	8794.0	608.20	5348511.
.00600	10360.0	608.00	6298880.
.00700	11730.0	607.80	7129494.
.00800	12760.0	607.50	7751700.
.00900	13810.0	607.20	8385432.
.01000	14900.0	607.00	9044300.
.01200	16770.0	606.60	10172682.
.01400	18610.0	606.30	11283243.
.01600	20180.0	606.10	12231098.
.01800	21640.0	605.80	13109512.
.02000	23120.0	605.70	14003784.
.02200	25410.0	605.70	15390837.
.02400	27630.0	605.70	16735491.
.02600	27520.0	605.70	16668864.
.02800	27450.0	605.70	16626465.
.03000	27470.0	605.70	16638579.
.03200	27590.0	605.70	16711263.
.03400	28540.0	606.10	1729[illegible].
.03600	28500.0	605.90	17268150.
.03800	28830.0	606.00	17470980.
.04000	28840.0	606.00	17477040.
.04200	28700.0	606.00	17392200.
.04400	28530.0	606.00	17289180.
.04600	28390.0	606.00	17204340.
.04800	28670.0	606.10	17376887.
.05000	30640.0	606.40	18580096.
.05500	30750.0	606.50	18649875.
.06000	30100.0	606.40	18252640.
.06500	29790.0	606.40	18064656.
.07000	28500.0	606.20	17276700.
.07500	27760.0	606.10	16825336.
.08000	27700.0	606.00	16786200.
.08500	27580.0	606.00	16713480.
.09000	27490.0	606.00	16658940.
.09500	27420.0	606.00	16616520.
.10000	27400.0	606.00	16604400.
.11000	27660.0	606.00	16761960.
.12000	28200.0	606.00	17089200.
.13000	27680.0	605.90	16771312.
.14000	27460.0	605.80	16635268.

(CONTINUED)

TABLE 4.3.9B (CONT.)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	27400.0	605.80	16598920.
.16000	27350.0	605.80	16568630.
.17000	27170.0	605.70	16456809.
.18000	26980.0	605.70	16341706.
.19000	26890.0	605.70	16287273.
.20000	26880.0	605.70	16281216.
.22000	26670.0	605.60	16151352.
.24000	26220.0	605.50	15876210.
.26000	25820.0	605.50	15634010.
.28000	25560.0	605.50	15476580.
.30000	25270.0	605.50	15300985.
.32000	24830.0	605.40	15032082.
.34000	24290.0	605.40	14705166.
.36000	24010.0	605.40	14535654.
.38000	23720.0	605.40	14360088.
.40000	23390.0	605.50	14162645.
.42000	23020.0	605.50	13938610.
.44000	22660.0	605.50	13720630.
.46000	22560.0	605.60	13662336.
.48000	22510.0	605.60	13632056.
.50000	22440.0	605.70	13591908.
.55000	22150.0	605.80	13418470.
.60000	21920.0	606.00	13283520.
.65000	21800.0	606.20	13215160.
.70000	21690.0	606.50	13154985.
.75000	21550.0	606.70	13074385.
.80000	21370.0	606.90	12969453.
.85000	21140.0	607.20	12836208.
.90000	20870.0	607.40	12676438.
.95000	20550.0	607.60	12486180.
1.00000	20200.0	607.80	12277560.
1.10000	19910.0	608.10	12101170.
1.20000	19730.0	608.50	12005705.
1.30000	19550.0	609.00	11905950.
1.40000	19380.0	609.40	11810172.
1.50000	19210.0	609.90	11716179.
1.60000	19060.0	610.40	11634224.
1.70000	18910.0	610.90	11552119.
1.80000	18750.0	611.30	11461875.
1.90000	18580.0	611.70	11365386.
2.00000	18370.0	612.10	11244277.
2.25000	17910.0	612.70	10973457.
2.50000	17520.0	612.70	10734504.
2.75000	17180.0	612.50	10522750.
3.00000	16940.0	612.30	10372302.

TABLE 4.3.10A

MASS/ENERGY RELEASE RATES,
1414 SQ IN SUCTION LEG GUILLOTINE BREAK
AT STEAM GENERATOR NOZZLE.
FOR RCS ASYMMETRIC LOADS EVALUATION,
(FLOW FROM SG SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	544.70	0.
.00100	3987.0	544.60	2171320.
.00200	7311.0	544.40	4252308.
.00300	11360.0	544.10	6180976.
.00400	14300.0	543.70	7774910.
.00500	16550.0	543.10	8988305.
.00600	18630.0	542.60	10108638.
.00700	20070.0	542.10	10879947.
.00800	21010.0	541.60	11379016.
.00900	21670.0	541.20	11727804.
.01000	22340.0	540.90	12083796.
.01200	23950.0	540.50	12944975.
.01400	26220.0	540.30	14166666.
.01600	29210.0	540.30	15782163.
.01800	33520.0	540.40	18114208.
.02000	41650.0	540.80	22524320.
.02200	45850.0	541.20	24814020.
.02400	46160.0	541.20	24981792.
.02600	45110.0	541.20	24413532.
.02800	44140.0	541.10	23884154.
.03000	43650.0	541.10	23619015.
.03200	43450.0	541.10	23510206.
.03400	43270.0	541.10	23412219.
.03600	43280.0	541.10	23418808.
.03800	43710.0	541.20	23655852.
.04000	44680.0	541.30	24185284.
.04200	46110.0	541.50	24968565.
.04400	47740.0	541.70	25860758.
.04600	49370.0	541.90	26753603.
.04800	50890.0	542.00	27582380.
.05000	52150.0	542.20	28275730.
.05500	53690.0	542.40	29121456.
.06000	54390.0	542.60	29512014.
.06500	55010.0	542.70	29853927.
.07000	51920.0	542.50	28166600.
.07500	49530.0	542.30	26860119.
.08000	49800.0	542.40	27011520.
.08500	49220.0	542.40	26696928.
.09000	47480.0	542.40	25753152.
.09500	46980.0	542.40	25481952.
.10000	50310.0	542.80	27308268.
.11000	52410.0	543.20	28469112.
.12000	49940.0	543.10	27122414.
.13000	48250.0	543.10	26204575.
.14000	48630.0	543.30	26420679.

(CONTINUED)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	48130.0	543.40	26153842.
.16000	47770.0	543.50	25962995.
.17000	49290.0	543.90	26808831.
.18000	49480.0	544.00	26917120.
.19000	47780.0	544.00	25992320.
.20000	46540.0	544.10	25322414.
.22000	46460.0	544.40	25292824.
.24000	47960.0	544.90	26133404.
.26000	46980.0	545.10	25608798.
.28000	46310.0	545.40	25257474.
.30000	46270.0	545.70	25249539.
.32000	45850.0	546.00	25034100.
.34000	46030.0	546.40	25150792.
.36000	45280.0	546.60	24750048.
.38000	45420.0	547.00	24844740.
.40000	45310.0	547.30	24798163.
.42000	44430.0	547.50	24325425.
.44000	44690.0	547.80	24481182.
.46000	44100.0	548.10	24171210.
.48000	43520.0	548.30	23862016.
.50000	44190.0	548.60	24242634.
.55000	43690.0	549.30	23998917.
.60000	42760.0	549.90	23513724.
.65000	42250.0	550.50	23258625.
.70000	41850.0	551.10	23063535.
.75000	41440.0	551.60	22858304.
.80000	41120.0	552.10	22702352.
.85000	40910.0	552.60	22606866.
.90000	40640.0	553.10	22477984.
.95000	40320.0	553.50	22317120.
1.00000	39980.0	553.90	22144922.
1.10000	39340.0	554.70	21821898.
1.20000	38710.0	555.40	21499534.
1.30000	38400.0	556.00	21350400.
1.40000	37850.0	556.50	21063525.
1.50000	37320.0	556.90	20783508.
1.60000	36930.0	557.30	20581089.
1.70000	36810.0	557.70	20528937.
1.80000	36610.0	558.00	20428380.
1.90000	36330.0	558.40	20286672.
2.00000	36010.0	558.80	20122388.
2.25000	35430.0	559.90	19837257.
2.50000	34670.0	561.10	19453337.
2.75000	33700.0	562.70	18962990.
3.00000	32670.0	564.60	18445482.

TABLE 4.3.10B

MASS/ENERGY RELEASE RATES.
1414-SQ IN SUCTION LEG GUILLOTINE BREAK
AT STEAM GENERATOR NOZZLE.
FOR RCS ASYMMETRIC LOADS EVALUATION.
(FLOW FROM PUMP SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	544.70	0.
.00100	3968.0	544.60	2160973.
.00200	7702.0	544.20	4191428.
.00300	10870.0	543.70	5910019.
.00400	13250.0	543.10	7196075.
.00500	15380.0	542.50	8343650.
.00600	16760.0	541.90	9082244.
.00700	17700.0	541.30	9581010.
.00800	18360.0	540.90	9930924.
.00900	18950.0	540.60	10284370.
.01000	19500.0	540.30	10535850.
.01200	20870.0	539.90	11267713.
.01400	23520.0	539.80	12696496.
.01600	26870.0	539.80	14504426.
.01800	30200.0	539.80	16301960.
.02000	33480.0	539.80	18072594.
.02200	33340.0	539.80	17996932.
.02400	33180.0	539.80	17910564.
.02600	33010.0	539.80	17818798.
.02800	32850.0	539.80	17732139.
.03000	32680.0	539.80	17640604.
.03200	32520.0	539.80	17554296.
.03400	32370.0	539.80	17473320.
.03600	32220.0	539.80	17392356.
.03800	32070.0	539.80	17311396.
.04000	31930.0	539.80	17235814.
.04200	31790.0	539.80	17160212.
.04400	31660.0	539.80	17090068.
.04600	31530.0	539.80	17019894.
.04800	31410.0	539.80	16955118.
.05000	31280.0	539.80	16884944.
.05500	30980.0	539.80	16723034.
.06000	30700.0	539.80	16571830.
.06500	30420.0	539.80	16420716.
.07000	30150.0	539.80	16274970.
.07500	29890.0	539.80	16134622.
.08000	29630.0	539.80	15994672.
.08500	29390.0	539.80	15864722.
.09000	29130.0	539.80	15724374.
.09500	28850.0	539.80	15573230.
.10000	28580.0	539.70	15424626.
.11000	28060.0	539.80	15146738.
.12000	27600.0	539.80	14898480.
.13000	27140.0	539.80	14650172.
.14000	26670.0	539.80	14396466.

(CONTINUED)

TABLE 4.3.10B (CONT.)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	26220.0	539.80	14153556.
.16000	25840.0	539.90	13951016.
.17000	25630.0	539.90	13837637.
.18000	25570.0	539.90	13805243.
.19000	25480.0	539.90	13756652.
.20000	25400.0	539.90	13713460.
.22000	25200.0	539.90	13605480.
.24000	24990.0	540.00	13494600.
.26000	24750.0	540.00	13365000.
.28000	24500.0	540.10	13232450.
.30000	24180.0	540.10	13059618.
.32000	23830.0	540.20	12872966.
.34000	23460.0	540.20	12673092.
.36000	23120.0	540.20	12489424.
.38000	22980.0	540.30	12416094.
.40000	22850.0	540.30	12345855.
.42000	22720.0	540.30	12275616.
.44000	22580.0	540.40	12202232.
.46000	22450.0	540.40	12131980.
.48000	22310.0	540.40	12056324.
.50000	22190.0	540.40	11991476.
.55000	21820.0	540.50	11793710.
.60000	21580.0	540.50	11663990.
.65000	21330.0	540.60	11530998.
.70000	21100.0	540.60	11406660.
.75000	20890.0	540.60	11293134.
.80000	20690.0	540.60	11185014.
.85000	20510.0	540.70	11089757.
.90000	20340.0	540.70	10997838.
.95000	20190.0	540.70	10916733.
1.00000	20050.0	540.70	10841035.
1.10000	19760.0	540.70	10684232.
1.20000	19390.0	540.70	10484173.
1.30000	18980.0	540.70	10262486.
1.40000	18560.0	540.70	10035392.
1.50000	18160.0	540.70	9819112.
1.60000	17790.0	540.80	9620832.
1.70000	17440.0	540.90	9433296.
1.80000	17140.0	540.90	9271026.
1.90000	16860.0	541.00	9121260.
2.00000	16600.0	541.10	8982260.
2.25000	16000.0	541.40	8662400.
2.50000	15670.0	541.80	8490006.
2.75000	15400.0	542.20	8349880.
3.00000	15180.0	542.70	8238186.

TABLE 4.3.11A

FORT CALHOUN MASS AND ENERGY RELEASE
RATES FOR 905 SQ. IN. DISCHARGE LEG
GUILLOTINE BREAK AT RV INLET NOZZLE
FOR RCS ASYMMETRIC LOADS EVALUATION
(FLOW FROM PUMP SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	541.00	0.
.00100	2282.0	540.90	1234334.
.00200	4337.0	540.30	2343281.
.00300	5748.0	539.40	3100471.
.00400	6803.0	538.40	3662735.
.00500	7110.0	537.40	3820914.
.00600	6848.0	536.50	3673952.
.00700	6450.0	535.80	3455910.
.00800	7369.0	535.80	3948310.
.00900	8288.0	535.80	4440710.
.01000	9206.0	535.80	4932575.
.01200	11040.0	535.80	5915232.
.01400	12870.0	535.80	6895746.
.01600	14690.0	535.90	7872371.
.01800	16500.0	535.90	8842350.
.02000	18310.0	535.90	9812329.
.02200	20100.0	535.90	10771590.
.02400	20960.0	535.90	11232464.
.02600	20910.0	535.90	11205669.
.02800	20860.0	535.90	11178874.
.03000	20800.0	535.90	11146720.
.03200	20760.0	535.90	11125284.
.03400	20710.0	536.00	11100560.
.03600	20670.0	536.00	11079120.
.03800	20620.0	536.00	11052320.
.04000	20580.0	536.00	11030880.
.04200	20540.0	536.00	11009440.
.04400	20500.0	536.00	10988000.
.04600	20460.0	536.10	10968606.
.04800	20420.0	536.10	10947162.
.05000	20380.0	536.10	10925718.
.05500	20270.0	536.10	10866747.
.06000	20170.0	536.10	10813137.
.06500	20060.0	536.10	10754166.
.07000	19950.0	536.20	10697190.
.07500	19830.0	536.20	10632846.
.08000	19710.0	536.20	10568502.
.08500	19580.0	536.20	10498796.
.09000	19440.0	536.20	10423728.
.09500	19310.0	536.20	10354022.
.10000	19170.0	536.20	10278954.
.11000	18910.0	536.30	10141433.
.12000	18660.0	536.30	10007358.
.13000	18430.0	536.40	9885852.
.14000	18220.0	536.40	9773208.

(CONTINUED)

TABLE 4.3.11A (CONT.)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	17970.0	536.40	9639108.
.16000	17700.0	536.40	9494280.
.17000	17440.0	536.50	9356560.
.18000	17190.0	536.50	9222435.
.19000	16950.0	536.60	9095370.
.20000	16720.0	536.60	8971952.
.22000	16440.0	536.70	8823348.
.24000	16330.0	536.80	8765944.
.26000	16190.0	536.80	8690792.
.28000	16050.0	536.90	8617245.
.30000	15890.0	537.00	8532930.
.32000	15700.0	537.10	8432470.
.34000	15480.0	537.20	8315856.
.36000	15240.0	537.30	8188452.
.38000	14980.0	537.50	8051750.
.40000	14800.0	537.60	7956480.
.42000	14720.0	537.70	7914944.
.44000	14640.0	537.80	7873392.
.46000	14560.0	538.00	7833280.
.48000	14480.0	538.10	7791688.
.50000	14400.0	538.30	7751520.
.55000	14160.0	538.70	7627992.
.60000	14010.0	539.20	7554192.
.65000	13870.0	539.70	7485639.
.70000	13740.0	540.20	7422348.
.75000	13610.0	540.70	7358927.
.80000	13500.0	541.30	7307550.
.85000	13390.0	541.90	7256041.
.90000	13280.0	542.50	7204400.
.95000	13180.0	543.10	7158058.
1.00000	13090.0	543.70	7117033.
1.10000	12900.0	544.90	7029210.
1.20000	12640.0	546.10	6902704.
1.30000	12290.0	547.20	6725088.
1.40000	11870.0	548.30	6508321.
1.50000	11390.0	549.20	6255388.
1.60000	10890.0	550.20	5991678.
1.70000	10410.0	551.20	5737992.
1.80000	9958.0	552.00	5496816.
1.90000	9630.0	552.90	5324427.
2.00000	9309.0	553.80	5155324.
2.50000	8351.0	557.10	4652342.

TABLE 4.3.11B

FORT CALHOUN MASS AND ENERGY RELEASE RATES FOR 905 SQ. IN. DISCHARGE LEG GUILLOTINE BREAK AT RV INLET NOZZLE FOR RCS ASYMMETRIC LOADS EVALUATION (FLOW FROM RV SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	541.00	0.
.00100	2167.0	540.30	1170830.
.00200	4072.0	539.70	2197658.
.00300	5867.0	539.50	3165247.
.00400	6840.0	538.40	3682656.
.00500	7231.0	537.50	3886663.
.00600	7625.0	536.90	4093863.
.00700	7488.0	536.20	4015066.
.00800	7756.0	535.90	4156440.
.00900	8851.0	536.00	4744136.
.01000	9894.0	536.10	5304173.
.01200	11740.0	536.10	6293814.
.01400	13540.0	536.20	7260148.
.01600	15320.0	536.40	8217648.
.01800	17090.0	536.50	9168785.
.02000	18870.0	536.70	10127529.
.02200	20680.0	536.90	11103092.
.02400	24290.0	537.40	13053446.
.02600	26240.0	537.80	14111872.
.02800	27950.0	538.20	15042690.
.03000	29420.0	538.50	15842670.
.03200	30680.0	538.80	16530384.
.03400	31740.0	539.00	17107860.
.03600	32630.0	539.10	17590833.
.03800	33360.0	539.20	17987712.
.04000	33960.0	539.30	18314628.
.04200	34430.0	539.30	18568099.
.04400	34770.0	539.40	18754938.
.04600	35000.0	539.30	18875500.
.04800	35110.0	539.30	18934823.
.05000	35120.0	539.20	18936704.
.05500	34880.0	539.00	18800320.
.06000	34530.0	538.70	18601311.
.06500	34150.0	538.60	18393190.
.07000	33530.0	538.30	18049199.
.07500	32740.0	538.10	17617394.
.08000	31990.0	537.90	17207421.
.08500	31300.0	537.70	16830010.
.09000	30660.0	537.60	16482816.
.09500	30360.0	537.50	16318500.
.10000	30670.0	537.70	16491259.
.11000	31840.0	538.00	17129920.
.12000	32150.0	538.10	17299915.
.13000	31950.0	538.00	17189100.
.14000	32140.0	538.10	17294534.

(CONTINUED)

TABLE 4.3.11B (CONT.)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	32100.0	538.00	17269800.
.16000	31830.0	538.00	17124540.
.17000	31170.0	537.80	16763226.
.18000	30650.0	537.70	16480505.
.19000	31090.0	537.70	16723311.
.20000	32070.0	538.10	17256867.
.22000	31260.0	537.90	16814754.
.24000	31260.0	537.90	16814754.
.26000	30860.0	537.90	16599594.
.28000	31190.0	538.00	16780220.
.30000	31430.0	538.10	16912483.
.32000	30640.0	537.90	16481256.
.34000	30670.0	538.00	16500460.
.36000	30600.0	538.00	16462800.
.38000	30600.0	538.00	16462800.
.40000	30200.0	538.00	16247600.
.42000	30330.0	538.10	16320973.
.44000	30490.0	538.20	16409718.
.46000	30270.0	538.20	16291314.
.48000	30050.0	538.20	16172910.
.50000	30010.0	538.30	16154383.
.55000	29910.0	538.40	16103544.
.60000	29880.0	538.60	16093368.
.65000	29730.0	538.80	16018524.
.70000	29560.0	539.00	15932840.
.75000	29390.0	539.20	15847088.
.80000	29220.0	539.50	15764190.
.85000	28990.0	539.80	15648802.
.90000	28850.0	540.20	15584770.
.95000	28630.0	540.50	15474515.
1.00000	28430.0	540.90	15377787.
1.10000	28040.0	541.70	15189268.
1.20000	27600.0	542.60	14975760.
1.30000	27100.0	543.50	14728850.
1.40000	26630.0	544.50	14500035.
1.50000	26140.0	545.50	14259370.
1.60000	25630.0	546.60	14009358.
1.70000	25390.0	547.80	13908642.
1.80000	24970.0	548.90	13706033.
1.90000	24570.0	549.90	13511043.
2.00000	24210.0	550.80	13334868.
2.50000	22740.0	554.20	12602508.

TABLE 4.3.12A

FORT CALHOUN MASS AND ENERGY RELEASE RATES FOR 200 SQ. IN. HOT LEG GUILLOTINE BREAK AT RV OUTLET NOZZLE FOR RCS ASYMMETRIC LOADS EVALUATION (FLOW FROM R.V. SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	616.70	0.
.00100	457.0	616.70	281832.
.00200	904.6	616.60	557776.
.00300	1345.0	616.50	829193.
.00400	1771.0	616.40	1091644.
.00500	2170.0	616.30	1337371.
.00600	2552.0	616.10	1572287.
.00700	2940.0	616.00	1811040.
.00800	3336.0	616.00	2054976.
.00900	3725.0	615.90	2294228.
.01000	4117.0	615.90	2535660.
.01200	4984.0	616.00	3070144.
.01400	5861.0	616.00	3610376.
.01600	6753.0	616.10	4160523.
.01800	7568.0	616.10	4662645.
.02000	8325.0	616.00	5128200.
.02200	8320.0	616.00	5125120.
.02400	8355.0	616.10	5147516.
.02600	8485.0	616.20	5228457.
.02800	8534.0	616.20	5258651.
.03000	8539.0	616.20	5261732.
.03200	8452.0	616.20	5208122.
.03400	8352.0	616.10	5145667.
.03600	8253.0	616.00	5083848.
.03800	8194.0	615.90	5046685.
.04000	8163.0	615.90	5027592.
.04200	8149.0	615.90	5018969.
.04400	8130.0	615.90	5007267.
.04600	8098.0	615.80	4986748.
.04600	8056.0	615.80	4962116.
.05000	8018.0	615.80	4937484.
.05500	7947.0	615.70	4892968.
.06000	7844.0	615.60	4828766.
.06500	7688.0	615.50	4731964.
.07000	7543.0	615.40	4641962.
.07500	7369.0	615.30	4534146.
.08000	7172.0	615.10	4411497.
.08500	7016.0	615.10	4315542.
.09000	6923.0	615.00	4257645.
.09500	6829.0	614.90	4199152.
.10000	6729.0	614.80	4136989.
.11000	6502.0	614.60	3996129.
.12000	6192.0	614.40	3804365.
.13000	5944.0	614.20	3650805.
.14000	5795.0	614.20	3559289.

(CONTINUED)

TABLE 4.3.12A (CONT.)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	5806.0	614.30	3566626.
.16000	5771.0	614.30	3545125.
.17000	5700.0	614.30	3501510.
.18000	5635.0	614.30	3461581.
.19000	5633.0	614.40	3460915.
.20000	5626.0	614.40	3456614.
.22000	5604.0	614.60	3444216.
.24000	5594.0	614.70	3438632.
.26000	5584.0	614.80	3433043.
.28000	5566.0	615.00	3424320.
.30000	5553.0	615.10	3415650.
.32000	5539.0	615.30	3408147.
.34000	5528.0	615.40	3401931.
.36000	5523.0	615.50	3399407.
.38000	5521.0	615.70	3399286.
.40000	5522.0	615.80	3400448.
.42000	5527.0	616.00	3404632.
.44000	5530.0	616.10	3407033.
.46000	5532.0	616.30	3409372.
.48000	5534.0	616.40	3411158.
.50000	5533.0	616.60	3411646.
.55000	5525.0	616.90	3408373.
.60000	5510.0	617.20	3405710.
.65000	5524.0	617.50	3411070.
.70000	5518.0	617.80	3409020.
.75000	5503.0	618.10	3401464.
.80000	5495.0	618.30	3397559.
.85000	5494.0	618.50	3398039.
.90000	5494.0	618.60	3399687.
.95000	5492.0	619.00	3399548.
1.00000	5488.0	619.10	3397621.
1.10000	5478.0	619.40	3393073.
1.20000	5461.0	619.60	3383636.
1.30000	5443.0	619.80	3373571.
1.40000	5422.0	619.90	3361098.
1.50000	5382.0	619.90	3336302.
1.60000	5354.0	620.10	3320015.
1.70000	5323.0	620.20	3301325.
1.80000	5258.0	620.20	3261012.
1.90000	5226.0	620.30	3241688.
2.00000	5216.0	620.40	3236006.
2.50000	5077.0	621.20	3153832.
3.00000	4896.0	622.60	3046250.

TABLE 4.3.128

FORT CALHOUN MASS AND ENERGY RELEASE
RATES FOR 200 SQ. IN. HOT LEG
GUILLOTINE BREAK AT RV OUTLET NOZZLE
FOR RCS ASYMMETRIC LOADS EVALUATION
(FLOW FROM S.G. SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	616.70	0.
.00100	458.2	616.70	282572.
.00200	909.0	616.60	560469.
.00300	1344.0	616.50	828576.
.00400	1757.0	616.30	1082839.
.00500	2153.0	616.20	1326679.
.00600	2536.0	616.00	1562176.
.00700	2910.0	615.90	1792269.
.00800	3283.0	615.80	2021671.
.00900	3672.0	615.80	2261218.
.01000	4079.0	615.80	2511848.
.01200	4934.0	615.80	3038357.
.01400	5843.0	615.90	3598704.
.01600	6731.0	616.00	4146296.
.01800	7552.0	616.00	4652032.
.02000	8285.0	615.90	5102732.
.02200	8233.0	615.80	5069881.
.02400	8342.0	615.90	5137838.
.02600	8475.0	616.10	5221448.
.02800	8571.0	616.20	5281450.
.03000	8561.0	616.20	5275268.
.03200	8474.0	616.10	5220831.
.03400	8348.0	616.00	5142368.
.03600	8243.0	615.90	5076854.
.03800	8181.0	615.80	5037860.
.04000	8162.0	615.80	5026160.
.04200	8158.0	615.80	5023696.
.04400	8145.0	615.80	5015691.
.04600	8112.0	615.70	4994556.
.04800	8065.0	615.70	4965621.
.05000	8018.0	615.70	4936683.
.05500	7945.0	615.60	4890942.
.06000	7842.0	615.50	4830444.
.06500	7677.0	615.40	4724426.
.07000	7525.0	615.20	4629380.
.07500	7354.0	615.10	4523445.
.08000	7154.0	614.90	4398995.
.08500	7002.0	614.80	4304830.
.09000	6930.0	614.80	4260564.
.09500	6841.0	614.70	4205163.
.10000	6747.0	614.60	4146706.
.11000	6531.0	614.40	4012646.
.12000	6207.0	614.10	3811719.
.13000	5945.0	613.90	3649636.
.14000	5792.0	613.80	3555130.

(CONTINUED)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	5807.0	613.80	3564337.
.16000	5772.0	613.80	3542854.
.17000	5707.0	613.80	3502957.
.18000	5644.0	613.70	3463723.
.19000	5640.0	613.70	3461266.
.20000	5638.0	613.80	3460604.
.22000	5630.0	613.80	3455694.
.24000	5627.0	613.90	3454415.
.26000	5618.0	613.90	3448890.
.28000	5607.0	614.00	3442698.
.30000	5594.0	614.10	3435275.
.32000	5581.0	614.10	3427292.
.34000	5572.0	614.20	3422322.
.36000	5568.0	614.30	3420422.
.38000	5569.0	614.40	3421594.
.40000	5574.0	614.50	3425223.
.42000	5581.0	614.70	3430641.
.44000	5587.0	614.80	3434886.
.46000	5591.0	614.90	3437906.
.48000	5593.0	615.00	3439695.
.50000	5593.0	615.10	3440254.
.55000	5588.0	615.40	3436855.
.60000	5583.0	615.70	3437453.
.65000	5591.0	616.00	3444056.
.70000	5584.0	616.30	3441419.
.75000	5566.0	616.60	3431996.
.80000	5556.0	616.90	3427496.
.85000	5553.0	617.20	3427312.
.90000	5550.0	617.40	3426570.
.95000	5545.0	617.70	3425147.
1.00000	5539.0	617.90	3422546.
1.10000	5523.0	618.40	3415423.
1.20000	5498.0	618.70	3401613.
1.30000	5471.0	619.00	3386549.
1.40000	5443.0	619.30	3370850.
1.50000	5395.0	619.40	3341663.
1.60000	5370.0	619.60	3327252.
1.70000	5337.0	619.80	3307873.
1.80000	5264.0	619.80	3262627.
1.90000	5235.0	620.00	3245700.
2.00000	5220.0	620.10	3236922.
2.50000	5094.0	620.70	3161846.
3.00000	4925.0	621.80	3064852.

TABLE 4.3.13A

FORT CALHOUN MASS AND ENERGY RELEASE
RATES FOR 1608 SQ. IN. HOT LEG
GUILLOTINE BREAK AT S.G. INLET NOZZLE
FOR RCS ASYMMETRIC LOADS EVALUATION
(FLOW FROM R.V. SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	616.70	0.
.00100	2608.0	616.60	1608093.
.00200	4989.0	616.30	3074721.
.00300	6982.0	615.70	4298817.
.00400	8526.0	615.10	5244343.
.00500	9714.0	614.50	5969253.
.00600	10760.0	614.10	6607716.
.00700	11650.0	613.70	7149605.
.00800	12930.0	613.60	7933848.
.00900	14540.0	613.60	8921744.
.01000	16140.0	613.60	9903504.
.01200	19340.0	613.60	11867024.
.01400	22530.0	613.60	13824408.
.01600	25680.0	613.60	15757248.
.01800	28810.0	613.60	17677816.
.02000	31890.0	613.70	19570893.
.02200	34920.0	613.70	21430404.
.02400	37920.0	613.70	23271504.
.02600	40890.0	613.70	25094193.
.02800	43880.0	613.70	26929156.
.03000	43740.0	613.70	26843238.
.03200	43620.0	613.80	26773956.
.03400	43520.0	613.80	26712576.
.03600	43430.0	613.80	26657334.
.03800	43360.0	613.80	26614368.
.04000	43300.0	613.80	26577540.
.04200	43260.0	613.90	26557314.
.04400	43220.0	613.90	26532758.
.04600	43200.0	613.90	26520480.
.04800	43190.0	613.90	26514341.
.05000	43180.0	613.90	26508202.
.05500	43200.0	614.00	26524800.
.06000	43230.0	614.00	26543220.
.06500	43270.0	614.00	26567780.
.07000	43310.0	614.00	26592340.
.07500	43340.0	614.00	26610760.
.08000	43370.0	614.00	26629180.
.08500	43400.0	614.00	26647600.
.09000	43420.0	614.00	26659880.
.09500	43450.0	614.00	26678300.
.10000	43460.0	614.00	26684440.
.11000	43490.0	614.10	26707209.
.12000	43490.0	614.10	26707209.
.13000	43480.0	614.10	26701068.
.14000	43440.0	614.10	26676504.

(CONTINUED)

TABLE 4.3.13A (CONT.)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	43380.0	614.10	26639658.
.16000	43290.0	614.20	26588718.
.17000	43180.0	614.20	26521156.
.18000	43050.0	614.20	26441310.
.19000	42890.0	614.20	26343038.
.20000	42710.0	614.30	26236753.
.22000	42290.0	614.30	25978747.
.24000	41790.0	614.40	25675776.
.26000	41220.0	614.40	25325568.
.28000	40580.0	614.40	24932352.
.30000	39890.0	614.50	24512405.
.32000	39140.0	614.50	24051530.
.34000	38370.0	614.50	23578365.
.36000	37580.0	614.50	23092910.
.38000	36740.0	614.60	22580404.
.40000	35890.0	614.60	22057994.
.42000	35080.0	614.60	21560168.
.44000	34330.0	614.60	21099218.
.46000	33650.0	614.70	20684655.
.48000	33050.0	614.70	20315835.
.50000	32520.0	614.80	19993296.
.55000	32010.0	614.90	19682949.
.60000	31800.0	615.00	19557000.
.65000	31590.0	615.30	19437327.
.70000	31380.0	615.60	19317528.
.75000	31130.0	615.80	19169854.
.80000	30810.0	616.10	18982041.
.85000	30410.0	616.50	18747765.
.90000	29950.0	616.90	18476155.
.95000	29520.0	617.70	18234504.
1.00000	29130.0	618.90	18028557.
1.10000	28410.0	622.40	17682384.
1.20000	27250.0	626.10	17061225.
1.30000	26210.0	629.90	16509679.
1.40000	25350.0	633.80	16066830.
1.50000	24450.0	638.00	15599100.
1.60000	23530.0	643.20	15134496.
1.70000	22610.0	650.60	14710066.
1.80000	21530.0	658.70	14181811.
1.90000	20460.0	668.50	13677510.
2.00000	19650.0	678.80	13338420.
2.50000	16040.0	728.00	11677120.
3.00000	17200.0	683.30	11752760.

TABLE 4.3.13B

FORT CALHOUN MASS AND ENERGY RELEASE
RATES FOR 1608 SQ. IN. HOT LEG
GUILLOTINE BREAK AT S.G. INLET NOZZLE
FOR RCS ASYMMETRIC LOADS EVALUATION
(FLOW FROM S.G. SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	616.70	0.
.00100	2486.0	616.20	1531873.
.00200	4936.0	616.20	3041563.
.00300	7072.0	615.80	4354938.
.00400	8642.0	615.20	5316558.
.00500	10210.0	614.90	6278129.
.00600	11270.0	614.30	6923161.
.00700	12260.0	613.90	7526414.
.00800	13140.0	613.60	8062704.
.00900	14540.0	613.60	8921744.
.01000	16130.0	613.60	9897368.
.01200	19180.0	613.50	11766930.
.01400	22030.0	613.50	13515405.
.01600	24670.0	613.40	15132578.
.01800	27130.0	613.40	16641542.
.02000	29450.0	613.30	18061685.
.02200	31630.0	613.20	19395516.
.02400	33570.0	613.20	20585124.
.02600	35060.0	613.10	21495286.
.02800	35570.0	613.00	21804410.
.03000	33520.0	612.90	20544408.
.03200	32470.0	612.90	19900863.
.03400	32410.0	612.90	19864089.
.03600	33120.0	613.10	20305872.
.03800	34290.0	613.20	21026628.
.04000	35630.0	613.30	21851879.
.04200	36970.0	613.30	22673701.
.04400	38210.0	613.40	23438014.
.04600	39170.0	613.40	24026878.
.04800	39950.0	613.40	24505330.
.05000	40520.0	613.30	24850916.
.05500	40890.0	613.20	25073748.
.06000	39900.0	613.00	24458700.
.06500	37940.0	612.70	23245838.
.07000	35190.0	612.40	21550356.
.07500	32500.0	612.20	19896500.
.08000	31760.0	612.00	19437120.
.08500	31310.0	611.80	19155458.
.09000	31000.0	611.60	18959600.
.09500	30860.0	611.40	18867804.
.10000	30810.0	611.10	18827991.
.11000	30690.0	610.20	18727038.
.12000	30450.0	609.20	18550140.
.13000	30390.0	608.10	18480159.
.14000	30520.0	607.00	18525640.

(CONTINUED)

TABLE 4.3.13B (CONT.)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	30570.0	605.90	18522363.
.16000	30350.0	604.90	18358715.
.17000	29920.0	604.00	18071680.
.18000	29320.0	603.20	17685824.
.19000	28560.0	602.50	17207400.
.20000	27720.0	601.80	16681896.
.22000	26420.0	600.30	15859926.
.24000	26130.0	598.20	15630966.
.26000	26470.0	595.70	15768179.
.28000	26780.0	593.20	15885896.
.30000	26710.0	591.00	15785610.
.32000	26340.0	589.10	15516894.
.34000	25880.0	587.40	15201912.
.36000	25420.0	585.70	14888494.
.38000	25140.0	584.00	14681760.
.40000	24980.0	582.30	14545854.
.42000	24850.0	580.60	14427910.
.44000	24730.0	579.00	14318670.
.46000	24630.0	577.40	14221362.
.48000	24570.0	575.80	14147406.
.50000	24510.0	574.30	14076093.
.55000	24250.0	570.90	13844325.
.60000	23870.0	567.80	13553386.
.65000	23580.0	565.20	13327416.
.70000	23350.0	562.70	13139045.
.75000	23190.0	560.50	12997995.
.80000	23120.0	558.50	12912520.
.85000	23070.0	556.60	12840762.
.90000	23010.0	554.80	12765948.
.95000	22950.0	553.30	12698235.
1.00000	22890.0	551.90	12632991.
1.10000	22840.0	549.40	12548296.
1.20000	22840.0	547.20	12498048.
1.30000	22840.0	545.50	12459220.
1.40000	22830.0	544.10	12421803.
1.50000	22810.0	542.90	12383549.
1.60000	22760.0	541.90	12333644.
1.70000	22660.0	541.10	12261326.
1.80000	22510.0	540.50	12166655.
1.90000	22300.0	540.10	12044230.
2.00000	22060.0	540.00	11912400.
2.50000	20300.0	541.50	10992450.
3.00000	18100.0	545.50	9873550.

TABLE 4.3.14A

FORT CALHOUN MASS AND ENERGY RELEASE
RATES FOR 905 SQ. IN. SUCTION LEG
GUILLOTINE BREAK AT SG OUTLET NOZZLE
FOR RCS ASYMMETRIC LOADS EVALUATION
(FLOW FROM PUMP SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	541.00	0.
.00100	2562.0	540.80	1385530.
.00200	4847.0	540.20	2618349.
.00300	6474.0	539.40	3492076.
.00400	7795.0	538.60	4198387.
.00500	8511.0	537.80	4577216.
.00600	9004.0	537.20	4836949.
.00700	9581.0	536.80	5143081.
.00800	10360.0	536.60	5559176.
.00900	11320.0	536.50	6073180.
.01000	12320.0	536.50	6609680.
.01200	13890.0	536.30	7449207.
.01400	14880.0	536.00	7975680.
.01600	17000.0	536.00	9112000.
.01800	19100.0	536.00	10237600.
.02000	21180.0	536.00	11352480.
.02200	21080.0	536.00	11298880.
.02400	20980.0	536.00	11245280.
.02600	20870.0	536.00	11186320.
.02800	20770.0	536.00	11132720.
.03000	20670.0	536.00	11079120.
.03200	20570.0	536.00	11025520.
.03400	20470.0	536.00	10971920.
.03600	20370.0	536.00	10918320.
.03800	20280.0	536.00	10870080.
.04000	20180.0	536.00	10816480.
.04200	20100.0	536.00	10773600.
.04400	20010.0	536.00	10725360.
.04600	19930.0	536.00	10682480.
.04800	19850.0	536.00	10639600.
.05000	19770.0	536.00	10596720.
.05500	19590.0	536.00	10500240.
.06000	19420.0	536.00	10409120.
.06500	19250.0	536.00	10318000.
.07000	19080.0	536.00	10226880.
.07500	18920.0	536.00	10141120.
.08000	18760.0	536.00	10055360.
.08500	18610.0	536.00	9974960.
.09000	18450.0	536.00	9889200.
.09500	18290.0	536.10	9805269.
.10000	18130.0	536.10	9719493.
.11000	17830.0	536.10	9558663.
.12000	17550.0	536.10	9408555.
.13000	17290.0	536.20	9270898.
.14000	17030.0	536.20	9131486.

(CONTINUED)

TABLE 4.3.14A (CONT.)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	16780.0	536.20	8997436.
.16000	16570.0	536.30	8886491.
.17000	16460.0	536.30	8827498.
.18000	16420.0	536.30	8806046.
.19000	16360.0	536.40	8775504.
.20000	16300.0	536.40	8743320.
.22000	16190.0	536.50	8685935.
.24000	16060.0	536.50	8616190.
.26000	15920.0	536.60	8542672.
.28000	15760.0	536.70	8458392.
.30000	15580.0	536.70	8361786.
.32000	15400.0	536.80	8266720.
.34000	15180.0	536.80	81486[illegible].
.36000	14940.0	536.[illegible]	8021[illegible]6.
.38000	14810.0	536.[illegible]	7951[illegible]89.
.40000	14750.0	537.00	7920750.
.42000	14680.0	537.00	7883160.
.44000	14610.0	537.00	7845570.
.46000	14540.0	537.10	7809434.
.48000	14480.0	537.10	7777208.
.50000	14410.0	537.10	7739611.
.55000	14230.0	537.20	7644356.
.60000	14100.0	537.30	7575930.
.65000	13980.0	537.30	7511454.
.70000	13880.0	537.40	7459112.
.75000	13770.0	537.40	7399998.
.80000	13670.0	537.40	7346258.
.85000	13570.0	537.50	7293875.
.90000	13480.0	537.50	7245500.
.95000	13400.0	537.50	7202500.
1.00000	13320.0	537.60	7160832.
1.10000	13170.0	537.60	7080192.
1.20000	13040.0	537.70	7011608.
1.30000	12920.0	537.90	6949668.
1.40000	12820.0	538.00	6897160.
1.50000	12720.0	538.20	6845904.
1.60000	12620.0	538.40	6794608.
1.70000	12520.0	538.60	6743272.
1.80000	12340.0	538.90	6650026.
1.90000	12080.0	539.10	6512328.
2.00000	11750.0	539.30	6336775.
2.50000	10090.0	540.80	5456672.
3.00000	9243.0	542.70	5016176.

TABLE 4.3.14B

FORT CALHOUN MASS AND ENERGY RELEASE RATES FOR 905 SQ. IN. SUCTION LEG GUILLOTINE BREAK AT SG OUTLET NOZZLE FOR RCS ASYMMETRIC LOADS EVALUATION (FLOW FROM SG SIDE)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
0.00000	0.0	541.00	0.
.00100	2399.0	540.20	1295940.
.00200	4904.0	540.40	2650122.
.00300	6556.0	539.60	3537618.
.00400	8224.0	539.10	4433558.
.00500	9407.0	538.50	5065670.
.00600	10330.0	538.10	5558573.
.00700	11030.0	537.70	5930831.
.00800	11720.0	537.50	6299500.
.00900	12450.0	537.30	6689385.
.01000	13200.0	537.20	7091040.
.01200	14750.0	536.90	7919275.
.01400	16310.0	536.80	8755205.
.01600	18830.0	536.80	10107944.
.01800	22610.0	536.90	12139309.
.02000	29110.0	537.40	15643714.
.02200	28070.0	537.20	15079204.
.02400	28110.0	537.20	15100692.
.02600	28130.0	537.20	15111436.
.02800	27890.0	537.20	14982508.
.03000	27830.0	537.20	14950276.
.03200	27960.0	537.30	15022908.
.03400	27960.0	537.30	15022908.
.03600	27910.0	537.40	14998834.
.03800	28250.0	537.50	15184375.
.04000	29080.0	537.70	15636316.
.04200	30030.0	537.90	16153137.
.04400	30860.0	538.10	16605766.
.04600	31720.0	538.30	17074876.
.04800	32630.0	538.50	17571255.
.05000	33190.0	538.60	17876134.
.05500	32440.0	538.50	17469940.
.06000	34960.0	539.10	18846936.
.06500	36880.0	539.60	19900448.
.07000	34780.0	539.20	18753376.
.07500	34740.0	539.30	18735282.
.08000	33920.0	539.20	18289664.
.08500	31030.0	538.80	16718964.
.09000	30640.0	538.90	16511896.
.09500	30380.0	539.00	16374820.
.10000	31290.0	539.30	16874697.
.11000	33150.0	539.90	17897685.
.12000	33430.0	540.20	18058886.
.13000	32270.0	540.20	17432254.
.14000	31250.0	540.30	16884375.

(CONTINUED)

TABLE 4.3.14B (CONT.)

TIME (SECONDS)	FLOW RATE (LB/SEC)	ENTHALPY (BTU/LB)	ENERGY RATE (BTU/SEC)
.15000	32340.0	540.80	17489472.
.16000	33460.0	541.20	18108552.
.17000	32810.0	541.30	17760053.
.18000	31760.0	541.40	17194864.
.19000	31680.0	541.70	17161056.
.20000	31840.0	542.00	17257280.
.22000	32140.0	542.60	17439164.
.24000	31740.0	543.10	17237994.
.26000	31110.0	543.50	16908285.
.28000	31710.0	544.20	17256582.
.30000	30530.0	544.50	16623585.
.32000	31740.0	545.30	17307922.
.34000	29990.0	545.50	16359545.
.36000	30990.0	546.30	16929837.
.38000	30240.0	546.70	16532208.
.40000	30330.0	547.20	16596576.
.42000	29710.0	547.70	16272167.
.44000	29540.0	548.20	16193828.
.46000	29420.0	548.70	16142754.
.48000	29340.0	549.10	16110594.
.50000	28940.0	549.60	15905424.
.55000	28750.0	550.70	15832625.
.60000	28270.0	551.80	15599386.
.65000	27910.0	552.70	15425957.
.70000	27720.0	553.70	15348564.
.75000	27500.0	554.50	15248750.
.80000	27340.0	555.40	15184636.
.85000	27190.0	556.20	15123078.
.90000	27000.0	557.00	15039000.
.95000	26800.0	557.70	14946360.
1.00000	26570.0	558.40	14836688.
1.10000	26110.0	559.60	14611156.
1.20000	25750.0	560.70	14438025.
1.30000	25390.0	561.70	14261563.
1.40000	24960.0	562.50	14040000.
1.50000	24550.0	563.20	13826560.
1.60000	24310.0	563.80	13705978.
1.70000	24010.0	564.40	13551244.
1.80000	23650.0	564.90	13359885.
1.90000	23240.0	565.50	13142220.
2.00000	22980.0	566.10	13008978.
2.50000	20140.0	568.20	11443549.
3.00000	17770.0	571.00	10146670.

TABLE 4.3.15

COMPARISON OF RCS PARAMETERS FOR MASS AND ENERGY RELEASES

PARAMETER	CALVERT CLIFFS	MILLSTONE	PALISADES	FORT CALHOUN
RCS TOTAL VOL. (FT^3)	11,100	10,980	10,960	6,555
HOT LEG ID (IN.)	42	42	42	32
COLD LEG ID (IN.)	30	30	30	24
PRESSURIZER PRESSURE (PSIA)	2,250	2,250	2,100	2,250
COLD LEG TEMP. (^{o}F)	548	548	548	545
HOT LEG TEMP. (^{o}F)	598.5	598.5	598.5	602.4
COLD LEG SATURATION PRESS. (PSIA)	1,028	1,028	1,028	1,003.5
HOT LEG SATURATION PRESS. (PSIA)	1,526	1,526	1,526	1,571.1

TABLE 4.2.16A

MILLSTONE 2/CALVERT CLIFFS 1, 2
SG COMPARTMENT ANALYSIS
MAXIMUM DIFFERENTIAL PRESSURES
ACROSS THE SG FOR THE 1000 SQ. IN. HLG

NODES (FROM-TO)	MAXIMUM DIFFERENTIAL PRESSURE (PSID)	TIME OF OCCURRENCE (SEC)
6 - 9	11.08	0.060
7 - 9	11.03	0.060
13 - 16	5.12	0.075
14 - 16	4.46	0.029
20 - 23	3.45	0.082
21 - 24	2.81	0.041
30 - 33	1.67	0.142
31 - 34	1.06	0.058
6 - 36	13.27	0.060
7 - 36	13.27	0.061
8 - 36	6.97	0.089
9 - 36	7.25	0.083
10 - 36	6.98	0.092

TABLE 4.3.16B

MILLSTONE 2/CALVERT CLIFFS 1, 2
SG COMPARTMENT ANALYSIS
MAXIMUM DIFFERENTIAL PRESSURES
ACROSS THE SG FOR THE 1414 SQ. IN. SLG

NODES (FROM-TO)	MAXIMUM DIFFERENTIAL PRESSURE (PSID)	TIME OF OCCURRENCE (SEC)
8 - 6	13.74	0.025
9 - 6	24.03	0.024
9 - 7	18.20	0.025
15 - 13	6.92	0.041
16 - 13	7.44	0.029
16 - 14	6.21	0.026
22 - 25	4.57	0.041
23 - 20	4.79	0.037
24 - 21	3.00	0.088
32 - 35	1.82	0.054
33 - 30	2.36	0.094
34 - 31	2.53	0.094
6 - 36	9.10	0.099
7 - 36	9.36	0.081
8 - 36	16.49	0.031
9 - 36	25.69	0.026
10 - 36	9.00	0.096

TABLE 4.3.17

COMPARISON OF SG COMPARTMENT PARAMETERS

PARAMETER	MILLSTONE	CALVERT CLIFFS	PALISADES	FORT CALHOUN
HEIGHT	63.5'	53.0'	51.5'	62.5'
MAXIMUM WIDTH (ALONG PRIMARY SHIELD WALL)	58.5'	48.0'	48.0'	47.0'
MAXIMUM DEPTH (PRIMARY SHIELD TO SECONDARY WALL)	27.5'	27.5'	27.0'	23.0'
NORMALIZED VOLUME	1.0	SIMILAR TO MILLSTONE	1.02	0.45*
NORMALIZED VENT AREA	1.0	SIMILAR TO MILLSTONE	0.87	1.44*

*EXCLUDES COOLANT PUMP COMPARTMENTS

TABLE 4.3.18A

PALISADES
SG COMPARTMENT ANALYSIS
MAXIMUM DIFFERENTIAL PRESSURES
ACROSS THE SG FOR THE 1000 SQ IN. HLG

NODES (FROM-TO)	MAXIMUM DIFFERENTIAL PRESSURE (PSID)	TIME OF OCCURRENCE (SEC)
6 - 9	11.41	0.060
7 - 9	11.43	0.060
13 - 16	5.05	0.076
14 - 16	4.56	0.029
20 - 23	3.37	0.083
21 - 24	2.89	0.041
30 - 33	1.58	0.144
31 - 34	1.15	0.058
6 - 36	14.10	0.059
7 - 36	14.11	0.060
8 - 36	7.60	0.091
9 - 36	7.73	0.085
10 - 36	7.65	0.094

TABLE 4.3.18B

PALISADES
SG COMPARTMENT ANALYSIS
MAXIMUM DIFFERENTIAL PRESSURES
ACROSS THE SG FOR THE 1414 SQ. IN. SLG

NODES (FROM-TO)	MAXIMUM DIFFERENTIAL PRESSURE (PSID)	TIME OF OCCURRENCE (SEC)
8 - 6	14.05	0.025
9 - 6	24.55	0.025
9 - 7	18.80	0.026
15 - 13	7.12	0.041
16 - 13	7.55	0.030
16 - 14	6.33	0.026
22 - 25	4.60	0.041
23 - 20	4.84	0.038
24 - 21	3.12	0.090
32 - 35	1.89	0.054
33 - 30	2.46	0.095
34 - 31	2.72	0.096
6 - 36	9.98	0.101
7 - 36	9.97	0.086
8 - 36	16.80	0.032
9 - 36	26.35	0.027
10 - 36	10.05	0.100

TABLE 4.3.19A

FORT CALHOUN
SG COMPARTMENT ANALYSIS
MAXIMUM DIFFERENTIAL PRESSURES
ACROSS THE SG FOR THE 1608 SQ. IN. HLG

NODES (FROM-TO)	MAXIMUM DIFFERENTIAL PRESSURE (PSID)	TIME OF OCCURRENCE (SEC)
6 - 9	12.08	0.012
7 - 9	12.66	0.016
13 - 16	6.83	0.047
14 - 16	5.20	0.048
20 - 23	5.07	0.052
21 - 24	3.68	0.053
30 - 33	1.79	0.058
31 - 34	1.39	0.059
6 - 36	20.82	0.029
7 - 36	20.86	0.028
8 - 36	10.98	0.064
9 - 36	9.79	0.072
10 - 36	10.29	0.064

TABLE 4.3.19B

FORT CALHOUN
SG COMPARTMENT ANALYSIS
MAXIMUM DIFFERENTIAL PRESSURES
ACROSS THE SG FOR THE 905 SQ. IN. SLG

NODES (FROM-TO)	MAXIMUM DIFFERENTIAL PRESSURE (PSID)	TIME OF OCCURRENCE (SEC)
8 - 6	8.05	0.012
9 - 6	14.20	0.013
9 - 7	12.03	0.009
15 - 13	4.05	0.021
16 - 13	5.31	0.018
16 - 14	4.47	0.017
22 - 25	3.36	0.029
23 - 20	3.82	0.025
24 - 21	2.35	0.049
32 - 35	1.15	0.107
33 - 30	1.41	0.081
34 - 31	2.09	0.057
6 - 36	5.27	0.025
7 - 36	6.47	0.018
8 - 36	11.59	0.025
9 - 36	15.22	0.022
10 - 36	4.09	0.038

TABLE 4.3.20

SCALING FACTORS FOR SG COMPARTMENT ANALYSIS

	MILLSTONE*		CALVERT CLIFFS		PALISADES		FORT CALHOUN	
BREAK TYPE	SLG (1)	HLG (2)	SLG	HLG	SLG	HLG	SLG	HLG
HORIZONTAL DIRECTION	1.0	1.0	1.0	1.0	1.03	1.02	0.64	1.19
VERTICAL DIRECTION	1.0	1.0	1.0	1.0	1.05	1.07	0.61	1.52

* GENERIC PLANT

(1) SUCTION LEG GUILLOTINE BREAK

(2) HOT LEG GUILLOTINE BREAK

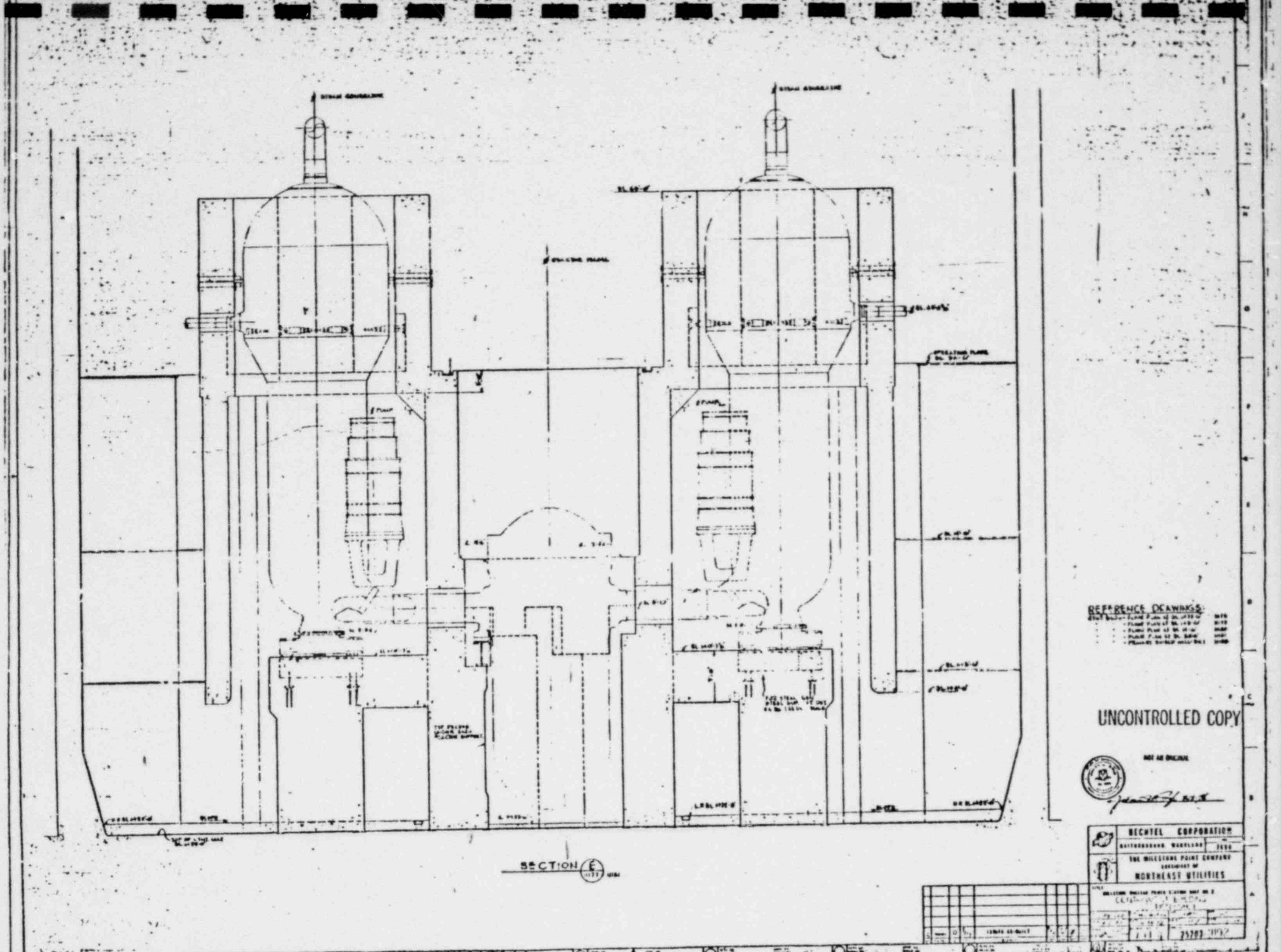
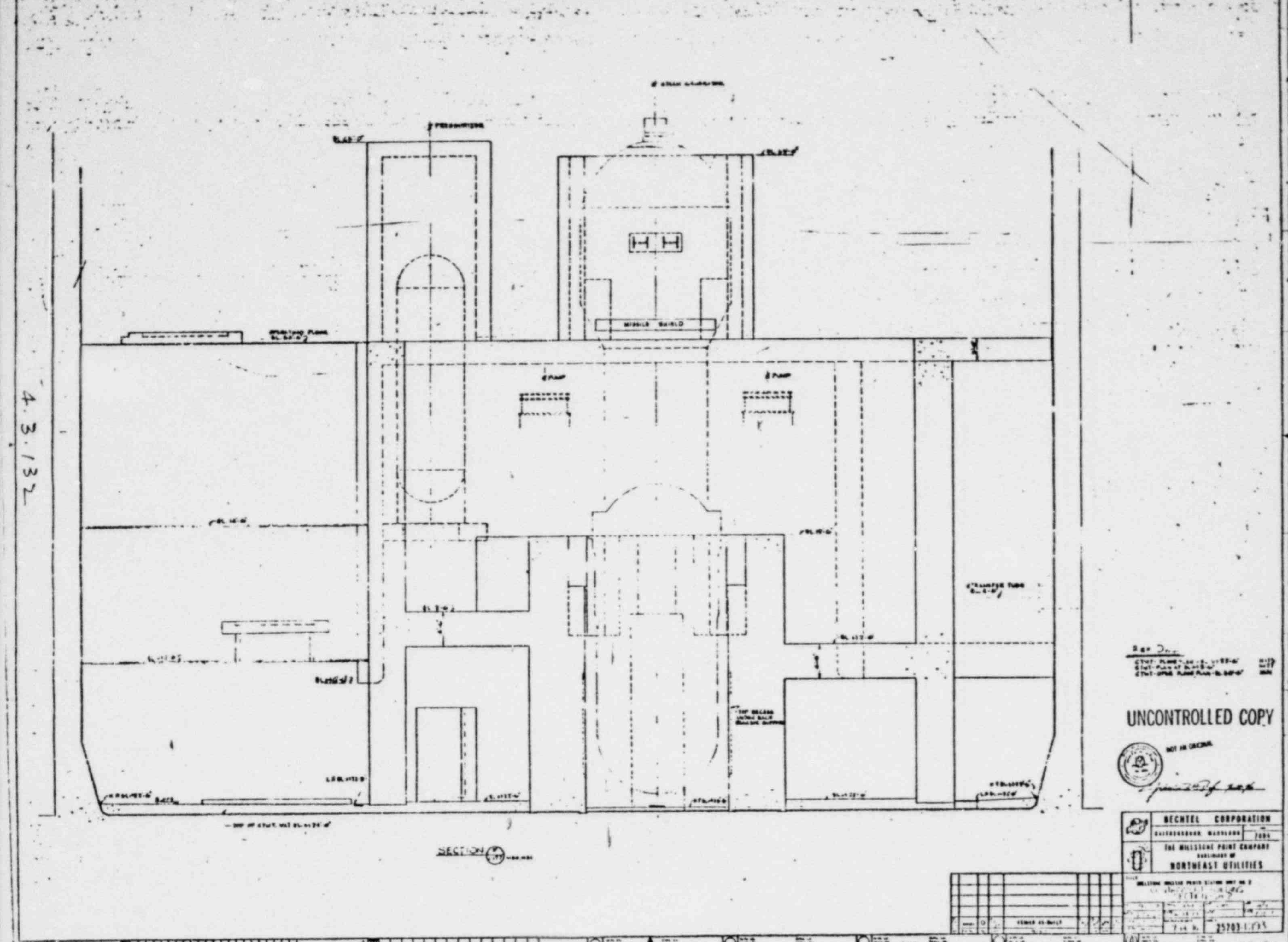

REFERENCE DRAWINGS:
UNCONTROLLED COPY
NOT AN ORIGINAL
BECHTEL CORPORATION
THE MILLSTONE POINT COMPANY
NORTHEAST UTILITIES
SECTION E

FIGURE 4.3.1


MISSILE SHIELD
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SECTION
BECHTEL CORPORATION
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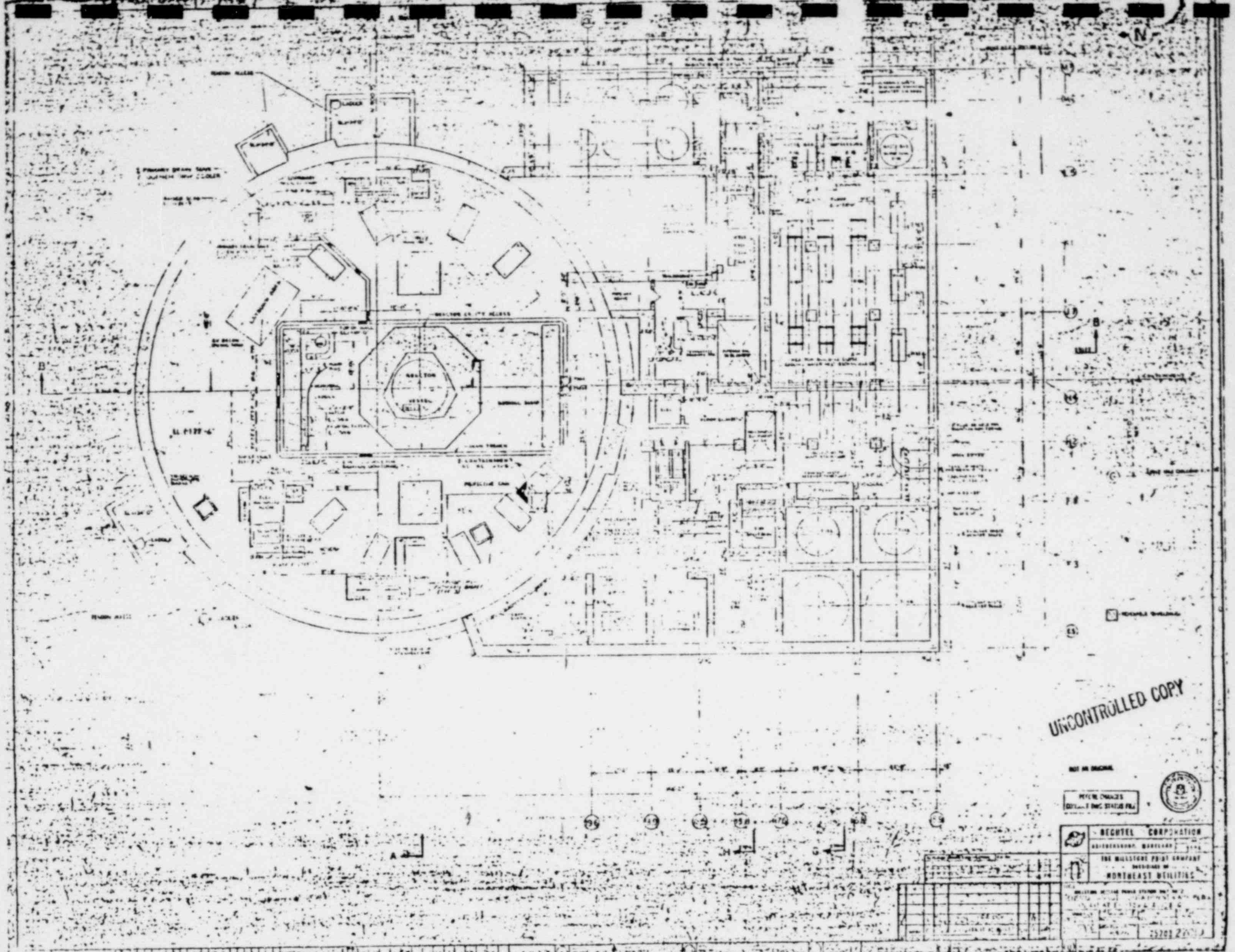
NORTHEAST UTILITIES
25203

FIGURE 4.3.2



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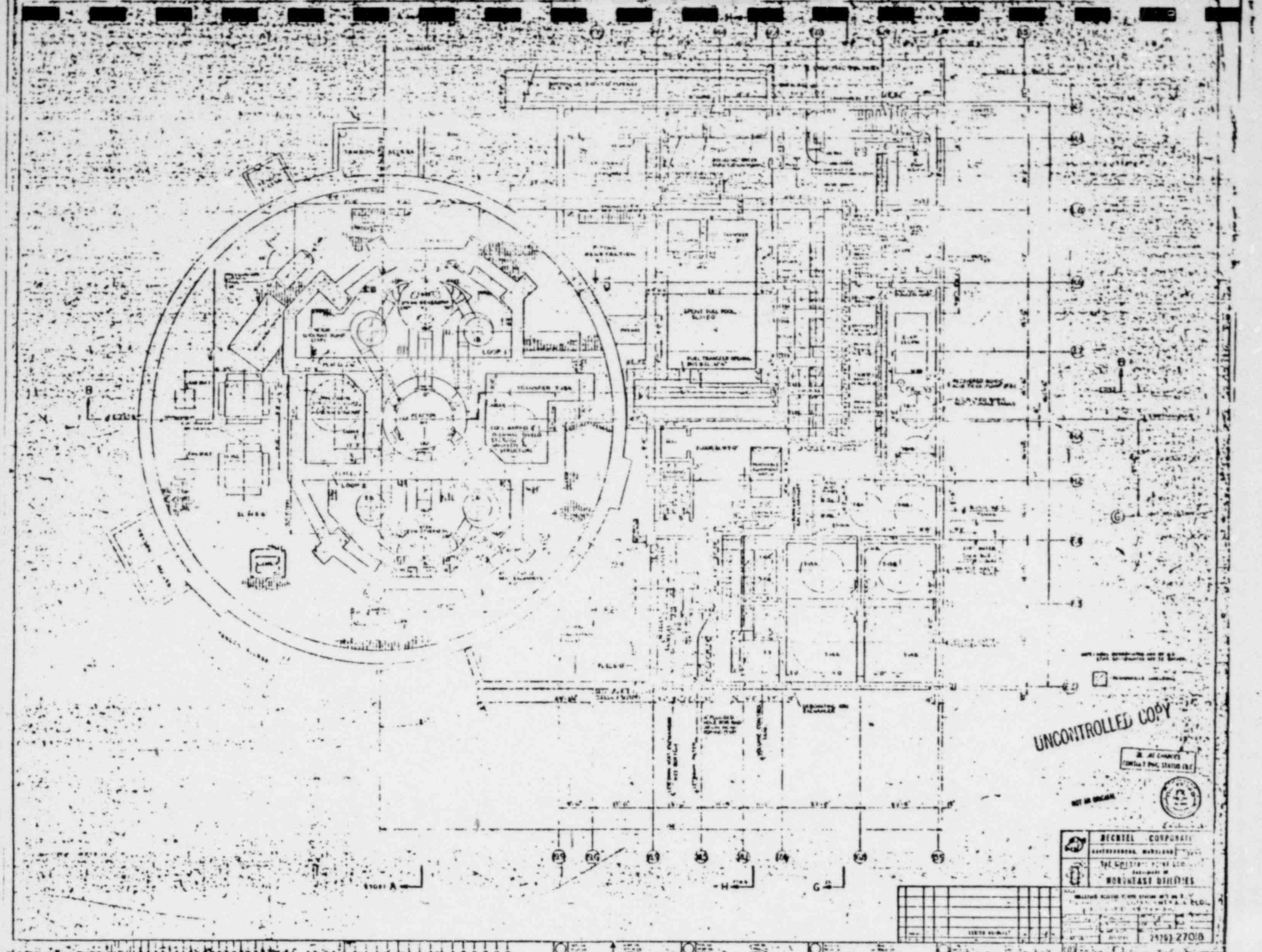
NORTHEAST UTILITIES

FIGURE 4.3.3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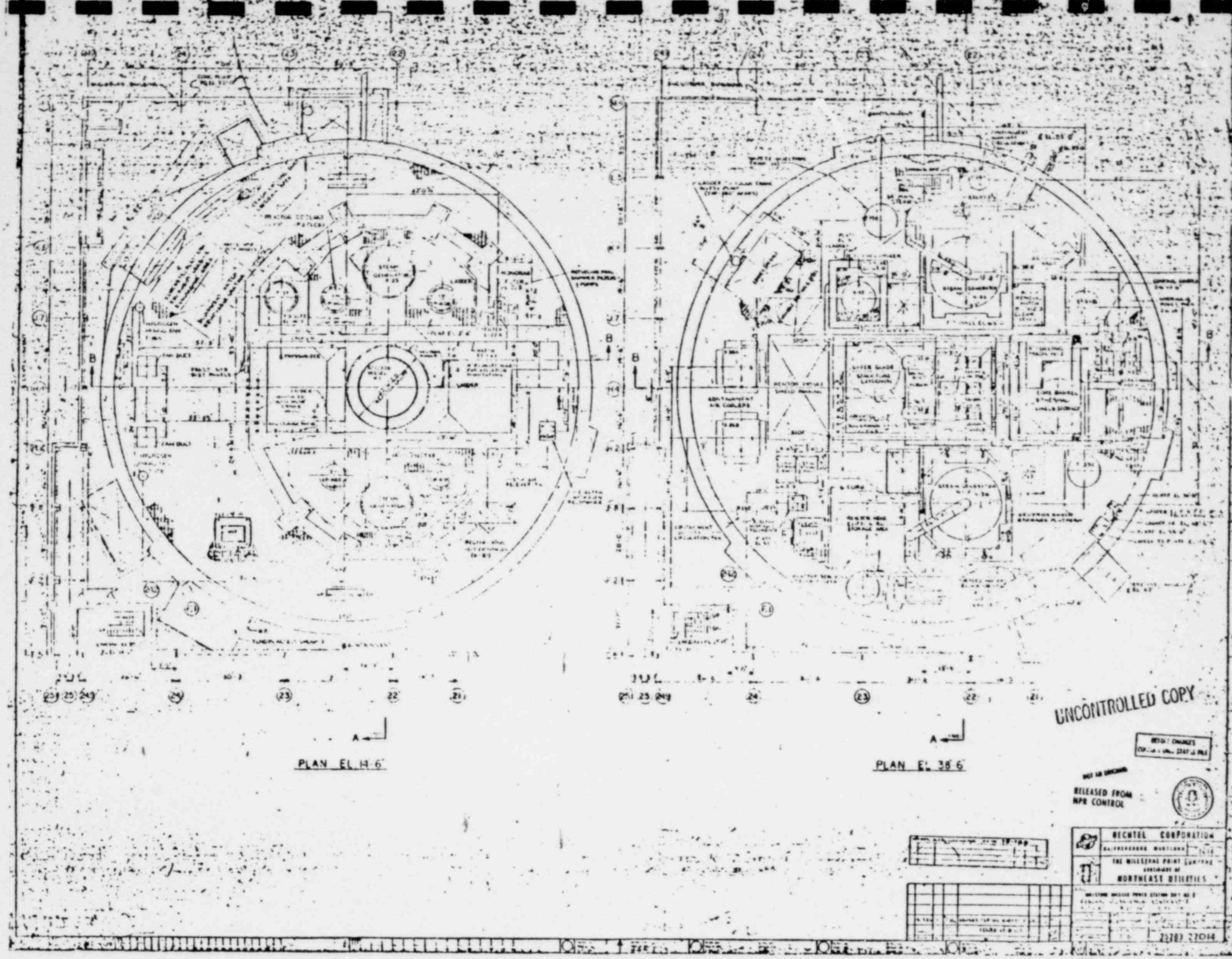
NORTHEAST UTILITIES
SPENT FUEL POOL

FIGURE 4.3.4


PLAN EL 14'-6"
PLAN EL 38'-6"
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RELEASED FROM
NPR CONTROL
BECHTEL CORPORATION
NORTHEAST UTILITIES

FIGURE 4.3.5

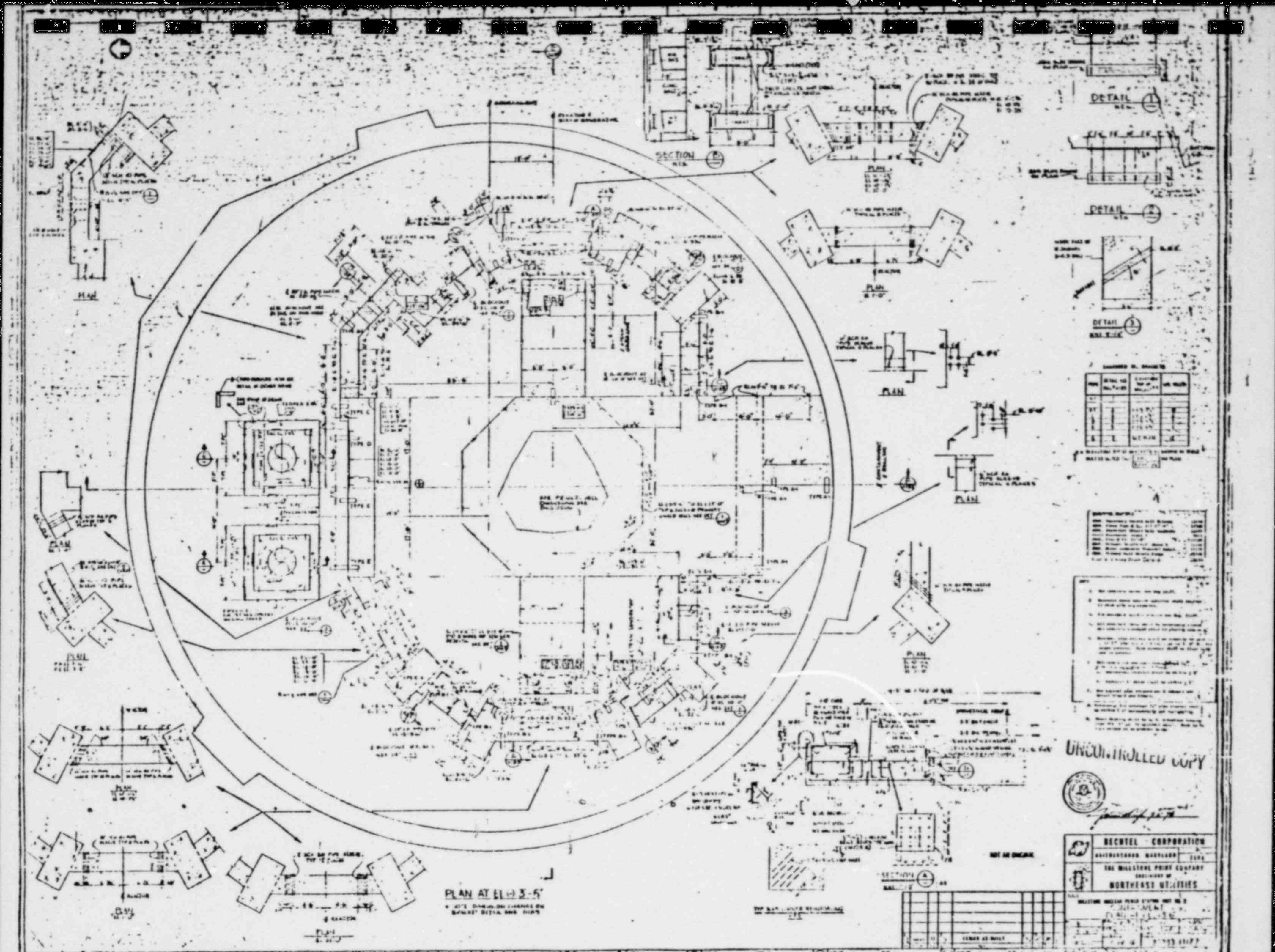

DETAIL
SECTION
PLAN
PLAN AT EL (-) 3'-5"
UNCONTROLLED COPY
BECHTEL CORPORATION
THE MILLSTONE POINT COMPANY
NORTHEAST UTILITIES

FIGURE 4.3.6

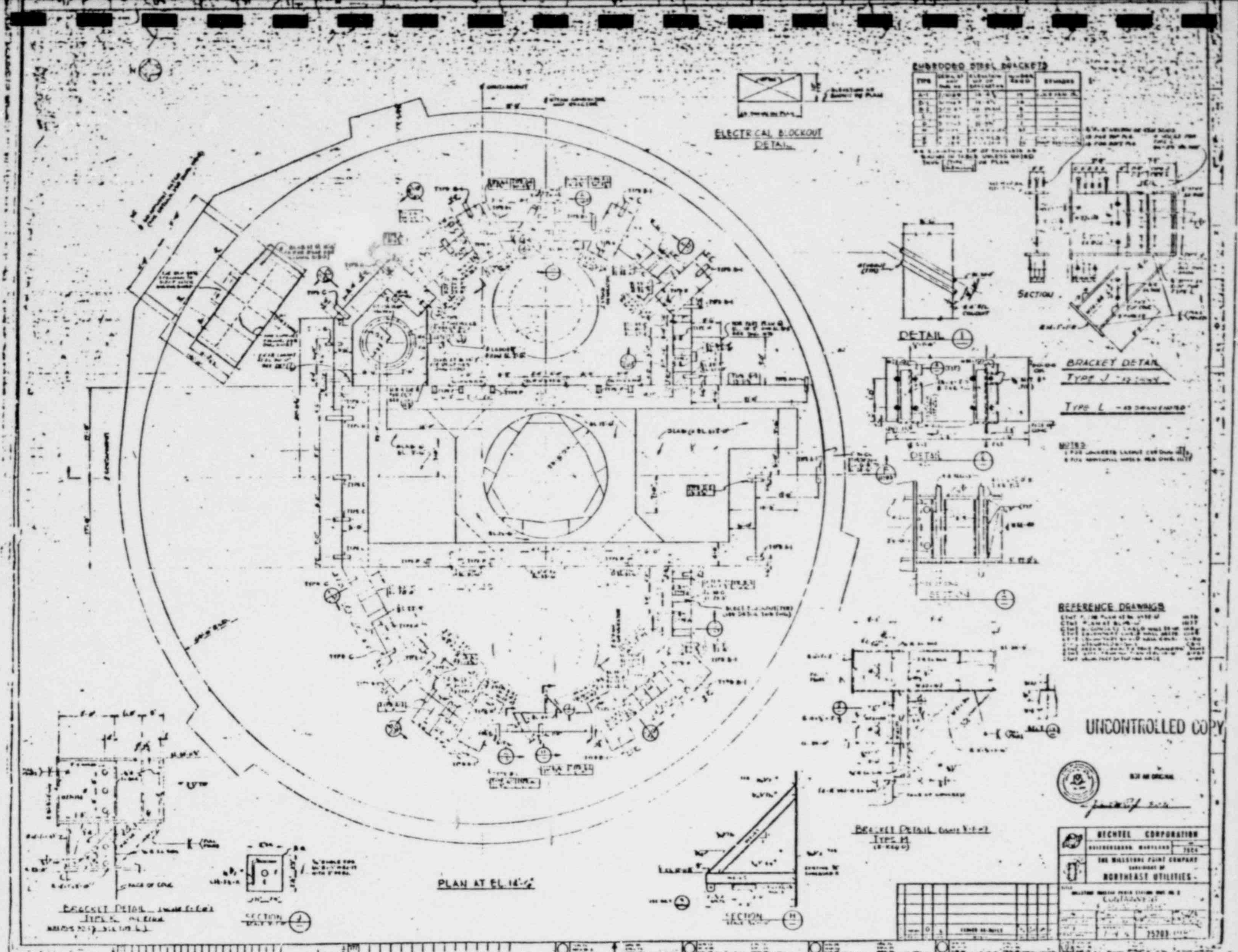

ELECTRICAL BLOCKOUT DETAIL
EMBEDDED STEEL BRACKETS
SECTION
DETAIL
BRACKET DETAIL
TYPE J
TYPE L
NOTES
REFERENCE DRAWINGS
UNCONTROLLED COPY
PLAN AT EL. 14'-6"
BRACKET DETAIL
TYPE H
BRACKET DETAIL
TYPE K
SECTION
BECHTEL CORPORATION
THE MILLSTONE POINT COMPANY
NORTHEAST UTILITIES
CONTAINMENT
25203

FIGURE 4.3.7

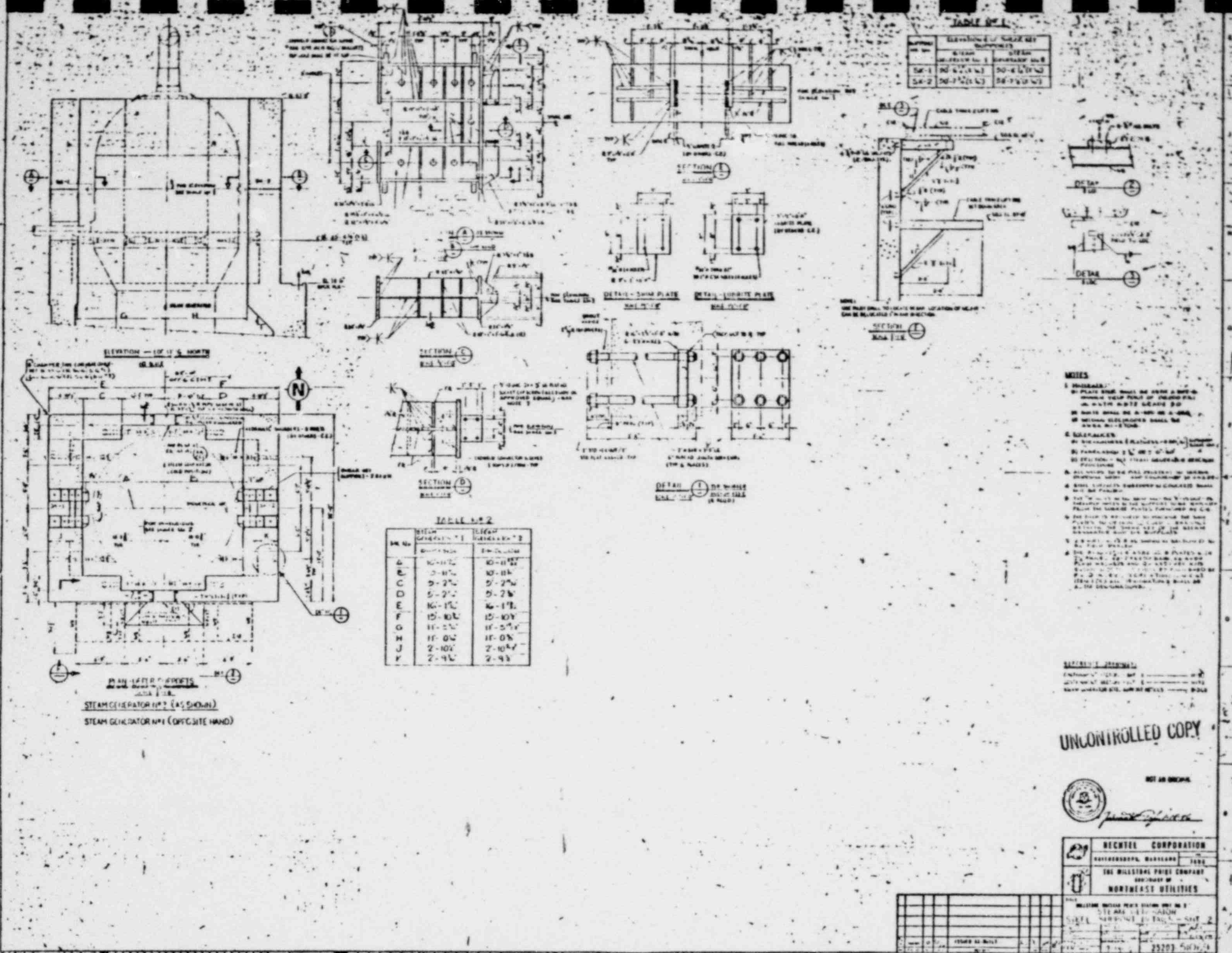
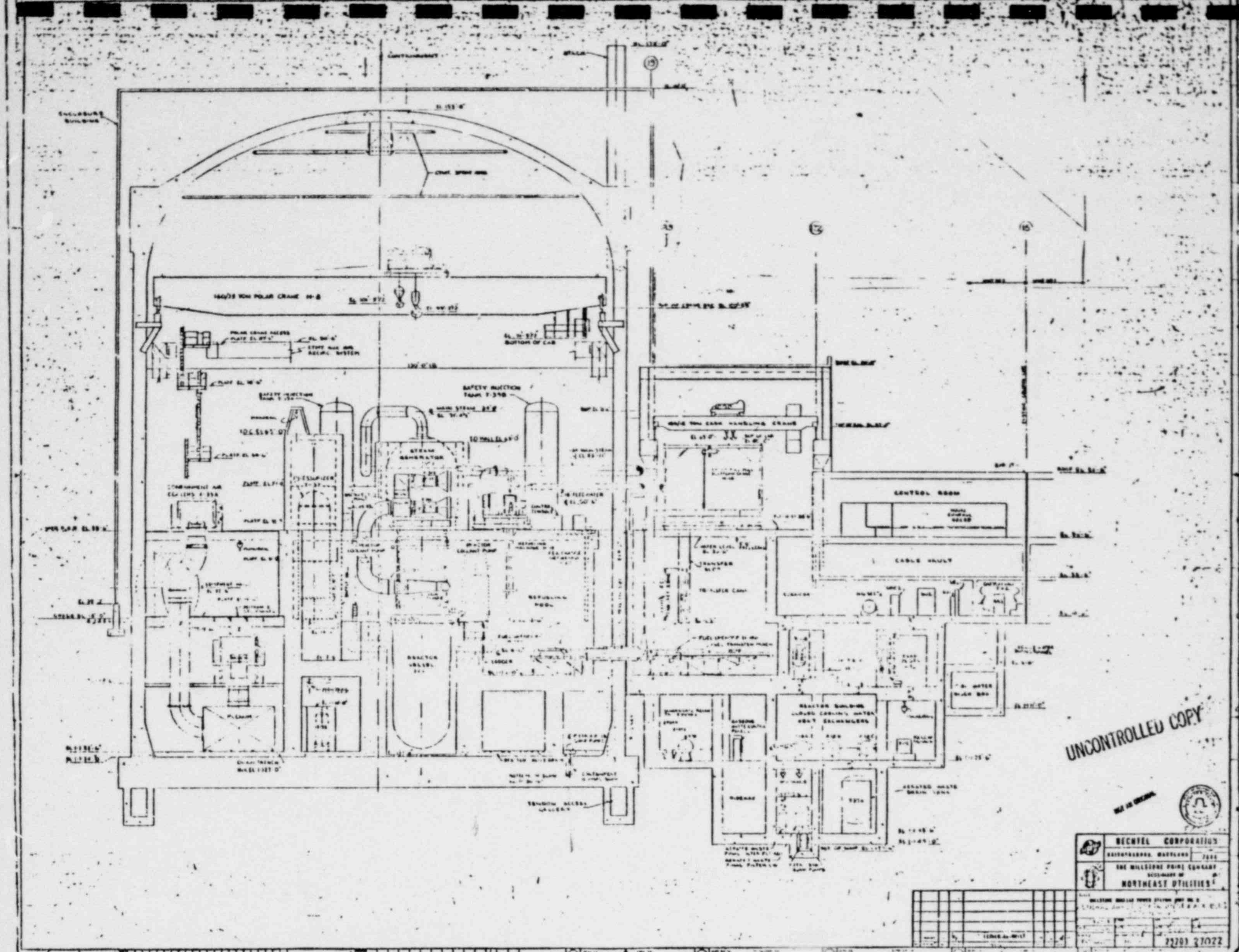


TABLE No 2

MK No	STEAM GENERATOR No 1	STEAM GENERATOR No 2
A	10'-11"	10'-11"
B	10'-11"	10'-11"
C	5'-2"	5'-2"
D	5'-2"	5'-2"
E	16'-1"	16'-1"
F	15'-10"	15'-10"
G	11'-5"	11'-5"
H	11'-0"	11'-0"
J	2'-10"	2'-10"
K	2'-9"	2'-9"


CONTROL ROOM
CABLE VAULT
STEAM GENERATOR
REACTOR VESSEL
REFUELING POOL
PRESSURIZER
SAFETY INJECTION TANK T-35B
CASK HANDLING CRANE
REACTOR BUILDING CLOSED COOLING WATER HEAT EXCHANGERS
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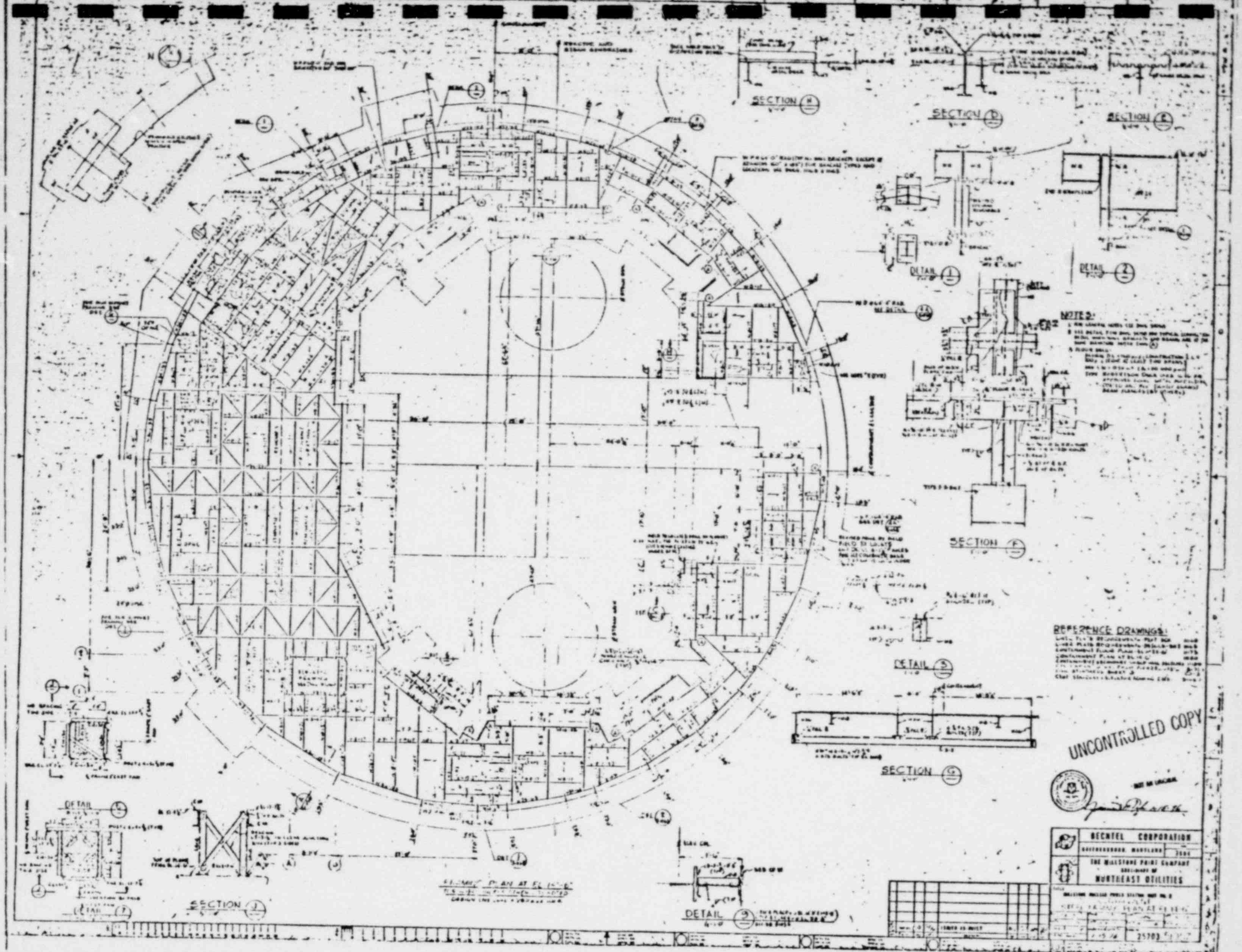
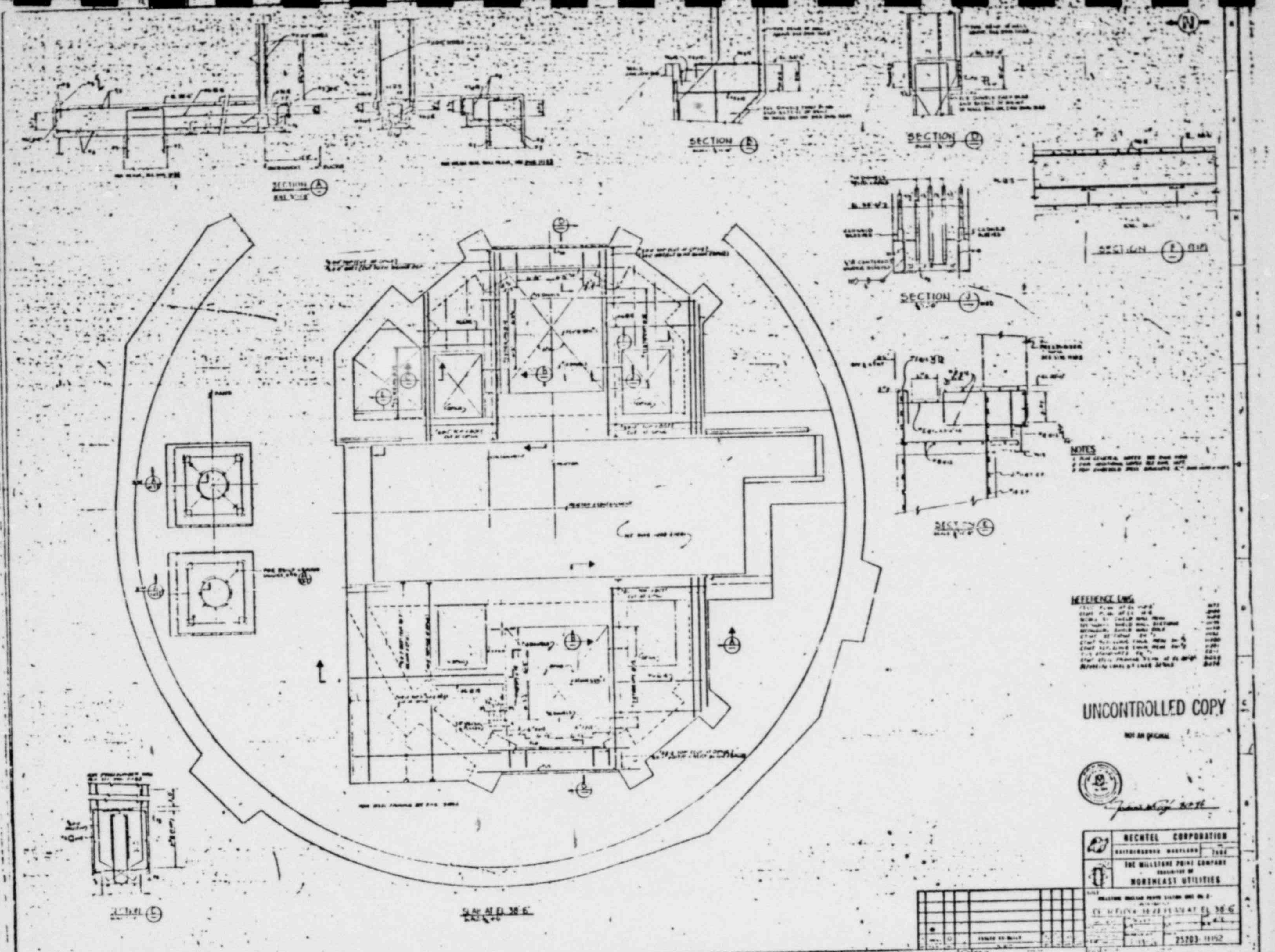
BECHTEL CORPORATION
THE MILLSTONE POINT COMPANY
NORTHEAST UTILITIES
25203-27022

FIGURE 4.3.9



SECTION H
SECTION D
SECTION E
DETAIL 1
DETAIL 2
NOTES:
SECTION F
REFERENCE DRAWINGS:
DETAIL 3
SECTION G
UNCONTROLLED COPY
BECHTEL CORPORATION
THE MILLSTONE POINT COMPANY
NORTHEAST UTILITIES
DETAIL 4
SECTION J
DETAIL 7
DETAIL 9
25703


SECTION A
SECTION B
SECTION D
SECTION F
SECTION J
SECTION K
SECTION L
SLAB AT EL 38'-6"
NOTES
REFERENCE DWG
UNCONTROLLED COPY
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THE MILLSTONE POINT COMPANY
NORTHEAST UTILITIES
25203-11152

FIGURE 4.3.11

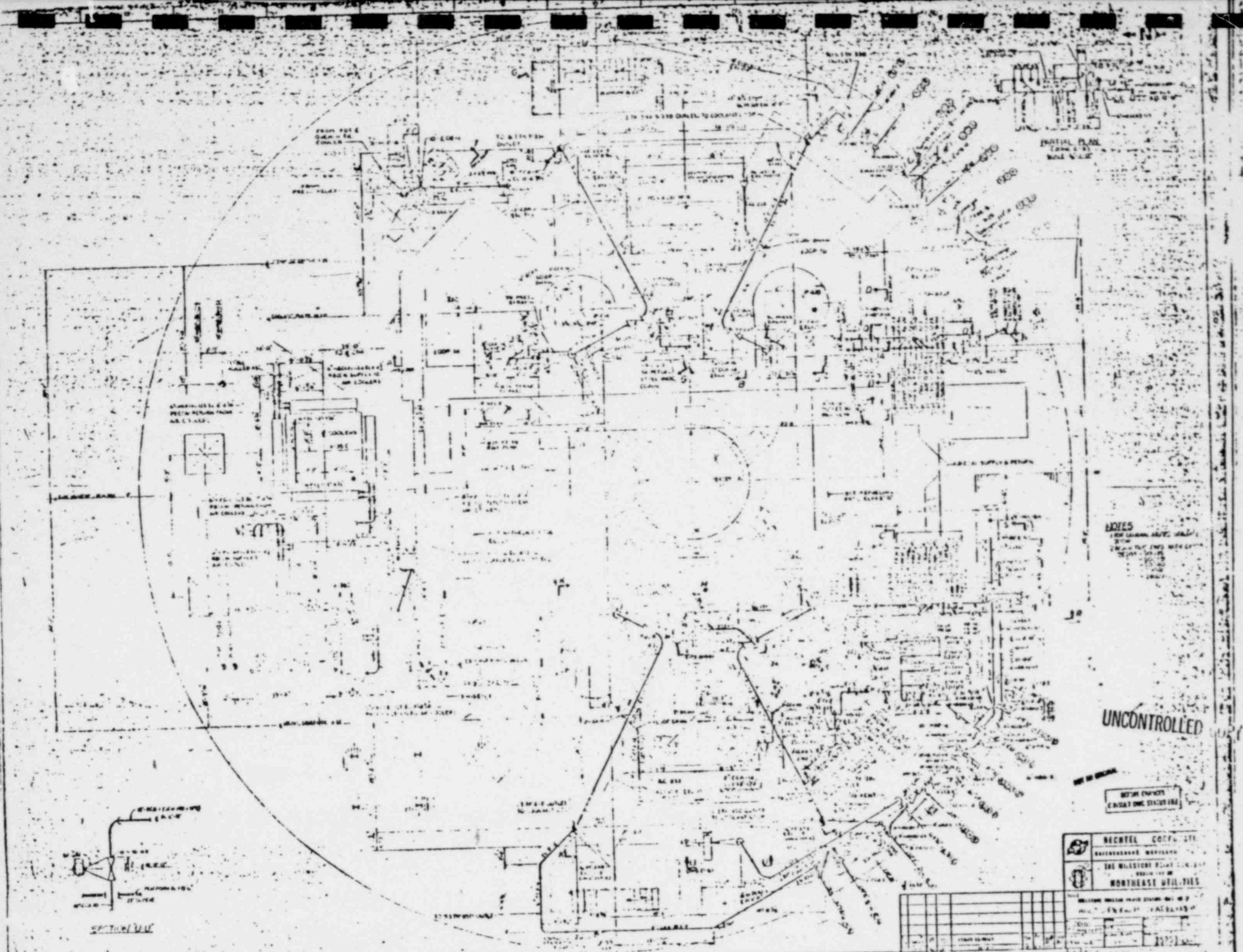
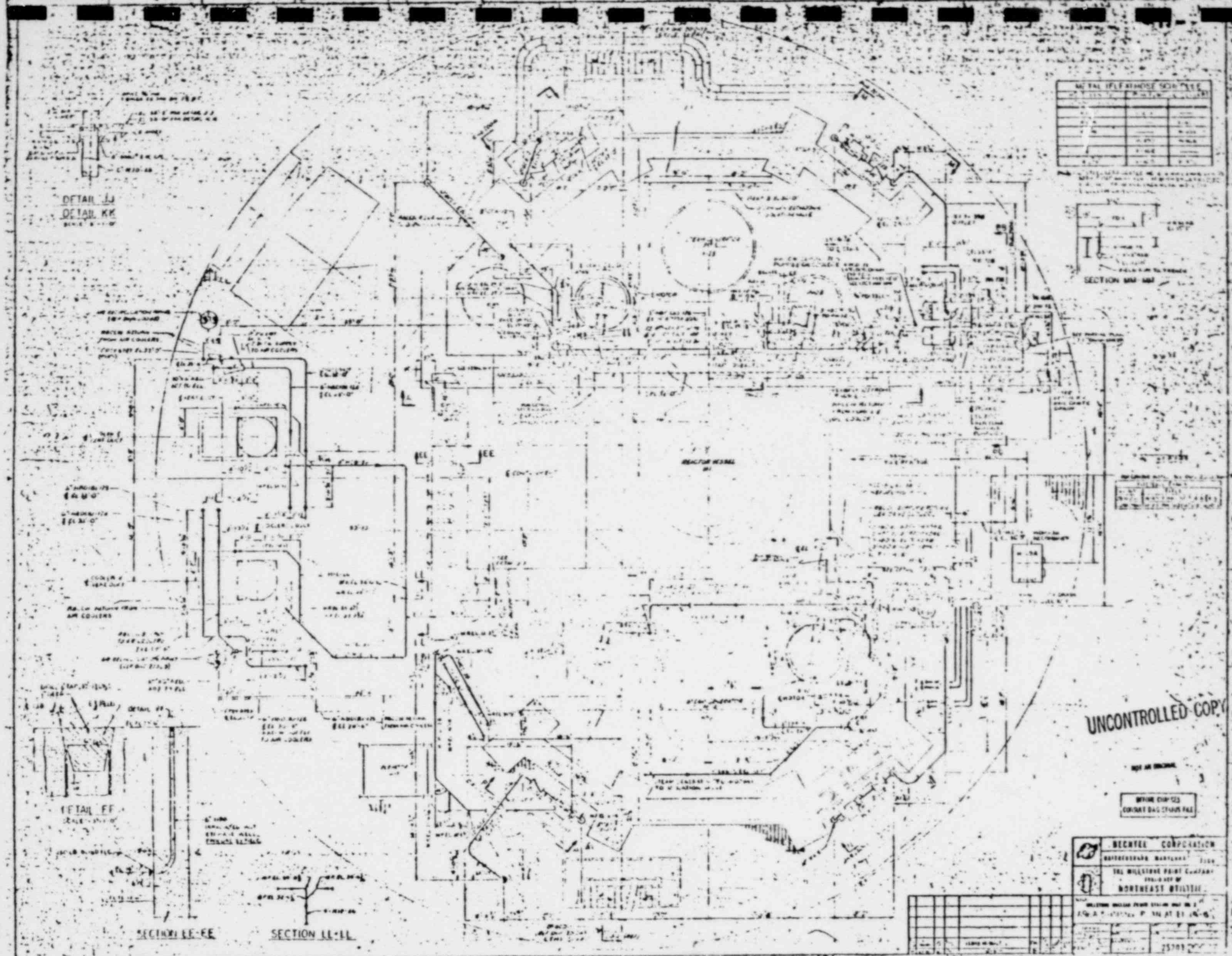

UNCONTROLLED
NOTES
PARTIAL PLAN
SECTION "U-U"
BECHTEL CORPORATION
THE MILLSTONE POINT COMPANY
NORTHEAST UTILITIES

FIGURE 4.3.12



METAL (FLEX)HOSE SCHEDULE
DETAIL JJ
DETAIL KK
SECTION MM-MM
REACTOR VESSEL
UNCONTROLLED COPY
DETAIL FF
SECTION EE-EE
SECTION LL-LL
BECHTEL CORPORATION
THE MILLSTONE POINT COMPANY
NORTHEAST UTILITIES

FIGURE 4.3.13

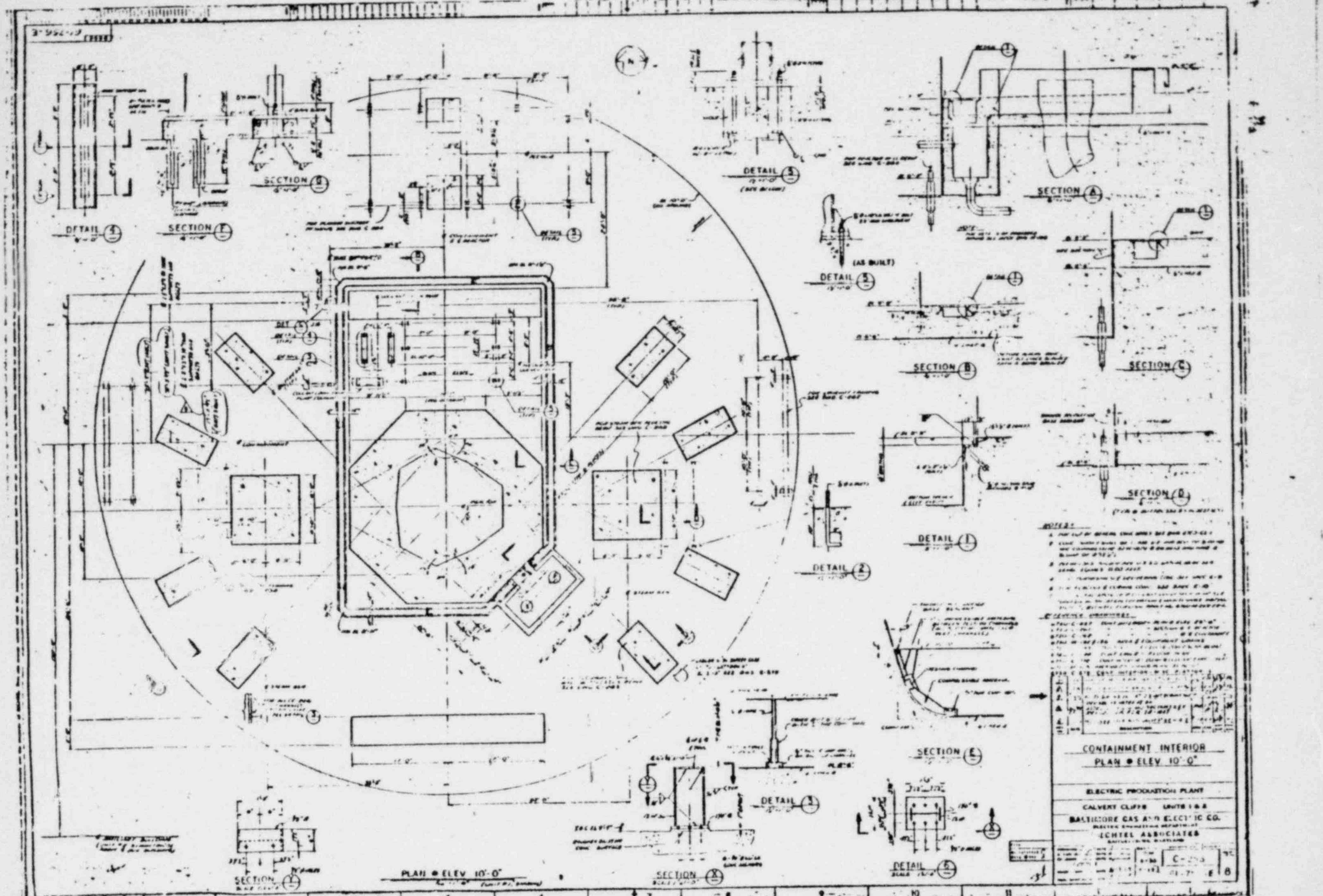
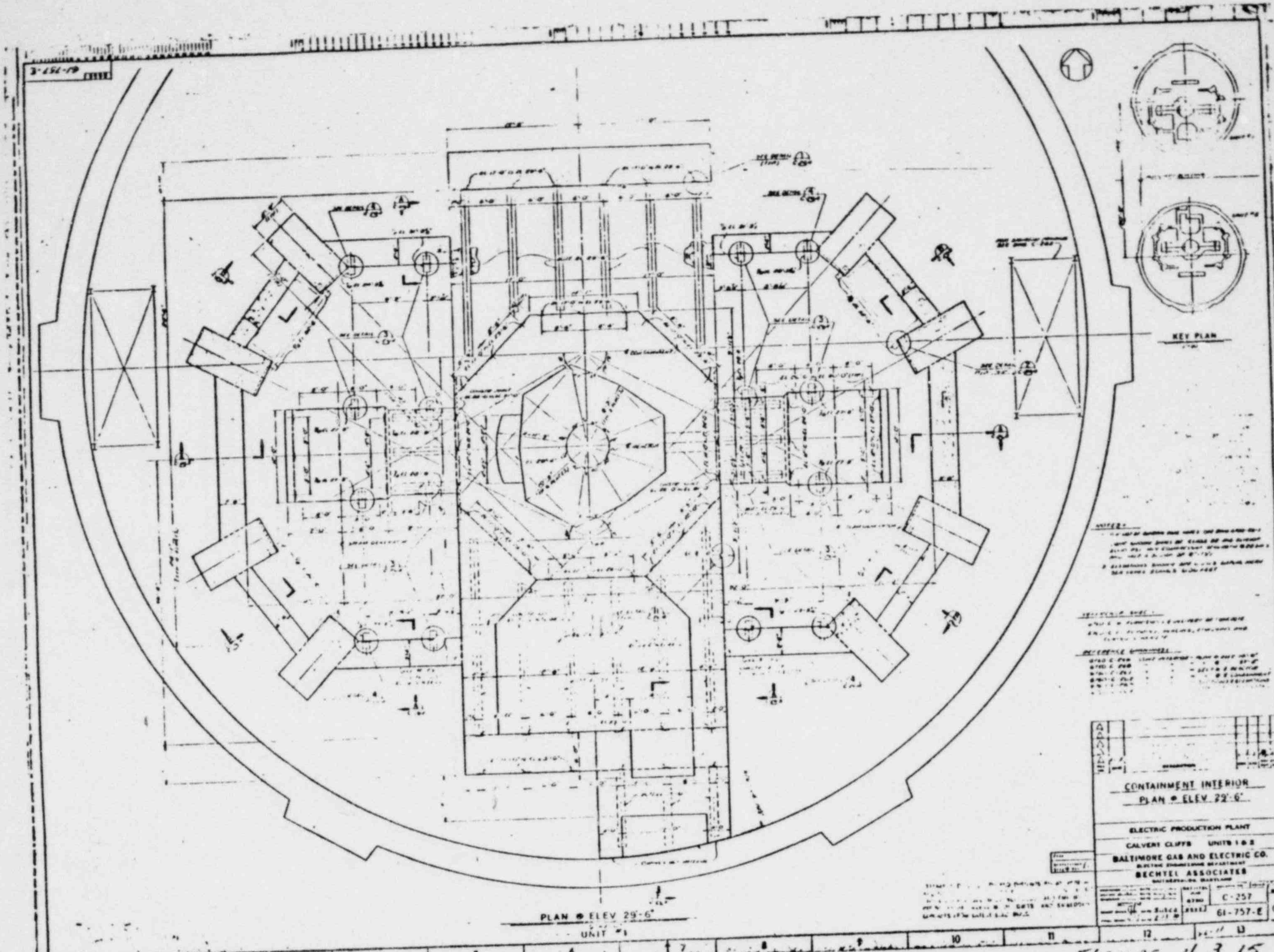

SECTION A
SECTION B
SECTION C
SECTION D
SECTION E
SECTION X
DETAIL 1
DETAIL 2
DETAIL 3
(AS BUILT)
PLAN @ ELEV 10'-0"
NOTES:
CONTAINMENT INTERIOR
PLAN @ ELEV 10'-0"
ELECTRIC PRODUCTION PLANT
CALVERT CLIFFS UNITS 1 & 2
BALTIMORE GAS AND ELECTRIC CO.
BECHTEL ASSOCIATES

FIGURE 4.3.14



KEY PLAN
PLAN @ ELEV 29'-6"
UNIT #1
CONTAINMENT INTERIOR
PLAN @ ELEV 29'-6"
ELECTRIC PRODUCTION PLANT
CALVERT CLIFFS UNITS 1 & 2
BALTIMORE GAS AND ELECTRIC CO.
BECHTEL ASSOCIATES
C-257
61-757-E

FIGURE 4.3.15

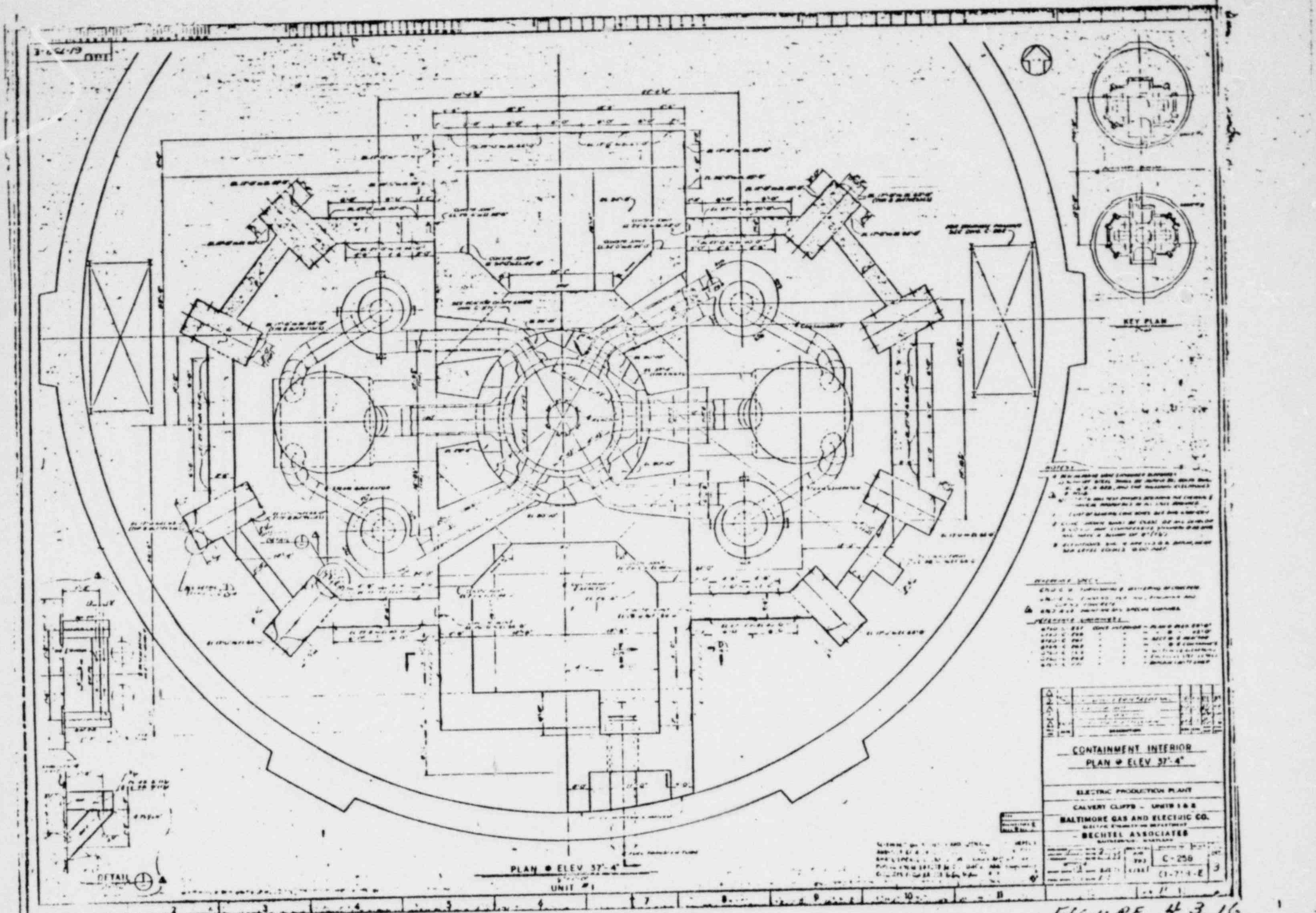

KEY PLAN
PLAN @ ELEV 37'-4"
UNIT #1
DETAIL
CONTAINMENT INTERIOR
PLAN @ ELEV 37'-4"
ELECTRIC PRODUCTION PLANT
CALVERT CLIFFS - UNITS 1 & 2
BALTIMORE GAS AND ELECTRIC CO.
BECHTEL ASSOCIATES
C-256

FIGURE 4.3.16

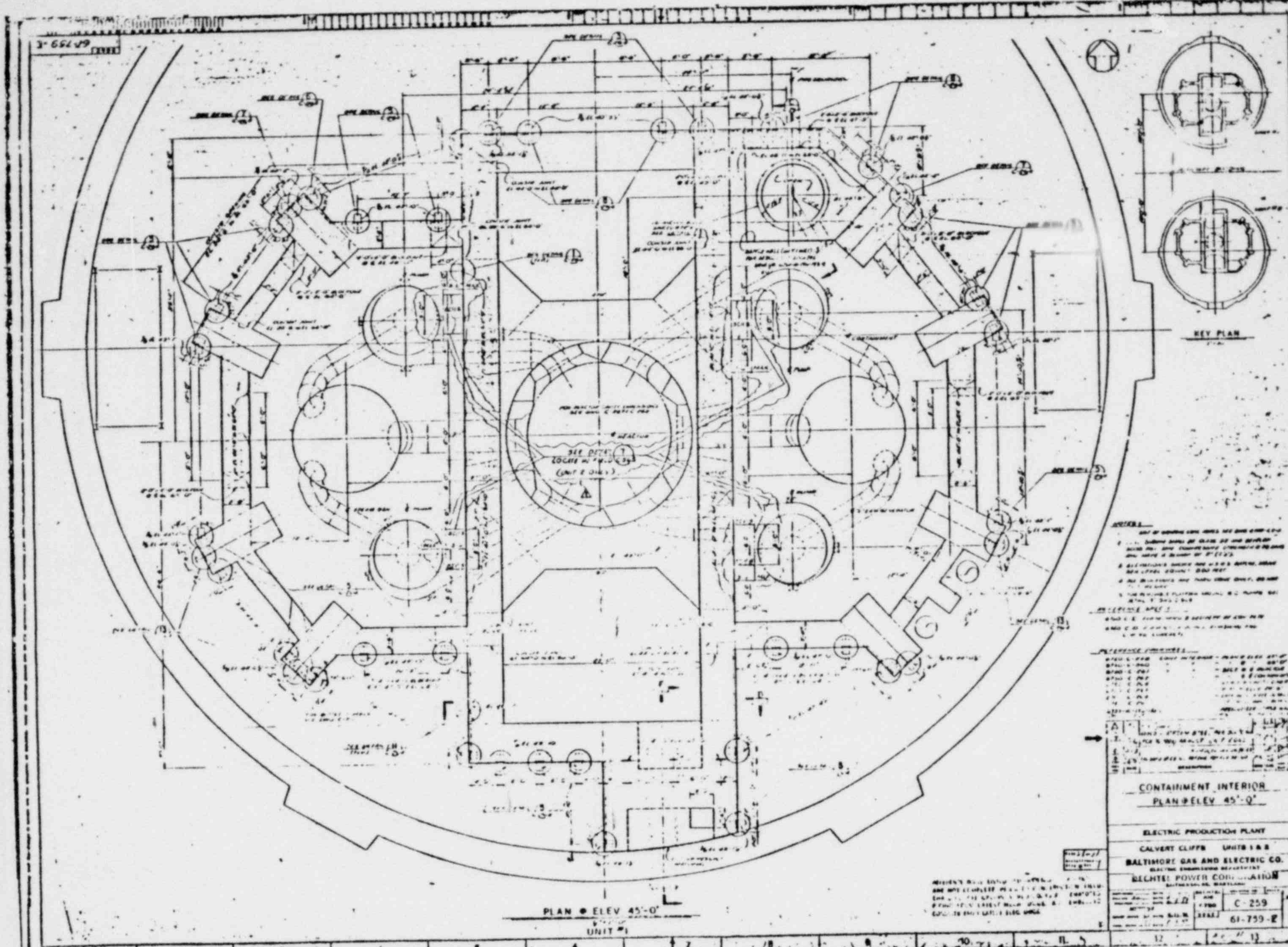
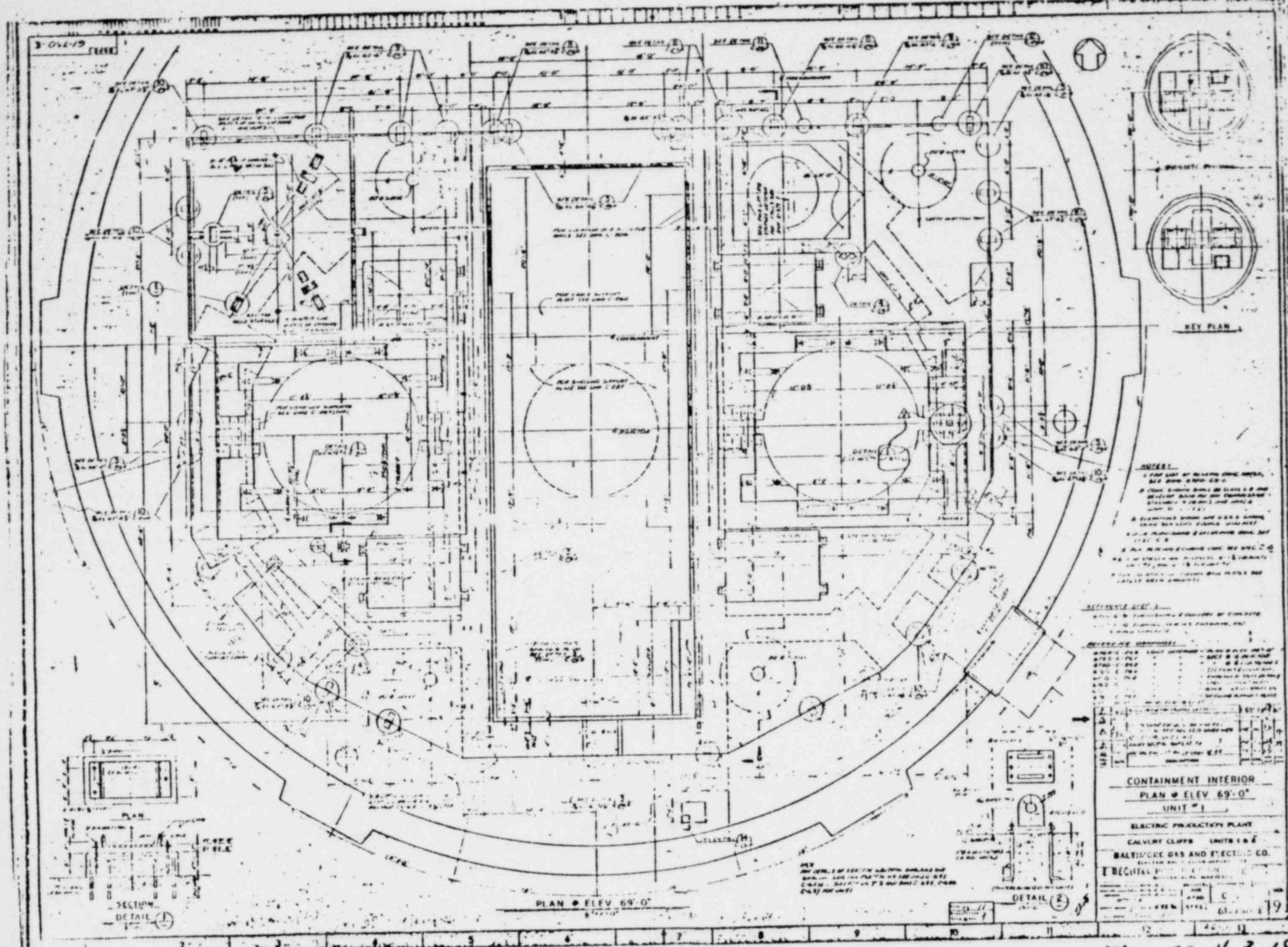

KEY PLAN
NOTES:
REFERENCE DRAWINGS
PLAN @ ELEV 45'-0"
UNIT #1
CONTAINMENT INTERIOR
PLAN @ ELEV 45'-0"
ELECTRIC PRODUCTION PLANT
CALVERT CLIFFS UNITS 1 & 2
BALTIMORE GAS AND ELECTRIC CO.
BECHTEL POWER CORPORATION
C-259
61-759-E
7

FIGURE 4.3.17



KEY PLAN
NOTES:
REFERENCE DRAWINGS
CONTAINMENT INTERIOR
PLAN @ ELEV 69'-0"
UNIT #1
ELECTRIC PRODUCTION PLANT
CALVERT CLIFFS UNITS 1 & 2
BALTIMORE GAS AND ELECTRIC CO.
BECHTEL
PLAN @ ELEV 69'-0"
DETAIL 2
SECTION
DETAIL 1
PLAN

FIGURE 4.3.18

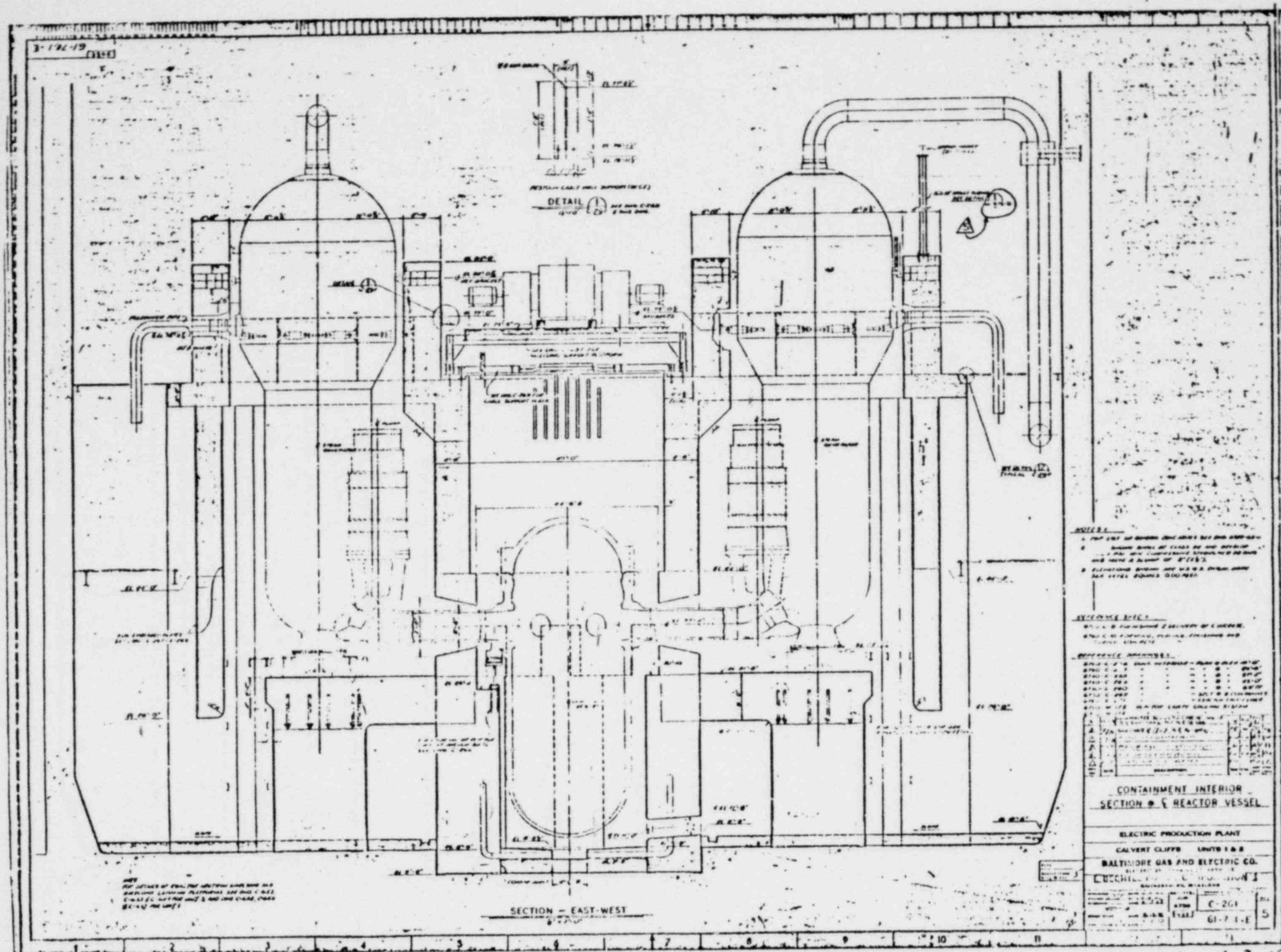

DETAIL
SECTION - EAST-WEST
CONTAINMENT INTERIOR
SECTION @ ℄ REACTOR VESSEL
ELECTRIC PRODUCTION PLANT
CALVERT CLIFFS UNITS 1 & 2
BALTIMORE GAS AND ELECTRIC CO.
C-261
61-7-1-E
5

FIGURE 4.3.19

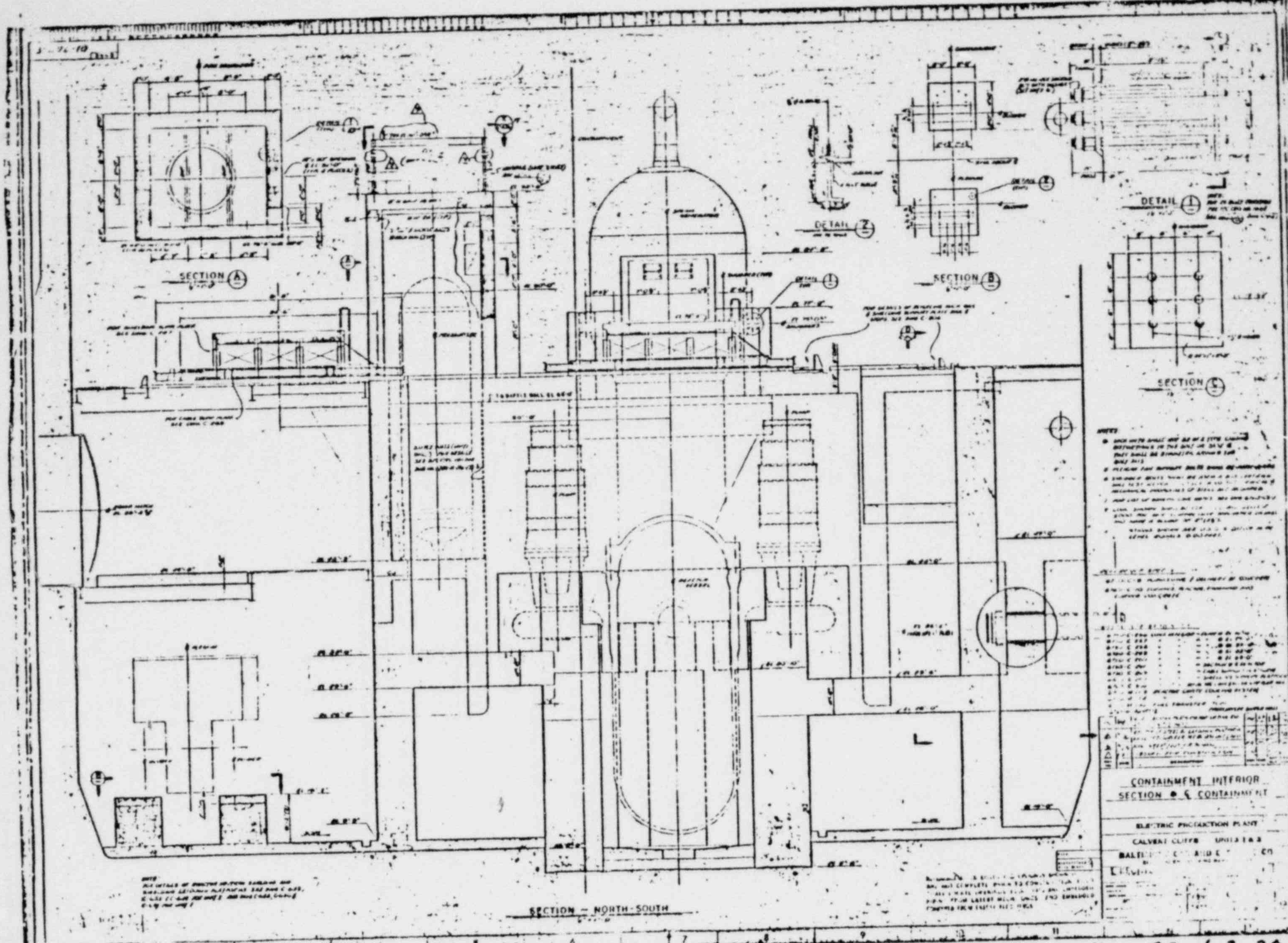
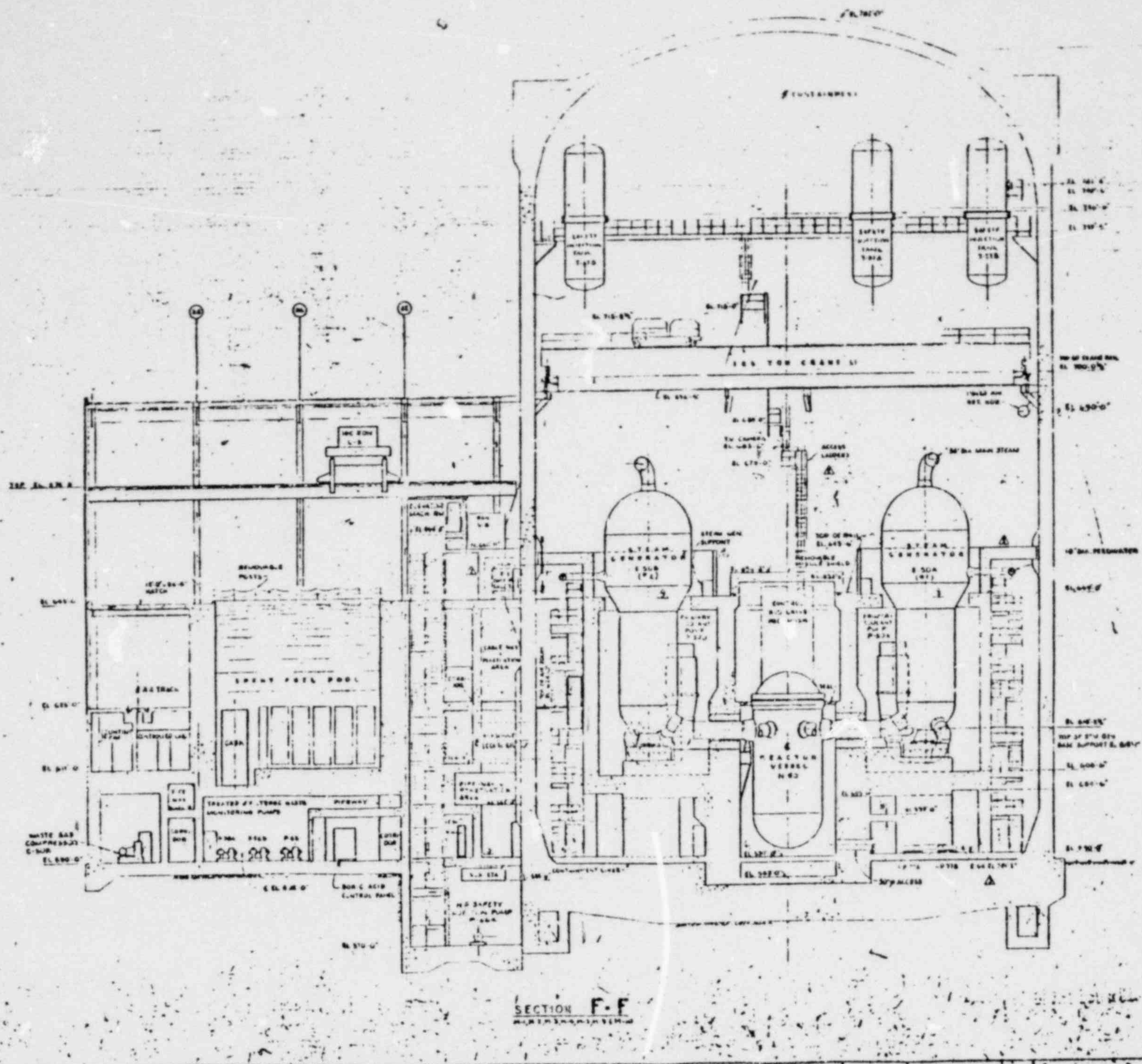

SECTION A
SECTION B
SECTION C
DETAIL 1
DETAIL 2
SECTION – NORTH-SOUTH
CONTAINMENT INTERIOR
SECTION • ℄ CONTAINMENT
CALVERT CLIFFS UNITS 1 & 2

FIGURE 4.3.20



INFORMATION COPY

BECHTEL COMPANY

PALISADES PLANT
CONSUMERS POWER COMPANY

EQUIPMENT LOCATION - REACTOR BLDG
SECTION F-F

5935 M-7

FIGURE 4.3.21

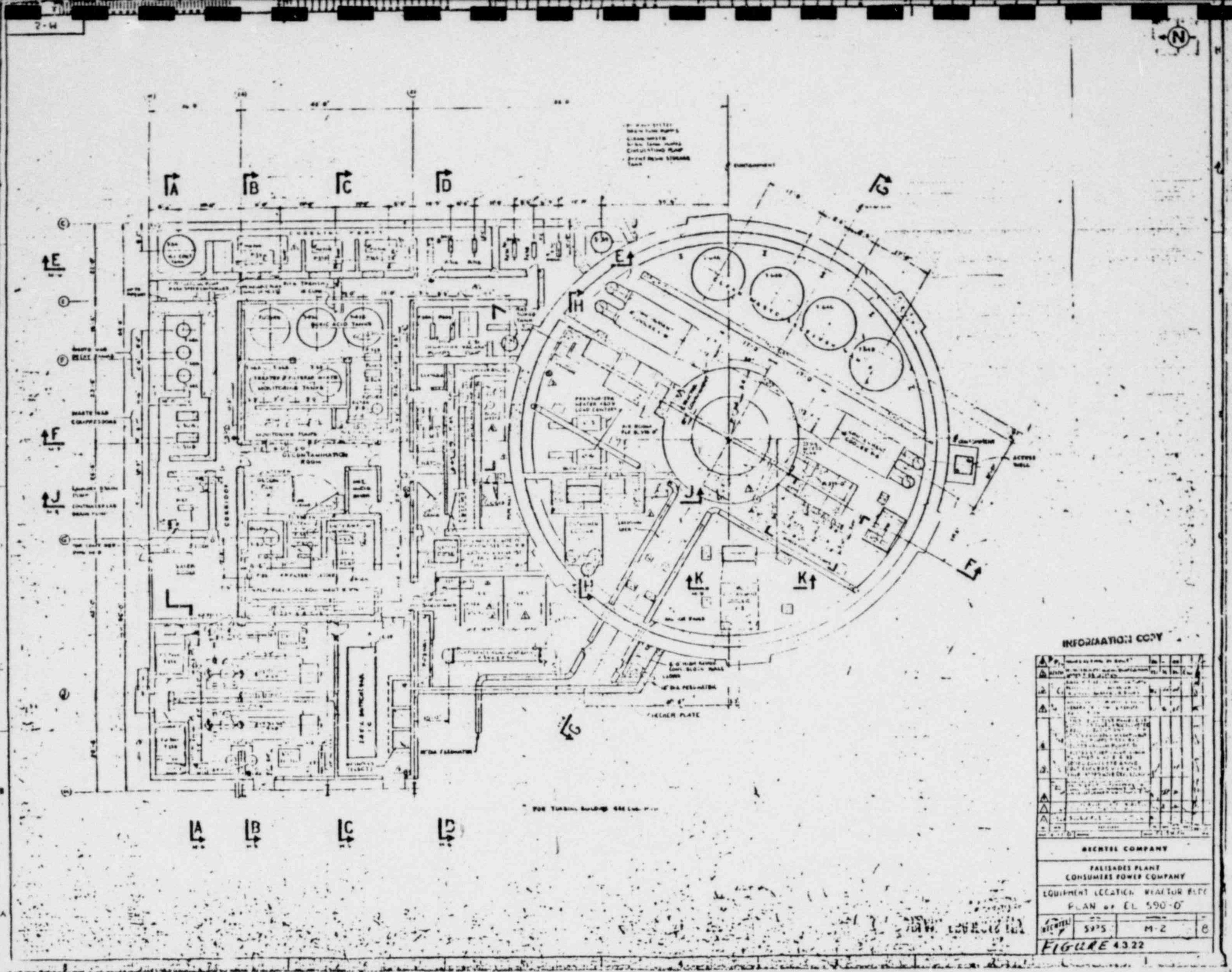
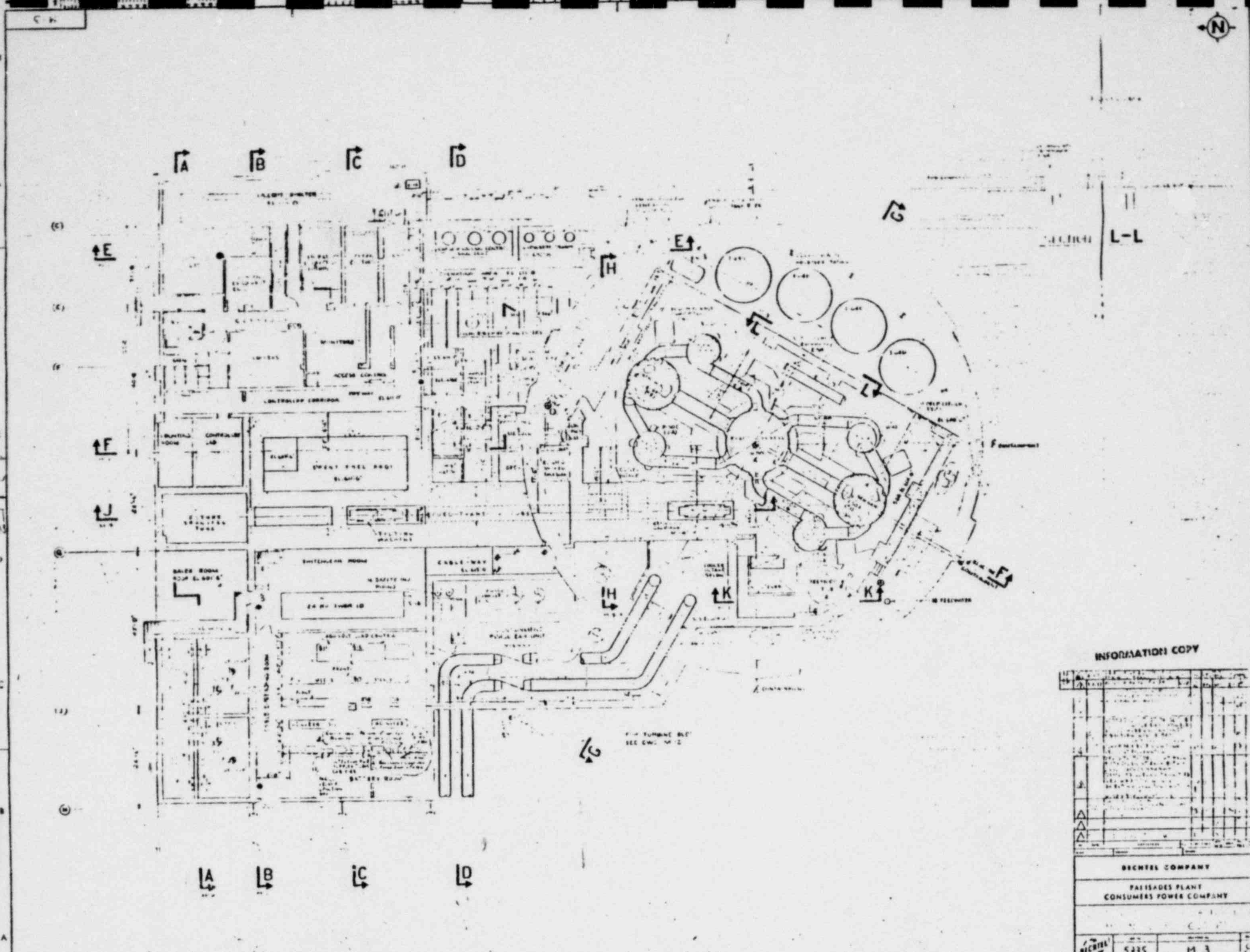
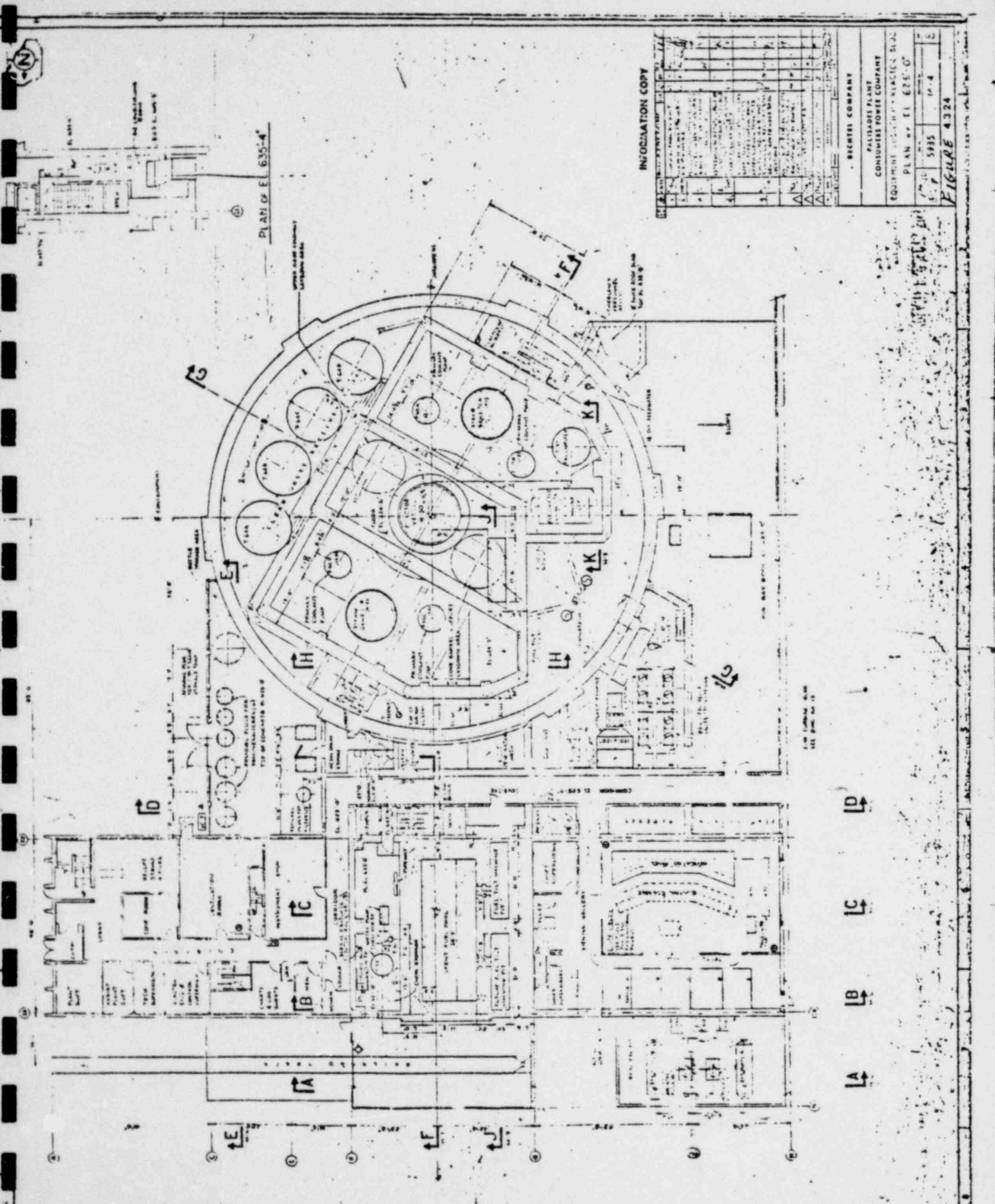

INFORMATION COPY
BECHTEL COMPANY
PALISADES PLANT
CONSUMERS POWER COMPANY
EQUIPMENT LOCATION REACTOR BLDG
PLAN AT EL 590'-0"
5935
M-2
8
DECONTAMINATION ROOM
CORRIDOR
BORIC ACID TANKS
CHECKER PLATE
ACCESS WELL
FOR TURBINE BUILDING SEE DWG M-1

FIGURE 4.3.22



A
B
C
D
E
F
J
H
K
L
G
L-L
SWITCHGEAR ROOM
CABLE SPREADING ROOM
SPENT FUEL POOL
CONTROLLED CORRIDOR
ACCESS CONTROL
BATTERY ROOM
INFORMATION COPY
BECHTEL COMPANY
PALISADES PLANT
CONSUMERS POWER COMPANY
5935
M 3

FIGURE 4.3.23


INFORMATION COPY
BECHTEL COMPANY
PALISADES PLANT
CONSUMERS POWER COMPANY
PLAN EL 625'-0"
5935
M-4
FIGURE 4324
PLAN OF EL 635'-4"

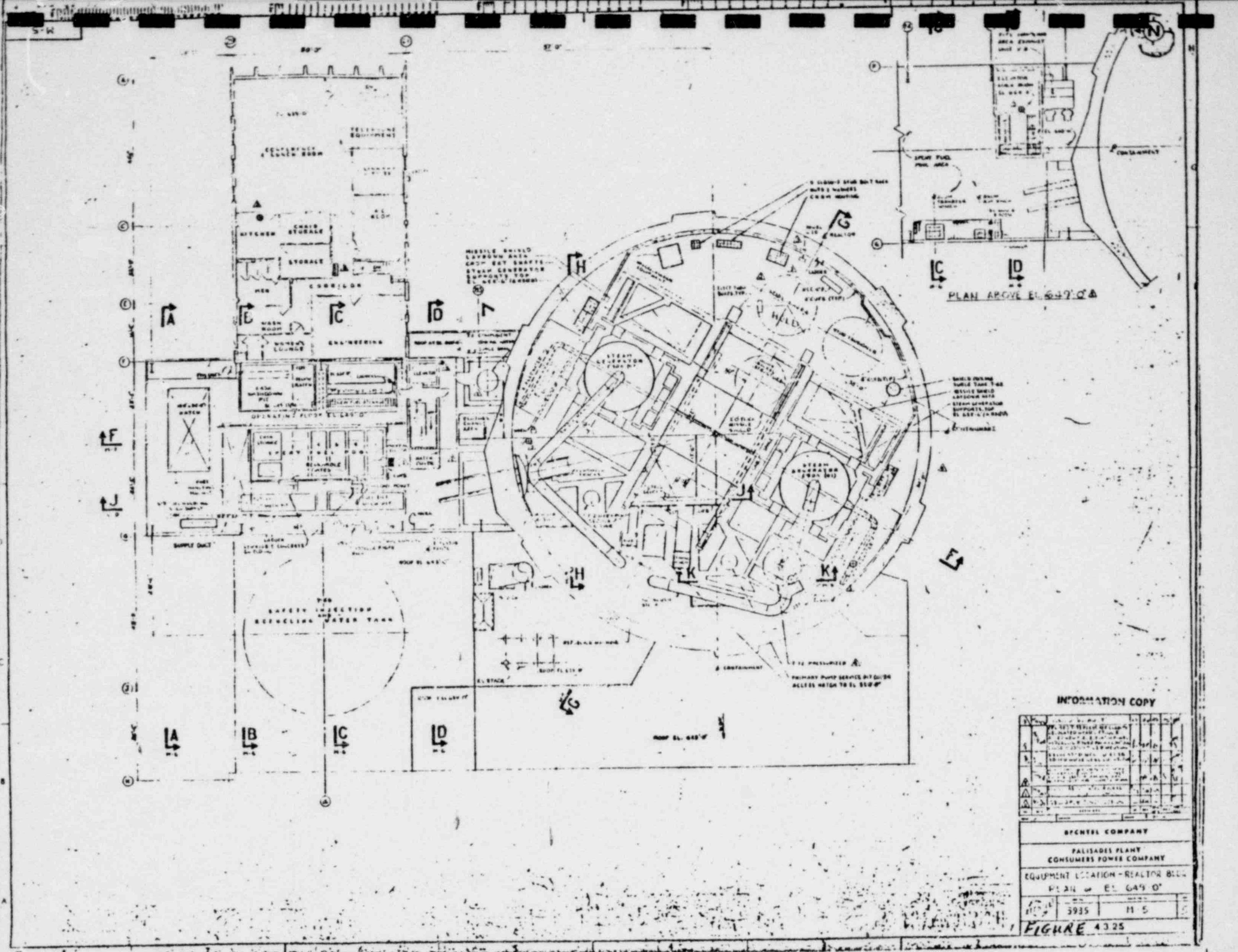

PLAN ABOVE EL. 649'-0"
STEAM GENERATOR
SAFETY INJECTION REFUELING WATER TANK
KITCHEN
STORAGE
CORRIDOR
ENGINEERING
INFORMATION COPY
BECHTEL COMPANY
PALISADES PLANT
CONSUMERS POWER COMPANY
EQUIPMENT LOCATION - REACTOR BLDG
PLAN @ EL. 649'-0"
5935
M-5

FIGURE 4.3.25

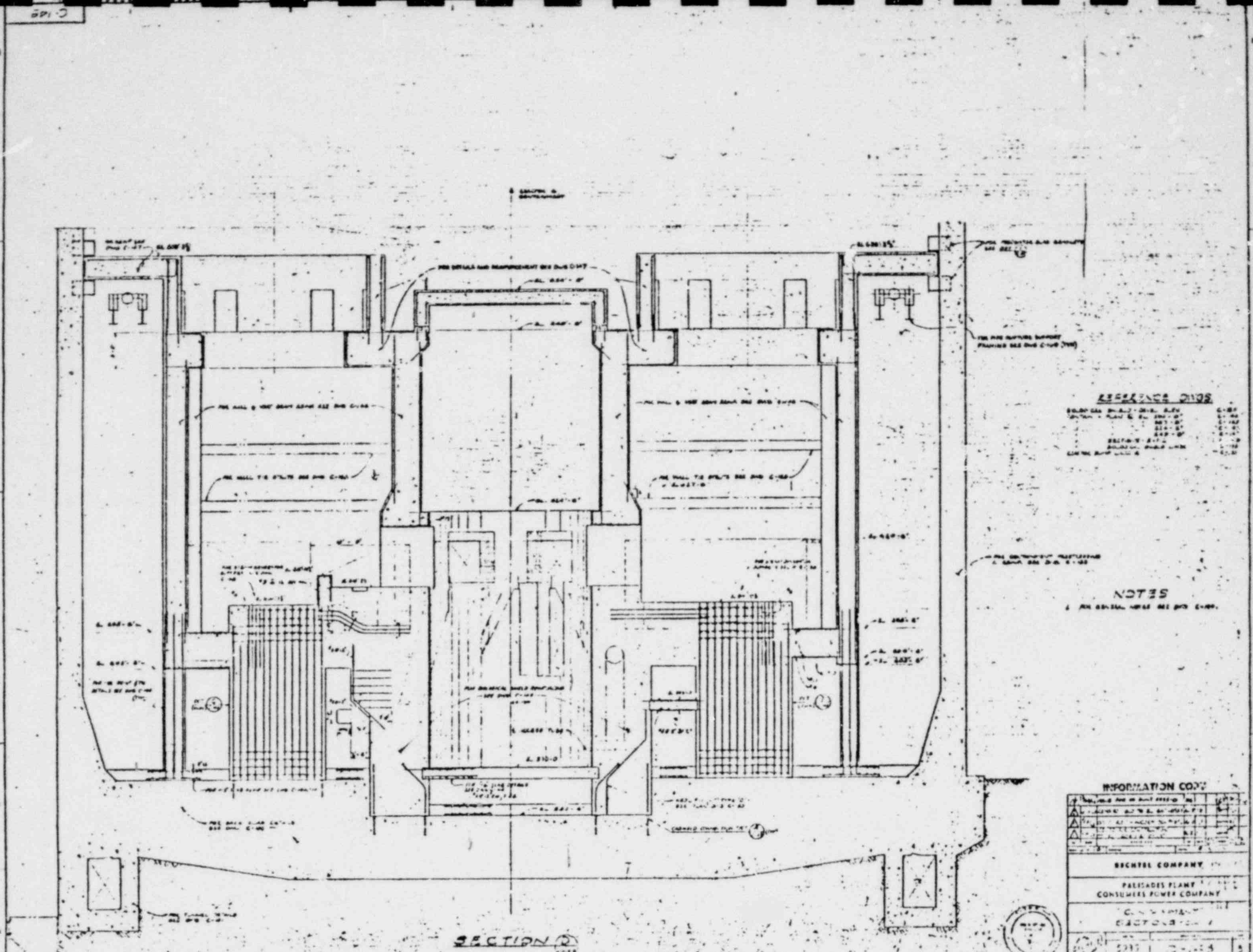
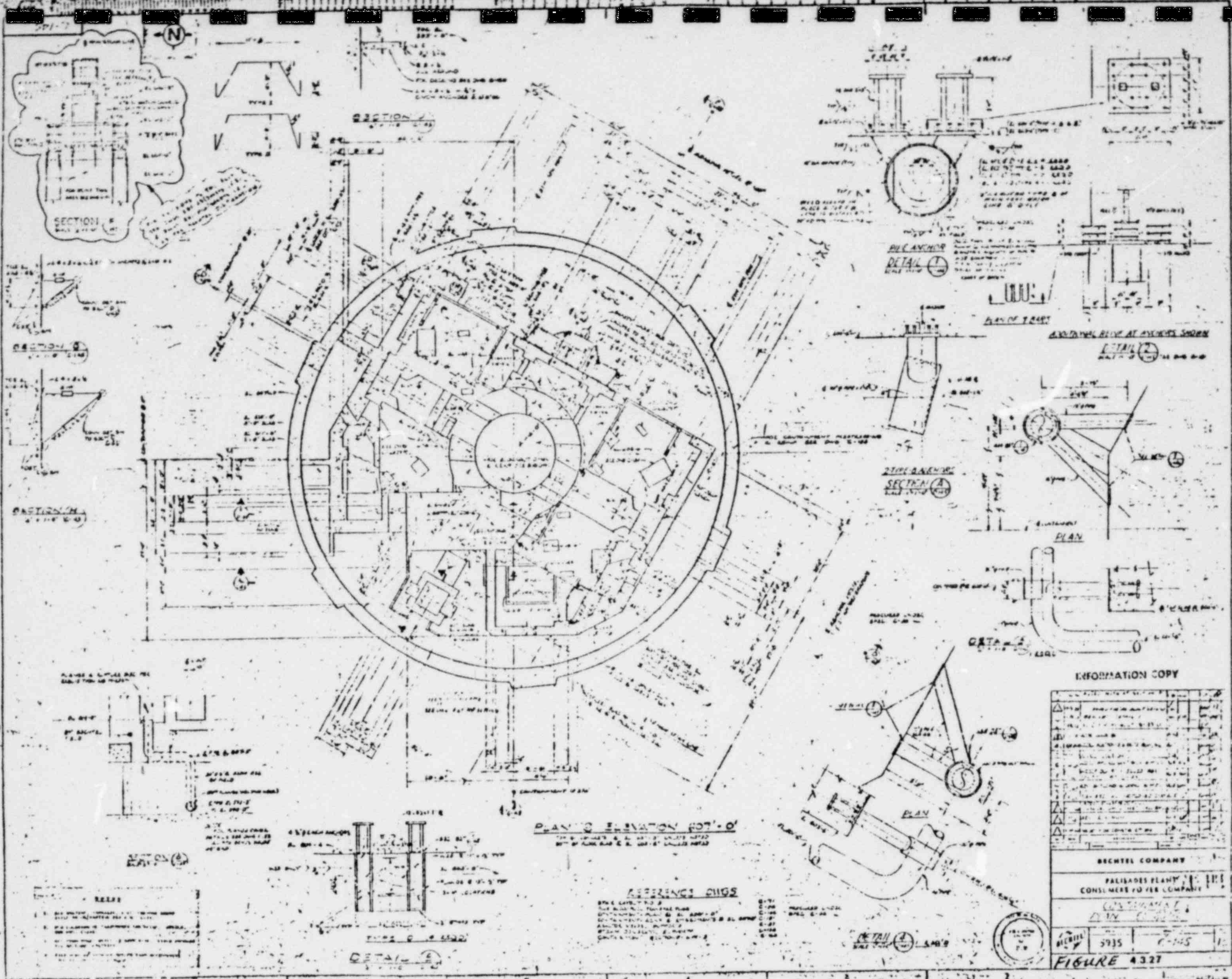
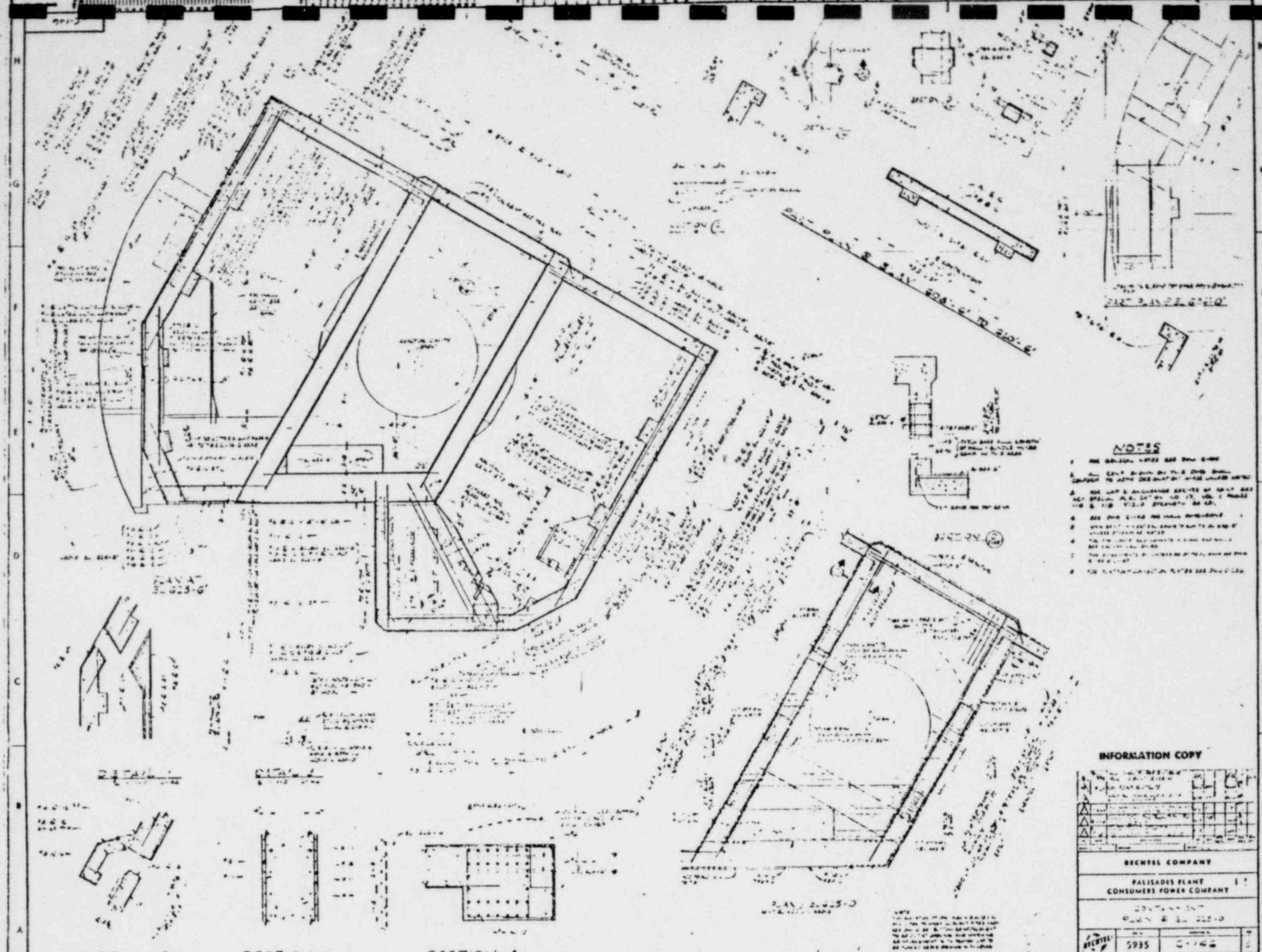

REFERENCE DWGS
NOTES
INFORMATION COPY
BECHTEL COMPANY
PALISADES PLANT
CONSUMERS POWER COMPANY
SECTION 2

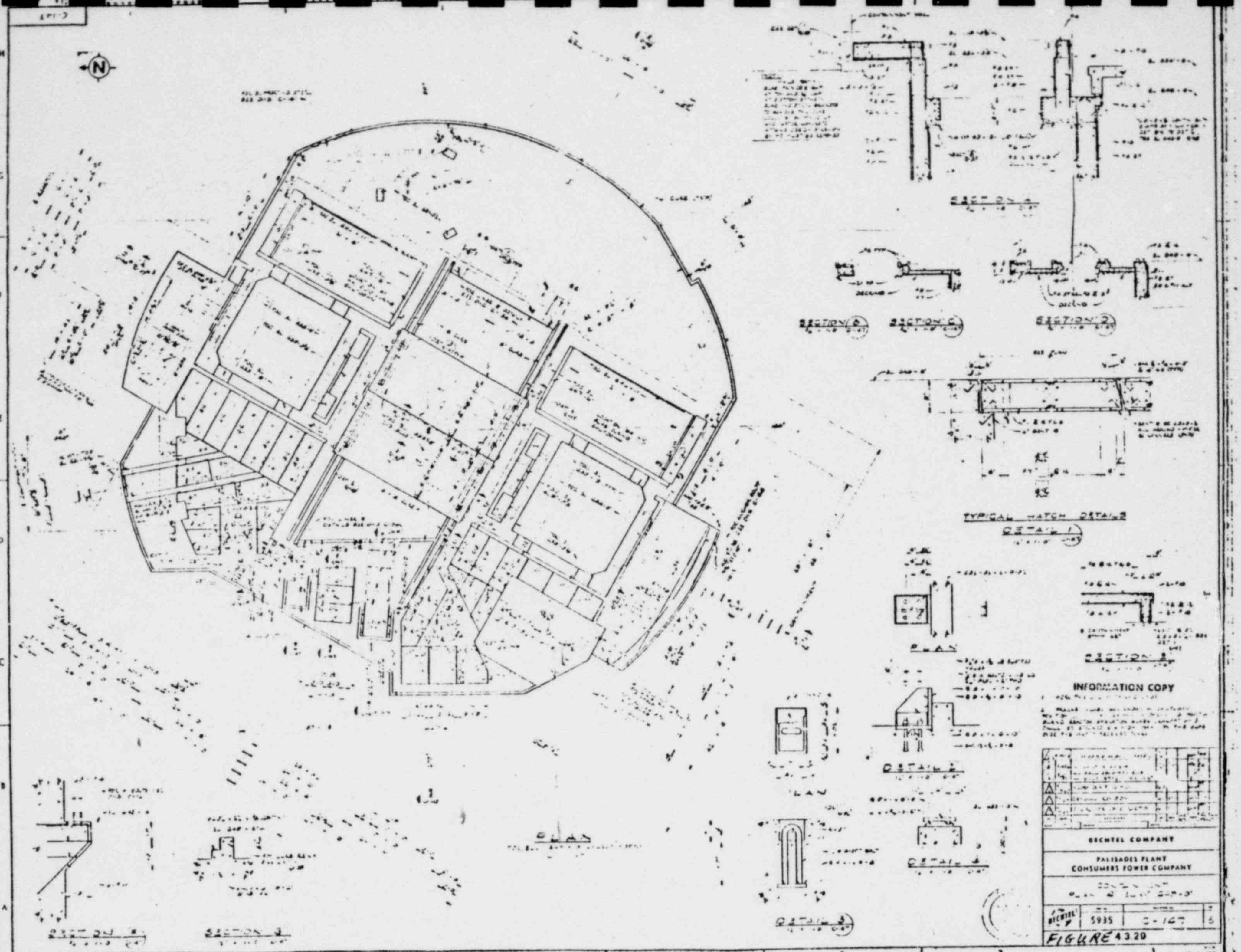
FIGURE 4326


SECTION E
SECTION
SECTION H
PLAN @ ELEVATION 607'-0"
REFERENCE DWGS
DETAIL
PILE ANCHOR
DETAIL 1
PLAN OF T-BARS
ADDITIONAL REINF AT ANCHORS SHOWN
DETAIL 2
PIPE ANCHORS
SECTION A
PLAN
DETAIL
INFORMATION COPY
BECHTEL COMPANY
PALISADES PLANT
CONSUMERS POWER COMPANY
5935
C-145
FIGURE 4.3.27



NOTES
DETAIL 1
DETAIL 2
SECTION A
SECTION A
INFORMATION COPY
BECHTEL COMPANY
PALISADES PLANT
CONSUMERS POWER COMPANY
5935

FIGURE 4328



SECTION A
SECTION B
SECTION C
SECTION 2
TYPICAL HATCH DETAILS
DETAIL 1
PLAN
SECTION 3
INFORMATION COPY
DETAIL 2
DETAIL 3
DETAIL 4
BECHTEL COMPANY
PALISADES PLANT
CONSUMERS POWER COMPANY
5935
FIGURE 4320

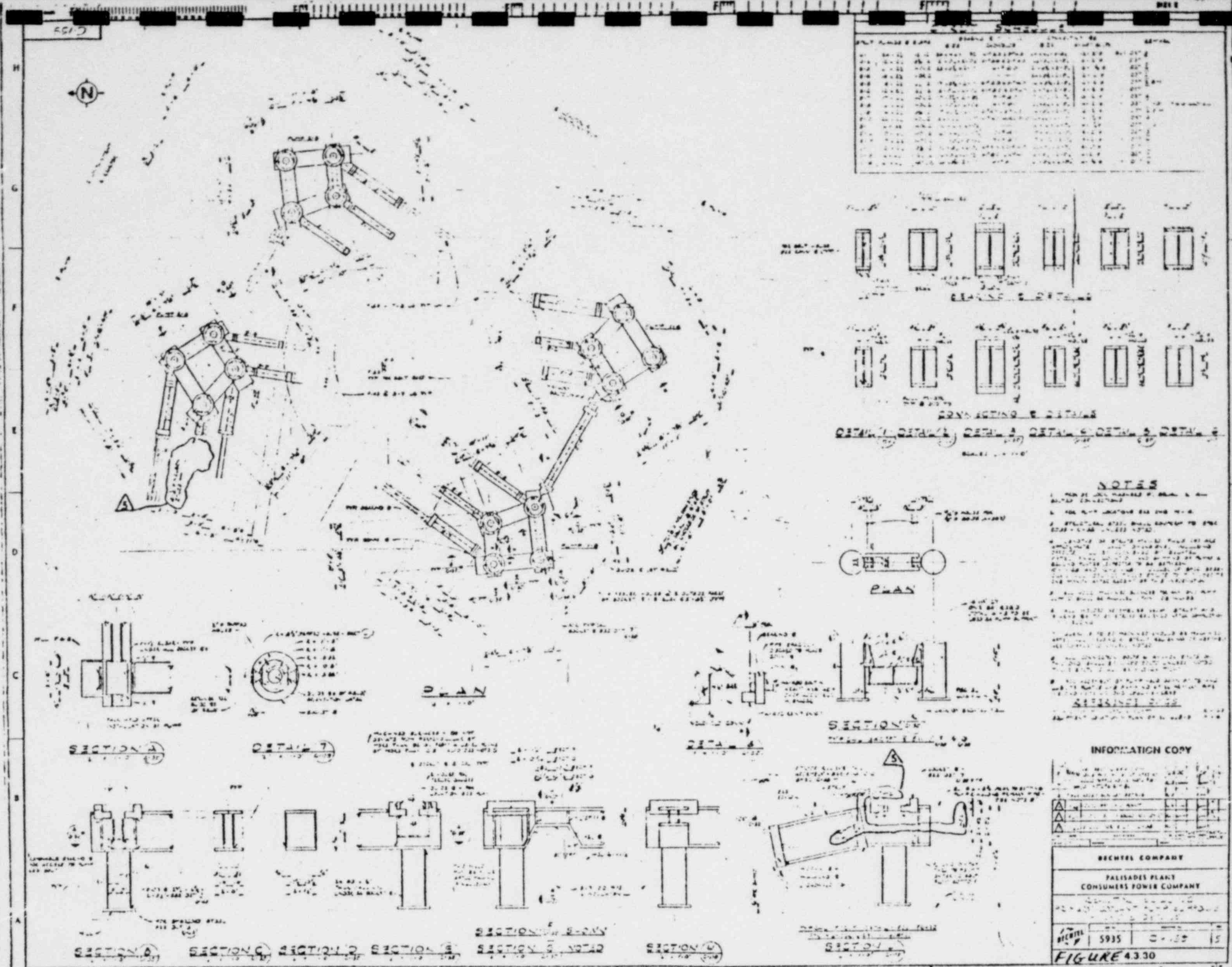

NOTES
PLAN
SECTION A
DETAIL 7
SECTION B
SECTION C
SECTION D
SECTION E
INFORMATION COPY
BECHTEL COMPANY
PALISADES PLANT
CONSUMERS POWER COMPANY
5935

FIGURE 4.3.30

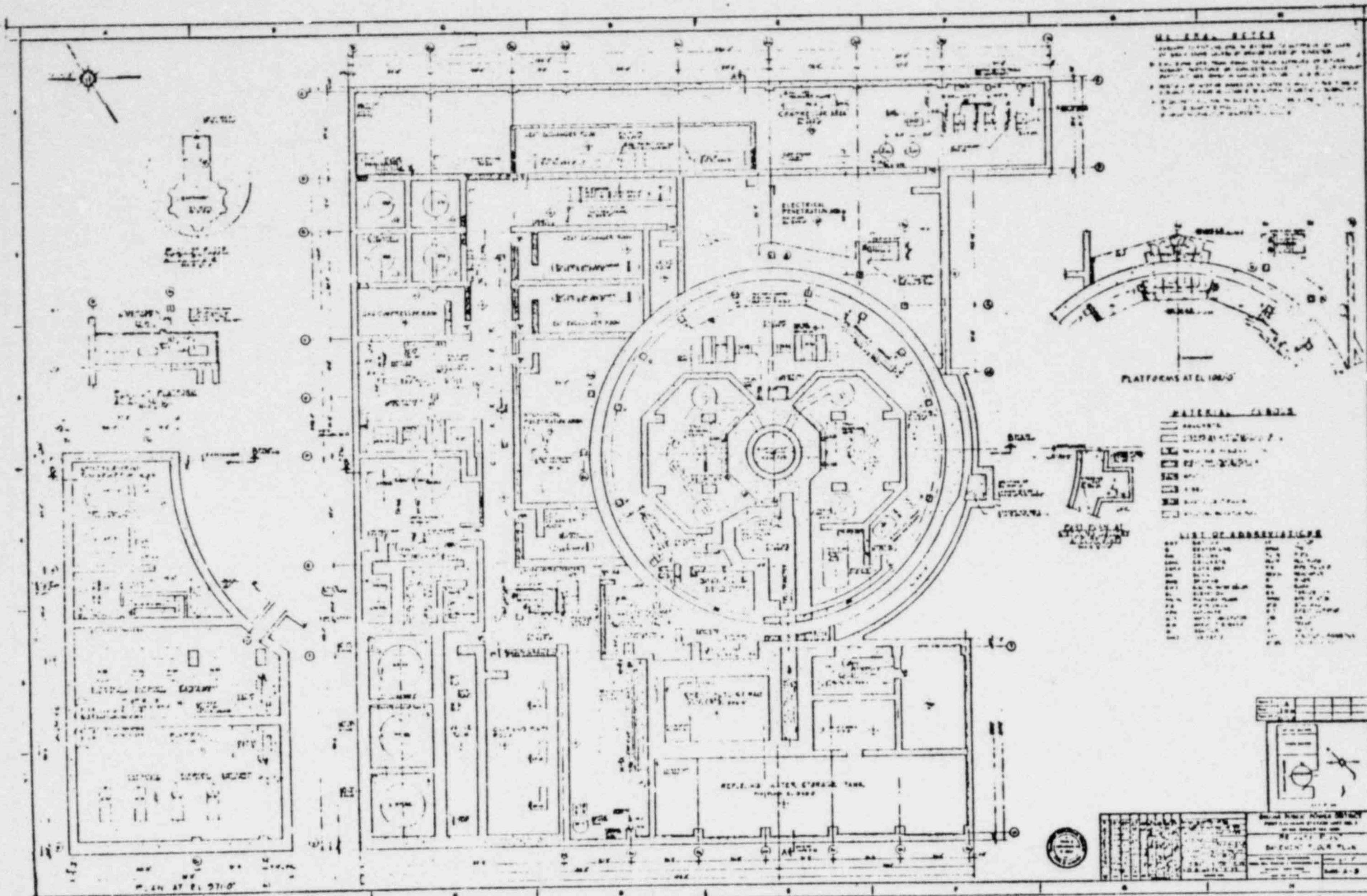

PLATFORMS AT EL 100'0"
MATERIAL SYMBOLS
LIST OF ABBREVIATIONS
REFUELING WATER STORAGE TANK
PLAN AT EL 97'0"

FIGURE 4.3.31

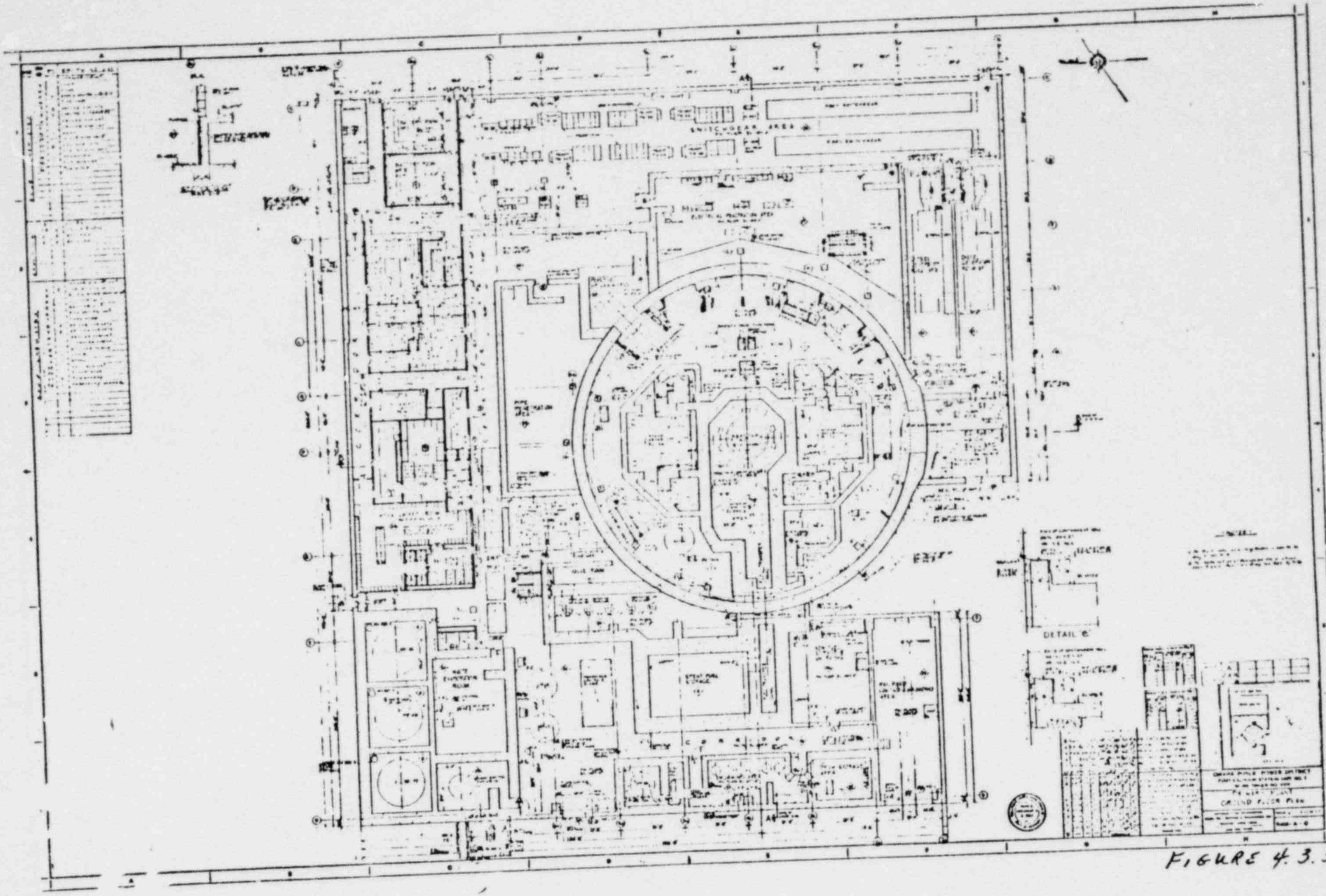


FIGURE 4.3.32

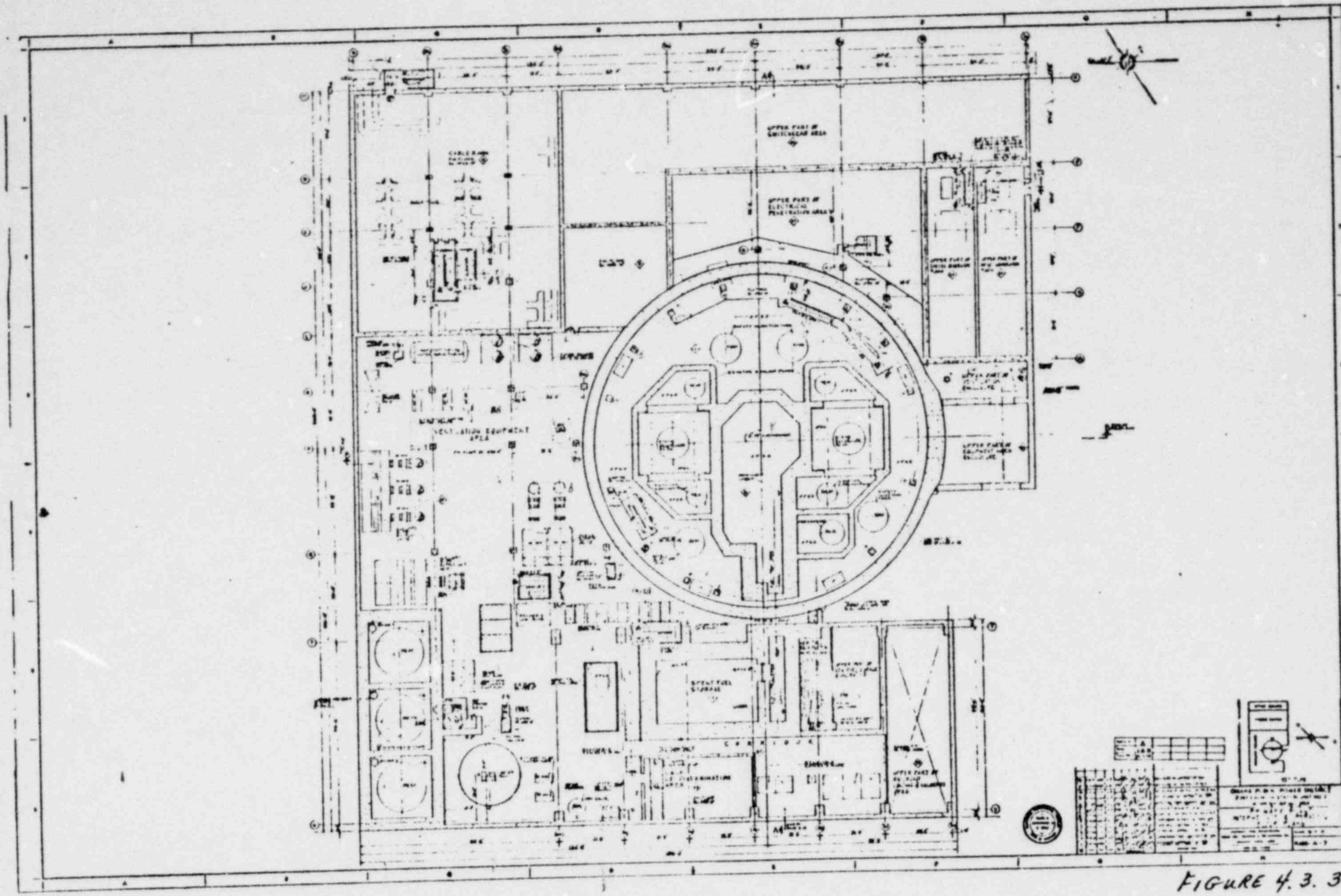


FIGURE 4.3.33

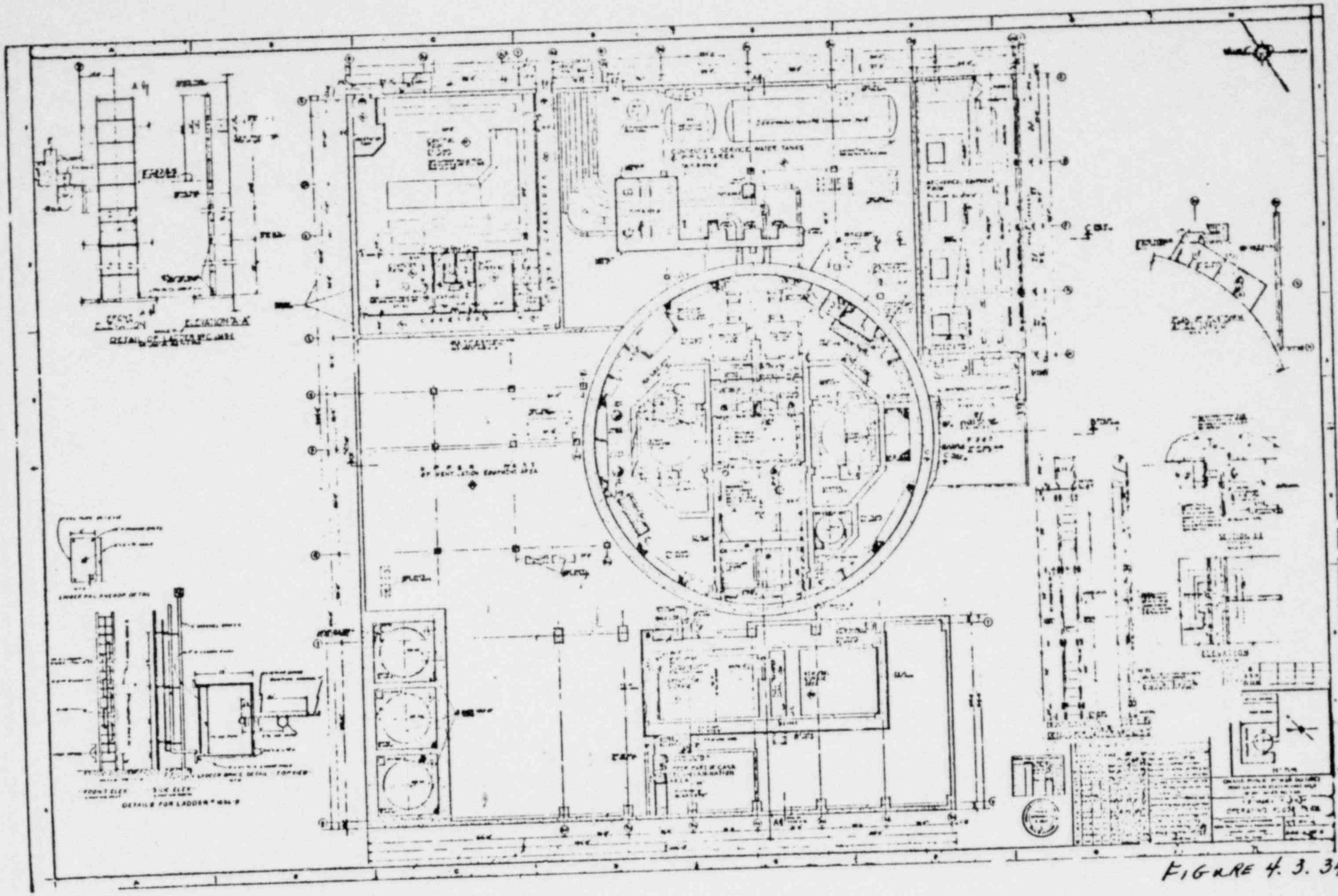

DETAIL OF LADDER
DETAILS FOR LADDER
FRONT ELEV.
SIDE ELEV.
ELEVATION
CONDENSATE SERVICE WATER TANKS
OPERATING FLOOR PLAN

FIGURE 4. 3. 34

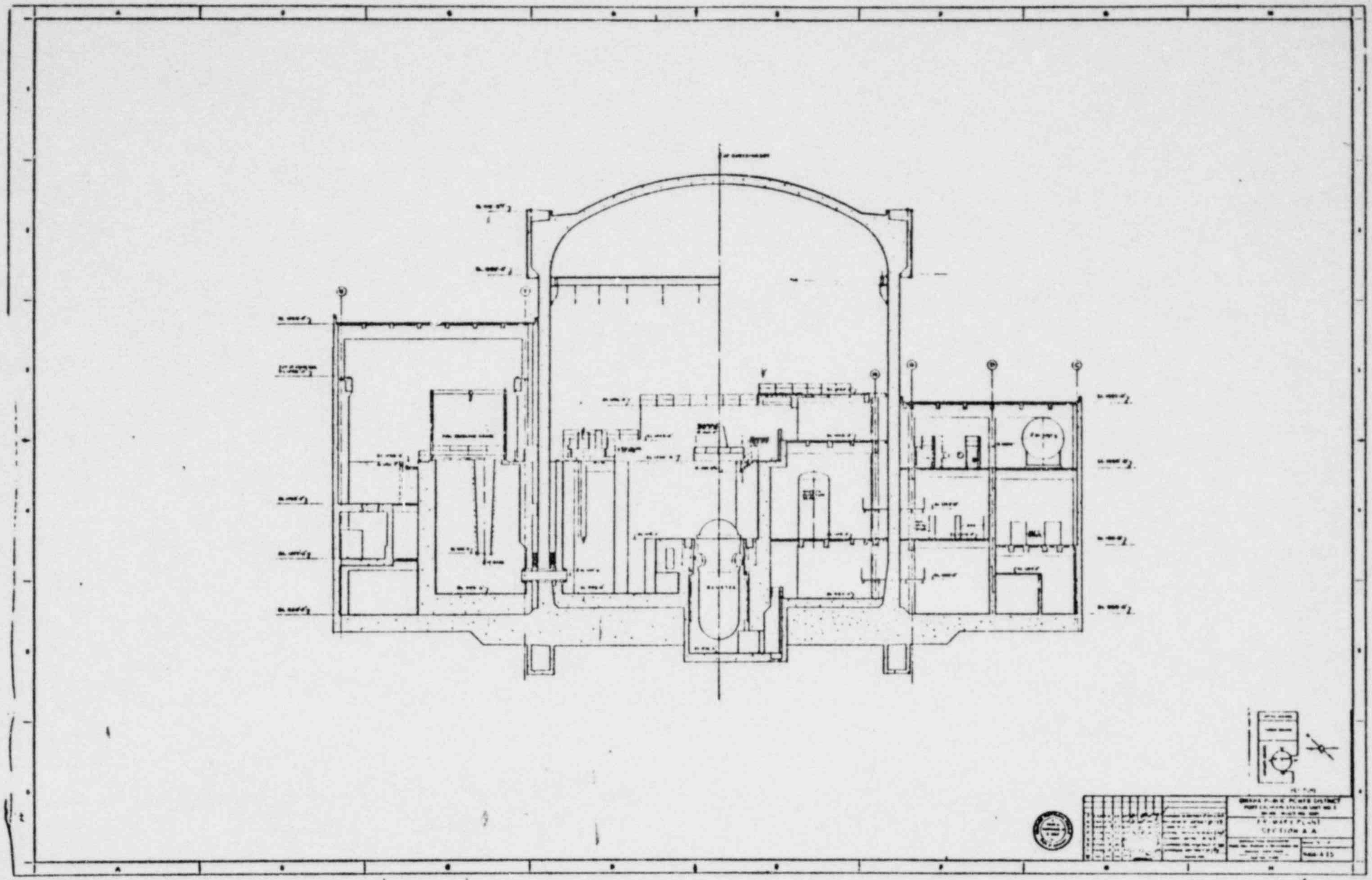

OMAHA PUBLIC POWER DISTRICT
FORT CALHOUN STATION UNIT NO 1
PRIMARY PLANT
SECTION A-A

FIGURE 4.3.35

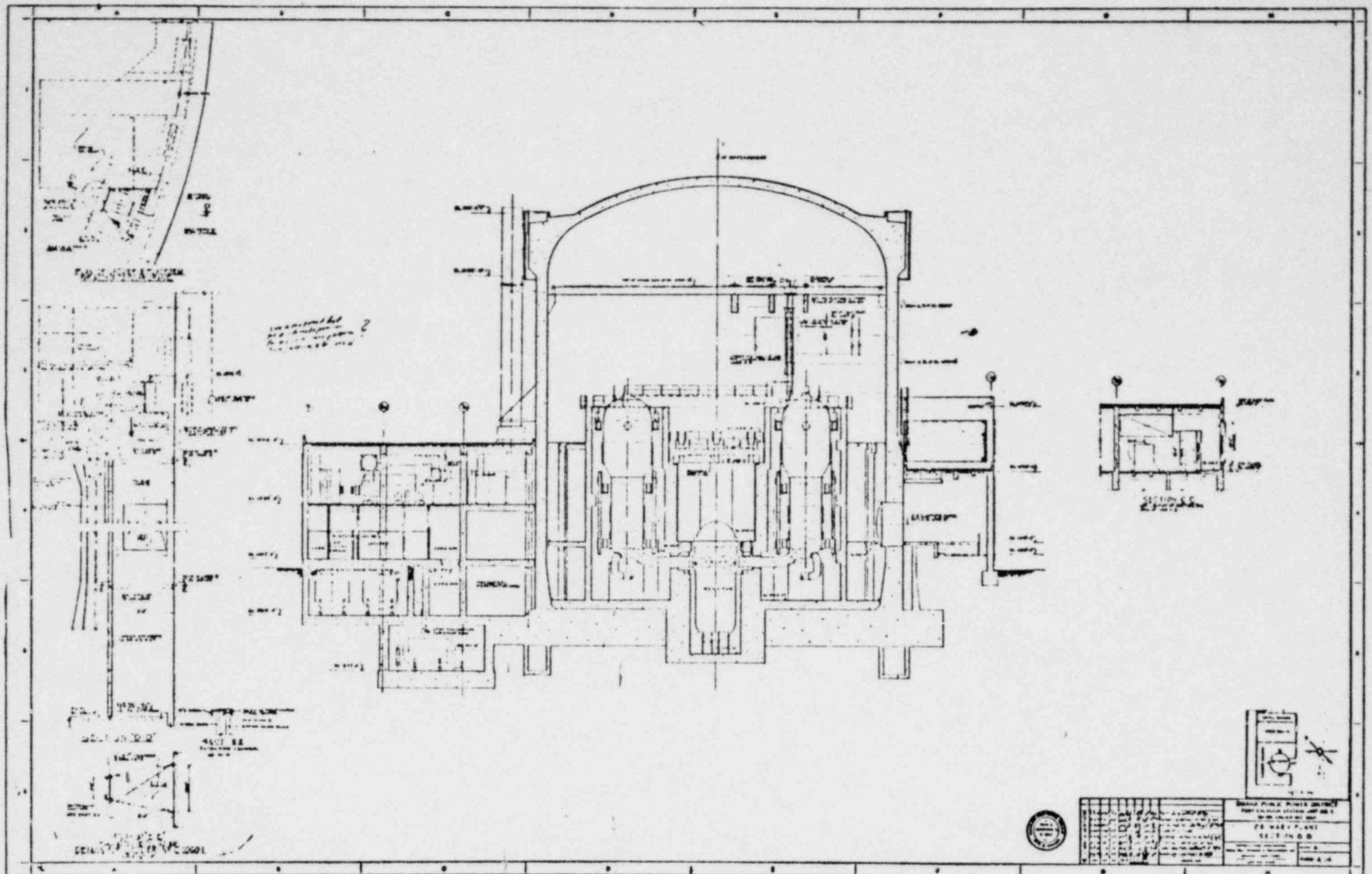


FIGURE 4. 3. 36

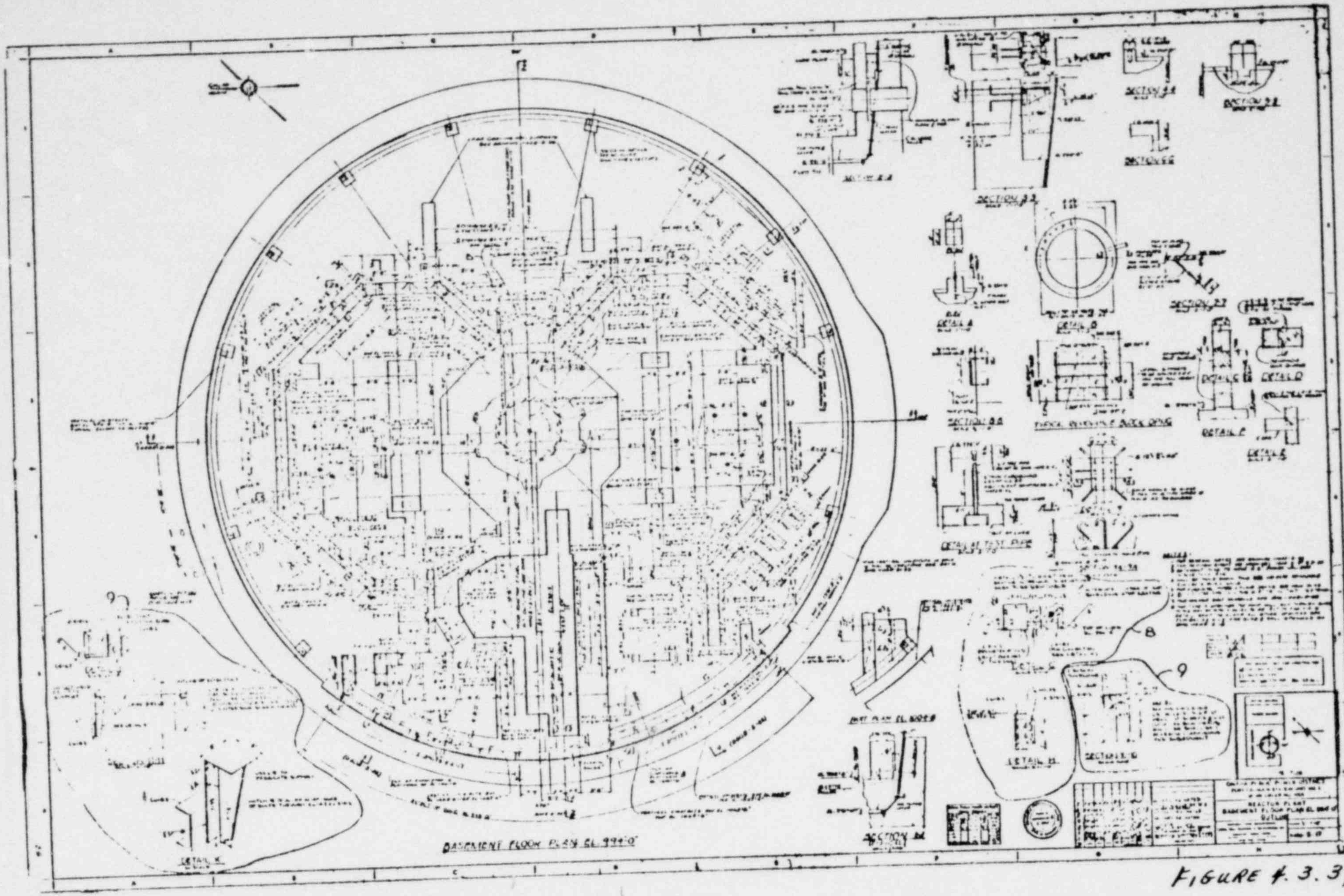

BASEMENT FLOOR PLAN EL 994'0"
SECTION B-B
DETAIL D
DETAIL K
DETAIL E
DETAIL F
9
8
9

FIGURE 4.3.37

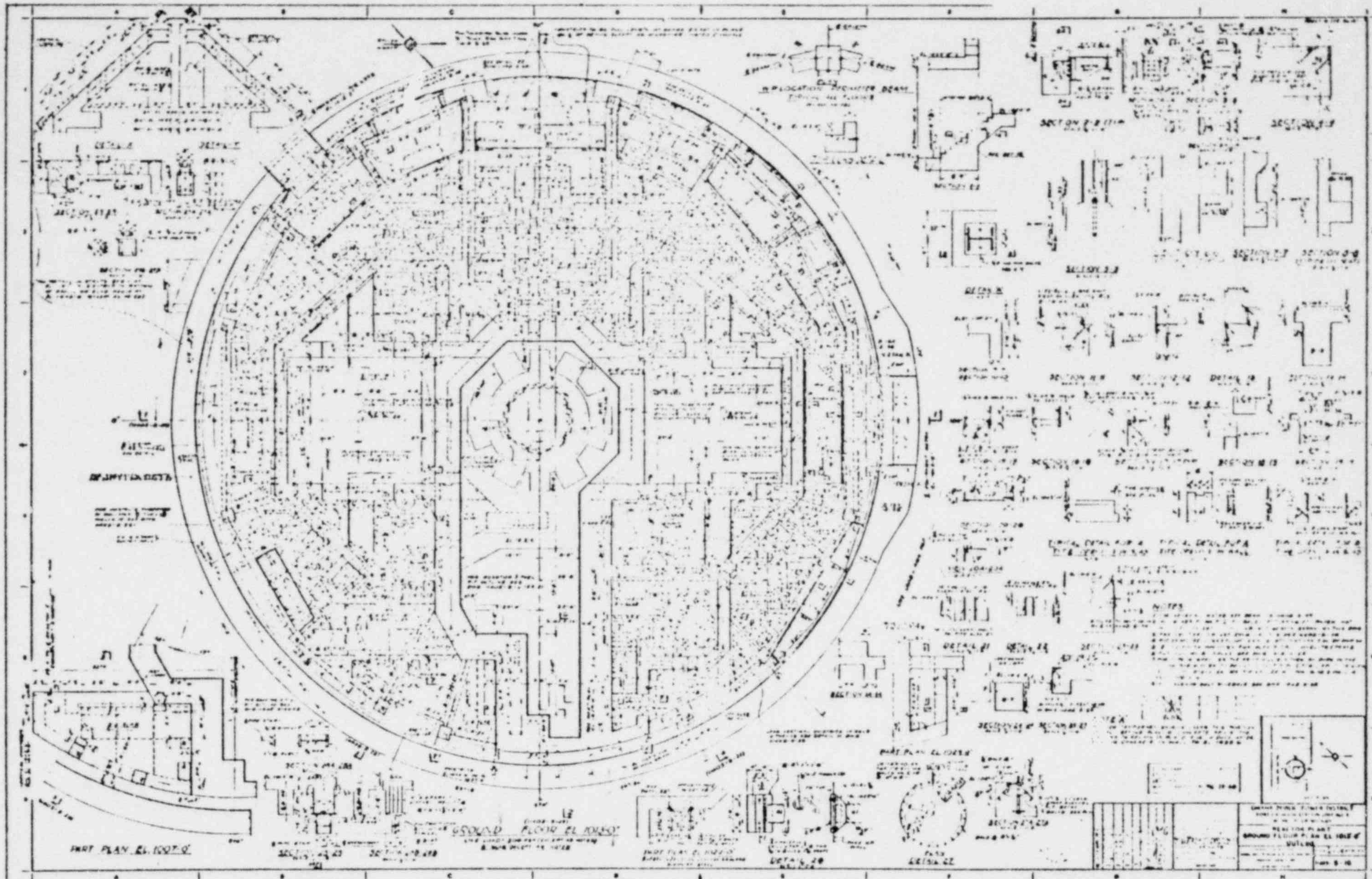


FIGURE 4. 3. 38

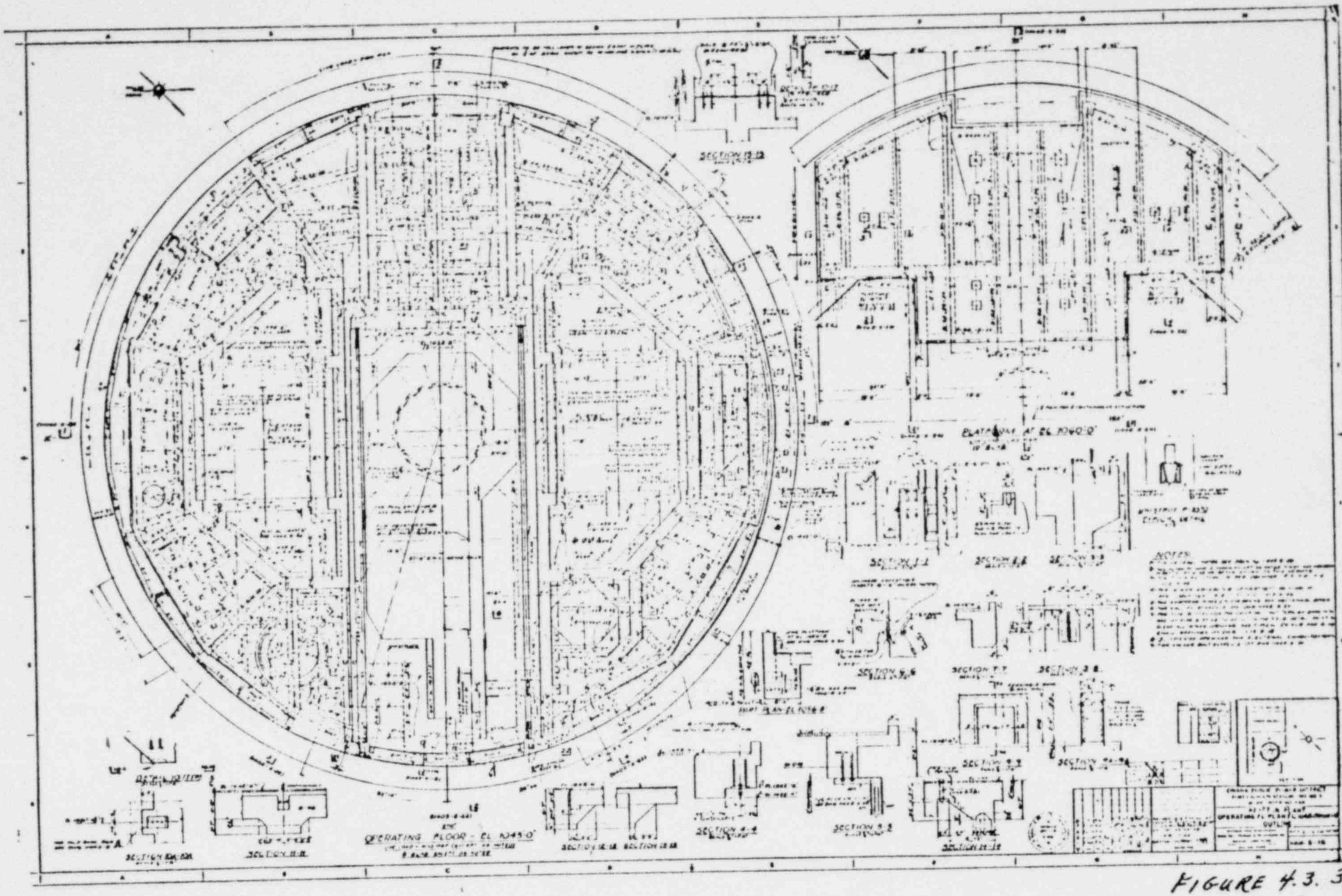

OPERATING FLOOR - EL 1045'-0"
PLATFORM AT EL 1040'-0"
NOTES:
SECTION 1-1
SECTION 5-5
SECTION 6-6
SECTION 7-7
SECTION 8-8
SECTION 12-12

FIGURE 4.3.39

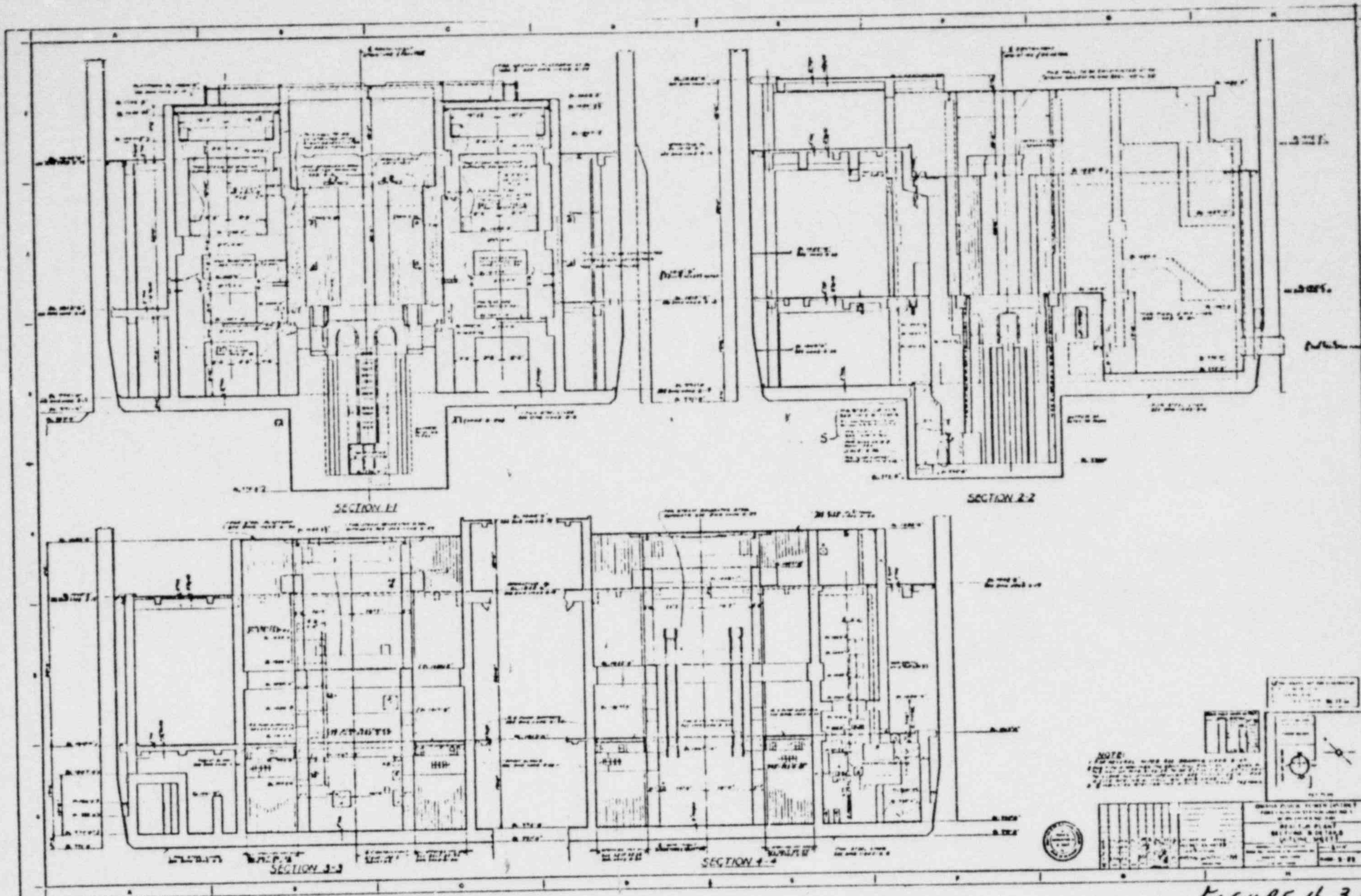


FIGURE 4.3.40

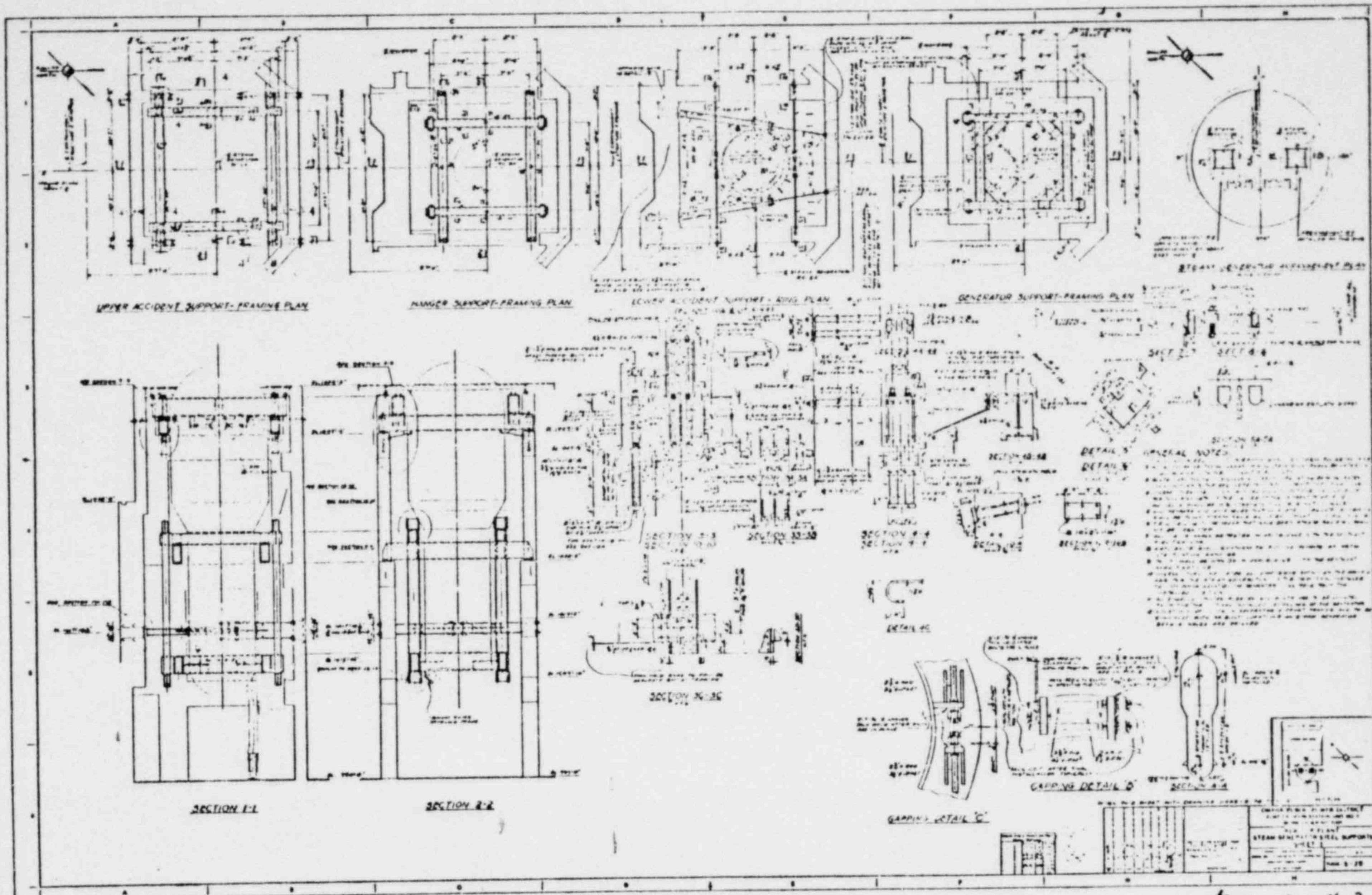

UPPER ACCIDENT SUPPORT - FRAMING PLAN
HANGER SUPPORT-FRAMING PLAN
LOWER ACCIDENT SUPPORT - RING PLAN
GENERATOR SUPPORT-FRAMING PLAN
STEAM GENERATOR ARRANGEMENT PLAN
GENERAL NOTES
SECTION 1-1
SECTION 2-2
SECTION 3C-3C
DETAIL 4C
GAPPING DETAIL 'C'
GAPPING DETAIL 'D'
STEAM GENERATOR STEEL SUPPORTS

FIGURE 4.3.41

FIGURE 4.3.42

STEAM GENERATOR COMPARTMENT
NODALIZATION SKETCH SECTION VIEW

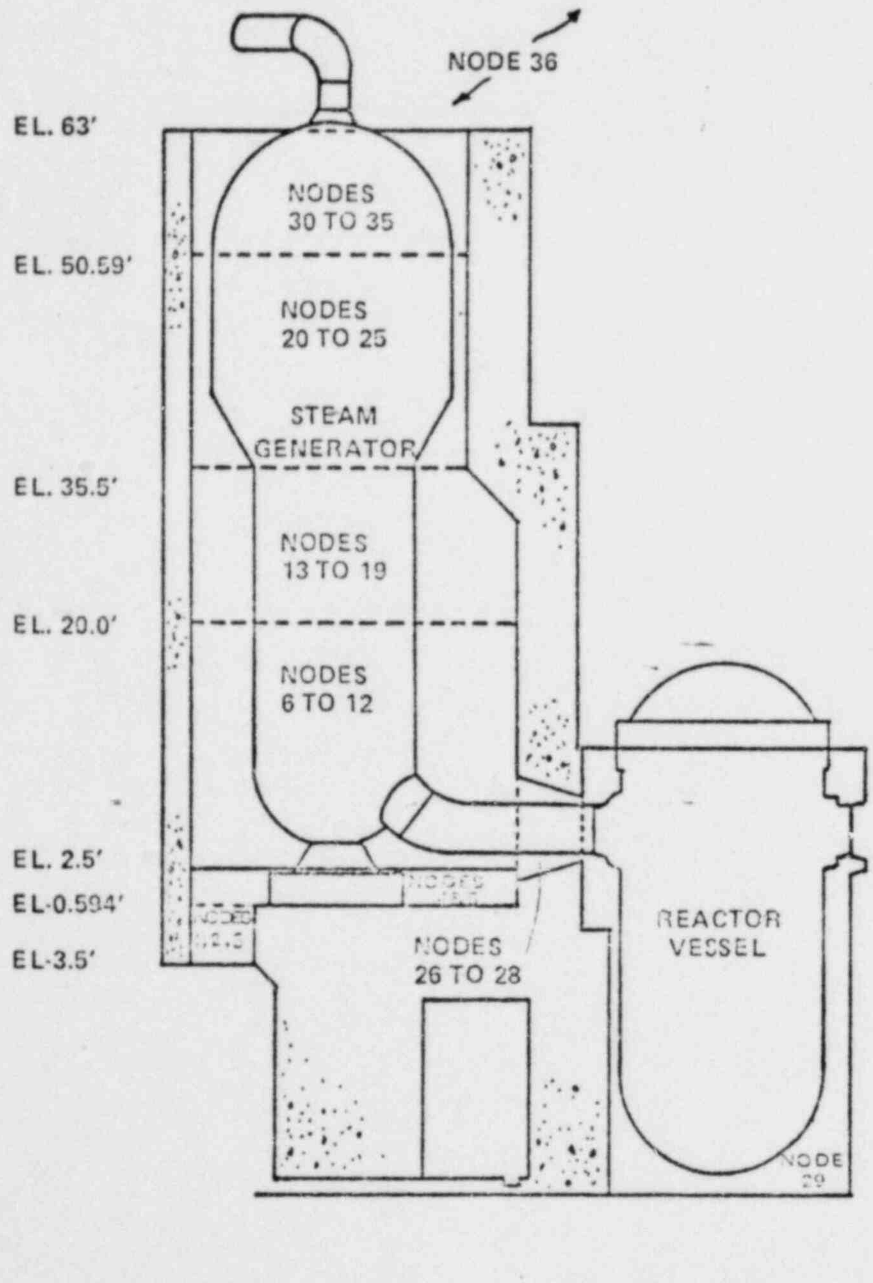
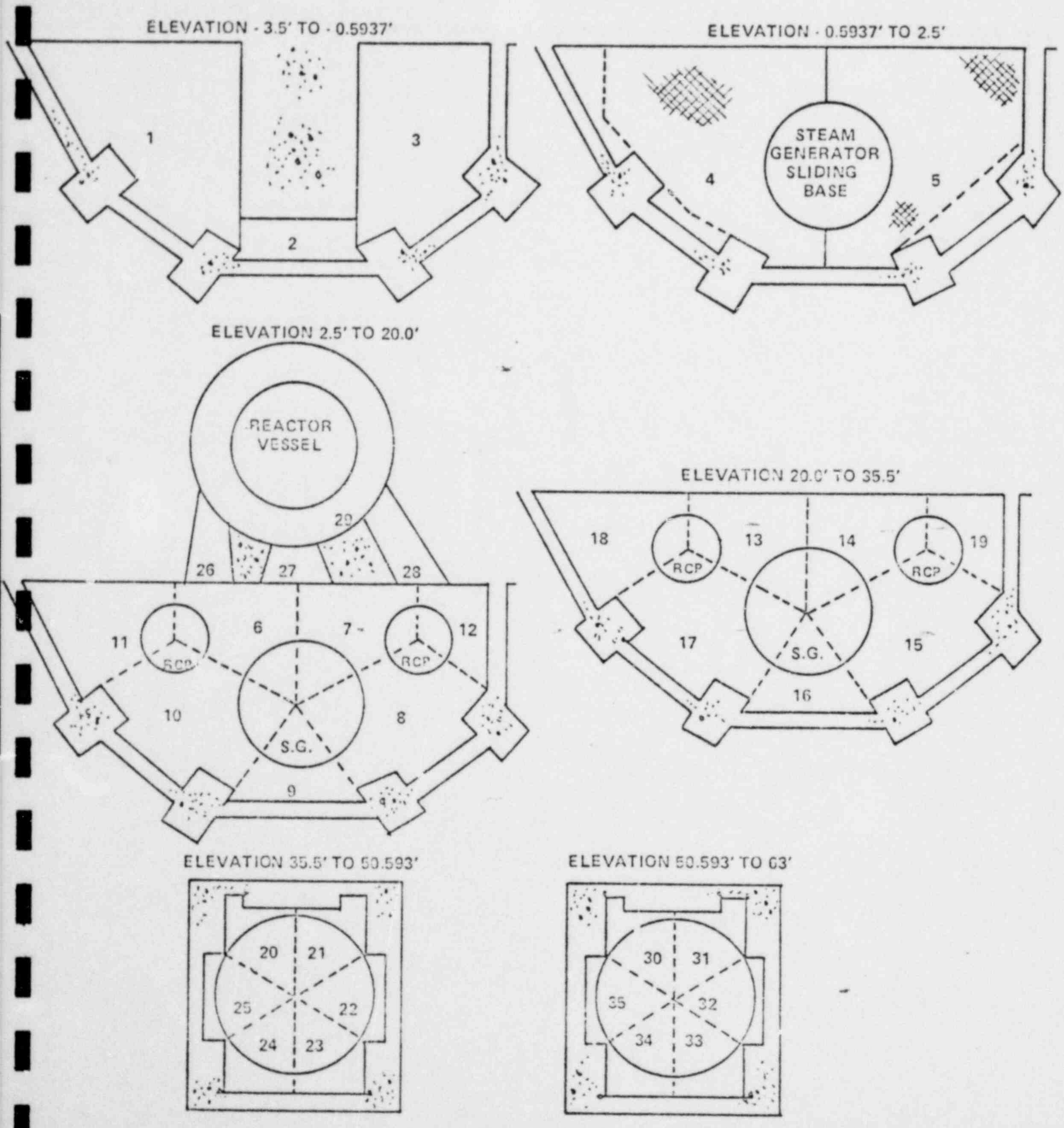


FIGURE 4.3.43
STEAM GENERATOR COMPARTMENT
NODALIZATION SKETCH TOP VIEW



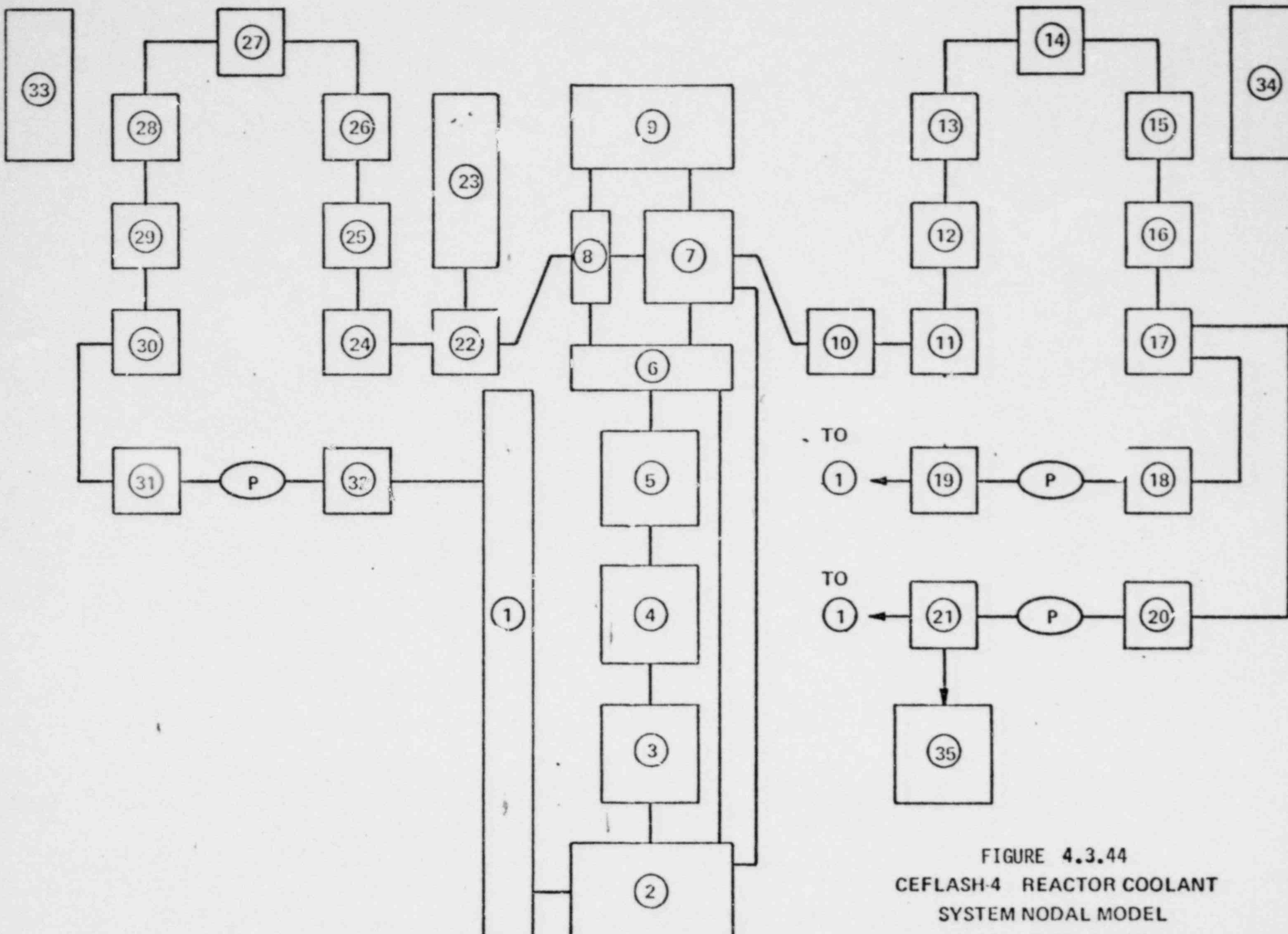


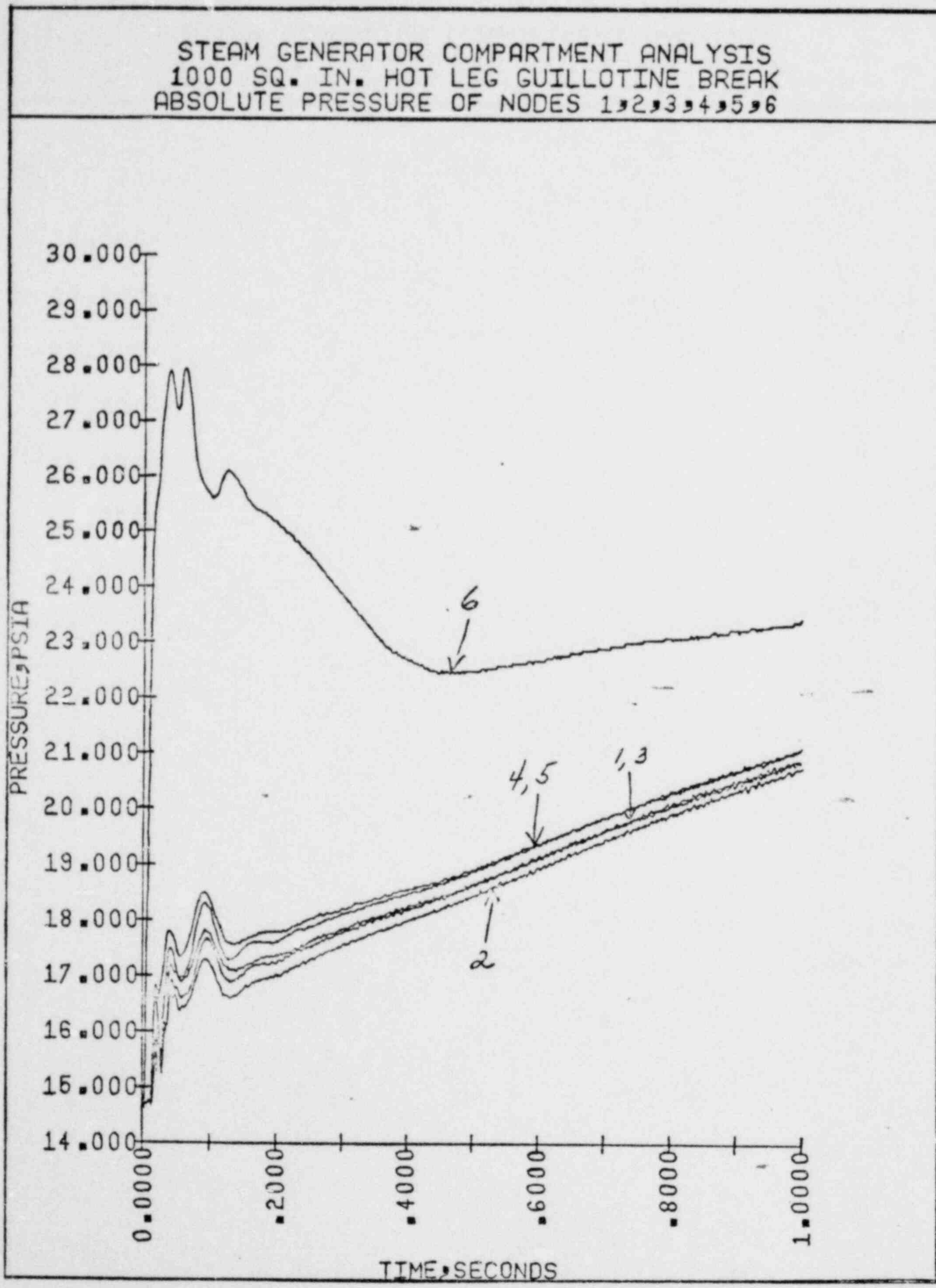
FIGURE 4.3.44
CEFLASH-4 REACTOR COOLANT
SYSTEM NODAL MODEL
(LEGEND FOLLOWS)

Legend for Figure 4.3.44

1. Reactor vessel downcomer.
2. Reactor vessel lower plenum.
3. -5. Reactor core.
6. Fuel alignment plate region.
7. Reactor vessel exit plenum.
8. CEA shrouds.
9. Reactor vessel upper head.
10. Reactor outlet pipe.
11. Steam generator inlet plenum.
12. -16. Steam generator tubes
17. Steam generator outlet plenum.
18. Pump suction pipe.
19. Pump discharge pipe.
20. Pump suction pipe.
21. Pump discharge pipe.
22. Reactor outlet pipe.
23. Pressurizer.
24. Steam generator inlet plenum.
25. -29. Steam generator tubes.
30. Steam generator outlet plenum.
31. Pump suction pipe (2).
32. Pump discharge pipe (2).
33. Steam generator secondary side.
34. Steam generator secondary side.
35. Containment.

When a circumferential pipe rupture is postulated, two nodes are used to represent the severed pipe.

FIGURE 4.3.45



STEAM GENERATOR COMPARTMENT ANALYSIS
1000 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES 1,2,3,4,5,6
PRESSURE,PSIA
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
6
4,5
1,3
2

FIGURE 4.3.46

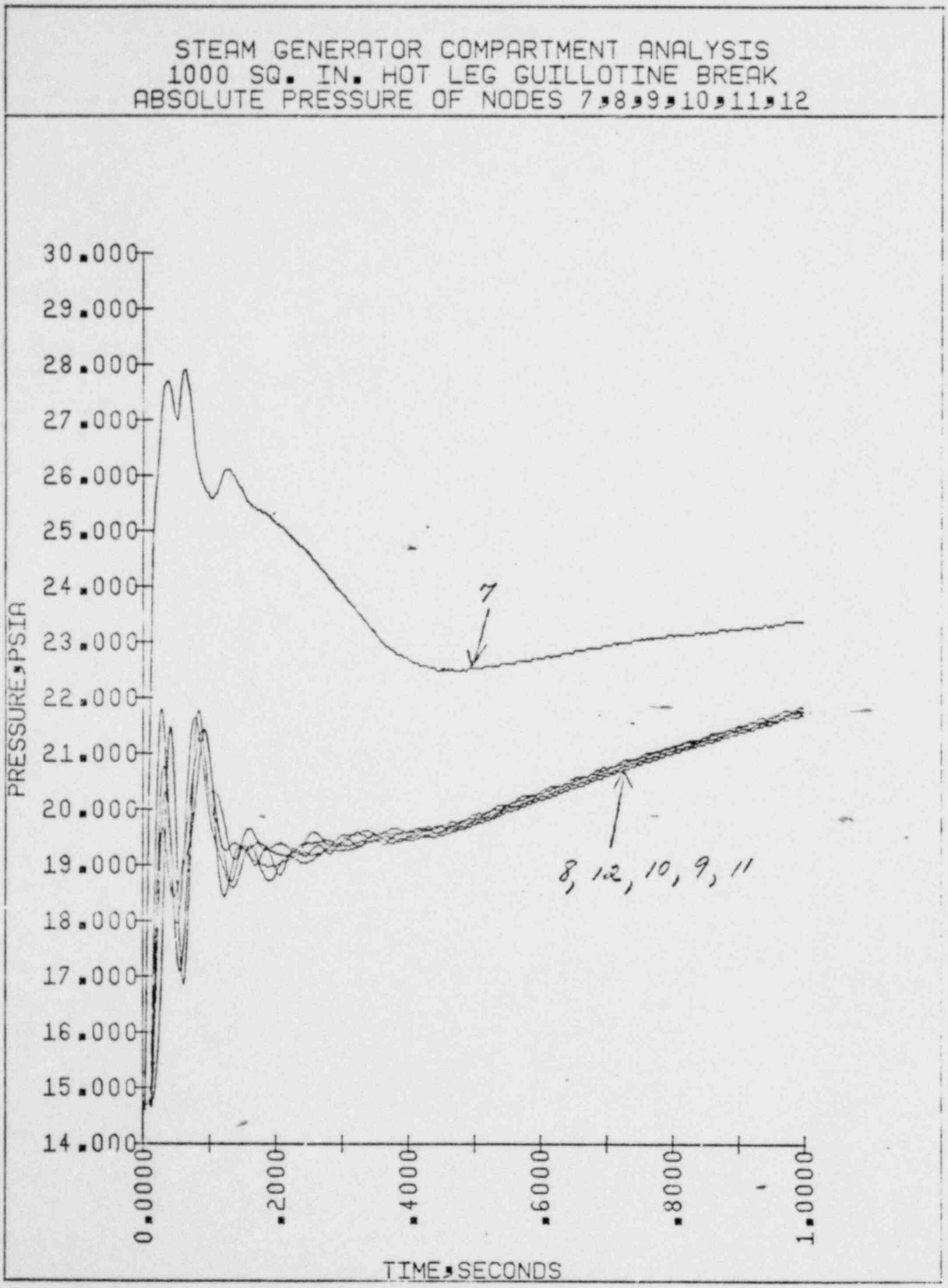

STEAM GENERATOR COMPARTMENT ANALYSIS
1000 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES 7,8,9,10,11,12
PRESSURE,PSIA
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
7
8, 12, 10, 9, 11

FIGURE 4.3.47

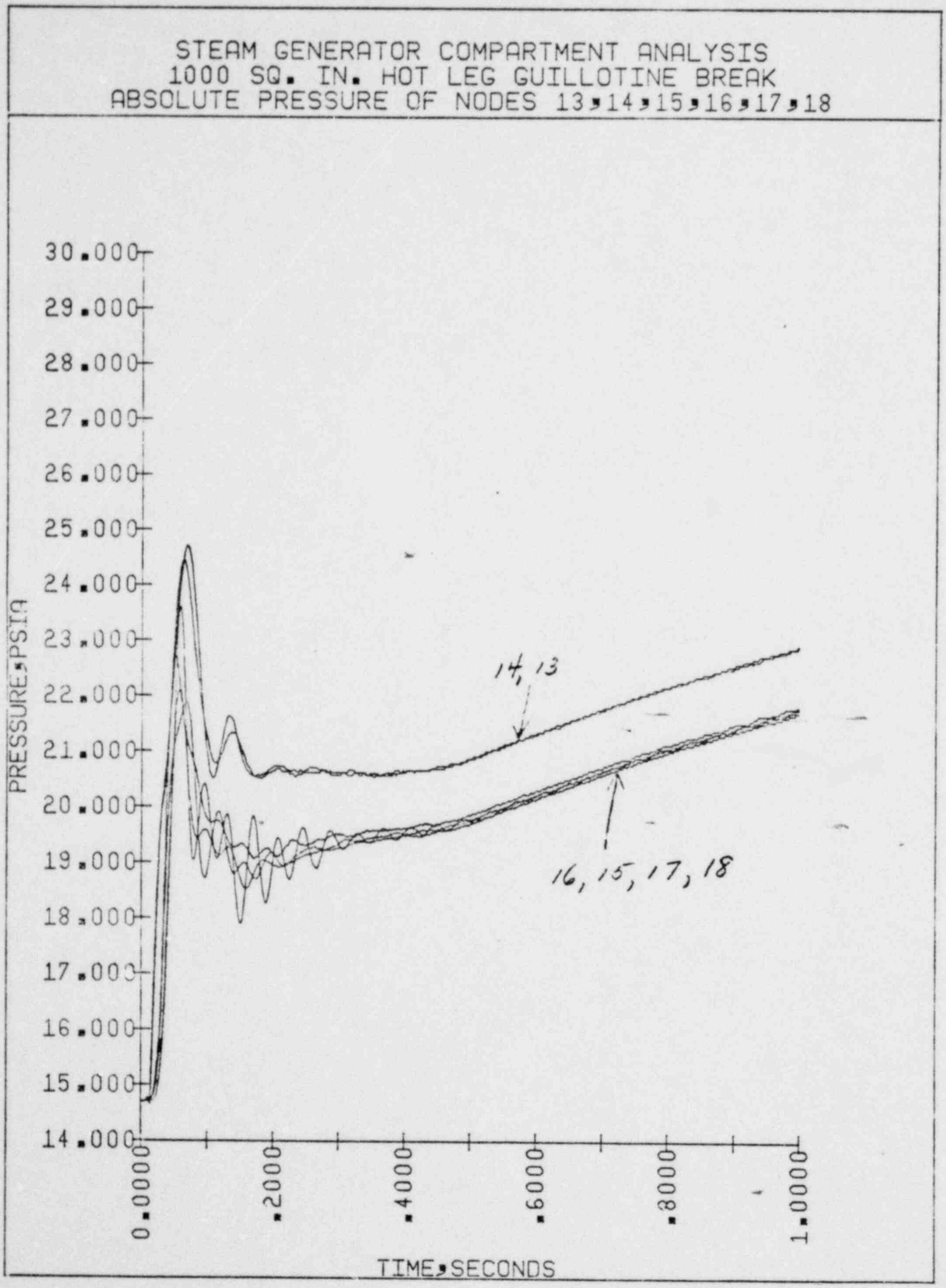
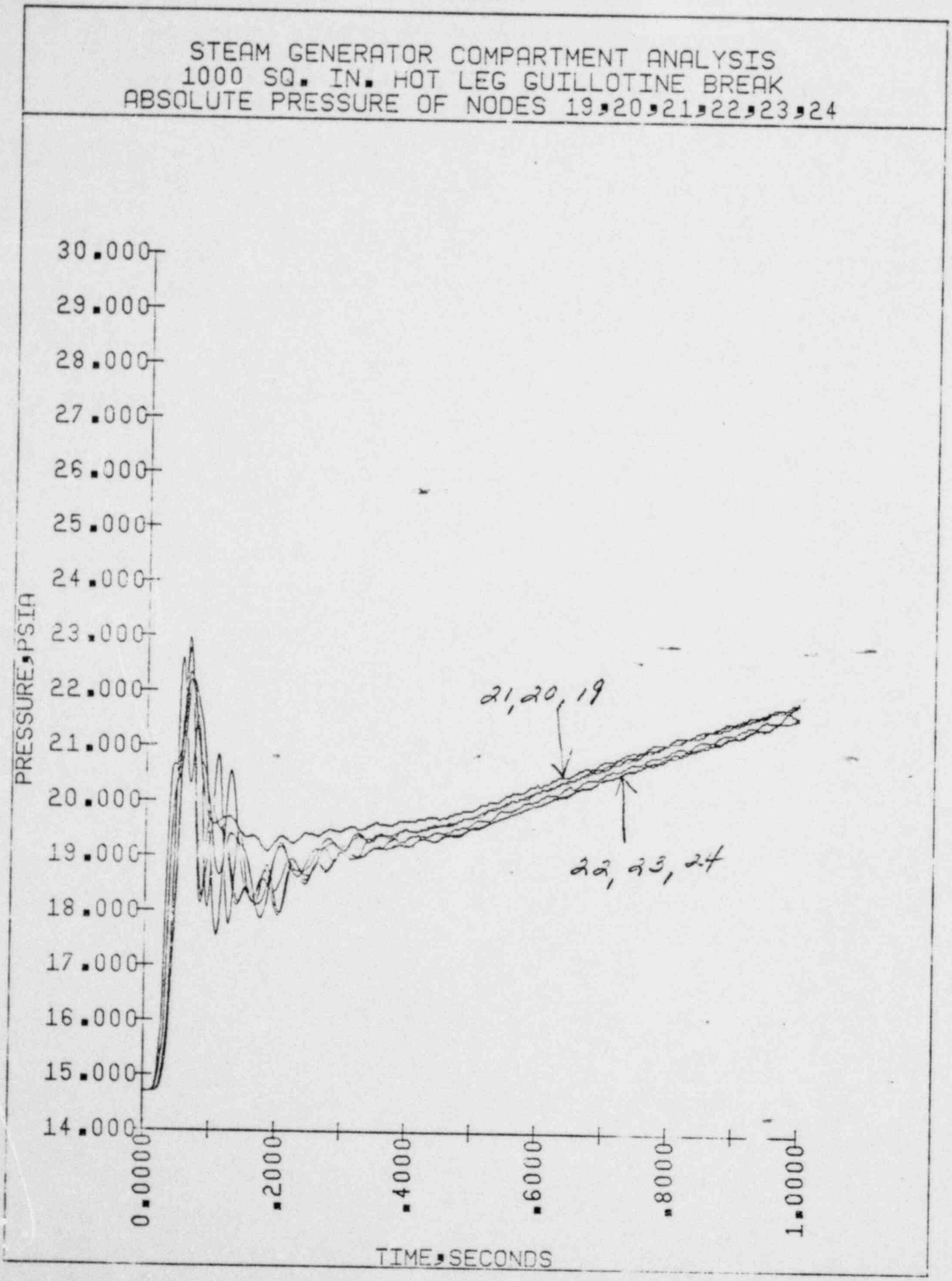
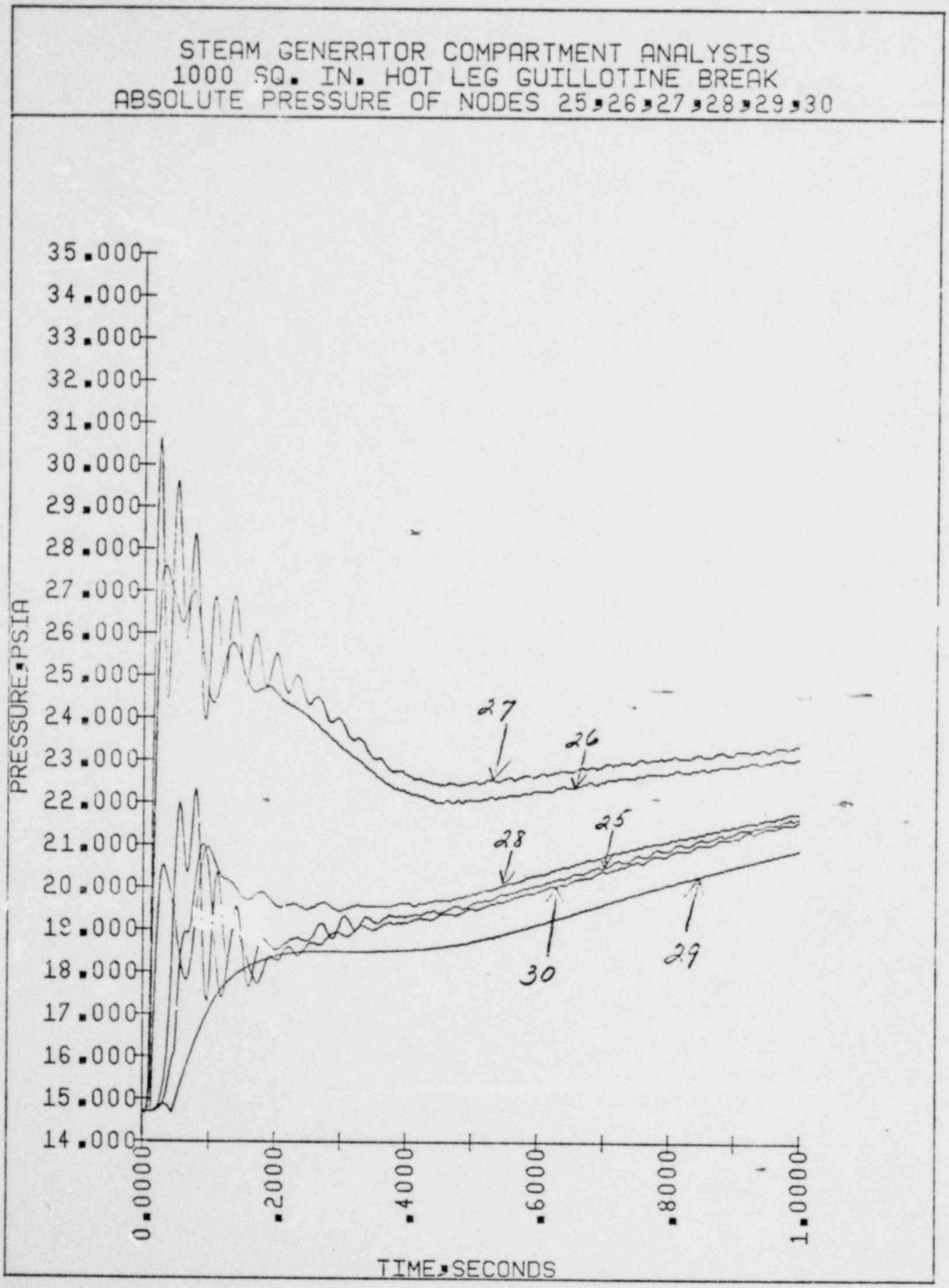

STEAM GENERATOR COMPARTMENT ANALYSIS
1000 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES 13,14,15,16,17,18
PRESSURE,PSIA
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
14, 13
16, 15, 17, 18

FIGURE 4.3.48



STEAM GENERATOR COMPARTMENT ANALYSIS
1000 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES 19,20,21,22,23,24
PRESSURE,PSIA
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
21, 20, 19
22, 23, 24

FIGURE 4.3.49



STEAM GENERATOR COMPARTMENT ANALYSIS
1000 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES 25,26,27,28,29,30
PRESSURE,PSIA
35.000
34.000
33.000
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
27
26
28
25
30
29

FIGURE 4.3.50

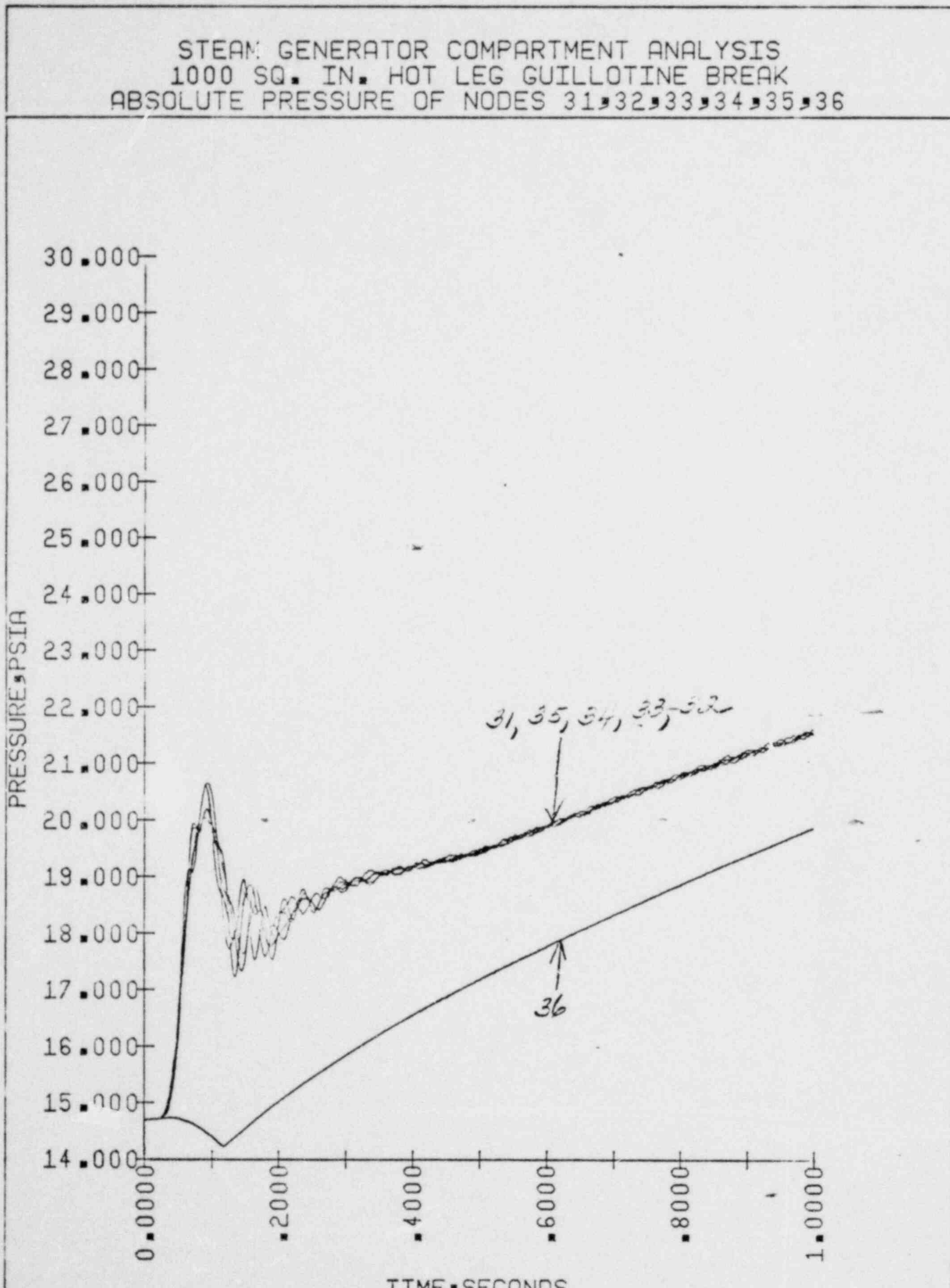

STEAM GENERATOR COMPARTMENT ANALYSIS
1000 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES 31,32,33,34,35,36
PRESSURE,PSIA
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
36

FIGURE 4.3.51

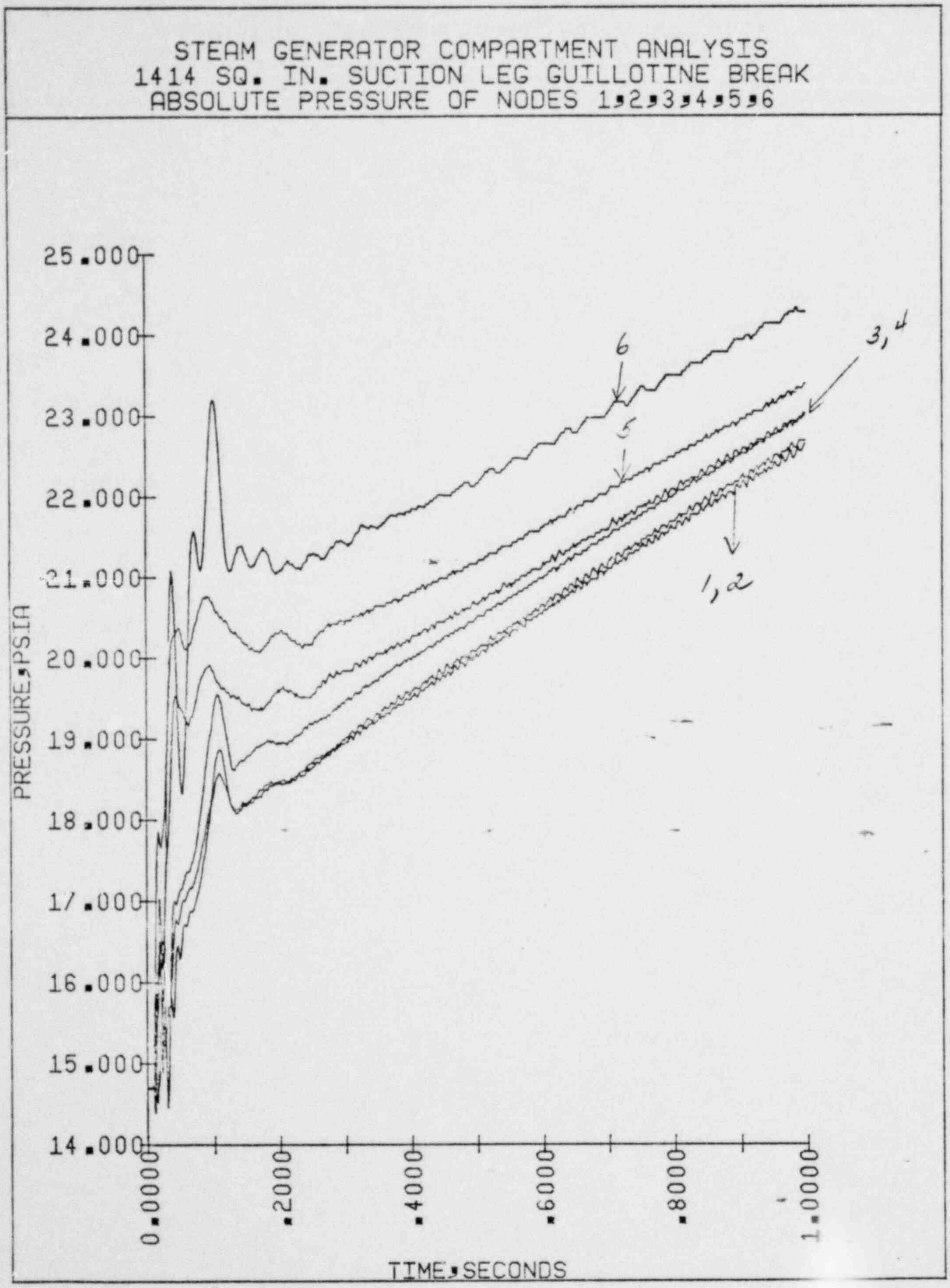

STEAM GENERATOR COMPARTMENT ANALYSIS
1414 SQ. IN. SUCTION LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES 1,2,3,4,5,6
PRESSURE, PSIA
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME, SECONDS
6
5
3,4
1,2

FIGURE 4.3.52

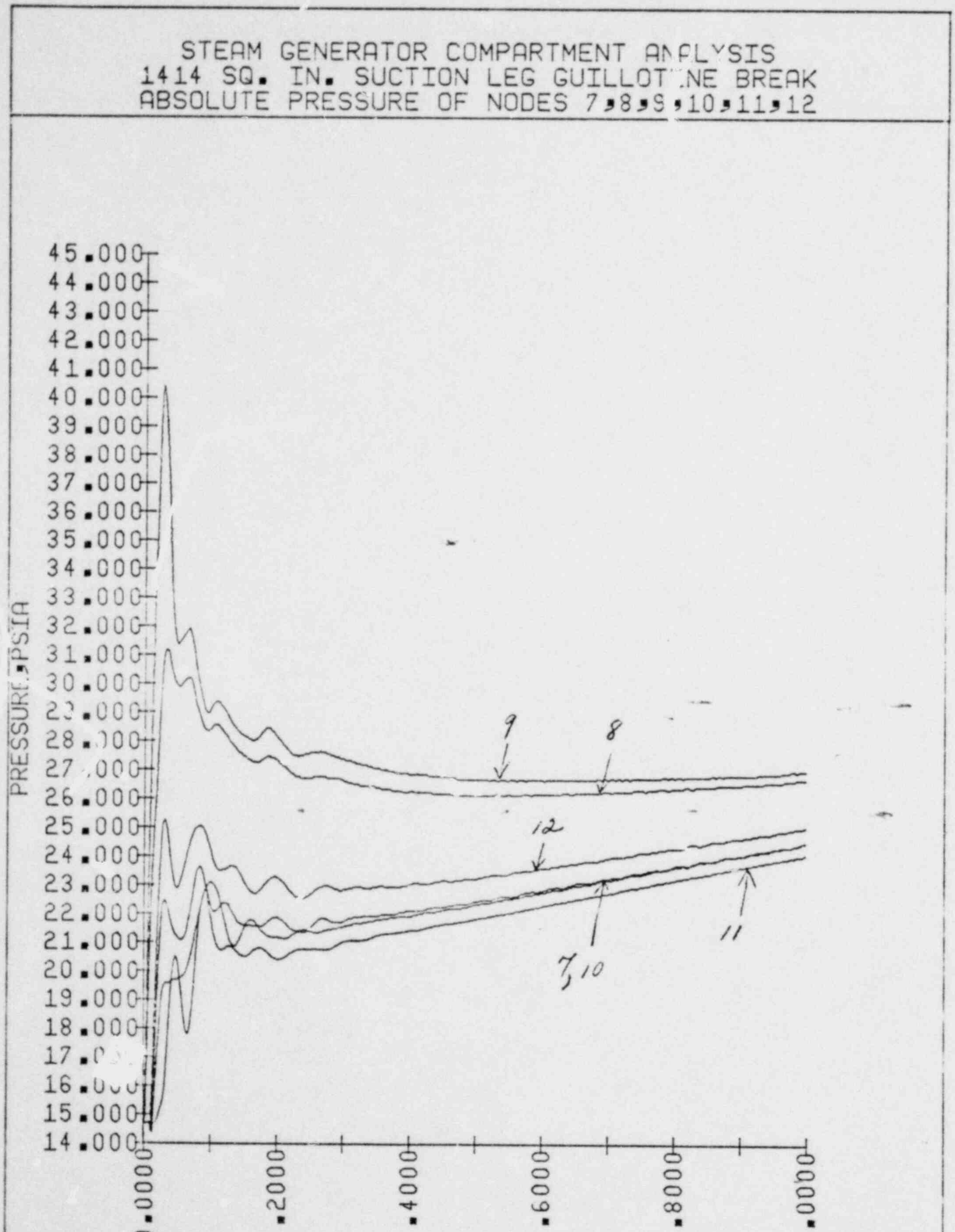

STEAM GENERATOR COMPARTMENT ANALYSIS
1414 SQ. IN. SUCTION LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES 7,8,9,10,11,12
PRESSURE,PSIA
45.000
44.000
43.000
42.000
41.000
40.000
39.000
38.000
37.000
36.000
35.000
34.000
33.000
32.000
31.000
30.000
28.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
9
8
12
7,10
11

FIGURE 4.3.53

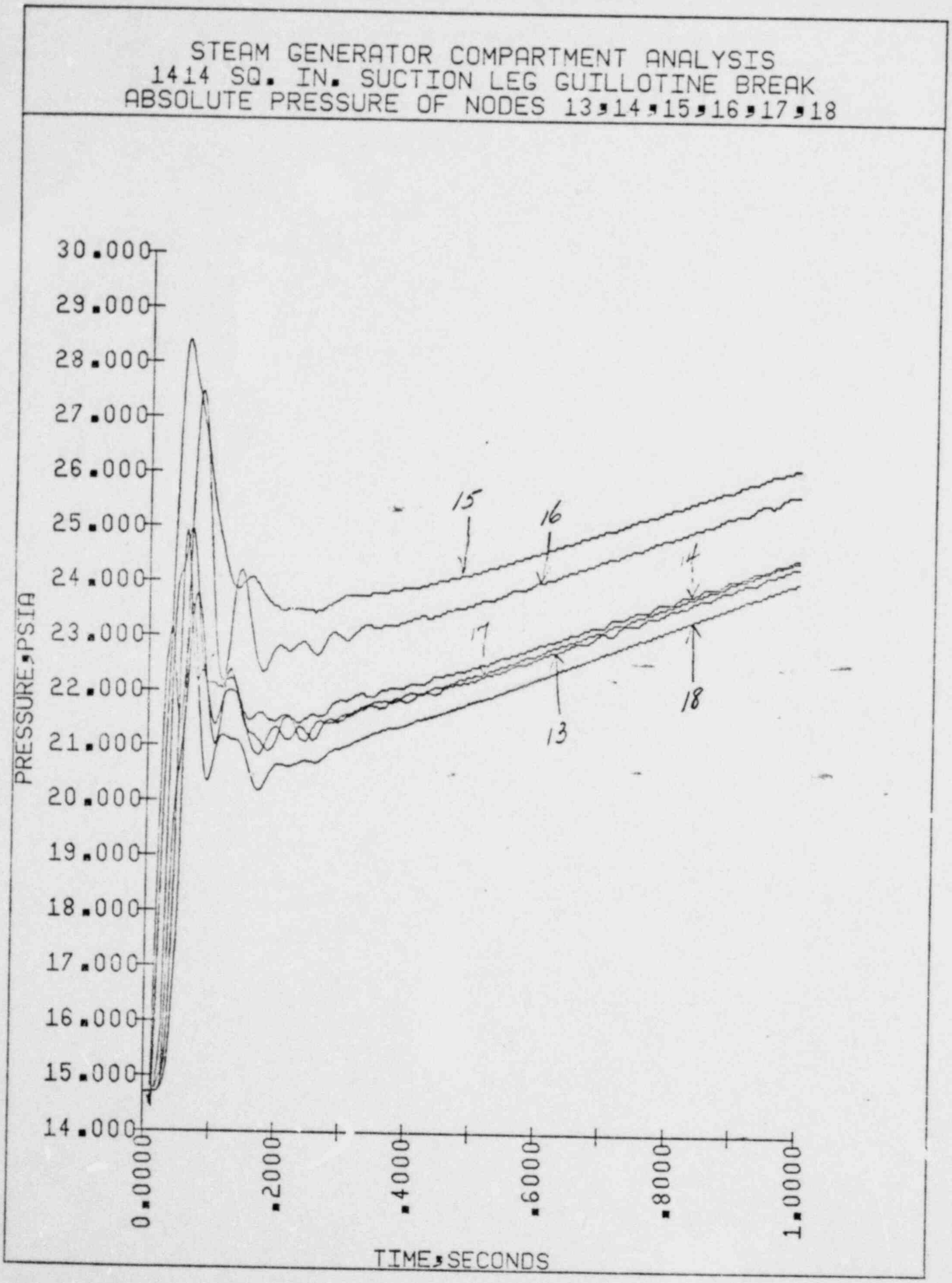
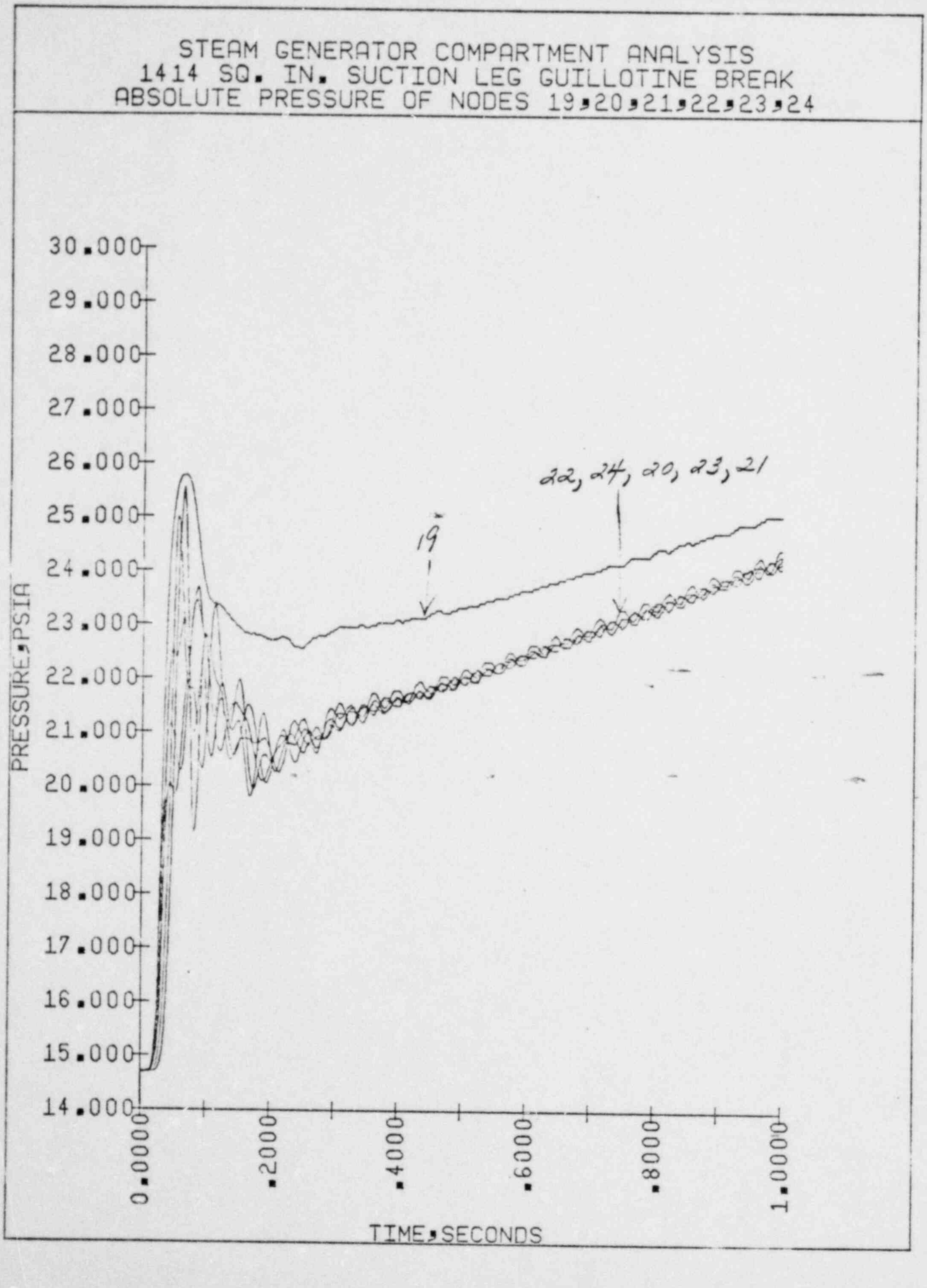
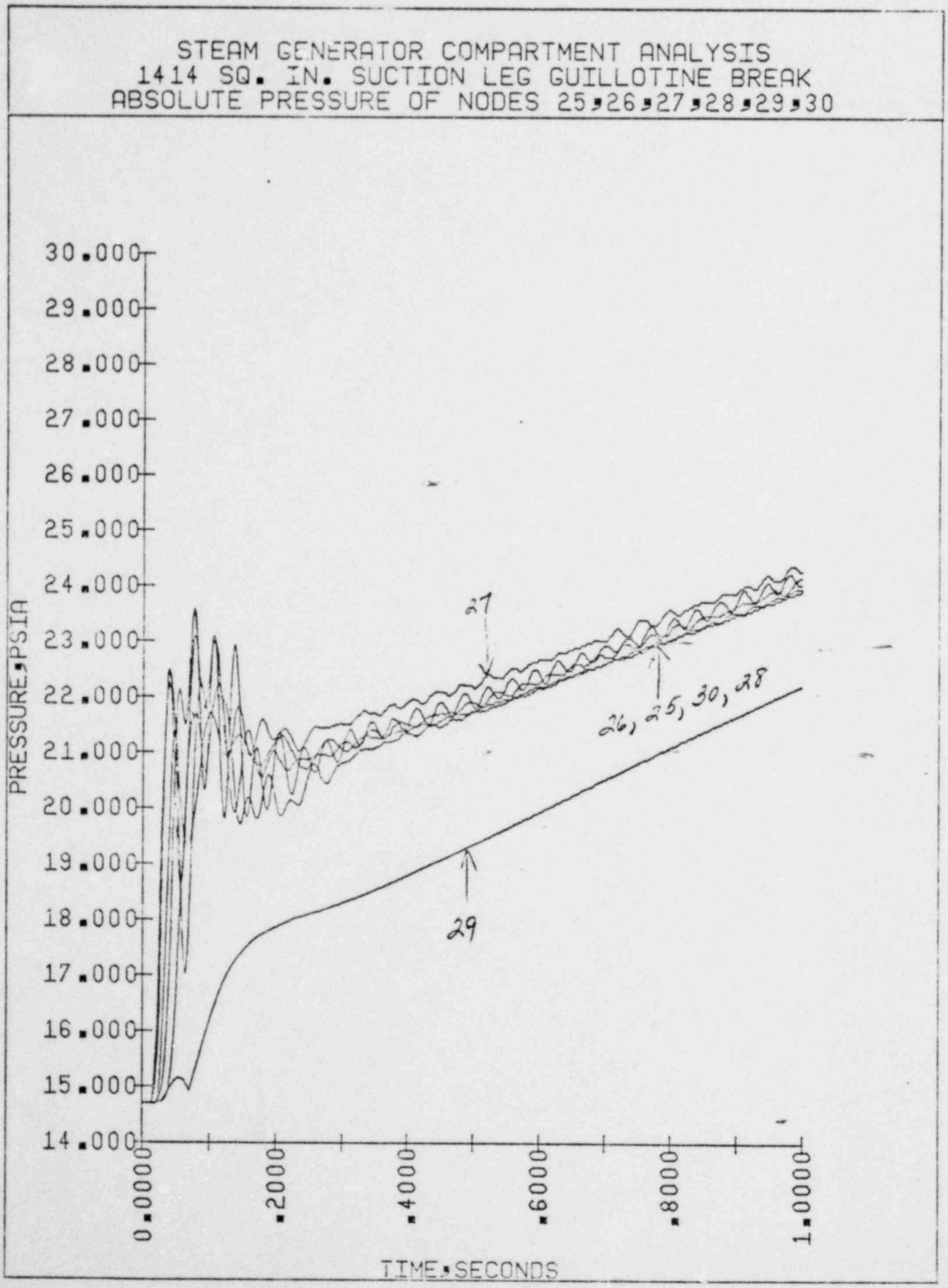

STEAM GENERATOR COMPARTMENT ANALYSIS
1414 SQ. IN. SUCTION LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES 13,14,15,16,17,18
PRESSURE,PSIA
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
15
16
14
17
18
13

FIGURE 4.3.54



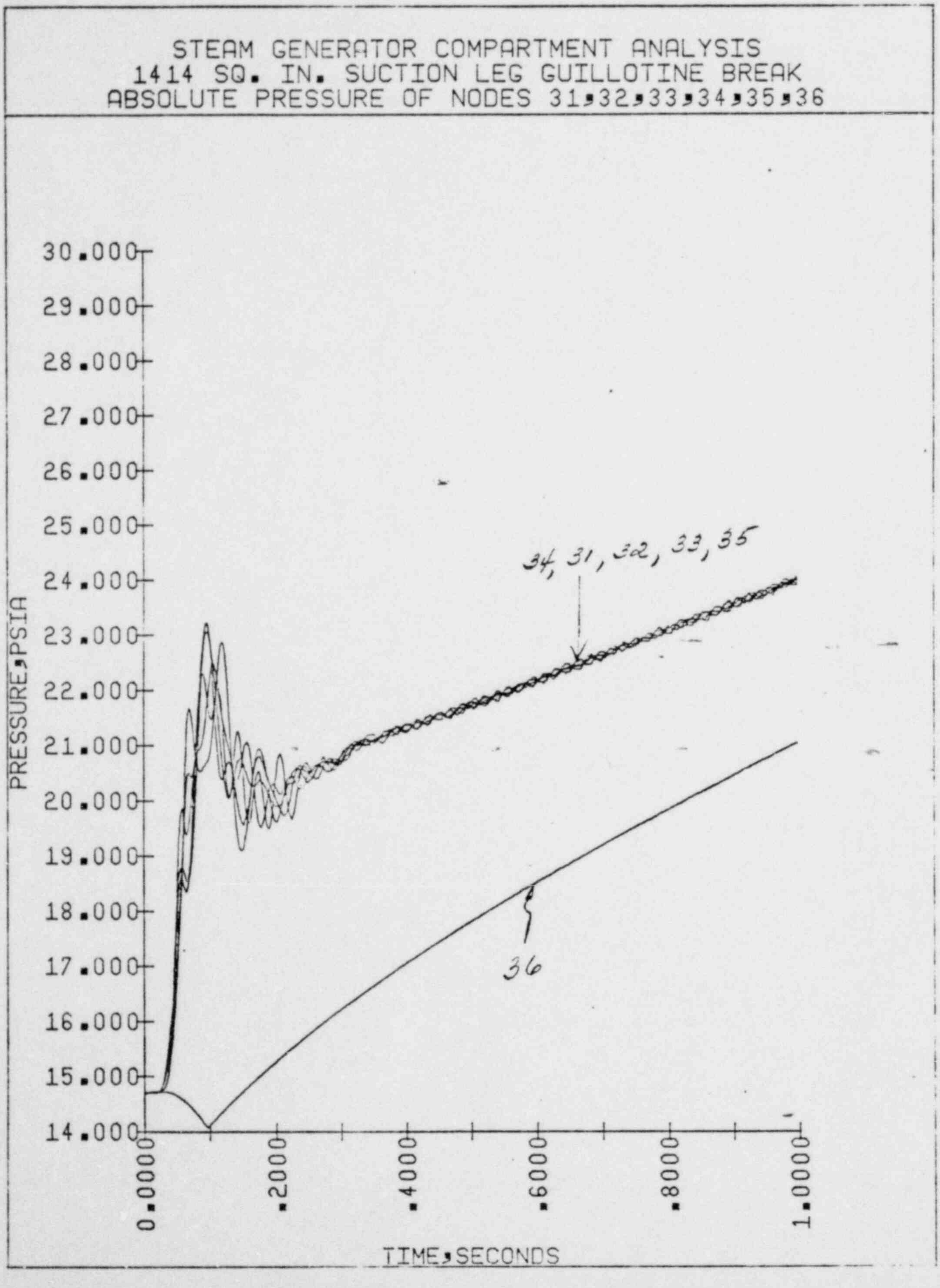
STEAM GENERATOR COMPARTMENT ANALYSIS
1414 SQ. IN. SUCTION LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES 19,20,21,22,23,24
PRESSURE,PSIA
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
19
22, 24, 20, 23, 21

FIGURE 4.3.55



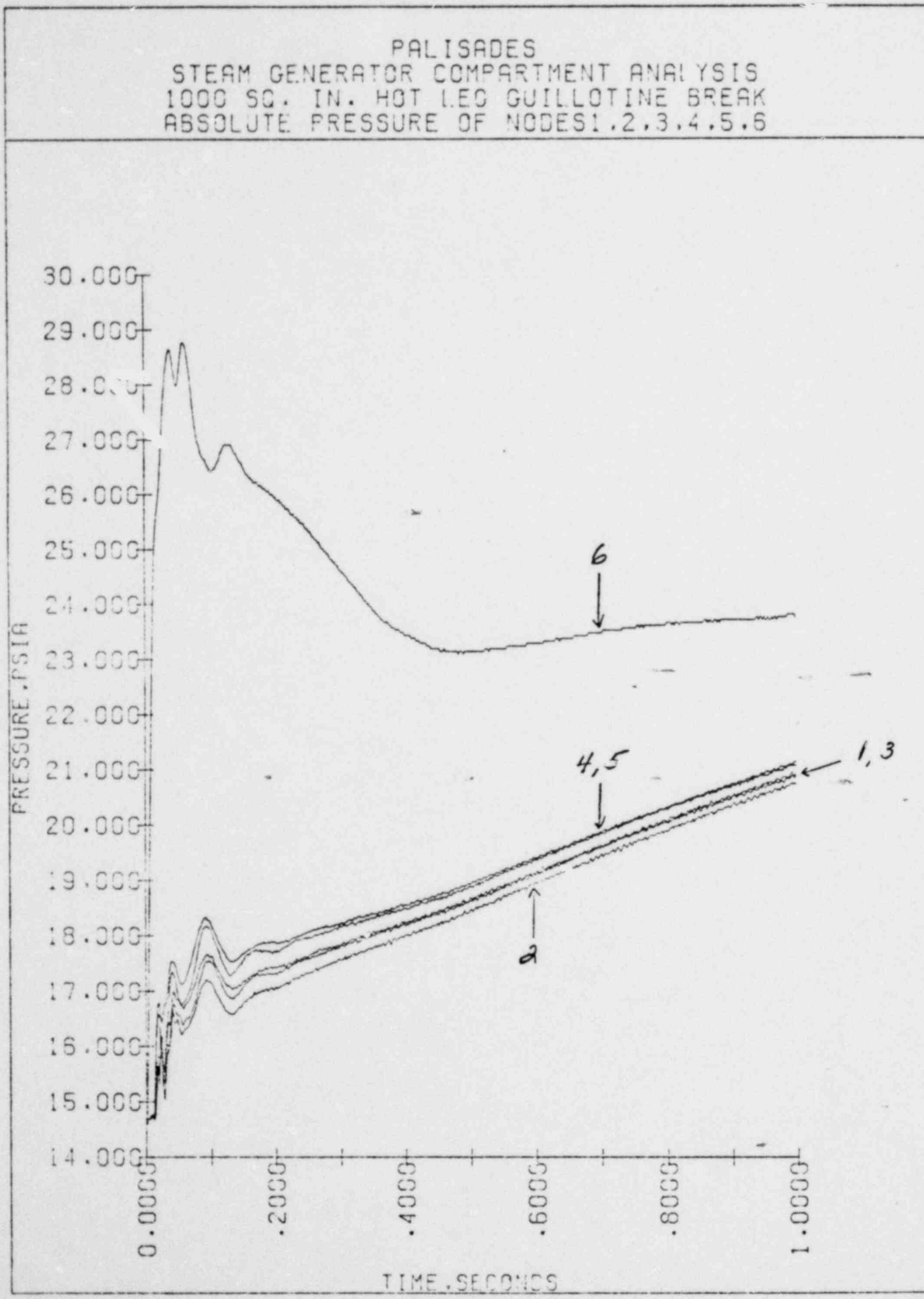
STEAM GENERATOR COMPARTMENT ANALYSIS
1414 SQ. IN. SUCTION LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES 25,26,27,28,29,30
PRESSURE,PSIA
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
27
26, 25, 30, 28
29

FIGURE 4.3.56



STEAM GENERATOR COMPARTMENT ANALYSIS
1414 SQ. IN. SUCTION LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES 31,32,33,34,35,36
PRESSURE,PSIA
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
34, 31, 32, 33, 35
36

FIGURE 4.3.57



PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
1000 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES1.2.3.4.5.6
PRESSURE,PSIA
30.000
29.000
27.000
26.000
25.000
23.000
22.000
21.000
20.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
6
4,5
1,3
2

FIGURE 4.3.58

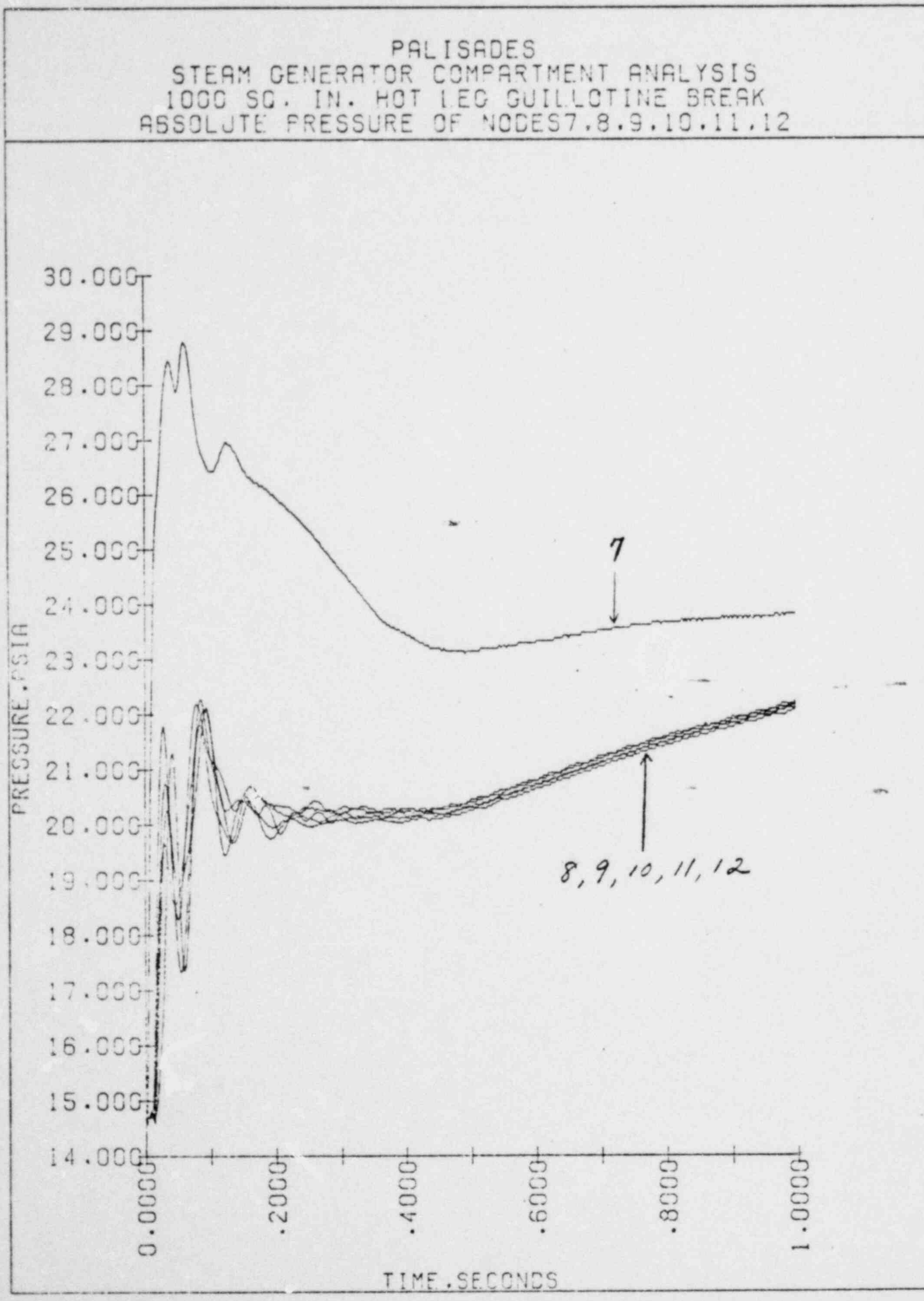
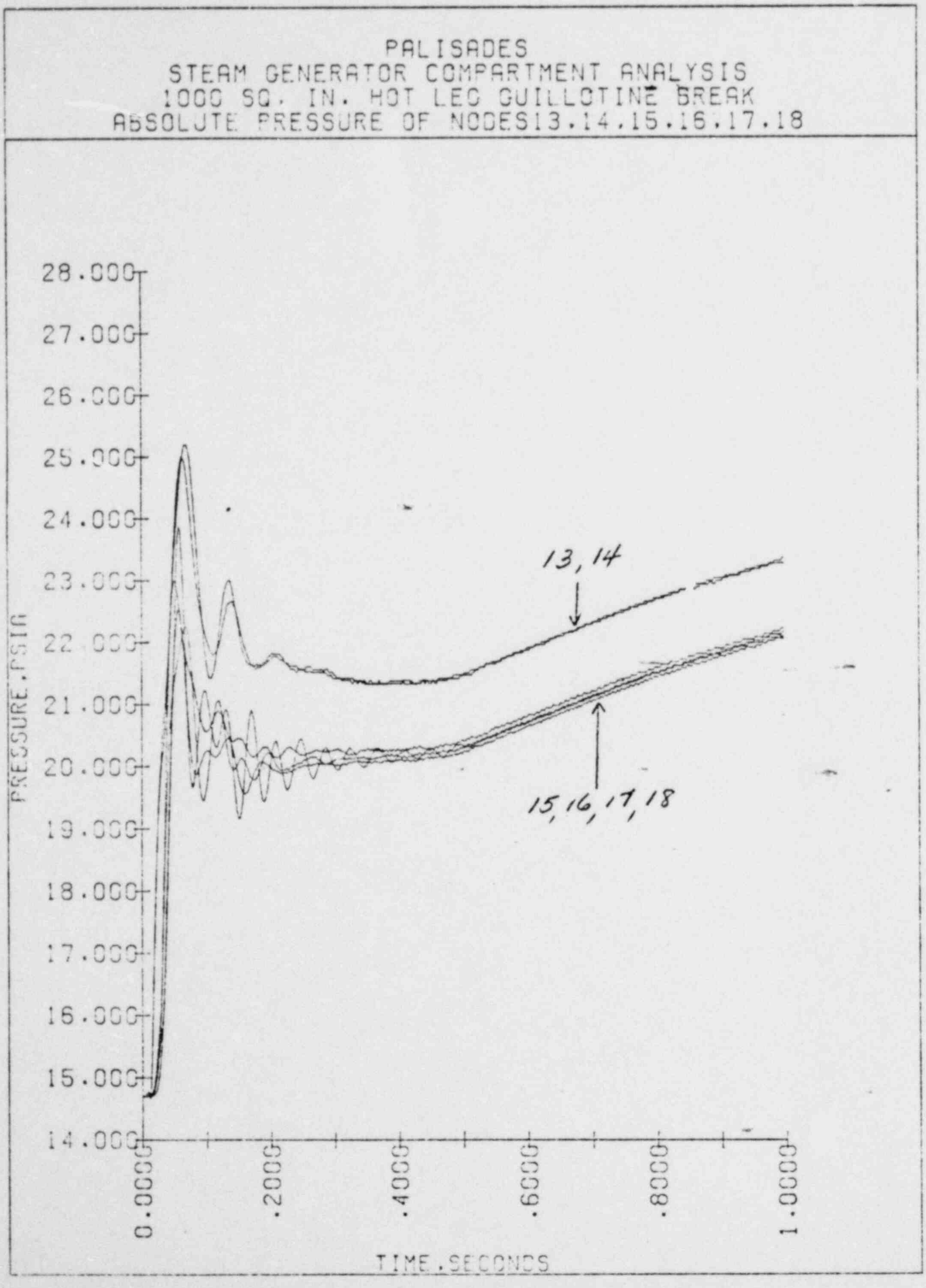

PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
1000 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES7.8.9.10.11.12
PRESSURE.PSIA
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME.SECONDS
7
8, 9, 10, 11, 12

FIGURE 4.3.59



PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
1000 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES13.14.15.16.17.18
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
PRESSURE.PSIA
13, 14
15, 16, 17, 18
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME.SECONDS

FIGURE 4.3.60

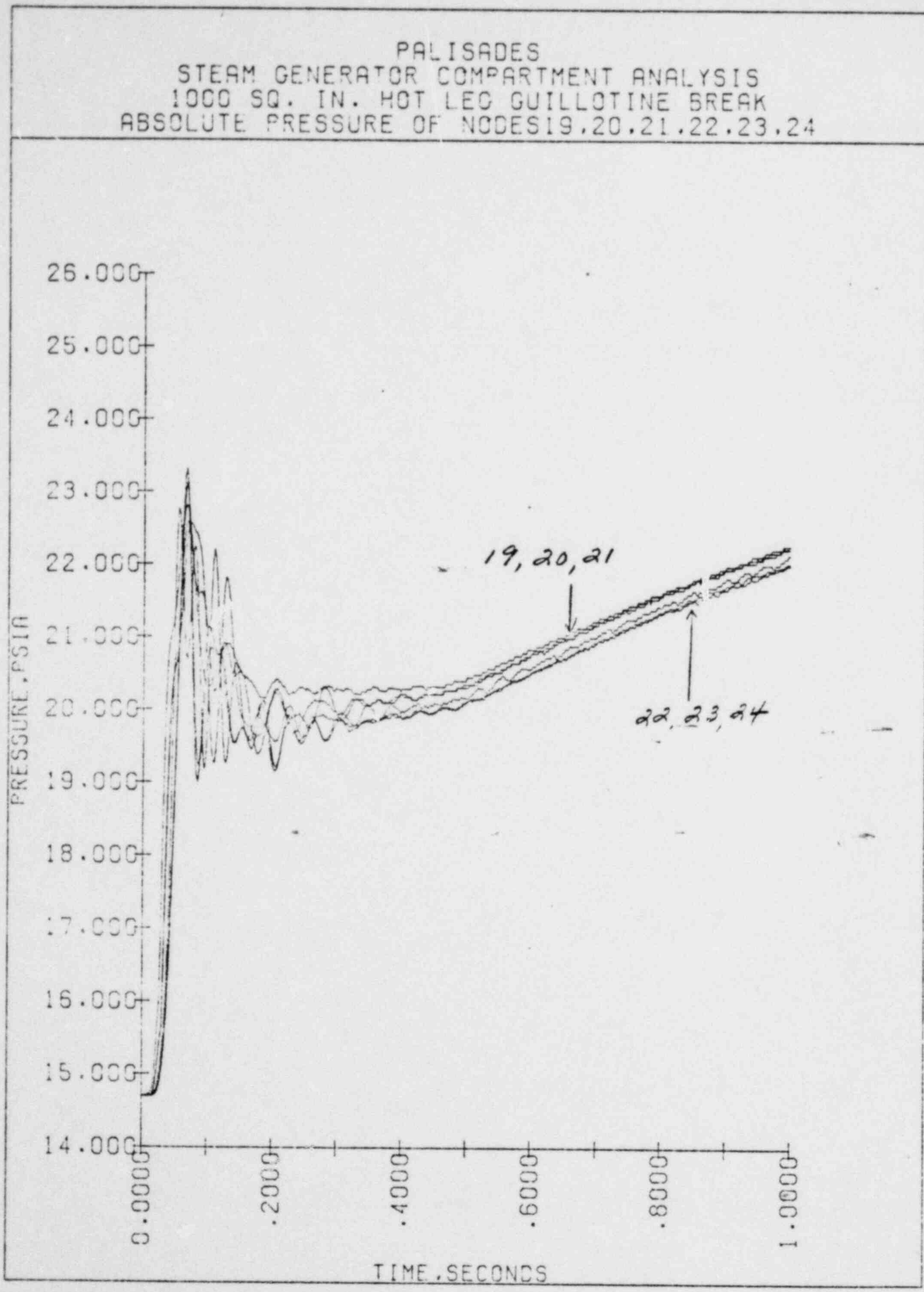

PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
1000 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES19,20,21,22,23,24
PRESSURE,PSIA
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
19, 20, 21
22, 23, 24

FIGURE 4.3.61

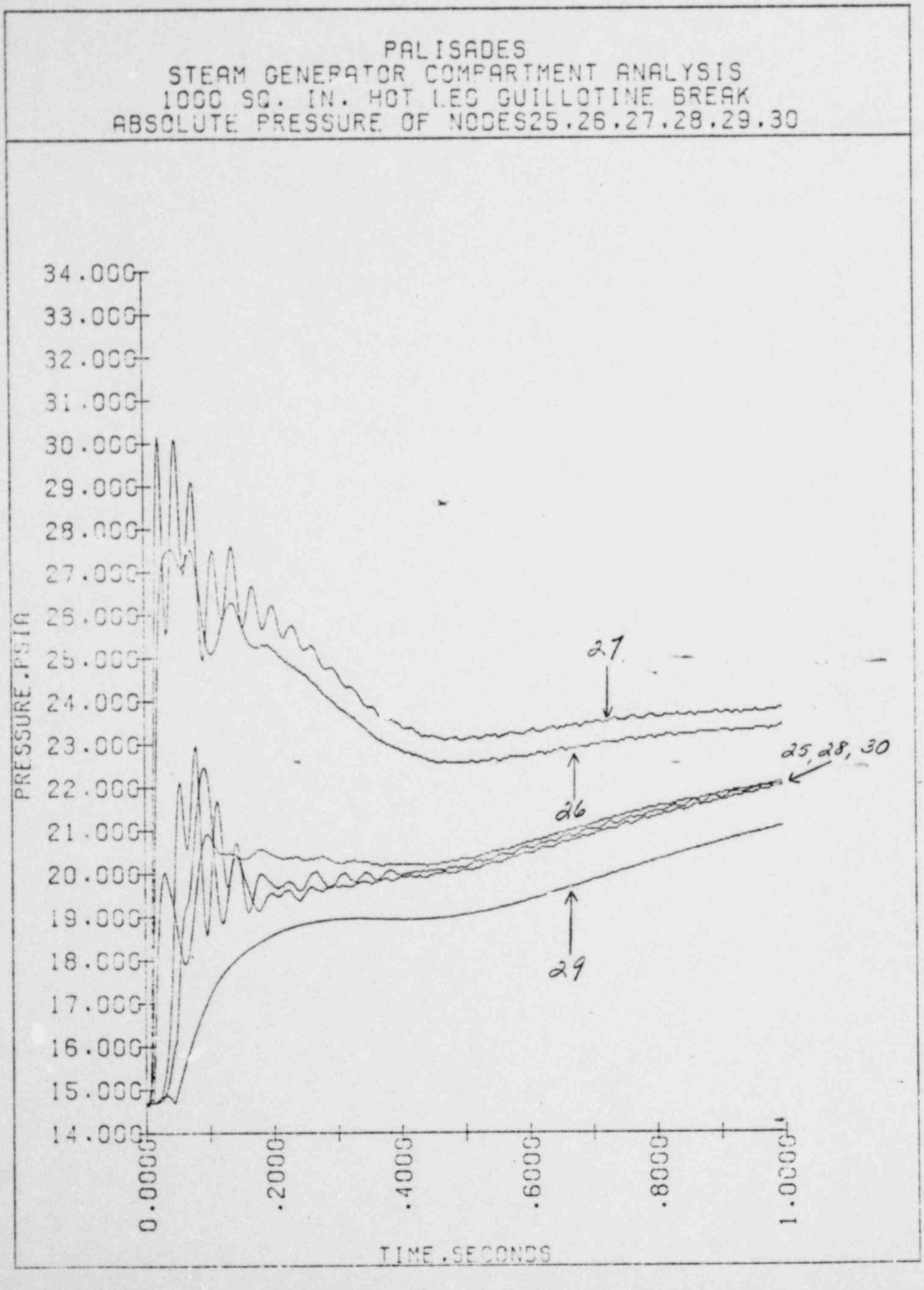
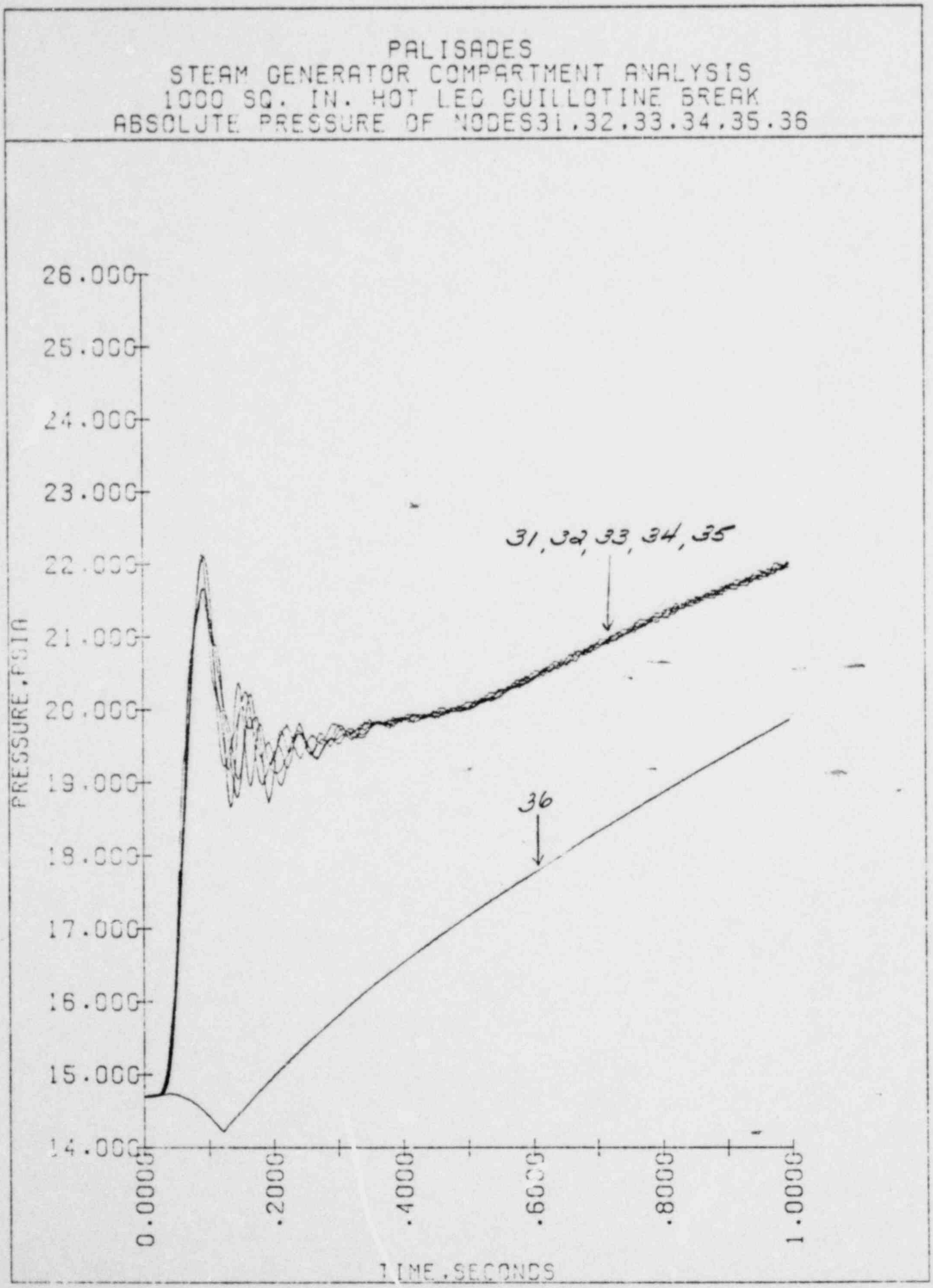

PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
1000 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES25.26.27.28.29.30
PRESSURE.PSIA
34.000
33.000
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME.SECONDS
27
26
25, 28, 30
29

FIGURE 4.3.62



PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
1000 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES31.32.33.34.35.36
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
PRESSURE,PSIA
31, 32, 33, 34, 35
36
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS

FIGURE 4.3.63

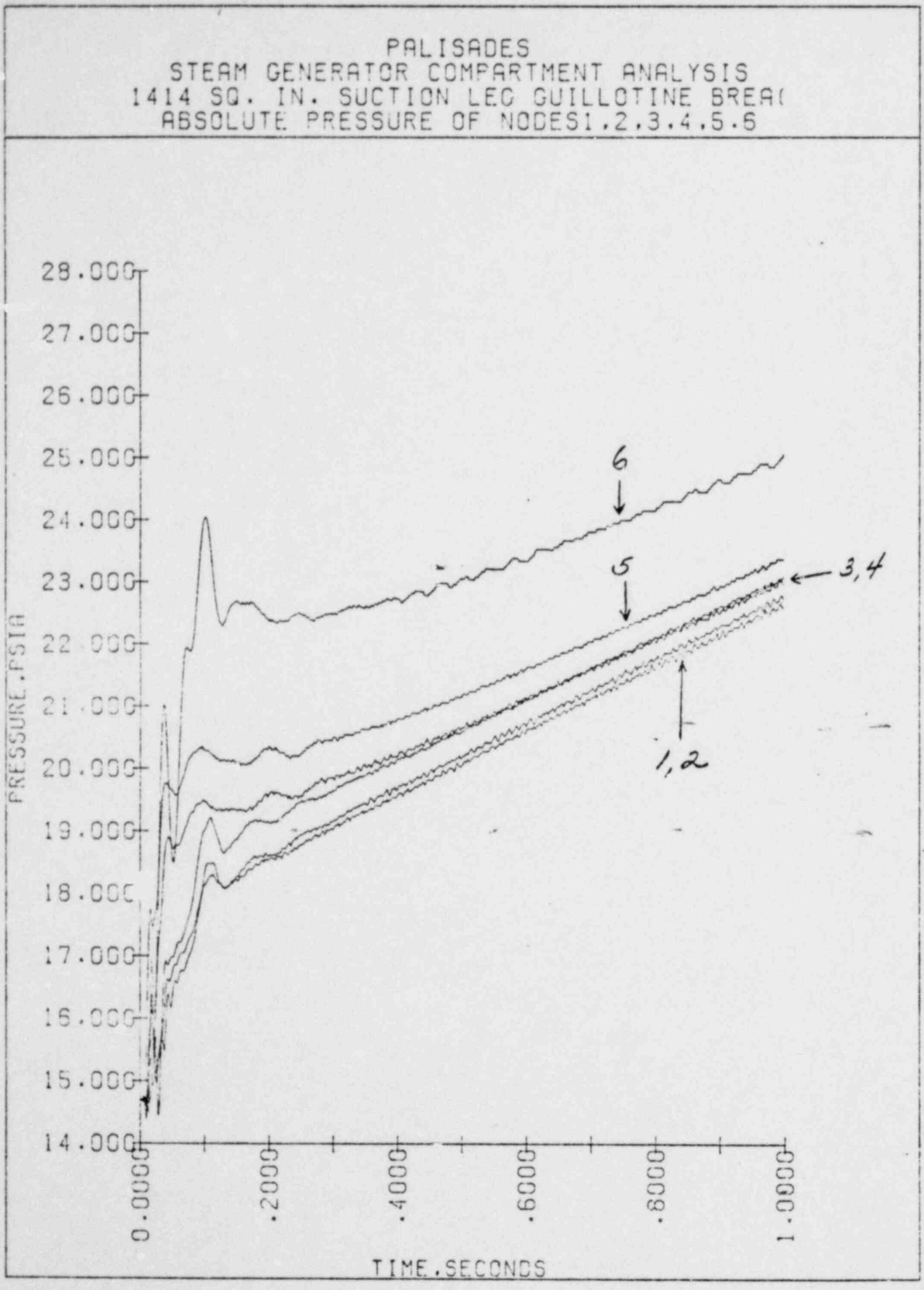

PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
1414 SQ. IN. SUCTION LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES1.2.3.4.5.6
PRESSURE, PSIA
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME, SECONDS
6
5
3,4
1,2

FIGURE 4.3.64

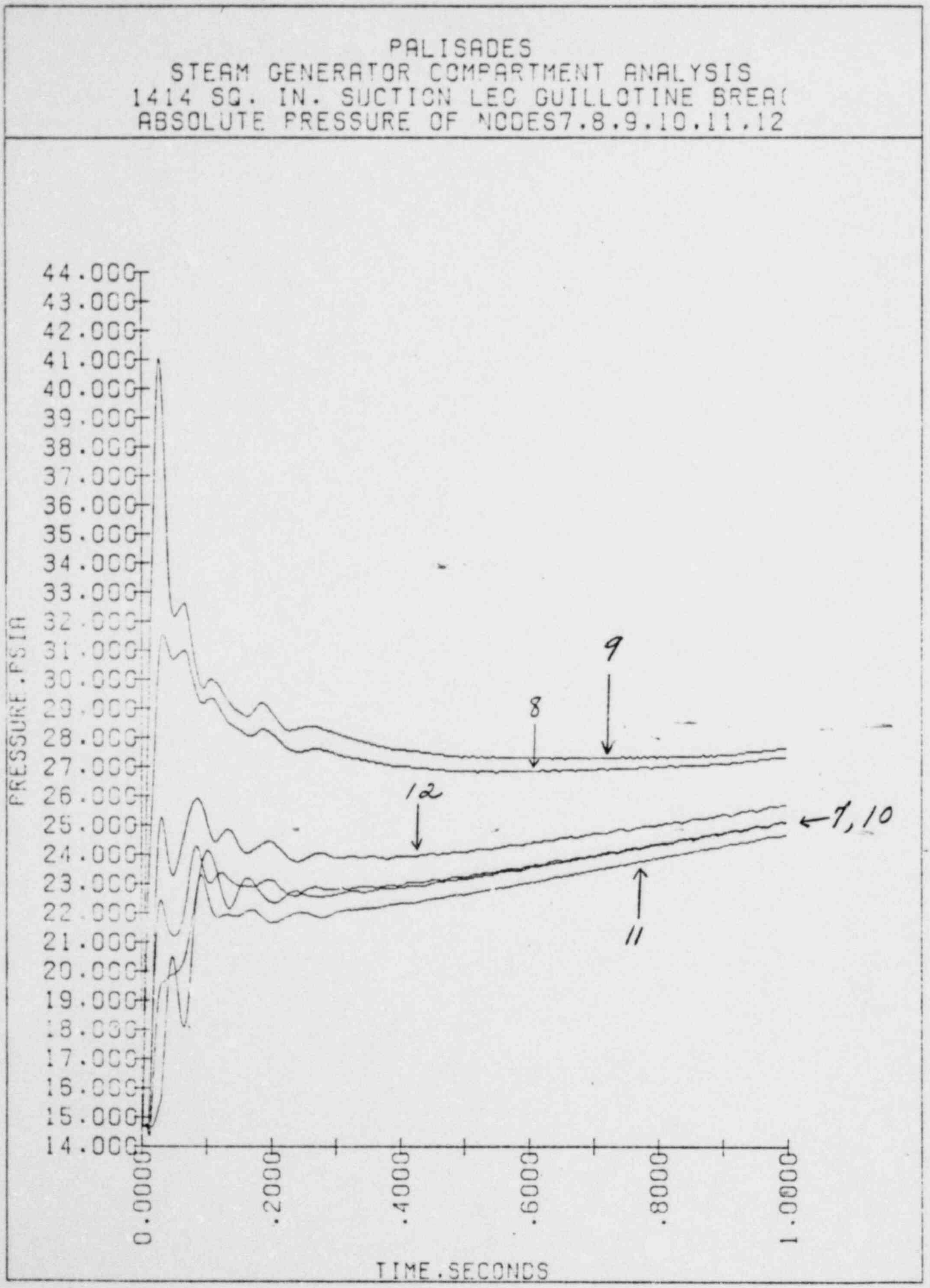

PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
1414 SQ. IN. SUCTION LEG GUILLOTINE BREA(
ABSOLUTE PRESSURE OF NODES7.8.9.10.11.12
PRESSURE.PSIA
44.000
43.000
42.000
41.000
40.000
39.000
38.000
37.000
36.000
35.000
34.000
33.000
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME.SECONDS
9
8
12
7,10
11

FIGURE 4.3.65

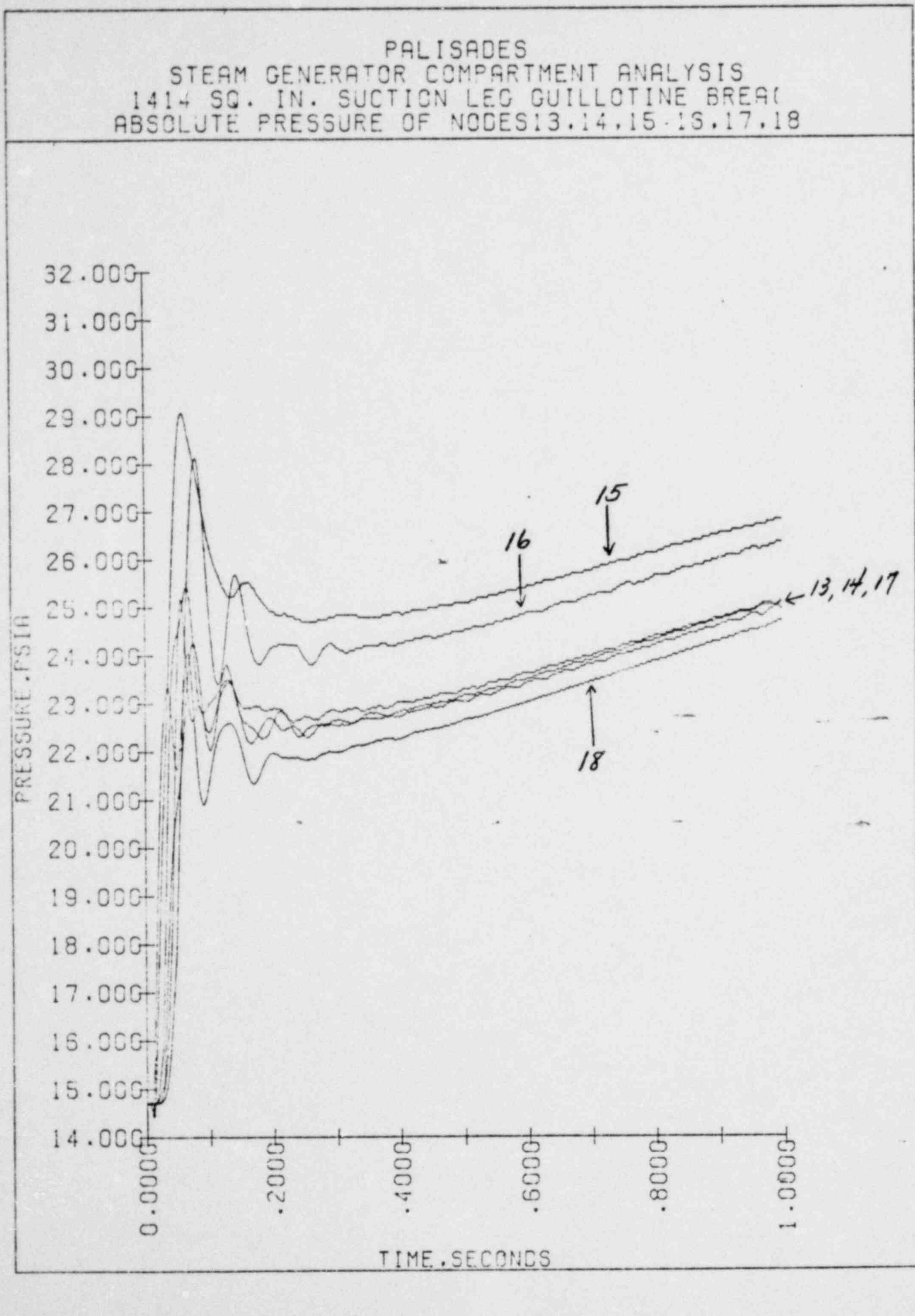

PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
1414 SQ. IN. SUCTION LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES13.14.15-16.17.18
PRESSURE.PSIA
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME.SECONDS
15
16
13, 14, 17
18

FIGURE 4.3.66

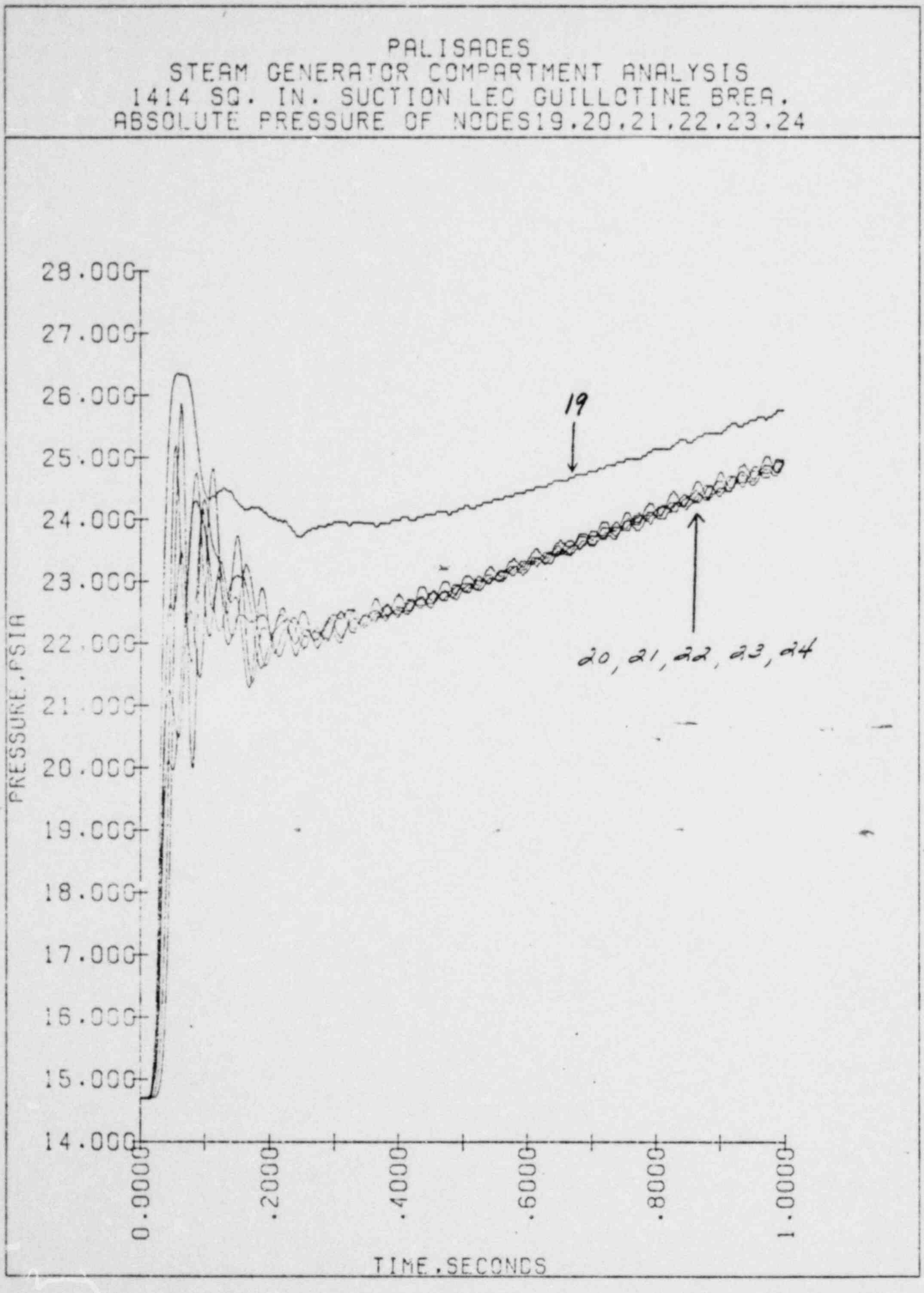

PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
1414 SQ. IN. SUCTION LEG GUILLOTINE BREA.
ABSOLUTE PRESSURE OF NODES19.20.21.22.23.24
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
PRESSURE.PSIA
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME.SECONDS
19
20, 21, 22, 23, 24

FIGURE 4.3.67

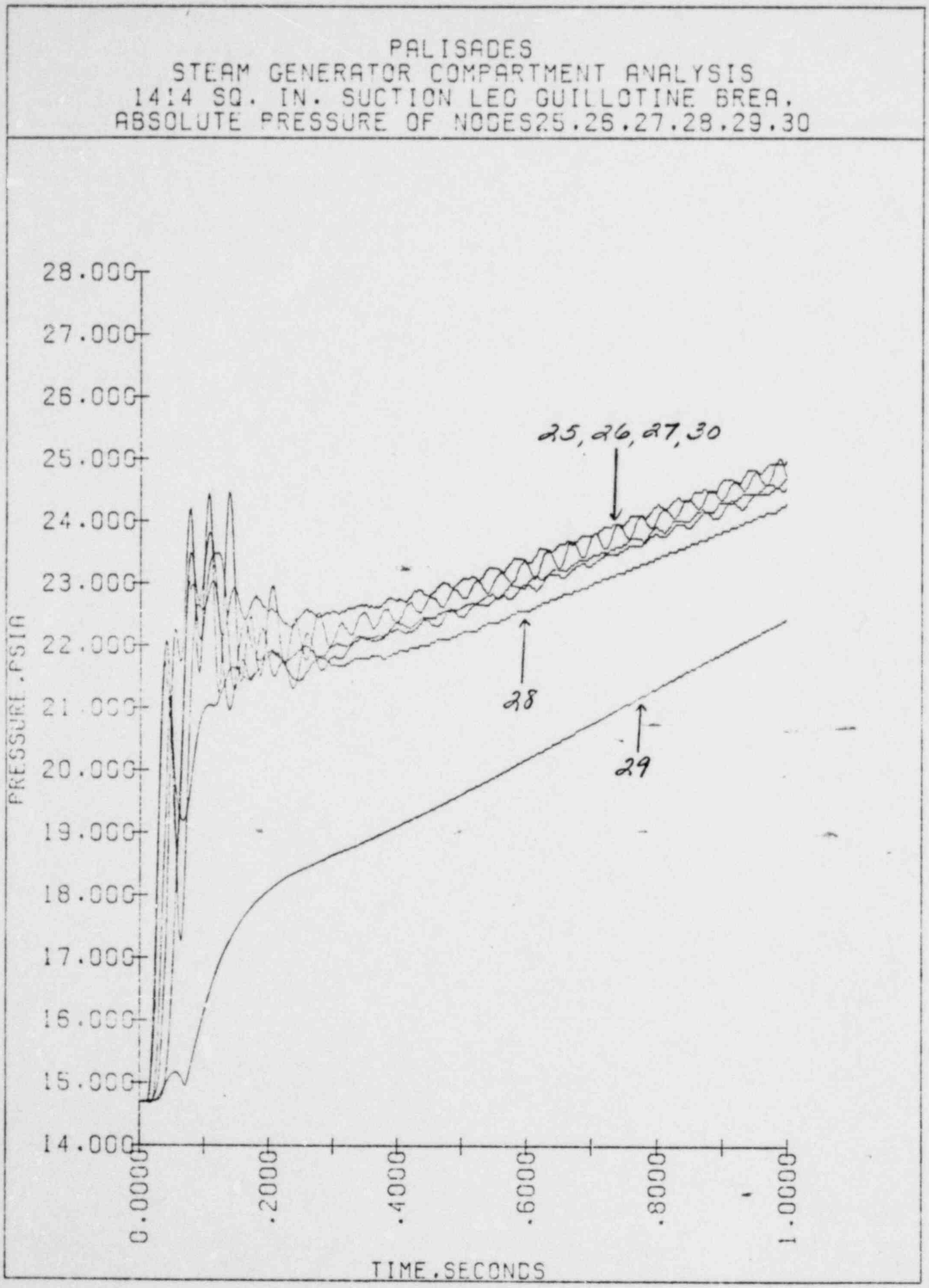

PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
1414 SQ. IN. SUCTION LEG GUILLOTINE BREA.
ABSOLUTE PRESSURE OF NODES25.26.27.28.29.30
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
PRESSURE.PSIA
25, 26, 27, 30
28
29
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME.SECONDS

FIGURE 4.3.68

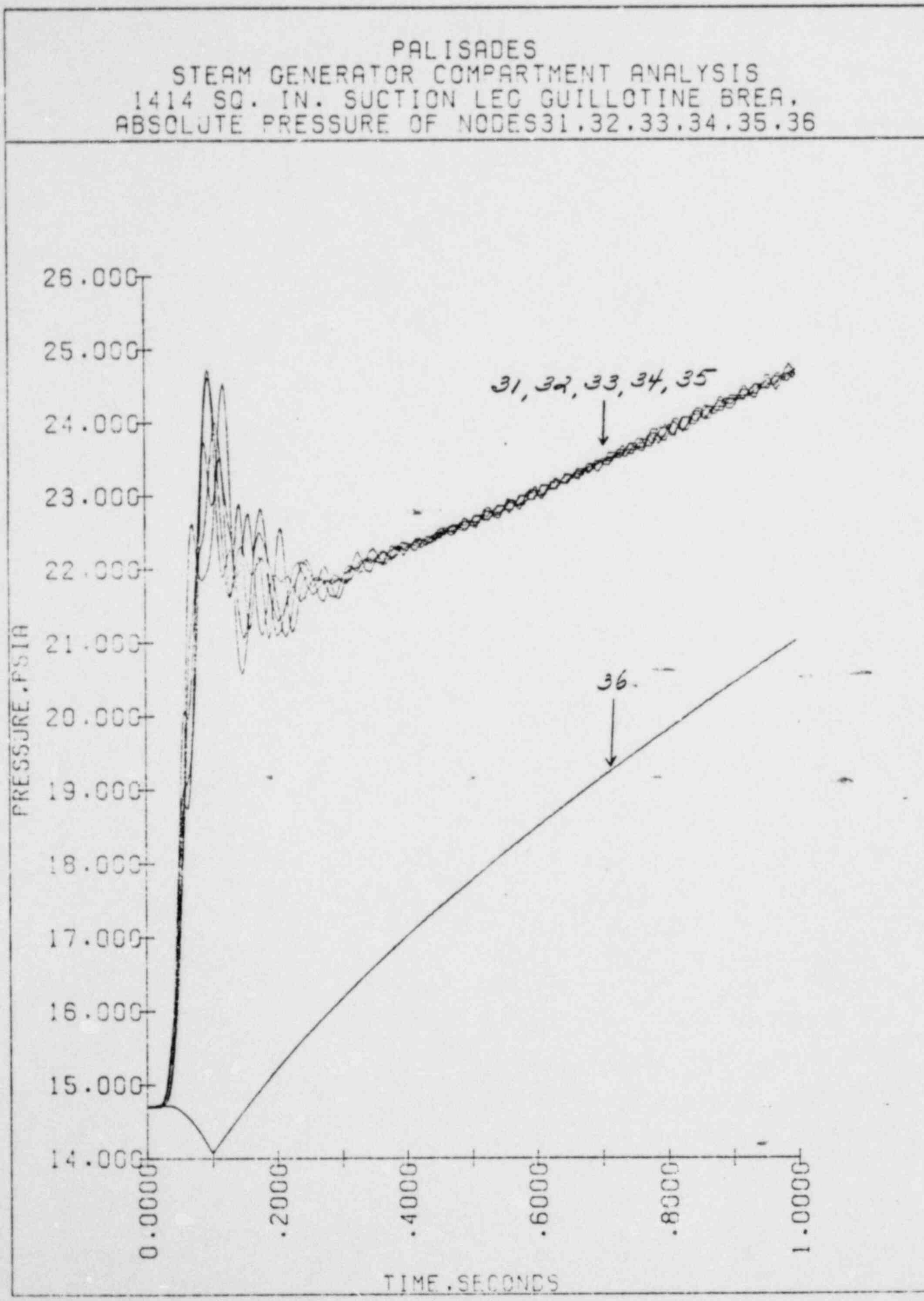
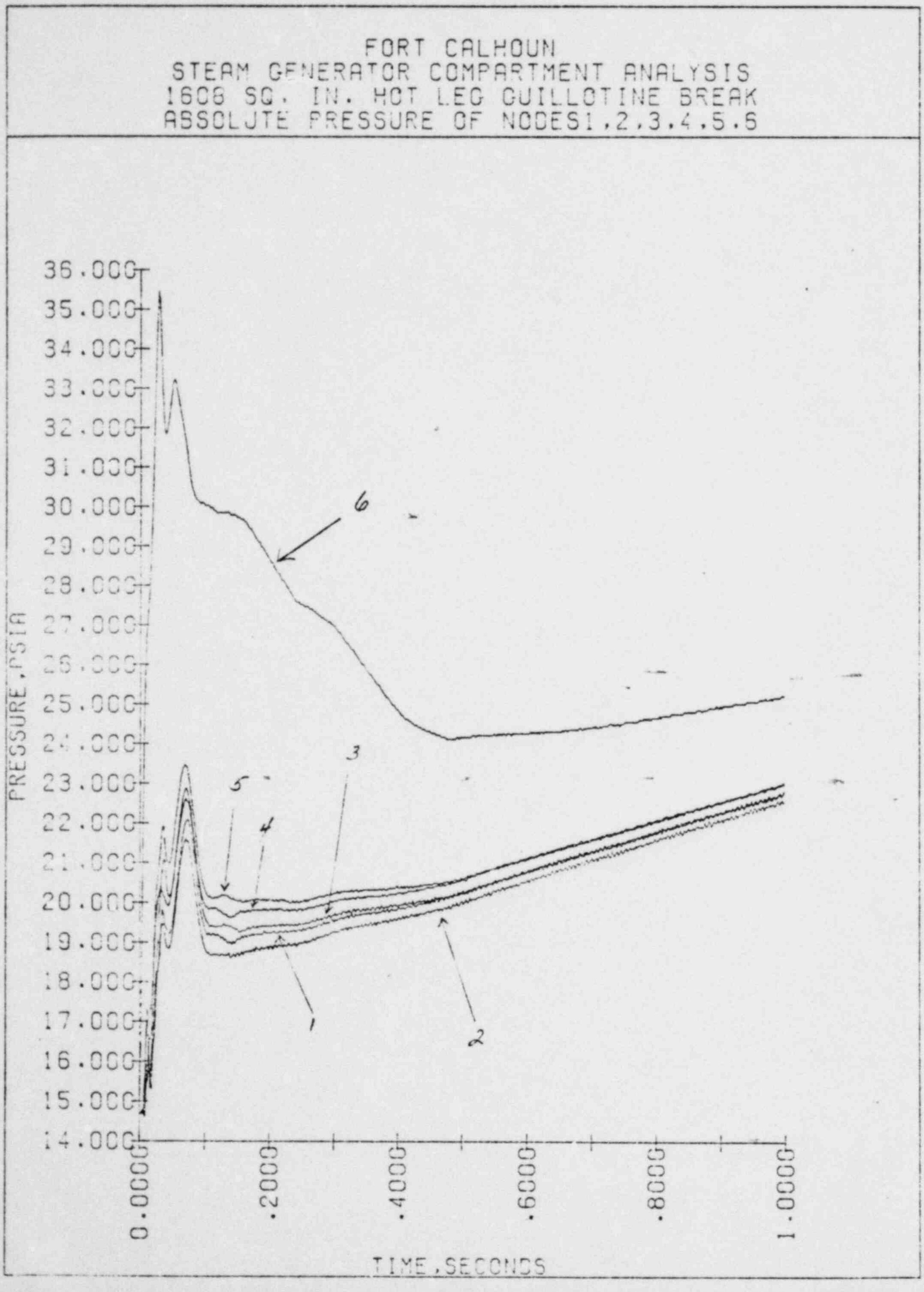

PALISADES
STEAM GENERATOR COMPARTMENT ANALYSIS
1414 SQ. IN. SUCTION LEG GUILLOTINE BREA.
ABSOLUTE PRESSURE OF NODES31.32.33.34.35.36
PRESSURE.PSIA
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME.SECONDS
31, 32, 33, 34, 35
36

FIGURE 4.3.69



FORT CALHOUN
STEAM GENERATOR COMPARTMENT ANALYSIS
1608 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES1,2,3,4,5,6
PRESSURE,PSIA
36.000
35.000
34.000
33.000
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
6
5
4
3
1
2

FIGURE 4.3.70

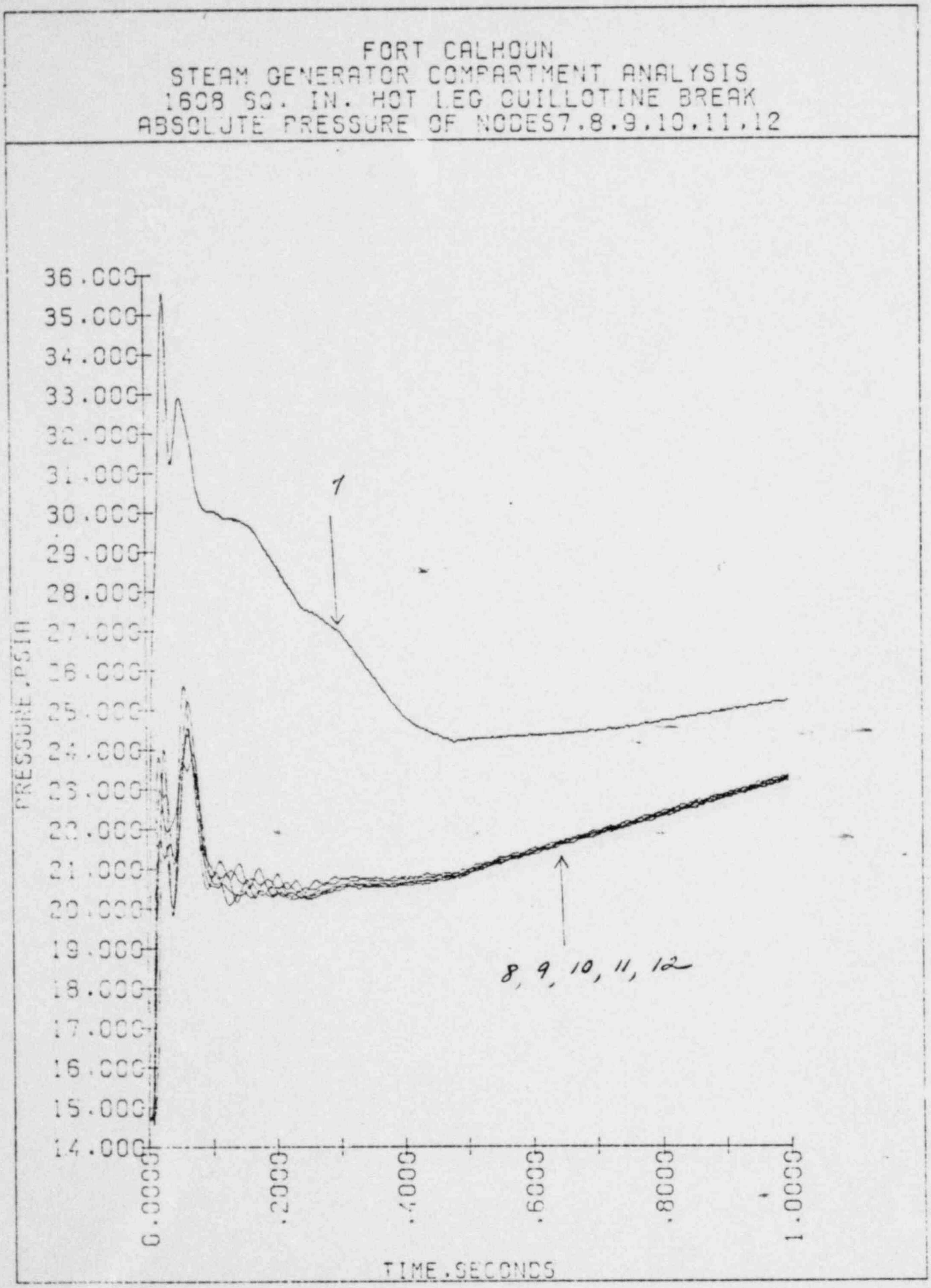

FORT CALHOUN
STEAM GENERATOR COMPARTMENT ANALYSIS
1608 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES7.8.9.10.11.12
PRESSURE,PSIA
36.000
35.000
34.000
33.000
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
7
8, 9, 10, 11, 12

FIGURE 4.3.71

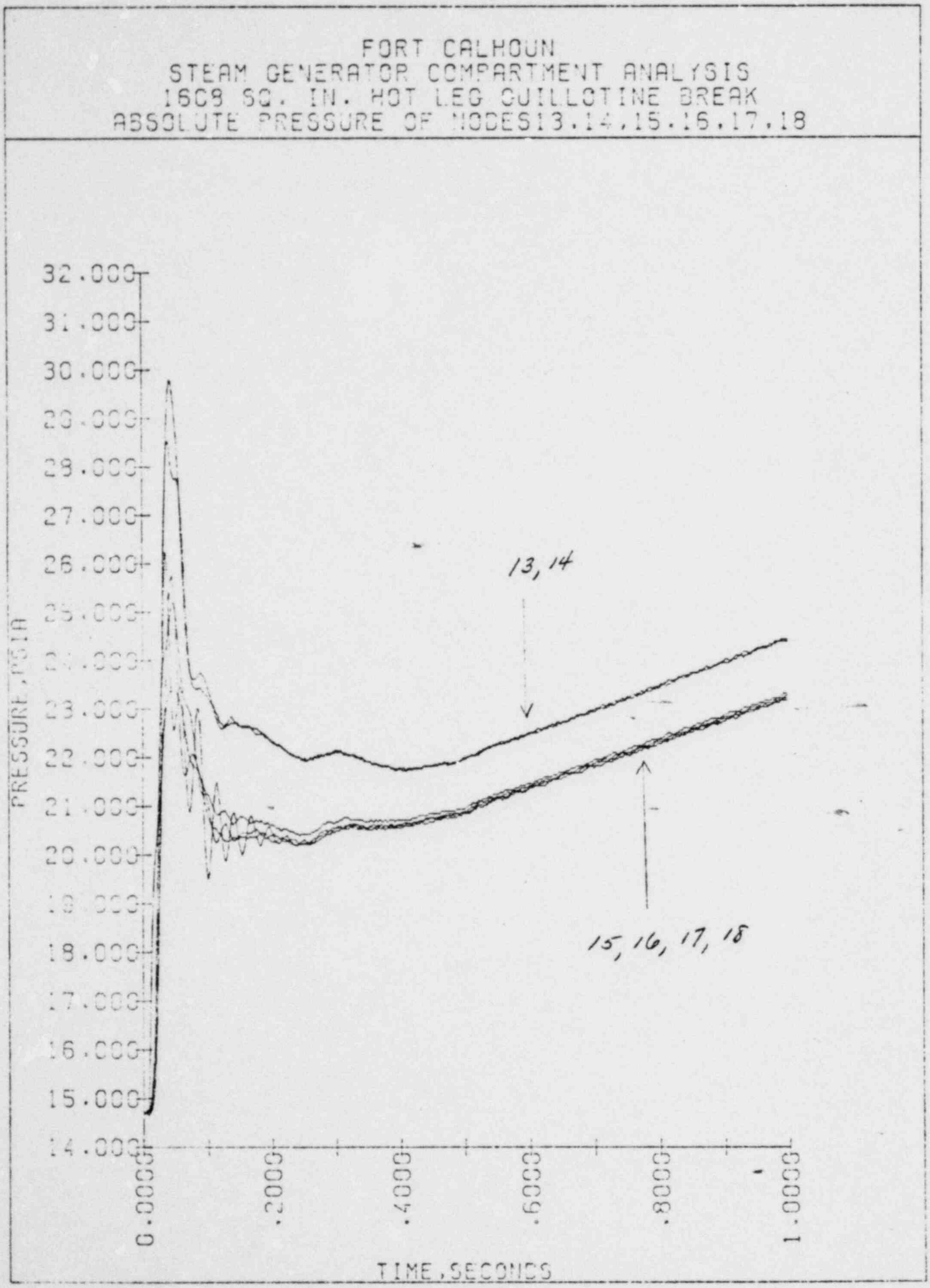
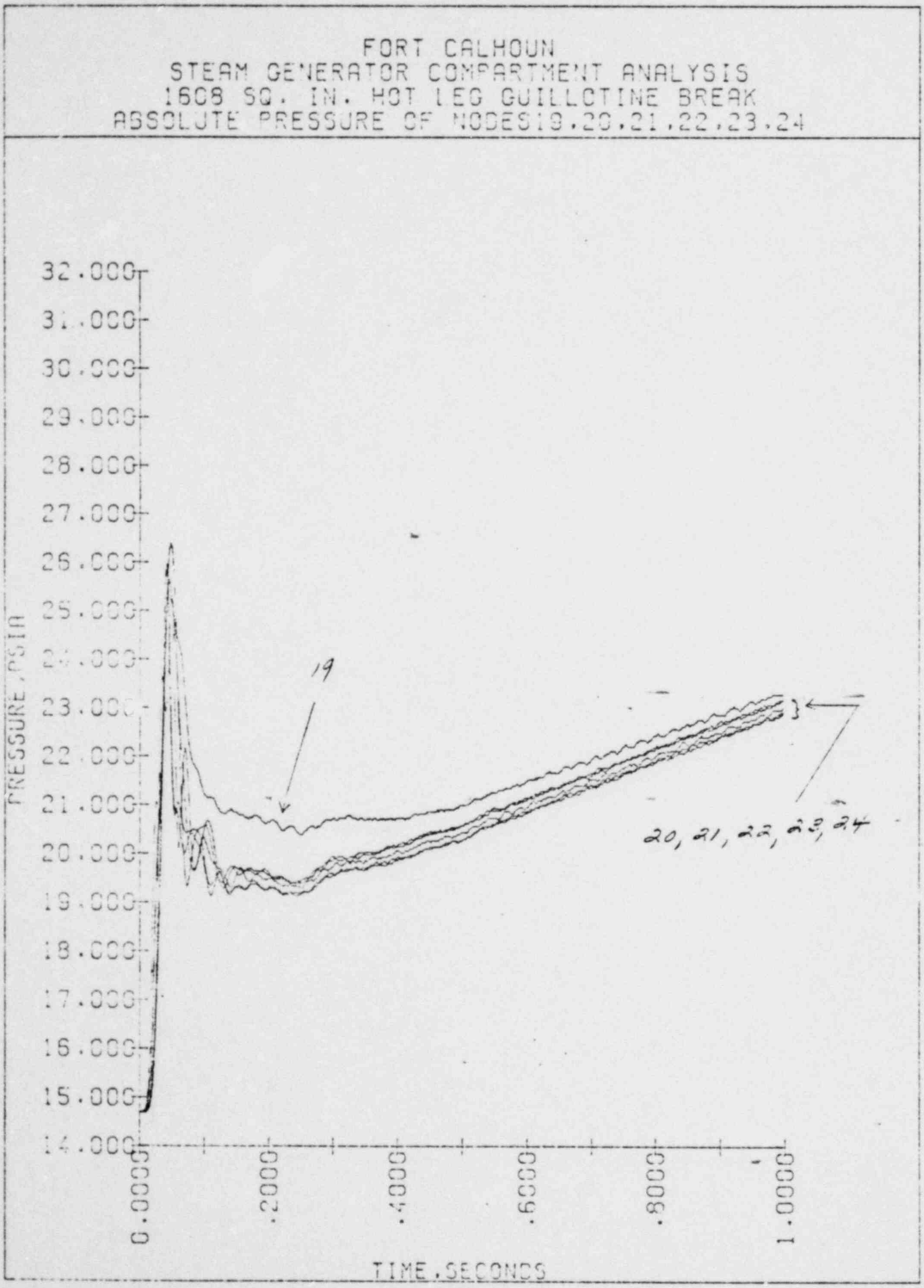
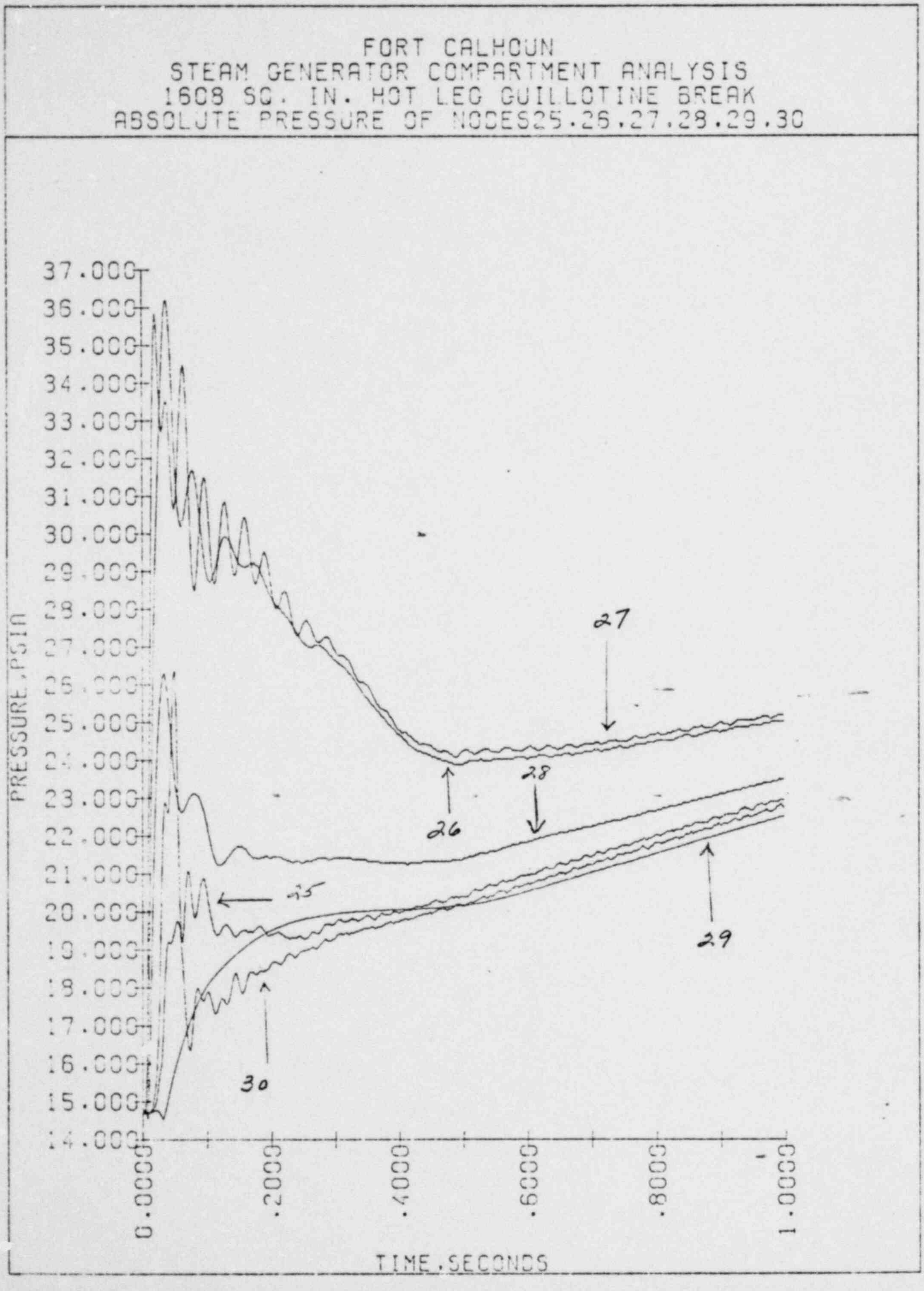

FORT CALHOUN
STEAM GENERATOR COMPARTMENT ANALYSIS
1608 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES13.14.15.16.17.18
PRESSURE,PSIA
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
13, 14
15, 16, 17, 18

FIGURE 4.3.72



FORT CALHOUN
STEAM GENERATOR COMPARTMENT ANALYSIS
1608 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES19.20.21.22.23.24
PRESSURE,PSIA
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
19
20, 21, 22, 23, 24

FIGURE 4.3.73



FORT CALHOUN
STEAM GENERATOR COMPARTMENT ANALYSIS
1608 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES25.26.27.28.29.30
PRESSURE,PSIA
37.000
36.000
35.000
34.000
33.000
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
27
26
28
25
29
30

FIGURE 4.3.74

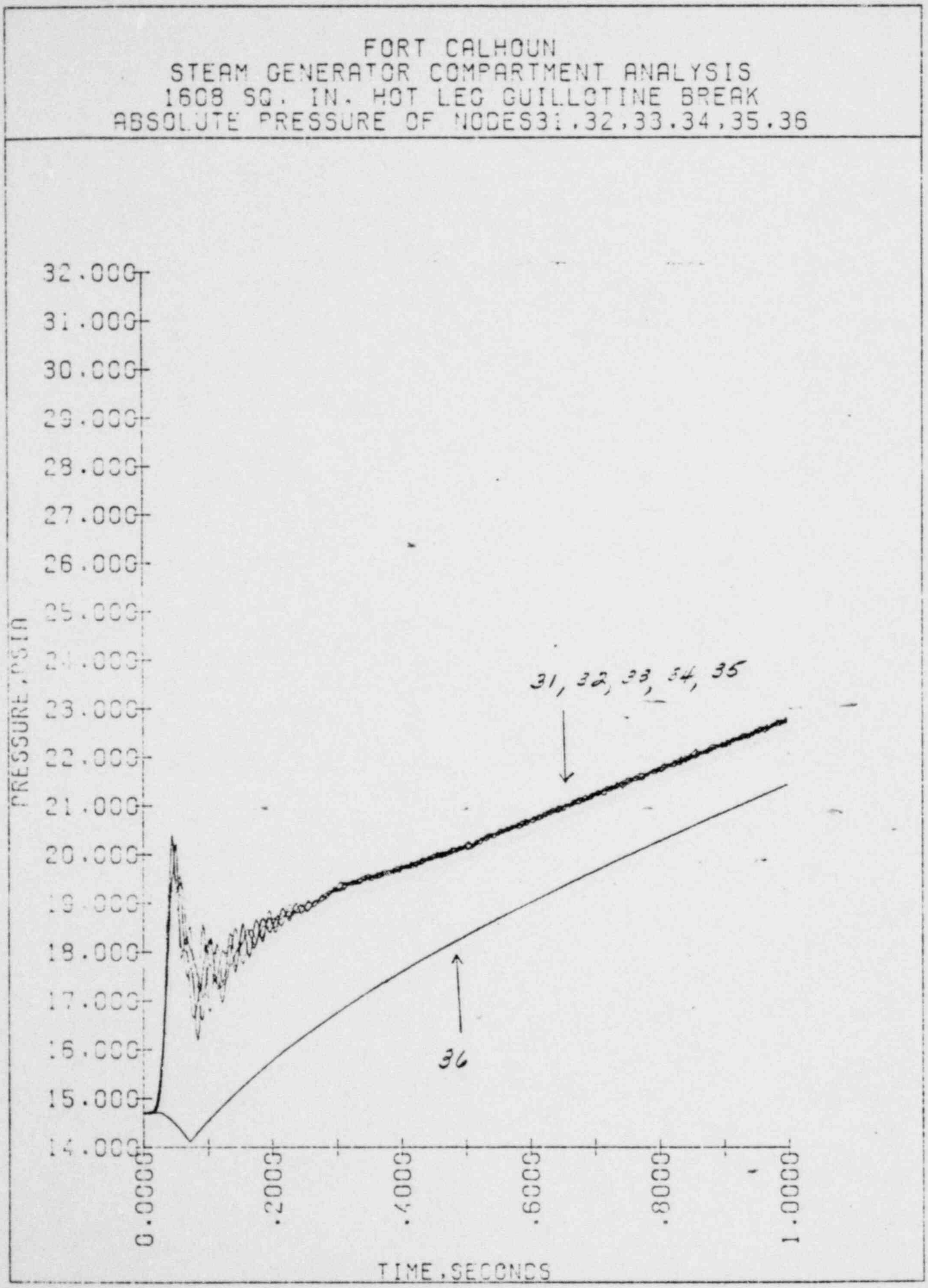

FORT CALHOUN
STEAM GENERATOR COMPARTMENT ANALYSIS
1608 SQ. IN. HOT LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES31.32,33.34,35.36
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
PRESSURE,PSIA
31, 32, 33, 34, 35
36
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS

FIGURE 4.3.75

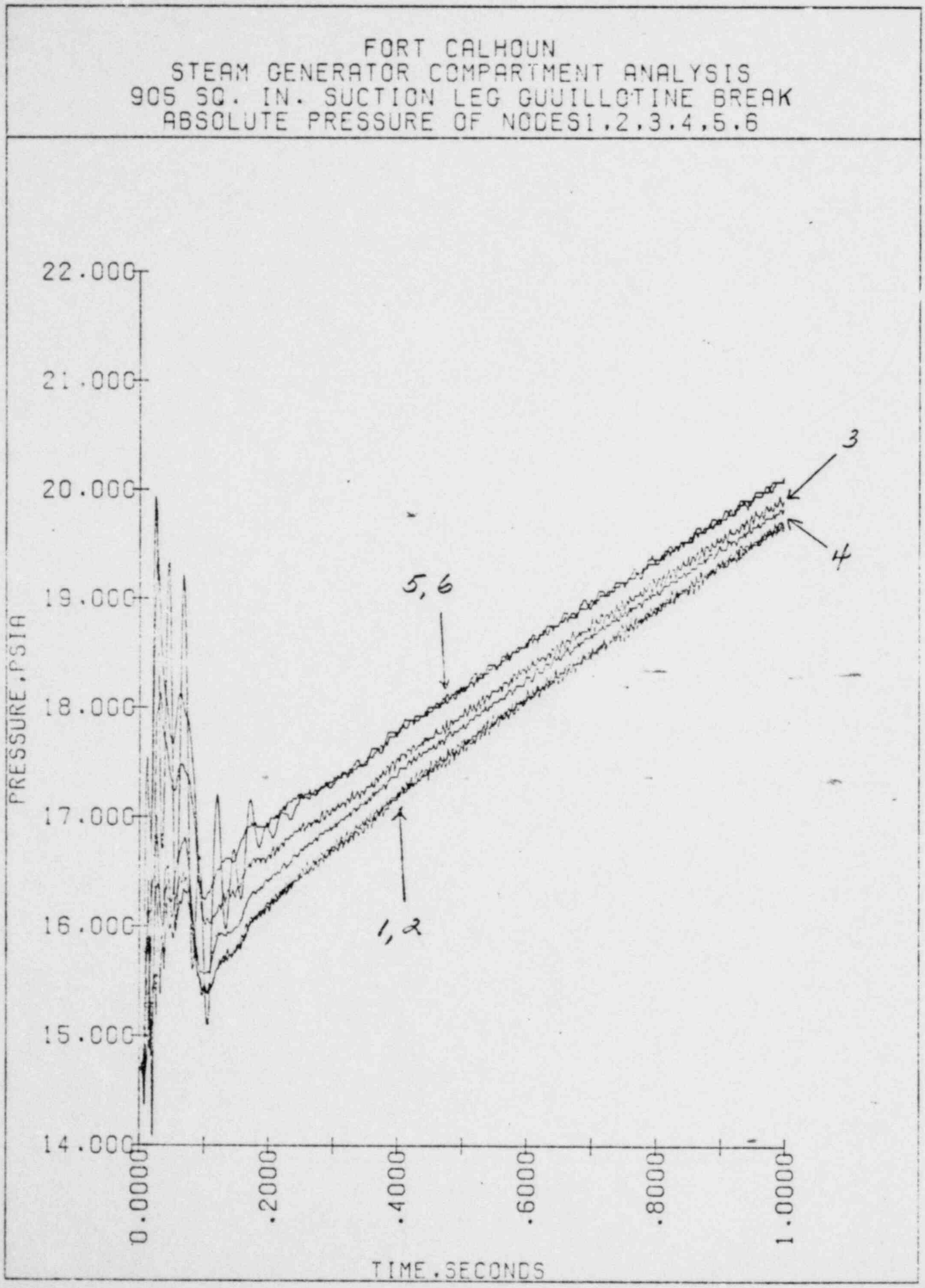

FORT CALHOUN
STEAM GENERATOR COMPARTMENT ANALYSIS
905 SQ. IN. SUCTION LEG GUUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES1.2.3.4.5.6
PRESSURE.PSIA
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME.SECONDS
3
4
5, 6
1, 2

FIGURE 4.3.76

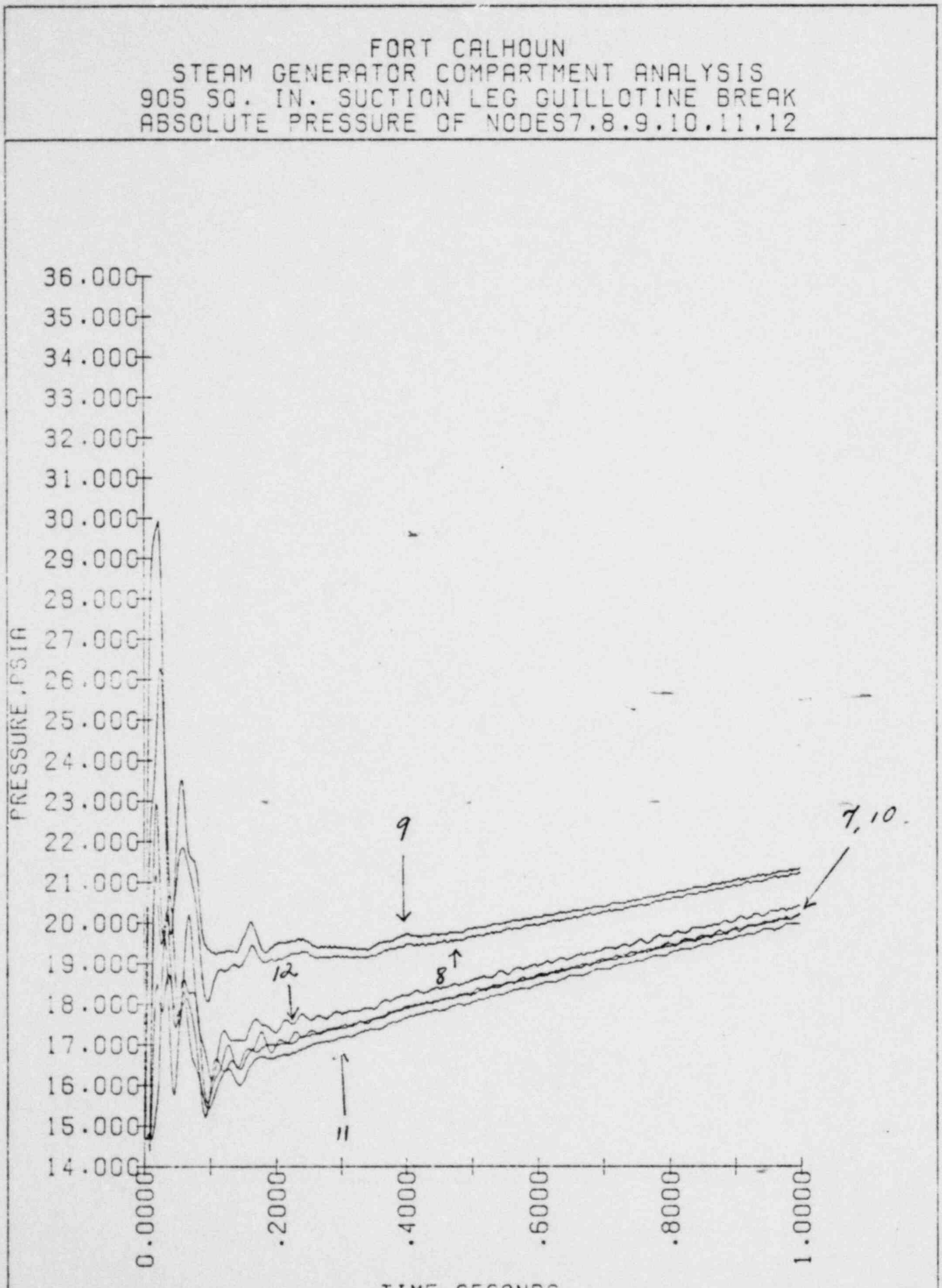

FORT CALHOUN
STEAM GENERATOR COMPARTMENT ANALYSIS
905 SQ. IN. SUCTION LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES7,8,9,10,11,12
PRESSURE,PSIA
36.000
35.000
34.000
33.000
32.000
31.000
30.000
29.000
28.000
27.000
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
9
7, 10.
12
8
11

FIGURE 4.3.77

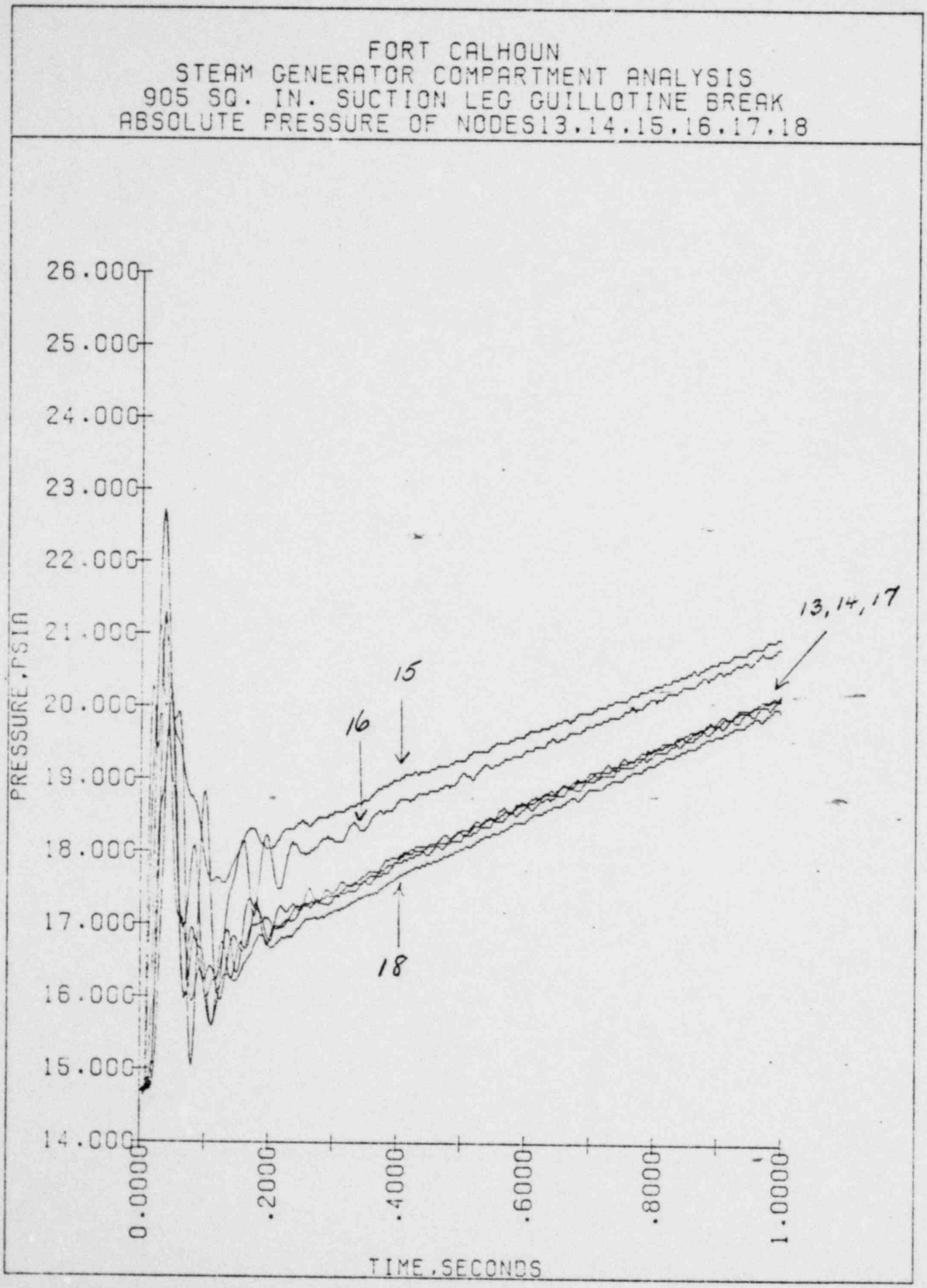
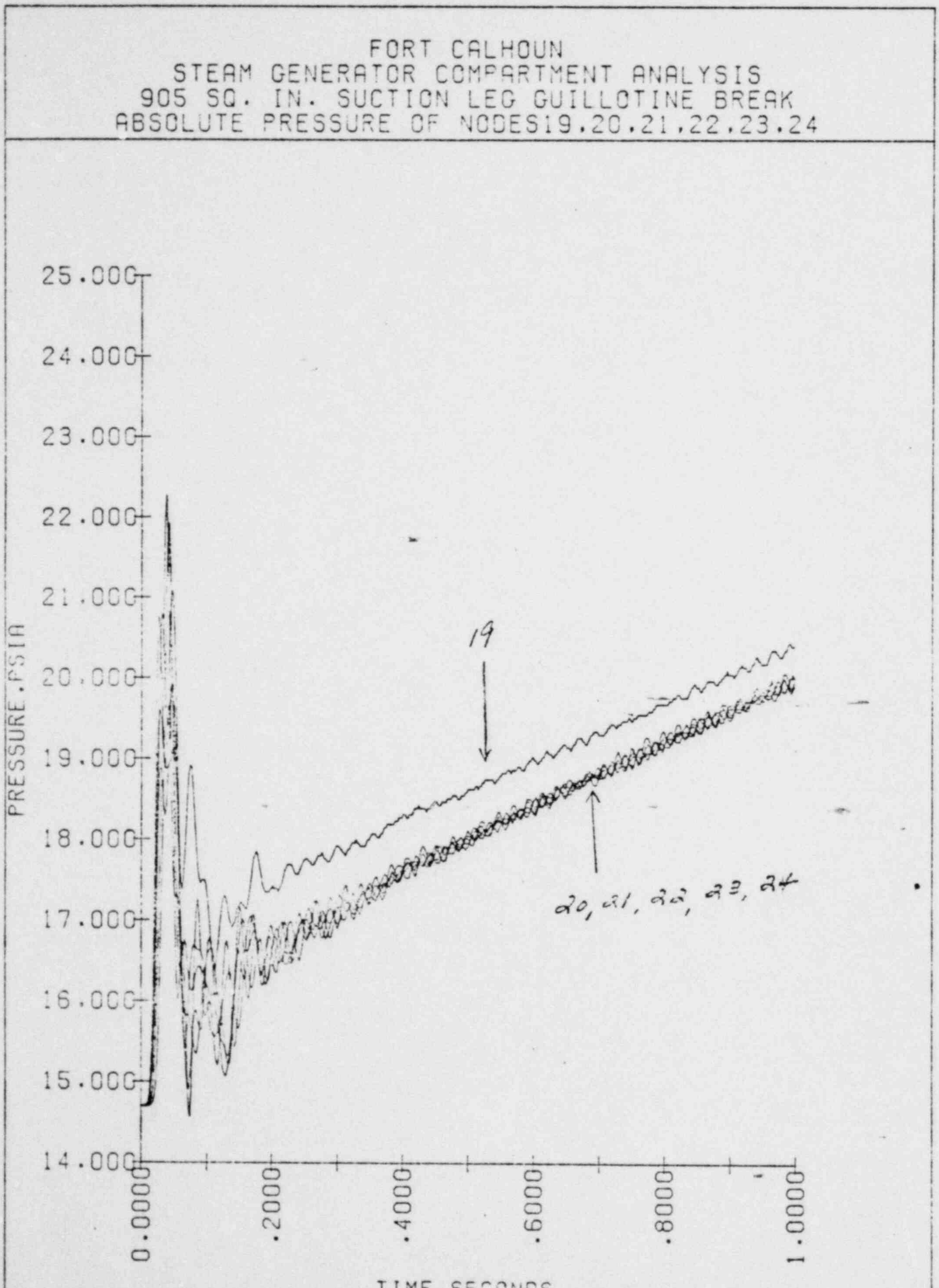
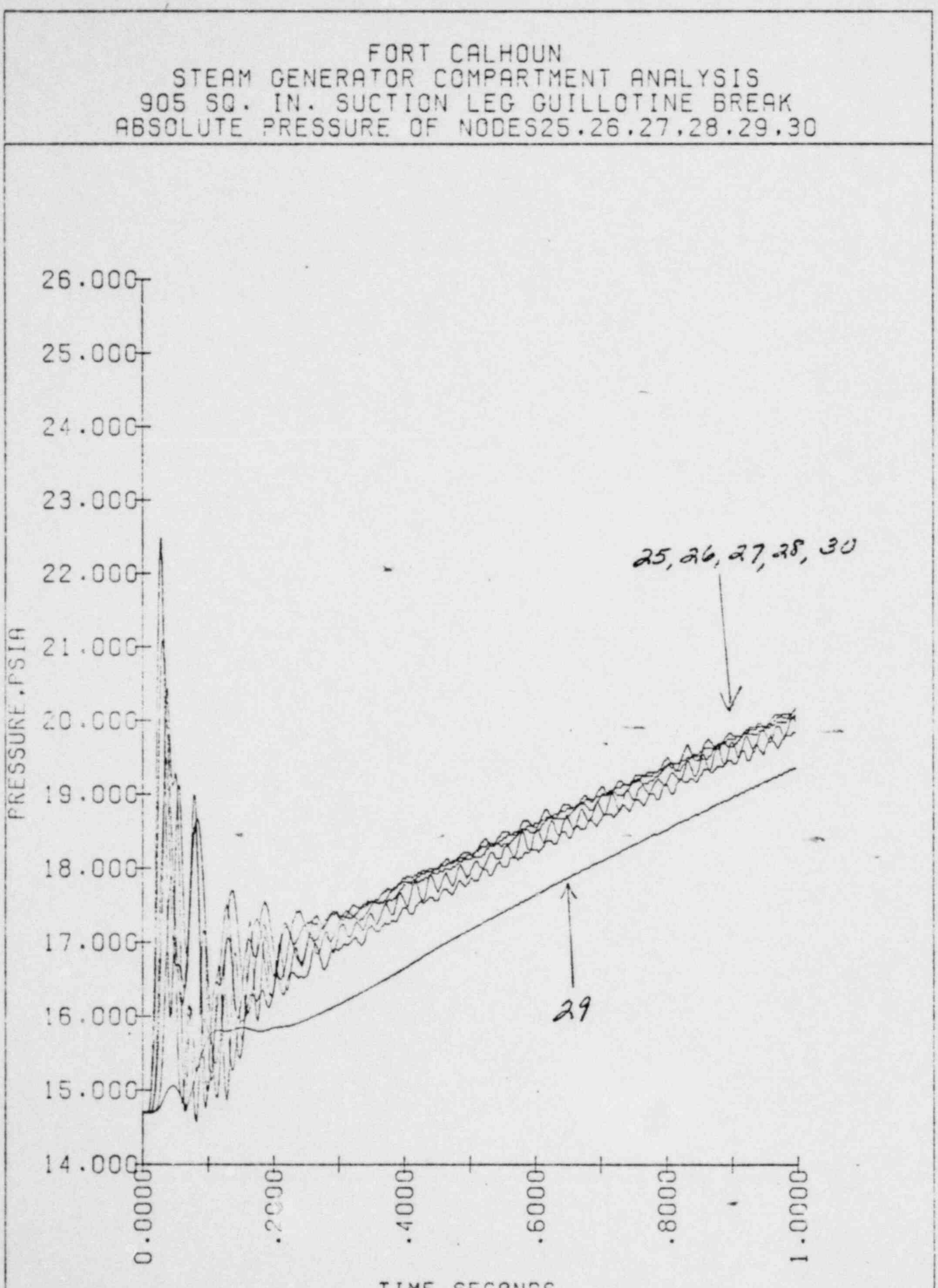

FORT CALHOUN
STEAM GENERATOR COMPARTMENT ANALYSIS
905 SQ. IN. SUCTION LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES13.14.15.16.17.18
PRESSURE,PSIA
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
13,14,17
15
16
18

FIGURE 4.3.78



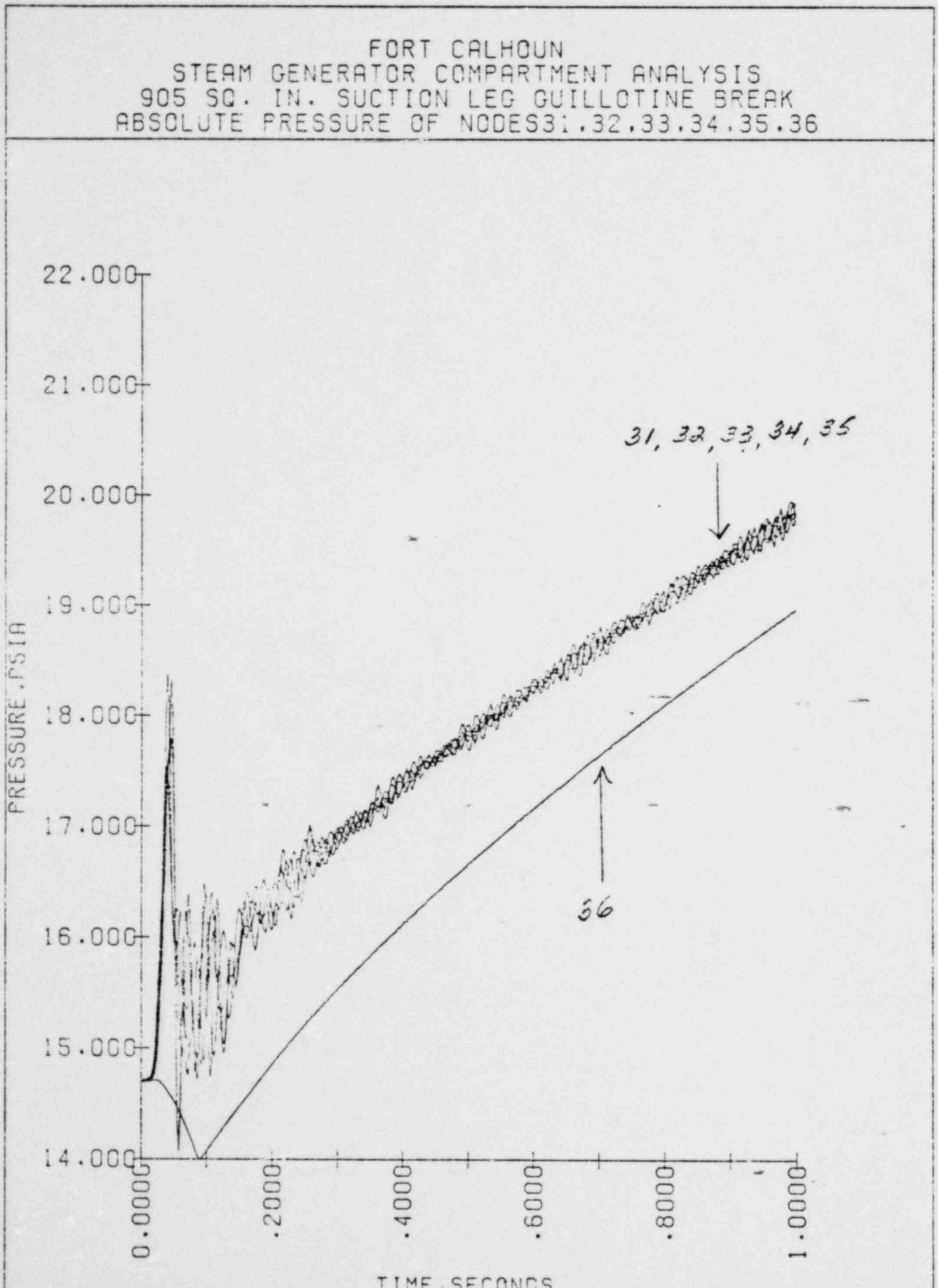
FORT CALHOUN
STEAM GENERATOR COMPARTMENT ANALYSIS
905 SQ. IN. SUCTION LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES19.20.21.22.23.24
PRESSURE.PSIA
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME.SECONDS
19
20, 21, 22, 23, 24

FIGURE 4.3.79



FORT CALHOUN
STEAM GENERATOR COMPARTMENT ANALYSIS
905 SQ. IN. SUCTION LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES25.26.27.28.29.30
PRESSURE.PSIA
26.000
25.000
24.000
23.000
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME.SECONDS
25, 26, 27, 28, 30
29

FIGURE 4.3.80



FORT CALHOUN
STEAM GENERATOR COMPARTMENT ANALYSIS
905 SQ. IN. SUCTION LEG GUILLOTINE BREAK
ABSOLUTE PRESSURE OF NODES31.32.33.34.35.36
PRESSURE,PSIA
22.000
21.000
20.000
19.000
18.000
17.000
16.000
15.000
14.000
0.0000
.2000
.4000
.6000
.8000
1.0000
TIME,SECONDS
31, 32, 33, 34, 35
36

APPENDIX A

SELECTION OF A FLOW MULTIPLIER FOR MASS AND ENERGY RELEASE CALCULATIONS

Recent blowdown experiments performed by various tests (References A.1, A.2 and A.3) have indicated that use of a combination critical flow correlation predicting the blowdown mass release rates is required. This is due to differences in the flow process when the fluid stagnation conditions are subcooled and saturated. All of these test data demonstrate the influence of some degree of non-equilibrium between the phases for subcooled and very low quality fluid conditions. But for the remainder of the saturated regime only equilibrium state prevails.

The combined Henry/Fauske and Moody correlation described in Reference 3.7 reflects these influences by the assumptions used in its derivation. However, the test data mentioned above has shown that the mass flow rate from the vessel through a short length of pipe is over-estimated by the combined Henry/Fauske and Moody correlation throughout the whole blowdown period.

For the actual reactor system following a postulated pipe rupture this over-estimation in the subcooled and low quality saturated blowdown may be amplified since the existence of upstream geometry may enhance the phase mass and heat transfer, and bubble formation processes. Upon reaching the throat, the phases are closer to equilibrium than existed in experiments which had no upstream geometry. In the saturated blowdown, a much less appreciable slip value, expected in the reactor system, may result in lower flow rate than the prediction of Moody's theory. Furthermore, blowdown tests performed by Sozzi and Sutherland (Reference A.4) have revealed that critical flow rate decreases with increased throat diameter regardless of flow regime. Non-ideal nozzle shapes of ruptured geometry along with a larger break area in the postulated ruptures will result in further decreasing the blowdown rate.

Comparisons of pressure vessel fluid pressure data from LOFT-Test L1-2 (Reference A.2) with CEFLASH-4 show that CEFLASH-4 pressures during the early phase of blowdown agree well with LOFT measurements when the Henry/Fauske correlation in conjunction with a 0.7 flow reducing multiplier was used. Reported values of the Moody flow multiplier for a large number of published saturated blowdown experiments are summarized in Reference A.5. The Moody multiplier has always been found to be less than unity. The fact that it is approximately equal to 0.7 is probably due to the over-estimation of phase slip ratio.

Based on CEFLASH-4 verification against available data and realistic assessment of break flow rates in the reactor system, the combined Henry/Fauske and Moody correlation with a flow multiplier of 0.7 provides a reasonable prediction of critical flow rate from subcooled and saturated fluid stagnation state.

REFERENCES:

A.1 Hall, D.G., "A Study of Critical Flow Prediction for Semi-scale MOD-1 Loss-of-Coolant Accident Experiments," Tree-Nureg-1006, December, 1976.

A.2 Robinson, H.C., "Experiment Data Report for LOFT Non-Nuclear Test L1-2," Tree-Nureg-1026, January, 1977.

A.3 Hutcherson, M.N., "Contribution to the Theory of Two-Phase Blow-Down Phenomenon," ANL/RAS 75-42, November, 1975.

A.4 Sozzi, G.L., and Sutherland, W.A., "Critical Flow of Saturated and Subcooled Water at High Pressure," G.E. Report NEDO-13418, July, 1975.

A.5 Ardron, K.H. and Furness, R.A., "A Study of the Critical Flow Models Used in Reactor Blowdown Analysis," Nuclear Engineering and Design 39, 1976, P 257-266.

4.4 BLOWDOWN LOADS

Hydraulic blowdown loads refer to the thermodynamic and hydrodynamic induced forcing functions that occur throughout the primary reactor system during a postulated Loss-of-Coolant Accident. These forcing functions consist of the space-time distribution of fluid pressures, flow rates and densities.

The transient pressures act directly on the adjacent structures. In addition, changes in the flow rates and fluid densities result in transient drag forces which also act on adjacent structures.

The plants represented by the RCS Asymmetric Loads Evaluation Owners' Group are Calvert Cliffs, Millstone 2, St. Lucie 1, Palisades and Ft. Calhoun. In order to obtain the blowdown loads forcing functions for these plants, a single generic plant was analyzed. In addition, modifications to this generic analysis for specific plants were performed as required. The following discussion pertains to the decompression (pressure loads) analysis and to the drag force analysis.

4.4.1 PRESSURE LOADS

The transient pressure, flow rate and density distributions have been computed with the CEFLASH-4B computer code according to the methods documented in Reference 3.9. These calculations are valid for both the subcooled and saturated portions of the decompression.

The CEFLASH-4B computer code is based on a node-flow path concept in which control volumes (nodes) are connected in any desired manner by flow areas (flow paths). A complex node-flow path network is used to model the primary reactor coolant system (RCS). The CEFLASH-4B modeling procedure has been compared to a large scale experimental blowdown test with excellent agreement (Reference 3.9).

4.4.1.1 Summary for Reactor Vessel Internal Pressure Loads

Calvert Cliffs was selected as the generic plant to be used in the blowdown loads analysis for the RCS Asymmetric Loads Evaluation. Two breaks at full power were identified for the generic analysis. These were a double-ended guillotine break at the RV inlet nozzle and a 135 sq. inch guillotine break at the reactor vessel outlet nozzle (see Section 4.2).

Analyses for Millstone 2, St. Lucie 1, Palisades and Ft. Calhoun employed the generic plant (Calvert Cliffs) blowdown loads model.

The break sizes, opening times and locations for Millstone 2, St. Lucie 1 and Palisades are identical to those determined for the generic plant, Calvert Cliffs. Also, the reactor vessel volumes are very similar (within 2%) to the generic plant. Thus, the results from the generic plant analysis are directly applicable to Millstone 2, St. Lucie 1 and Palisades.

The Ft. Calhoun break size is different than that for the generic plant and the reactor vessel volume is less. The use of the larger generic plant vessel volume for Ft. Calhoun is conservative (see below). The break sizes for Ft. Calhoun can be adjusted by the ratio of the reactor vessel volumes of the generic plant to that for Ft. Calhoun. This is explained further in Section 4.4.1.3.

4.4.1.2 Generic Plant Analysis

As indicated above, Calvert Cliffs was chosen to be the generic plant for the blowdown loads analysis in the RCS Asymmetric Loads Evaluation.

This selection was based on the fact that the predicted subcooled decompression (initial pressurizer pressure minus the isentropic saturation pressure) for Calvert Cliffs is greater than or equal to the subcooled decompression for the other plants. Also, the sizeable geometric dimensions for Calvert Cliffs indicate that these blowdown loads will be representative or greater than those for the other plants included in this study (larger pressure differences across components will result from the longer pressure wave travel times).

Two guillotine breaks were defined, one at the reactor vessel inlet nozzle and one at the reactor vessel outlet nozzle. A summary of the break parameters is given in Table 4.4.1. Operating conditions and certain geometrical data is presented in Table 4.4.2 for the plants represented by the generic model.

4.4.1.3 Plant Specific Analyses

A procedure was developed to obtain plant specific hydraulic loads from the generic plant CEFLASH-4B computer model. The plant specific pipe break area was adjusted by the ratio of the reactor vessel volumes of the generic plant to the specific plant. This factor is a measure of the time for the pressure to drop to a given value for systems of different initial fluid volumes and break sizes. The plant specific hydraulic loads were computed using the corrected pipe break area with the generic plant CEFLASH-4B model. The equation for computing the corrected break area is given below. The basis for this representation is to obtain an equivalent decompression in the generic model for the appropriate plant specific break area and vessel volume.

$$\text{Area}_{\text{corrected}} = (A/V)_{\substack{\text{plant}\\\text{specific}}} \times V_{\substack{\text{generic}\\\text{plant}}} \qquad (1)$$

The plant specific pipe break areas and break opening times are summarized in Table 4.4.1. The RV inlet breaks defined in Table 4.4.1 are all double-ended for each plant. Ft. Calhoun has 24 in. diameter cold legs and 32 in. diameter hot legs compared to 30 in. and 42 in. diameter pipes, respectively, for the other plants.

Due to the similarities of the Millstone 2, St. Lucie 1 and Palisades vessel volumes with Calvert Cliffs (generic plant) (see Table 4.4.2) additional CEFLASH-4B computer cases need be run only if the break sizes or locations were different than those determined for Calvert Cliffs.

The break sizes, locations and opening times for Millstone 2 , St. Lucie 1 and Palisades are identical to Calvert Cliffs (Table 4.4.1). Thus, the existing generic plant CEFLASH-4B results can be applied to Millstone 2, St. Lucie 1 and Palisades.

The Ft. Calhoun corrected inlet break area was calculated according to the procedure described above. From Equation (1) and Table 4.4.2:

$$
\begin{aligned}
Area_{corrected} &= (A/V)_{Ft.\ Calhoun} \times V_{Calvert\ Cliffs} \\
&= (905\ in^2/3014\ ft^3) \times 4595\ ft^3 \\
&= 1379\ in^2
\end{aligned}
$$

The corrected break area was used in the generic CEFLASH-4B model with a 23 msec break opening time as specified.

Likewise, the Ft. Calhoun corrected outlet break area was calculated using Equation (1) and Table 4.4.2 to be 305 sq. inches. This break area was used in the generic CEFLASH-4B model with a 20 msec break opening time.

4.4.1.4 Results of the Blowdown Loads Analysis

RESULTS OF THE GENERIC PLANT ANALYSIS

Double-Ended Inlet Break Results

A representative absolute pressure result from the generic plant double-ended inlet break case is shown on Figure 4.4.1. This figure represents the volume node closest to the broken nozzle . The pressure in the annulus rapidly decompresses during the first 120 msec and then fluctuates at about 1450 psia with reducing amplitude. (The isentropic saturation pressure of the hot side is 1468 psia. The strong initial decompression wave travels through the reactor vessel until the isentropic saturation pressure is reached in the outlet plenum. Then, the pressure throughout the reactor vessel ceases to drop rapidly.

Figure 4.4.2 shows the peak delta pressure across the core support barrel (inside-outside) which occurs at the nozzle centerline elevation. The magnitude of the initial delta pressure pulse decreases substantially for locations further down the annulus.

A plot of the pressure difference around the core barrel (difference between two annulus nodes 180° apart) is presented on Figure 4.4.3. The pressure difference around the CSB (and on the inside of the reactor vessel), the so called asymmetric load, is less than 80 psid after 200 msec. A polar plot showing the absolute pressure for each of the nodes at the nozzle centerline elevation is provided on Figure 4.4.4. Figure 4.4.4 shows the pressures starting to equalize at 25 msec. The core axial delta pressure is given on Figure 4.4.5.

135 Sq. Inch Outlet Break Results

A representative absolute pressure plot from the 135 sq. inch outlet break case is shown on Figure 4.4.6. This case was run to a transient time of 1000 msec since the break size is relatively small and results in a slow rate of subcooled decompression. Delta pressure results across the core barrel (inside-outside) are provided on Figure 4.4.7. It is seen from this plot that the magnitude of this load is relatively small compared to the double-ended cold leg break results shown on Figure 4.4.3. It is seen from Figure 4.4.8 that the outlet break results in a symmetric decompression around the annulus (difference between two annulus locations 180° apart). This figure is representative f the other pressure differences at other azimuthal as well as axial locations. This result is expected since the decompression wave must travel through the core barrel internals to reach the lower plenum from where the wave propogates uniformly up through the annulus. The core axial pressure difference is given on Figure 4.4.9.

RESULTS OF THE PLANT SPECIFIC ANALYSES

Results for Millstone 2, St. Lucie 1 and Palisades

The generic plant inlet and outlet break results are applicable to the Millstone 2, St. Lucie 1 and Palisades plants and are described above.

Results for the Ft. Calhoun Inlet Break

Figure 4.4.10 shows the pressure difference across the core support barrel (inside-outside). This figure provides a comparison of the Ft. Calhoun and generic plant analysis results of the peak delta pressure across the CSB. The two cases predict identical results through the first peak. Then, they diverge slightly, but in phase, until the system pressures have begun to equalize at about 200 msec. The pressure difference around the core barrel (difference between two annulus nodes 180° apart) is given in Figure 4.4.11 for both Ft. Calhoun and the generic plant. The two cases exhibit similar results through the first 25 msec. The core axial delta pressure is compared on Figure 4.4.12.

Results for the Ft. Calhoun Outlet Break

A representative absolute pressure plot of the decompression inside the reactor vessel is shown on Figure 4.4-13. The pressure difference across the core support barrel (inside-outside) is presented on Figure 4.4-14 at the nozzle centerline elevation. The symmetric decompression around the annulus is typified by Figure 4.4-15. This expected phenomena was explained above for the 135 sq. inch outlet break. The core axial pressure difference is given on Figure 4.4-16.

4.4.2 DRAG LOADS

During a rapid blowdown strong rarefaction pressure waves travel through the reactor primary system resulting in large pressure gradients across various reactor internal components. These pressure gradients, in turn, result in an acceleration (deceleration) of the primary circuit fluid which causes an increase (decrease) in the associated component drag load. The loads resulting from the depressurization are discussed above. This section is concerned with the drag loads.

4.4.2.1 CEA Shroud Drag Loads

During a blowdown the flow from the upper guide structure and into the hot leg nozzles undergoes a rapid change in magnitude and, possibly, direction. These give rise to transient drag loads on the individual CEA shrouds and to a total load on the upper guide structure (UGS). These loads add to the transient pressure loads (which for the case of the CEA shrouds consist of an inertial component).

4.4.2.1.1 Summary for CEA Shroud Drag Loads

The procedure for the analysis of drag loads was to select a generic plant (Calvert Cliffs) and to determine the crossflow drag factors for that plant. The drag factors on the UGS were determined from a flow model experiment. The experimental data was scaled to represent the actual forces on a reactor UGS. The scaling factors consisted of geometrical scale factors as well as the transient momentum parameters for the hot leg nozzles as computed with the CEFLASH-4B code. The results of this generic analysis were related to each individual plant. Where necessary, appropriate modifications were performed to account for specific plant features.

4.4.2.1.2 Description of Upper Guide Structure

Plan views for the shroud arrangements in the upper guide structures are shown for Calvert Cliffs (Figure 4.4.17), Millstone 2 and St. Lucie 1 (Figure 4.4.18), Ft. Calhoun (Figure 4.4.19) and Palisades (Figure 4.4.20). It is seen that the UGS shroud arrangements are quite similar for Calvert Cliffs, Millstone 2 and St. Lucie 1. The layout for Ft. Calhoun is similar in concept to Calvert Cliffs but smaller in overall diameter (individual shroud diameters are the same, however). For Palisades, the overall diameter of the UGS is similar to that for Calvert Cliffs. The individual shrouds are different, however, being of a cruciform design. Additional information on the various upper guide structures is given in Table 4.4.3.

4.4.2.1.3 Upper Guide Structure Drag Factors

The drag factors for Calvert Cliffs have been developed from geometrically similar experimental data as normalized drag force per unit axial length of CEA shroud at several discrete axial elevations. Forces have been normalized with respect to vW^2 (momentum parameter) of the scaled reactor outlet nozzle. A description of the procedure employed to obtain these drag factors is given in Section 6.1 of Reference 4.4.1. The drag factors have been developed in order to give crossflow loads on individual CEA shrouds and, by appropriate summation, on the entire upper guide structure.

For the additional plants represented by this study the drag factors for the generic plant have been modified to account for differences in the geometry and number of the shrouds and the flow area of the respective hot leg nozzles.

4.4.2.2 Core Drag Loads

Separate loads are calculated for individual nodes representing the fuel rods, guide tubes, upper end fitting, and lower end fitting. Loads are obtained based on a control volume approach utilizing an integrated fluid momentum equation. Drag loads are represented by the fluid shear term in this equation.

Drag loads are composed of two components--frictional drag and form drag. Frictional drag is calculated using a friction factor which is dependent on the channel equivalent diameter, channel cross-sectional area, fluid flow rate, and fluid density. The latter two quantities are obtained from CEFLASH-4B output. Friction factors are obtained using Colebrook's correlation which is an analytical representation of the Moody chart; this formulation requires the surface roughness and time dependent Reynolds' number. Form drag is calculated using a loss factor, along with channel area and equivalent diameter, and fluid density and flow rate. An experimentally determined correlation of loss factor as a function of Reynolds number is used. Crud effects are accounted for by multiplying the drag loads by an empirically determined factor.

Frictional drag is apportioned to the guide tubes and to the fuel rods on the basis of fraction of total wetted perimeter adjacent to a given flow channel or subchannel. The only form losses present are due to spacer grids. These losses are applied completely to the guide tubes, as the spacer grids are welded to the guide tubes. A portion of these losses is ultimately transmitted to the fuel rods through sliding friction; however, this effect is accounted for later via friction elements in the CESHOCK structural model.

For the end fittings, a solid plus fluid control volume is used. Therefore, end fitting drag loads are not explicitly calculated by summing contributions due to pressure, gravity, fluid inertia, and fluid momentum effects.

TABLE 4.4.1

BREAK PARAMETERS

ITEM	CALVERT CLIFFS	MILLSTONE 2	ST. LUCIE 1	PALISADES	FT. CALHOUN
INLET BREAK					
BREAK TYPE	GUILLOTINE	GUILLOTINE	GUILLOTINE	GUILLOTINE	GUILLOTINE
LOCATION	RV NOZZLE	RV NOZZLE	RV NOZZLE	RV NOZZLE	RV NOZZLE
SIZE (IN^2)	1414	1414	1414	1414	905
OPENING TIME (SEC)	0.023	0.023	0.023	0.023	0.023
OUTLET BREAK					
BREAK TYPE	GUILLOTINE	GUILLOTINE	GUILLOTINE	GUILLOTINE	GUILLOTINE
LOCATION	RV NOZZLE	RV NOZZLE	RV NOZZL	RV NOZZLE	RV NOZZLE
SIZE (IN^2)	135	135	135	135	200
OPENING TIME (SEC)	0.020	0.020	0.020	0.020	0.020

TABLE 4.4 2

PLANT PARAMETERS

ITEM	CALVERT CLIFFS	MILLSTONE 2 & ST. LUCIE 1	PALISADES	FT. CALHOUN
GEOMETRICAL DIFFERENCES				
UPPER GUIDE STRUCTURE PLATE	YES	YES	NO	YES
UGS DESIGN	SINGLE&DUAL SHROUDS	SINGLE&DUAL SHROUDS	CRUCIFORM CONTROL RODS	SINGLE&DUAL SHROUDS
CORE LENGTH (CSP TO FAP)	155 IN.	155 IN.	147.6 IN.	146.1 IN.
CORE BARREL LENGTH	328.5 IN.	328.5 IN.	318.5 IN.	311.6 IN.
CORE BARREL OD	153 IN.	153 IN.	153.75 IN.	124.6 IN.
REACTOR VESSEL ID	172 IN.	172 IN.	172 IN.	140 IN.
COLD LEG ID	30 IN.	30 IN.	30 IN.	24 IN.
HOT LEG ID	42 IN.	42 IN.	42 IN.	32 IN.
THERMAL SHIELD	NO	YES	NO	YES
THERMAL SHIELD LENGTH	N/A	137.75 IN.	N/A	171 IN.
VOLUME IN REACTOR VESSEL	4595 FT^3	4504 FT^3	4640 FT^3	3014 FT^3
THERMAL/HYDRAULIC DIFFERENCES				
POWER LEVEL	2631 MW_T	2611 MW_T	2580 MW_T	1591 MW_T
PRESSURIZER PRESSURE	2250 PSIA	2250 PSIA	2015 PSIA	2250 PSIA
$T_{COLD}(^{O}F)/P^{SAT}_{ISENTROPIC}$ (PSIA)	548/981	548/981	535.5/891	547/973
$T_{HOT}(^{O}F/P^{SAT}_{ISENTROPIC}$ (PSIA)	598.4/1468	598/1467	582/1305	607/1570

TABLE 4.4.3

COMPARISON OF PLANT UPPER GUIDE STRUCTURES

PLANT	UGS DESIGN(S)	CONTROL ROD ARRANGEMENT	HEIGHT OF SHROUDS EXPOSED TO CROSSFLOW
CALVERT CLIFFS	SINGLE & DUALS	20 DUALS/45 SINGLES	99.84"
MILLSTONE 2	SINGLE & DUALS	12 DUALS/57 SINGLES	99.84"
ST. LUCIE 1	SINGLE & DUALS	12 DUALS/57 SINGLES	99.84"
FT. CALHOUN	SINGLE & DUALS	12 DUALS/29 SINGLES	99.84"
PALISADES	CRUCIFORM	45	117.5"

FIGURE 4.4.1
GENERIC PLANT ANALYSIS
DOUBLE-ENDED RV INLET BREAK AT 60°
ABSOLUTE PRESSURE IN THE ANNULUS
NOZZLE CENTERLINE ELEVATION AT 60°

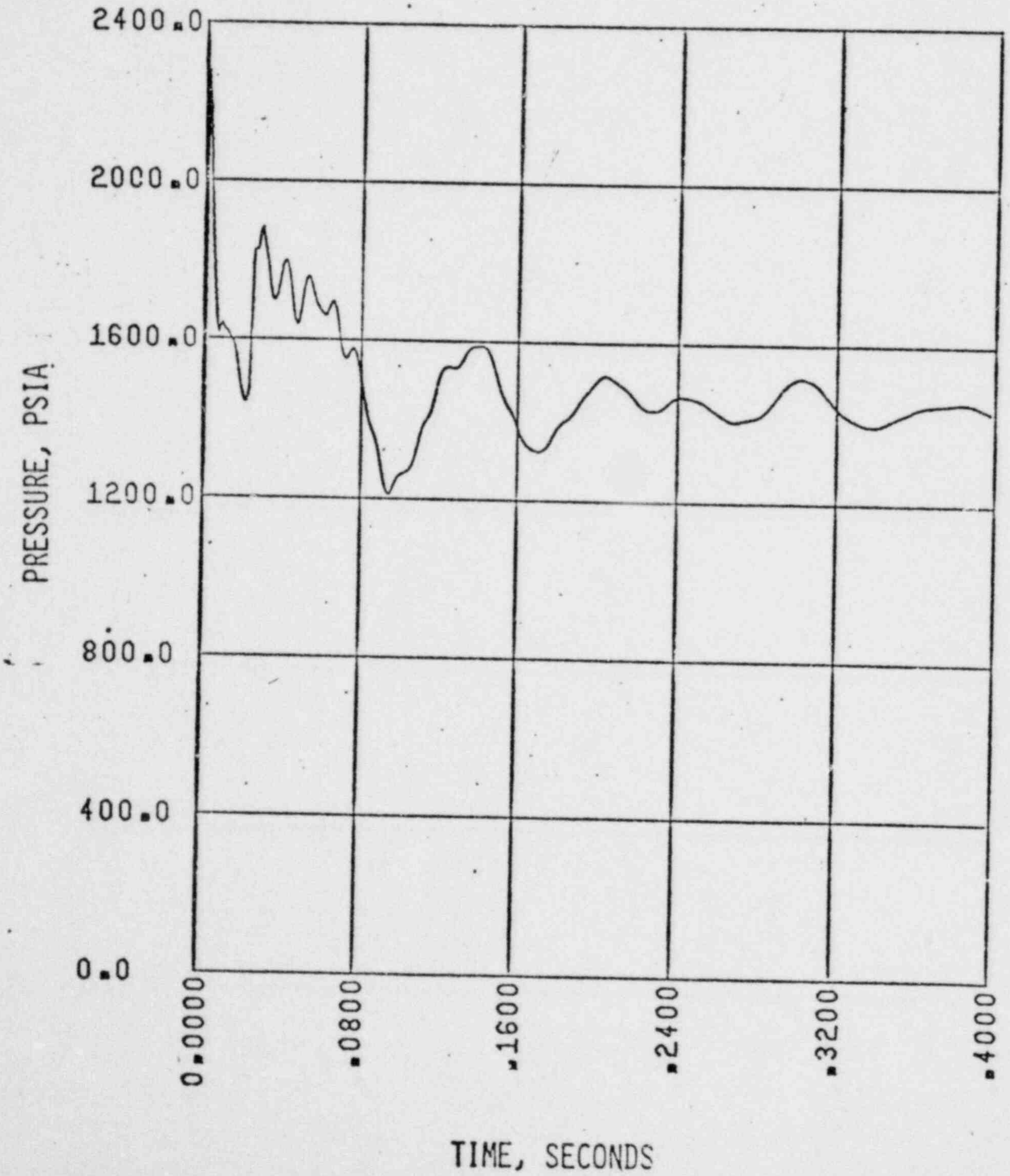


FIGURE 4.4.2
GENERIC PLANT ANALYSIS
DOUBLE-ENDED RV INLET BREAK AT 60°
PRESSURE DIFFERENCE ACROSS THE CORE BARREL
NOZZLE CENTERLINE ELEVATION AT 60°

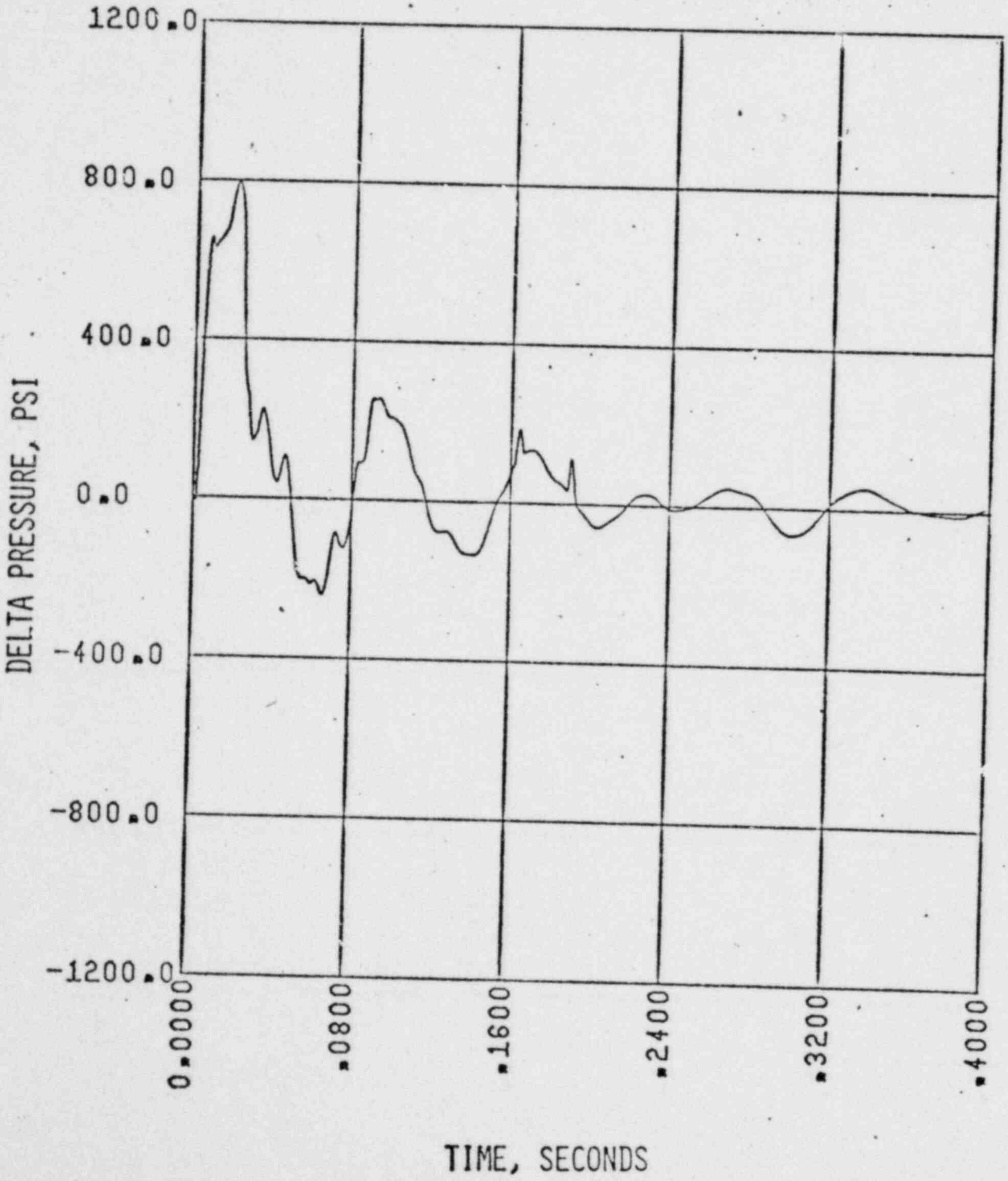
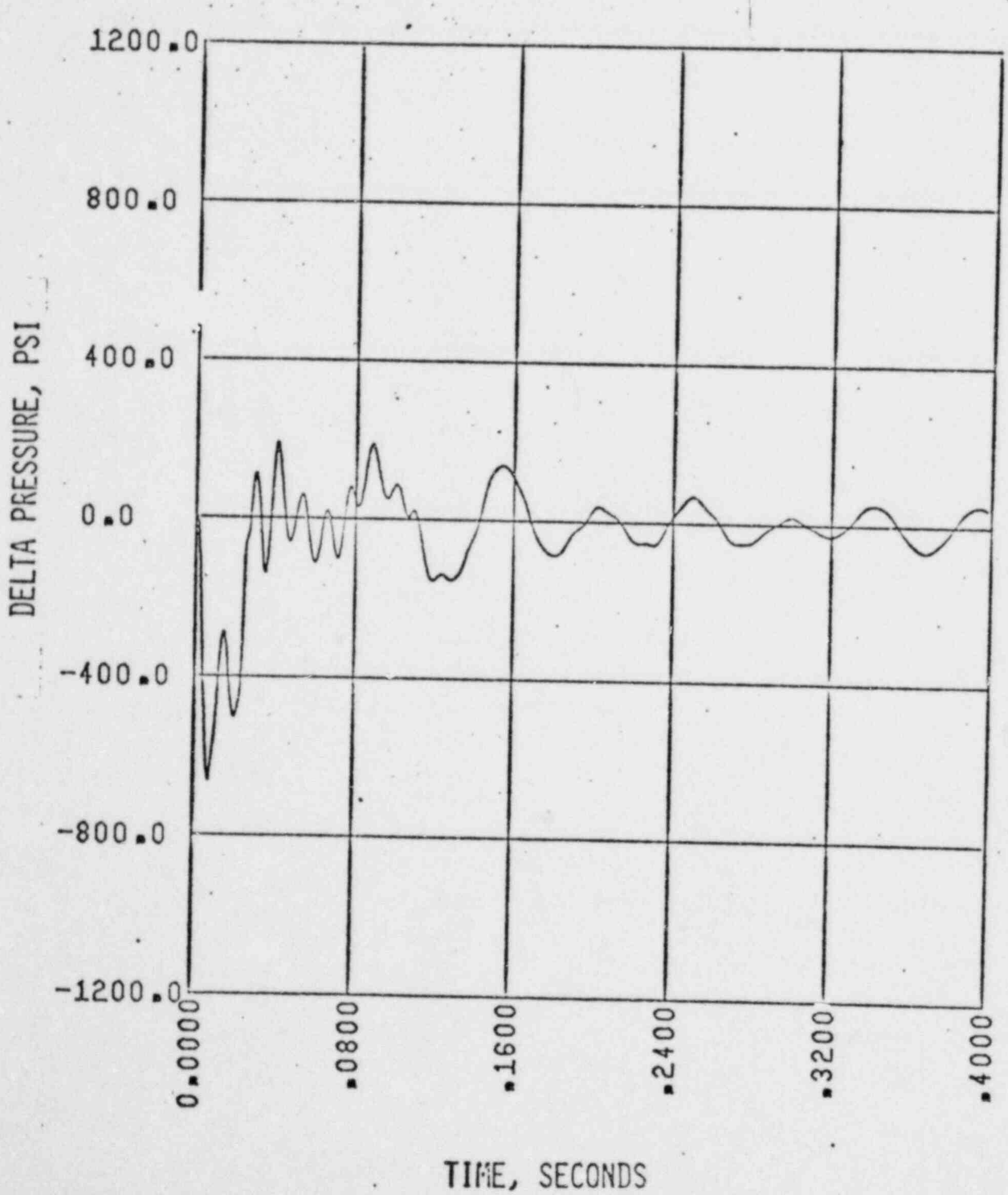


FIGURE 4.4.3
GENERIC PLANT ANALYSIS
DOUBLE-ENDED RV INLET BREAK AT 60°
PRESSURE DIFFERENCE AROUND THE CORE BARREL
NOZZLE CENTERLINE ELEVATION (60°-240°)



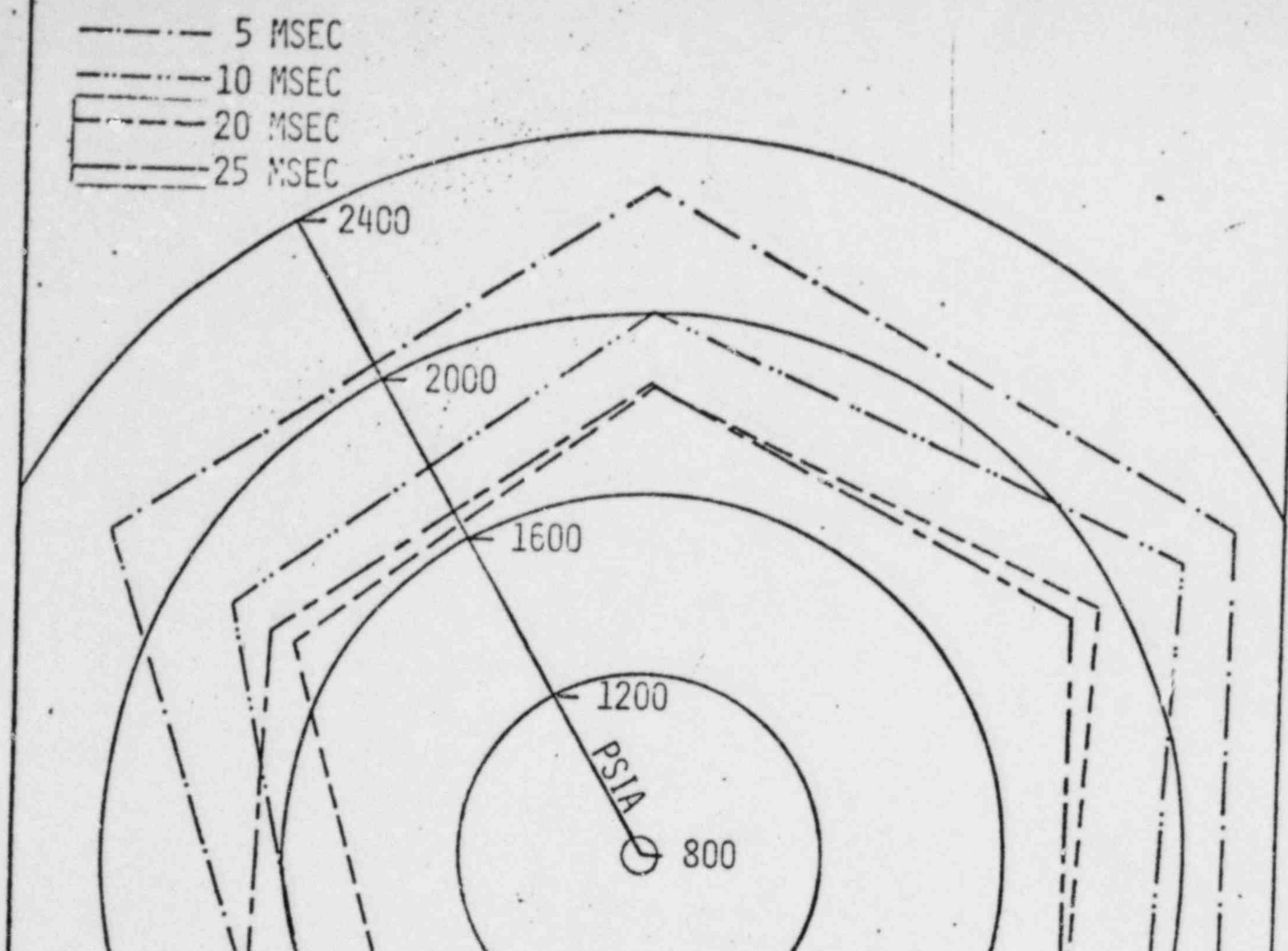


FIGURE 4.4.4
ABSOLUTE PRESSURE IN THE ANNULUS AT THE NOZZLE CENTERLINE ELEVATION FOLLOWING A DOUBLE-ENDED INLET BREAK AT 60° FOR CALVERT CLIFFS FOR VARIOUS TIMES AFTER RUPTURE

FIGURE 4.4.5
GENERIC PLANT ANALYSIS
DOUBLE-ENDED RV INLET BREAK
CORE AXIAL PRESSURE DIFFERENCE

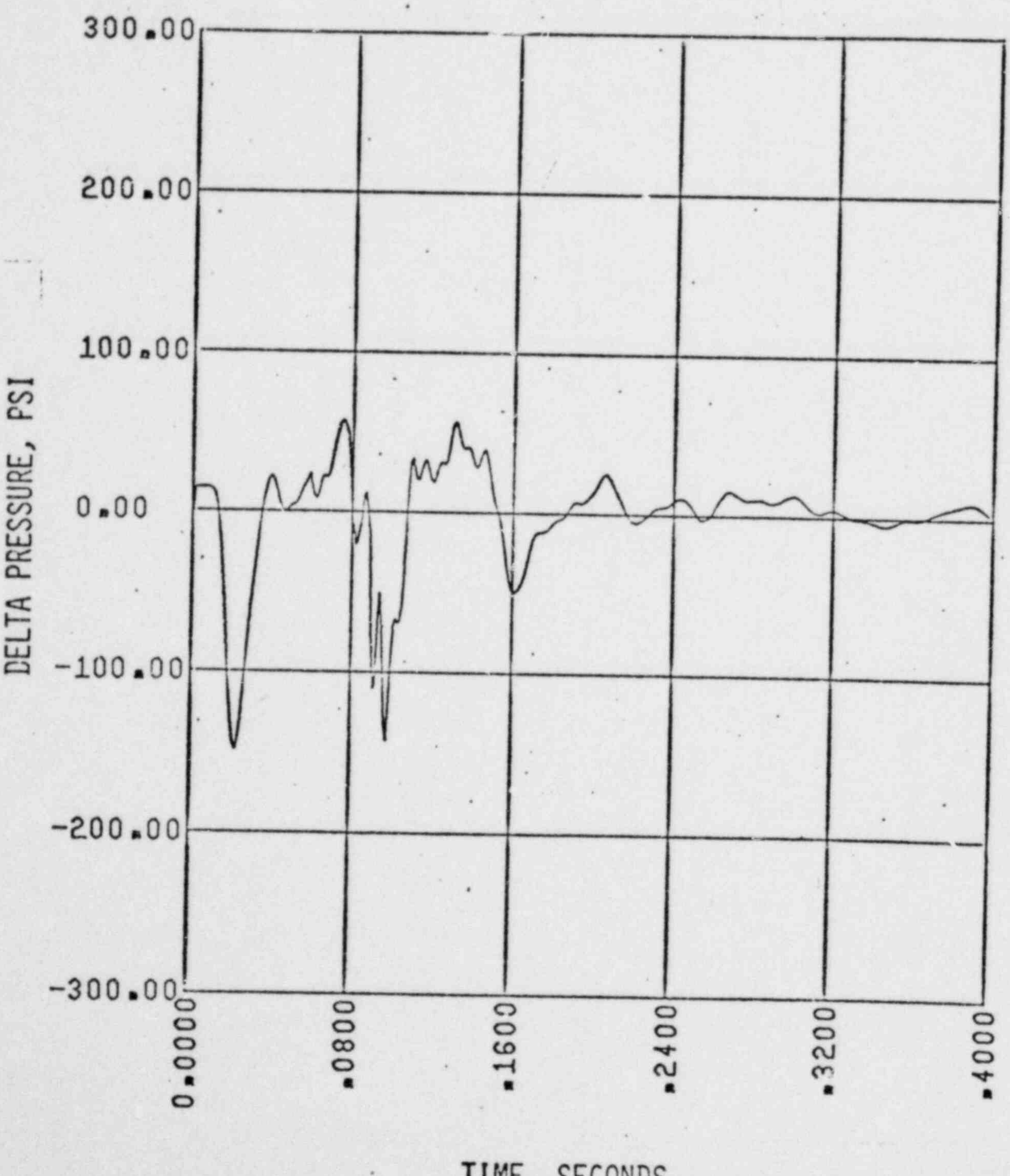


FIGURE 4.4.6
GENERIC PLANT ANALYSIS
135 SQ. IN. RV OUTLET NOZZLE BREAK AT 0°
ABSOLUTE PRESSURE IN THE ANNULUS
NOZZLE CENTERLINE ELEVATION AT 0°

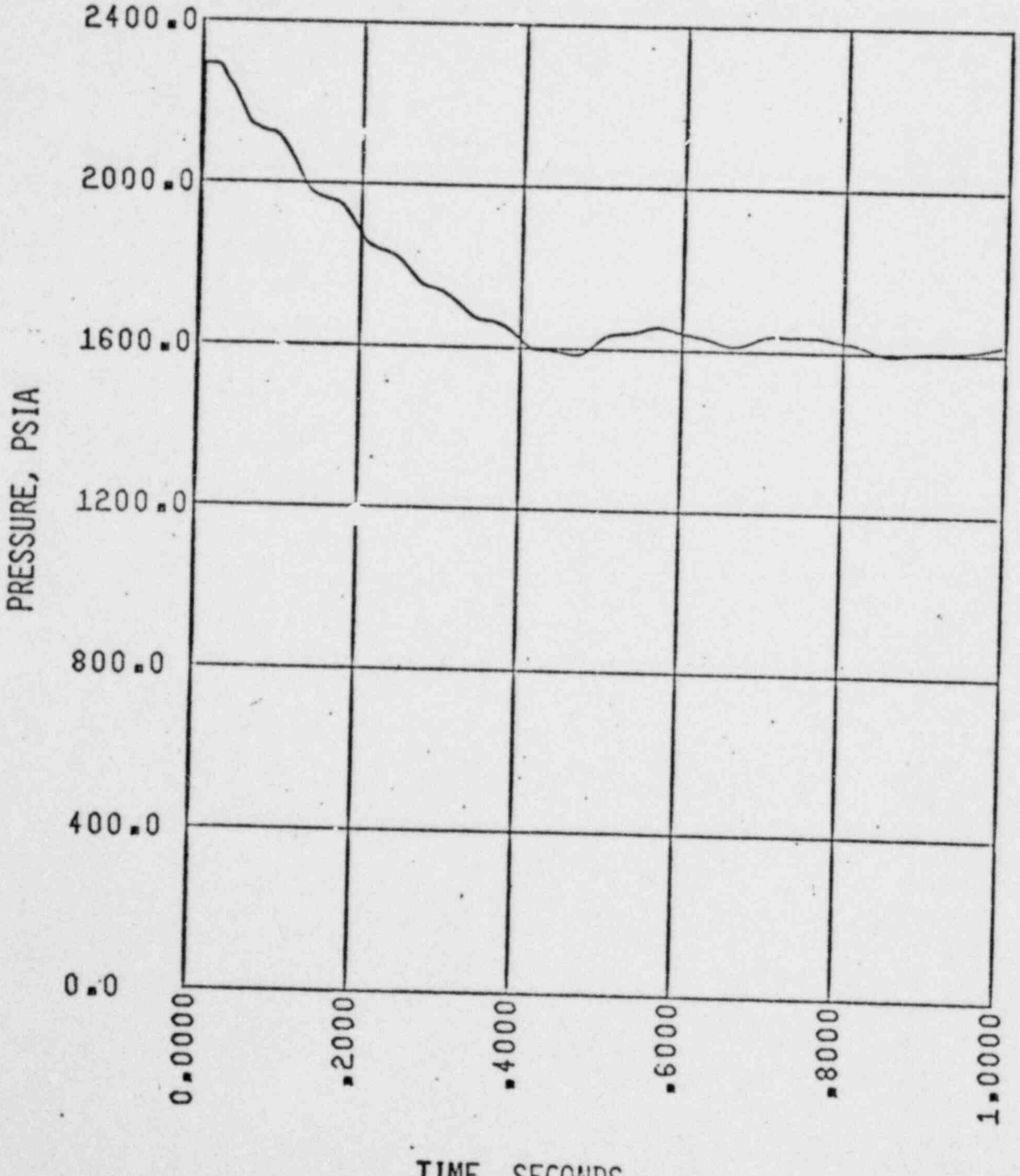


FIGURE 4.4.7
GENERIC PLANT ANALYSIS
135 SQ. IN. RV OUTLET NOZZLE BREAK AT 0°
PRESSURE DIFFERENCE ACROSS THE CORE BARREL
NOZZLE CENTERLINE ELEVATION AT 0°

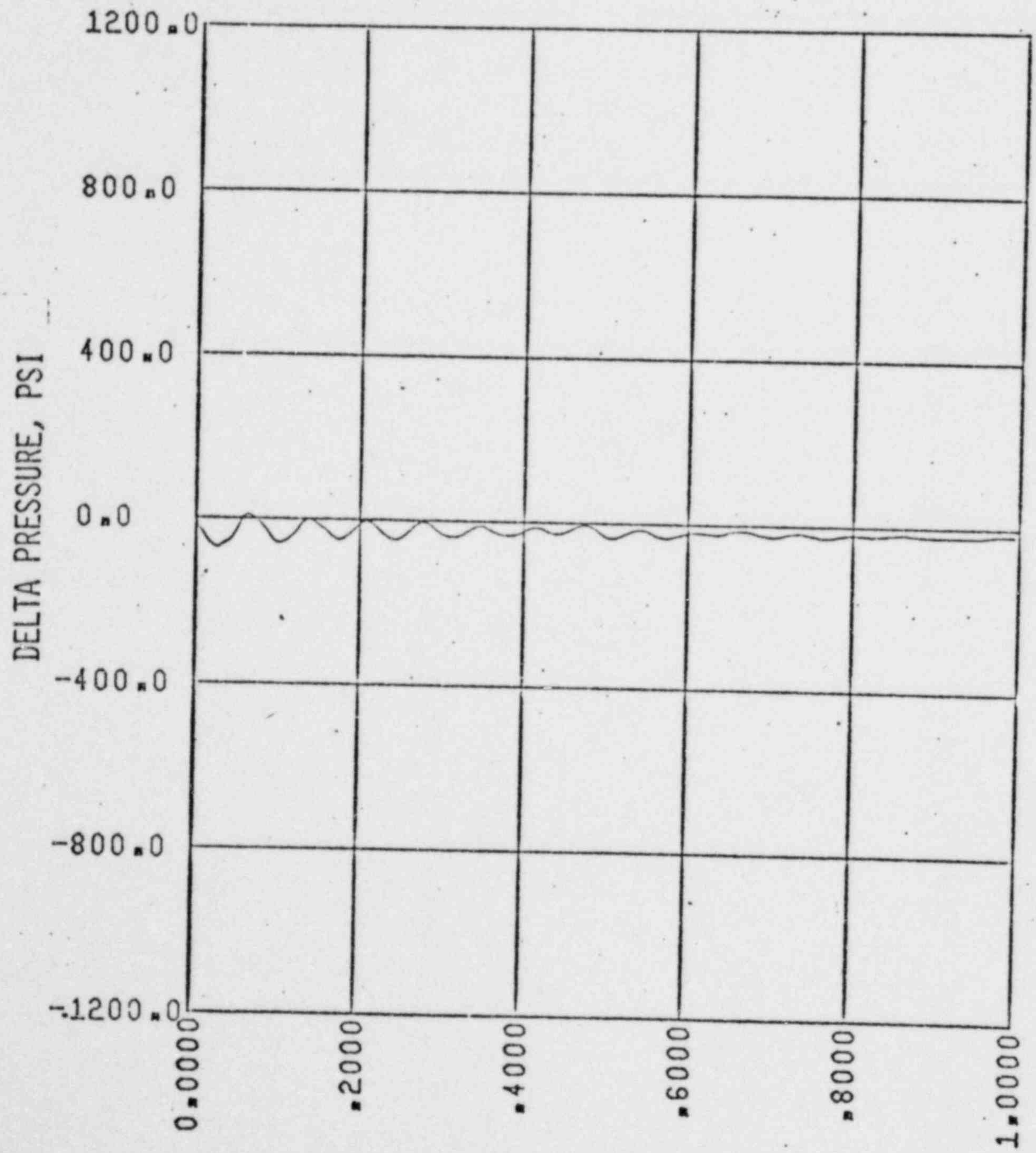


FIGURE 4.4.8
GENERIC PLANT ANALYSIS
135 SQ. IN. RV OUTLET NOZZLE BREAK AT 0°
PRESSURE DIFFERENCE AROUND THE CORE BARREL
NOZZLE CENTERLINE ELEVATION (0° - 180°)

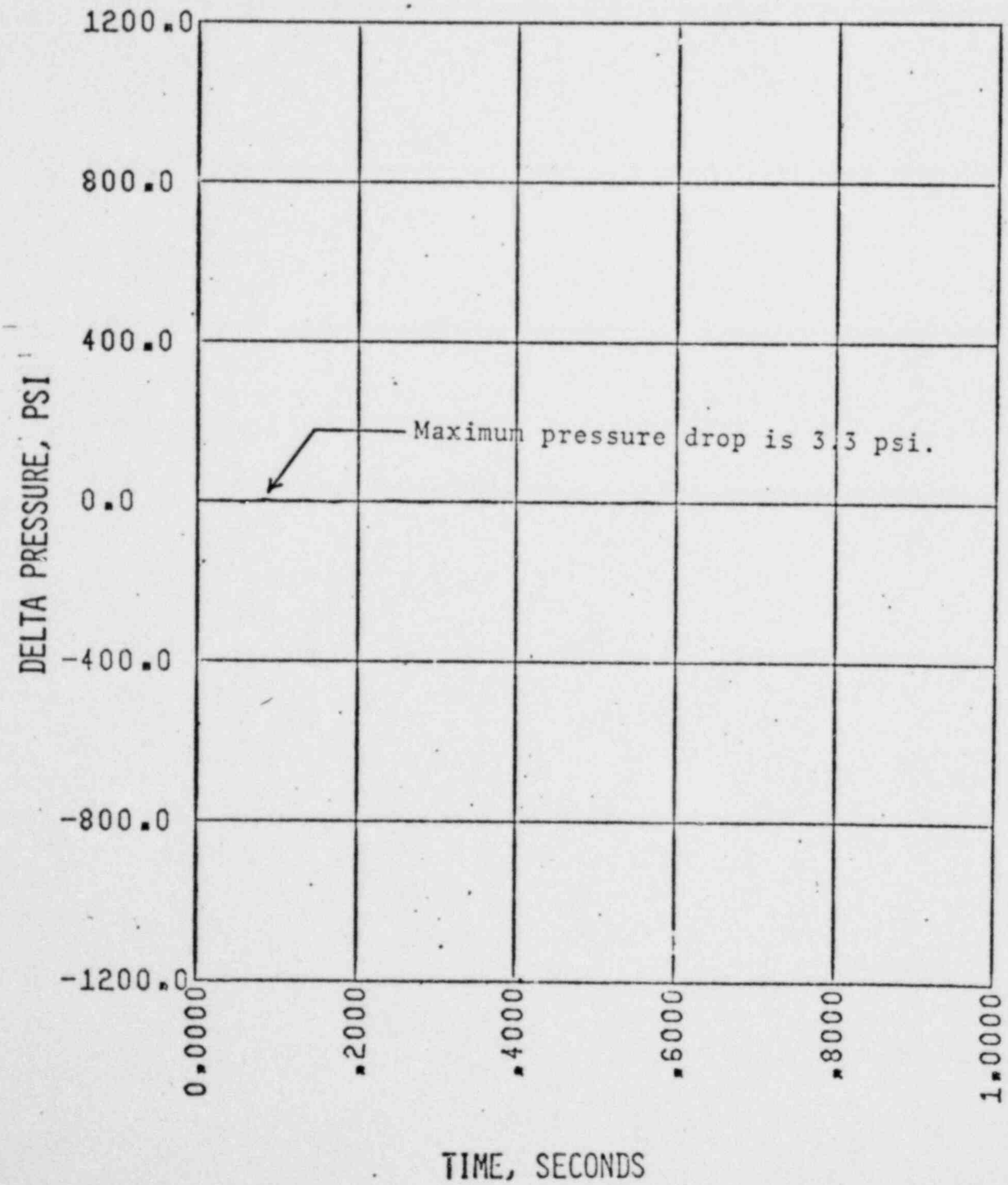


FIGURE 4.4.9

GENERIC PLANT ANALYSIS

135 SQ. IN. RV OUTLET NOZZLE BREAK AT FULL POWER

CORE AXIAL PRESSURE DIFFERENCE

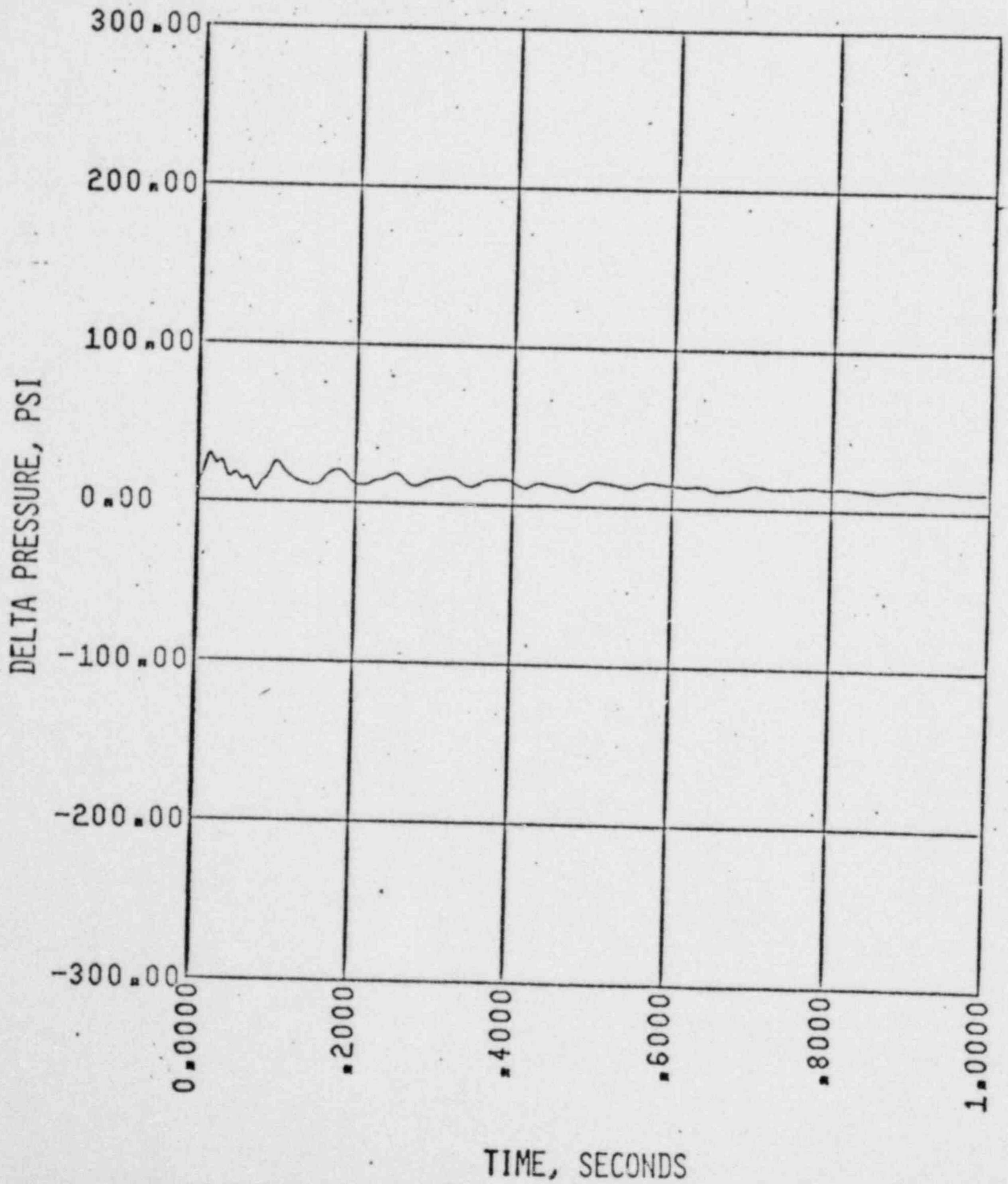


FIGURE 4.4.10

FT. CALHOUN PLANT SPECIFIC ANALYSIS

RV INLET BREAK AT 60°

PRESSURE DIFFERENCE ACROSS THE CORE BARREL

NOZZLE CENTERLINE ELEVATION AT 60°

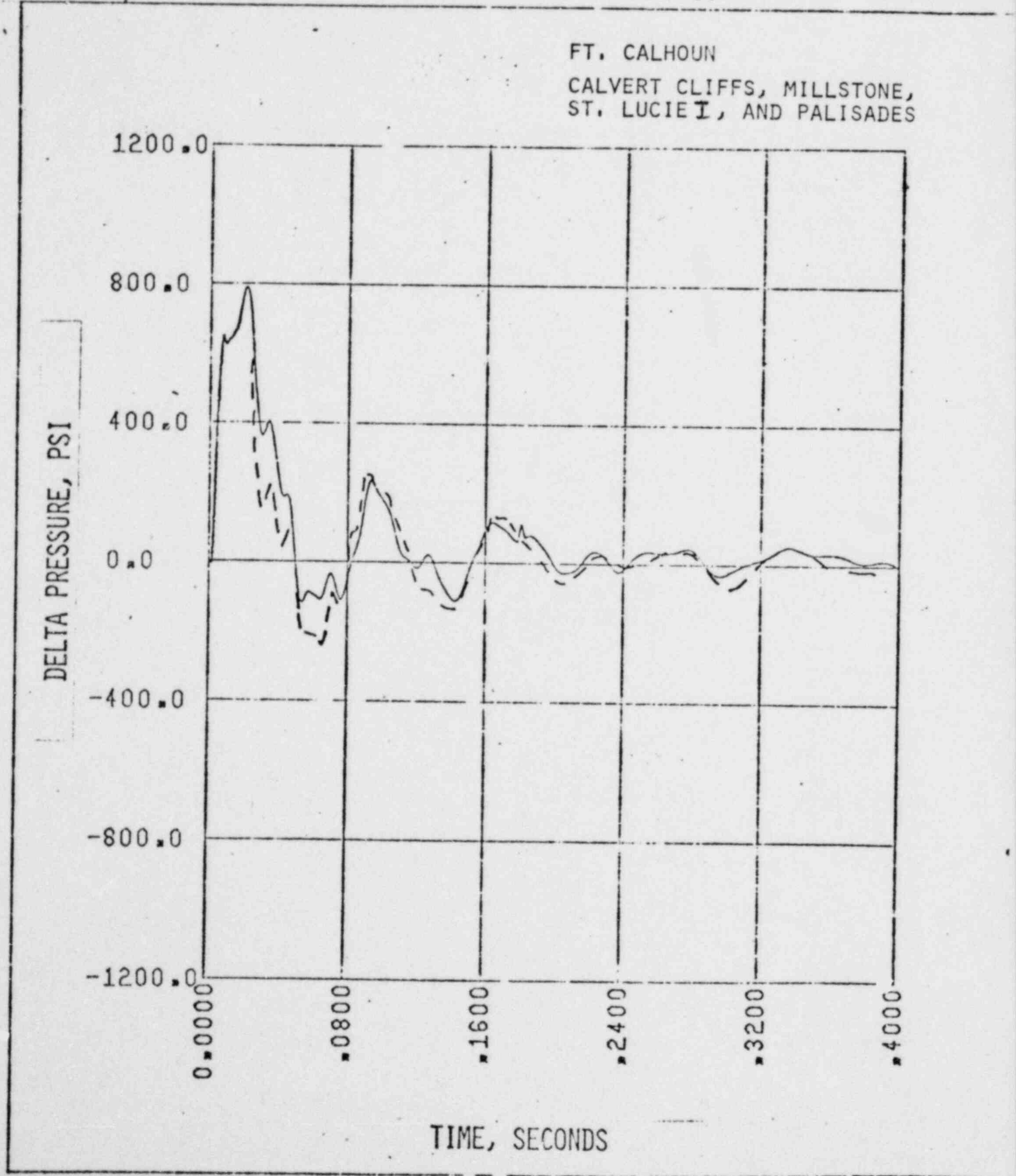


FIGURE 4.4.11
FT. CALHOUN PLANT SPECIFIC ANALYSIS
RV INLET BREAK AT 60°
PRESSURE DIFFERENCE AROUND THE CORE BARREL
NOZZLE CENTERLINE ELEVATION AT 60°

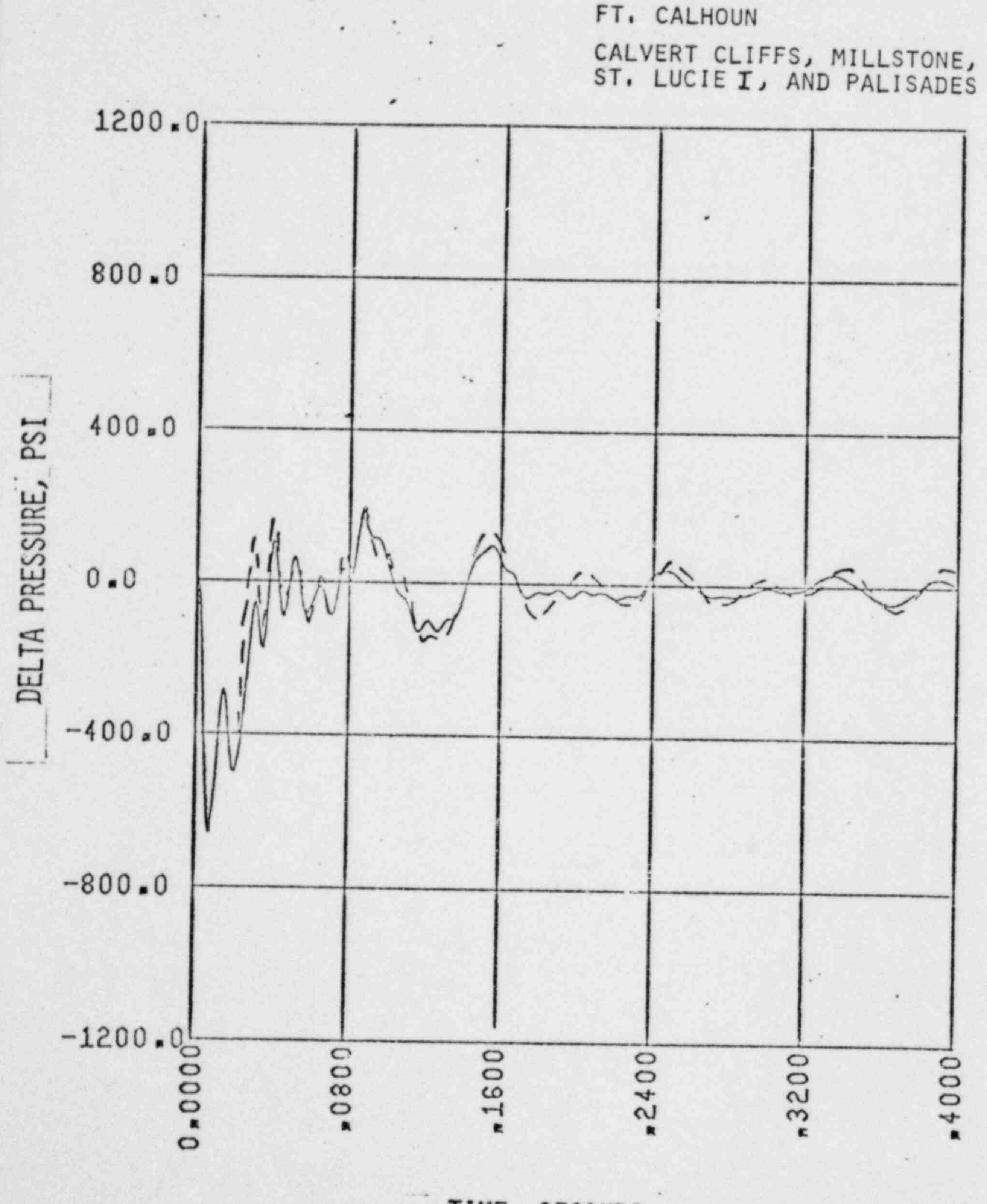


FIGURE 4.4.12
FT. CALHOUN PLANT SPECIFIC ANALYSIS
RV INLET BREAK
CORE AXIAL PRESSURE DIFFERENCE

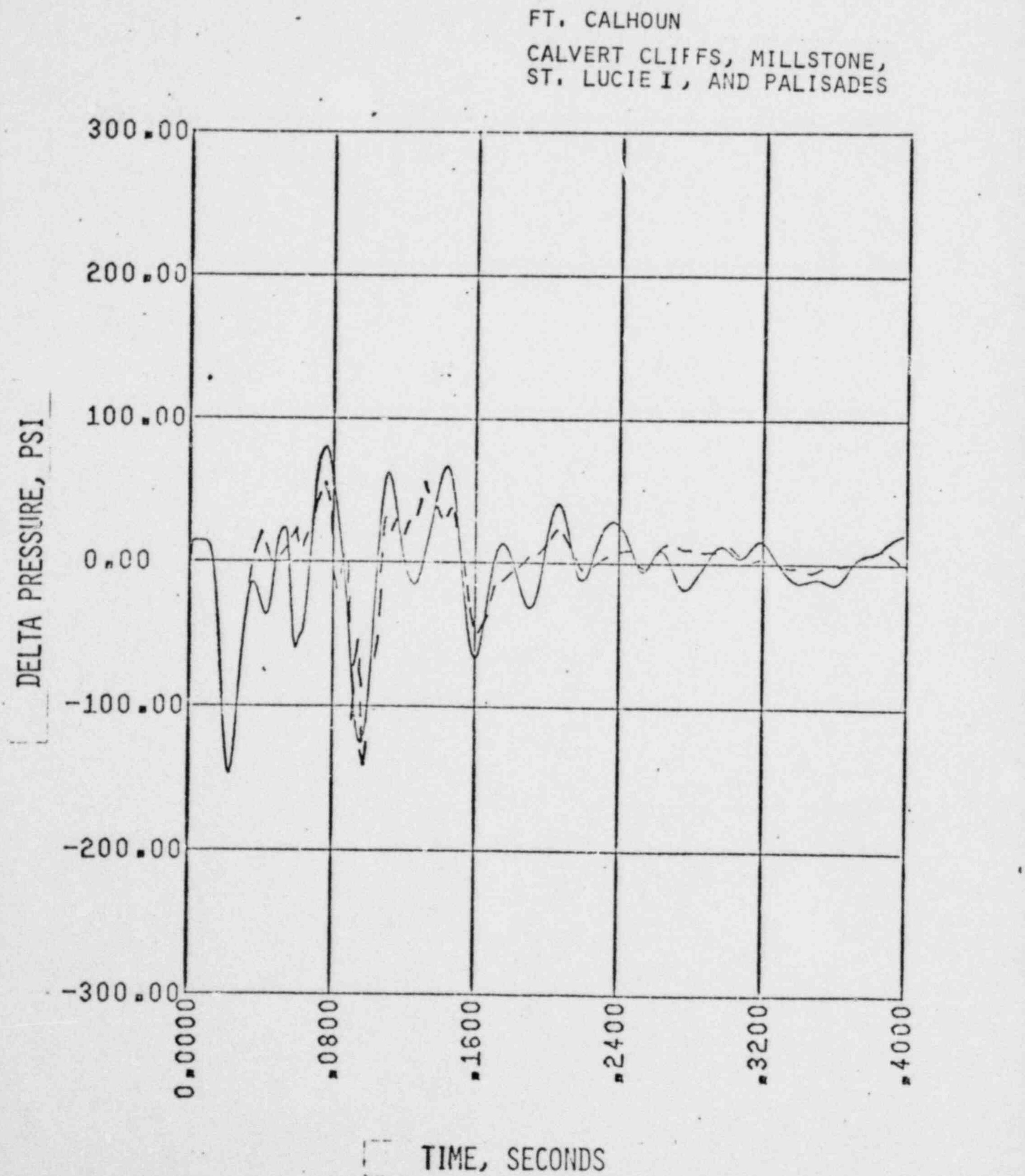


FIGURE 4.4.13

FT. CALHOUN PLANT SPECIFIC ANALYSIS

RV OUTLET BREAK AT 0°

ABSOLUTE PRESSURE IN THE OUTLET PLENUM

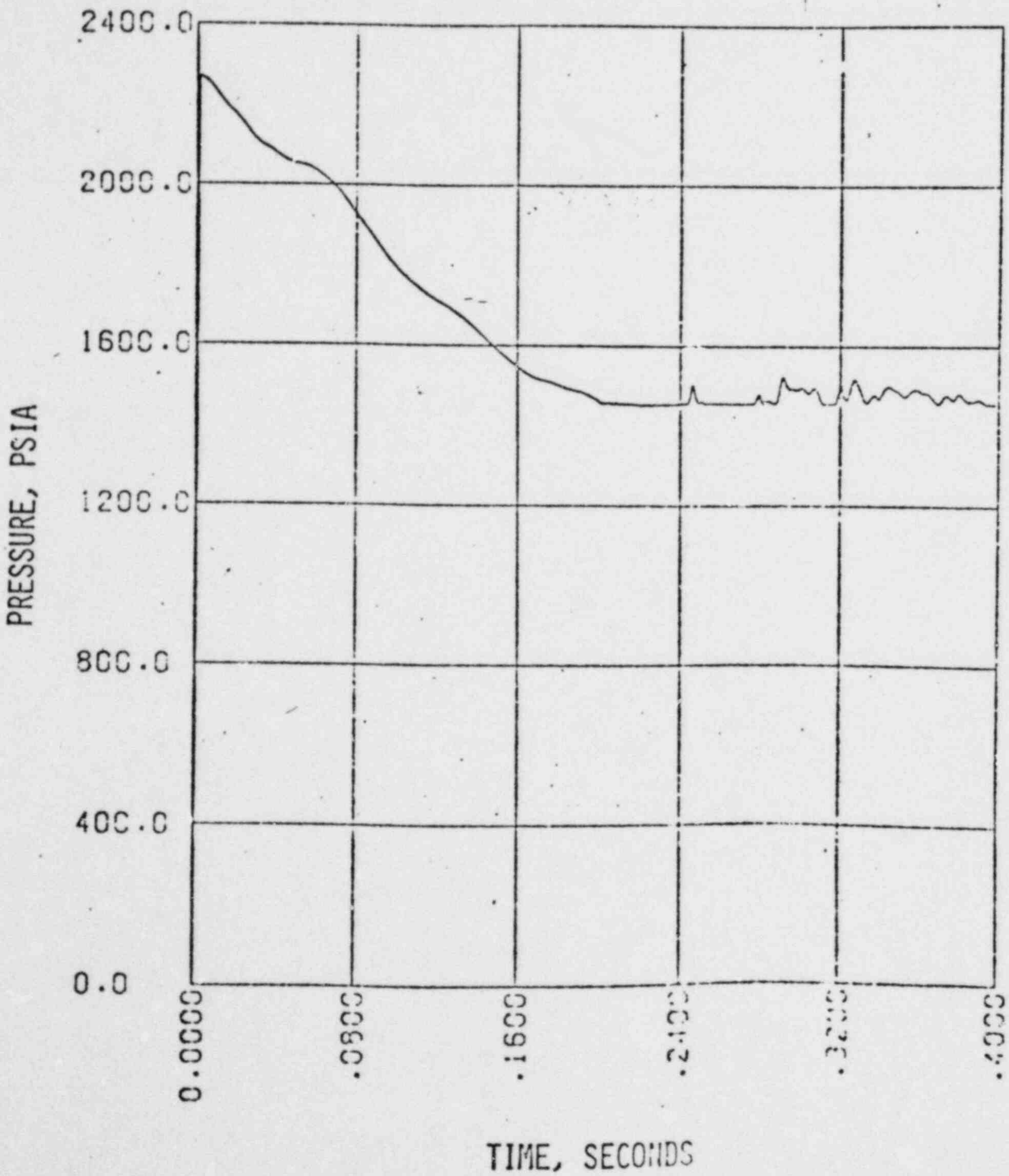


FIGURE 4.4.14

FT. CALHOUN PLANT SPECIFIC ANALYSIS
RV OUTLET BREAK AT 0°
PRESSURE DIFFERENCE ACROSS THE CORE BARREL
NOZZLE CENTERLINE ELEVATION AT 0°

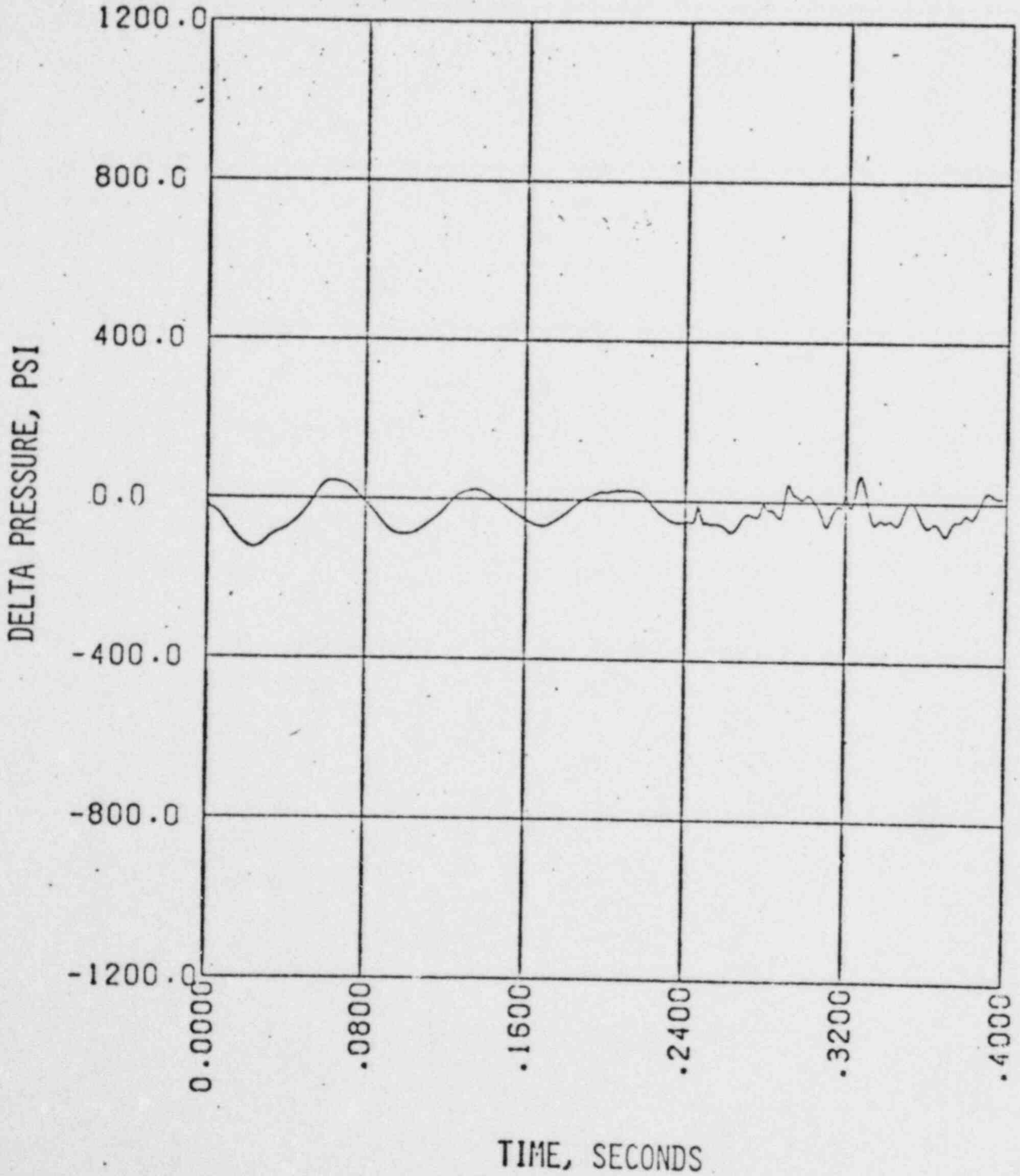


FIGURE 4.4.15

FT. CALHOUN PLANT SPECIFIC ANALYSIS
RV OUTLET BREAK AT 0°
PRESSURE DIFFERENCE AROUND THE CORE BARREL
NOZZLE CENTERLINE ELEVATION (0°-180°)

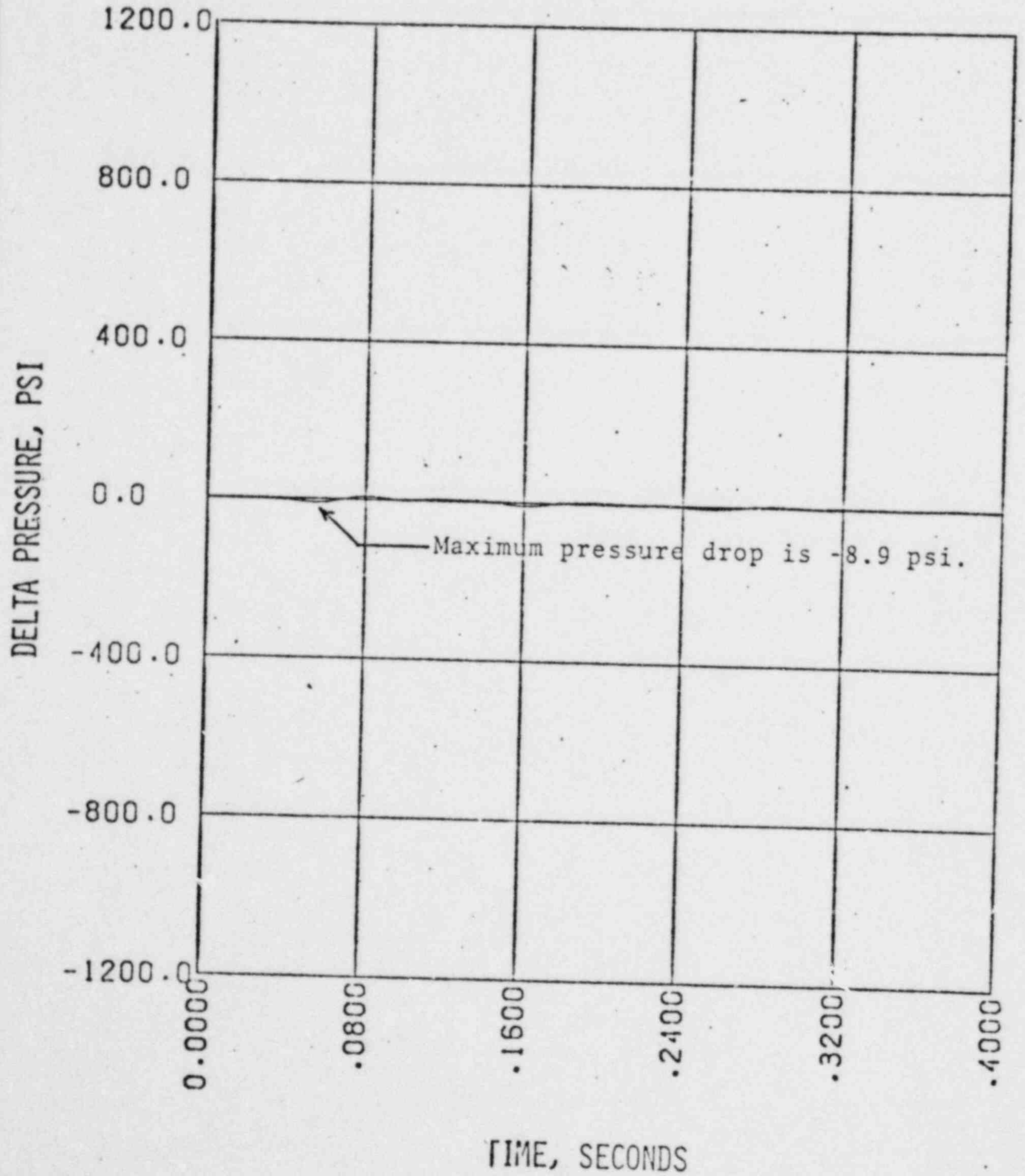
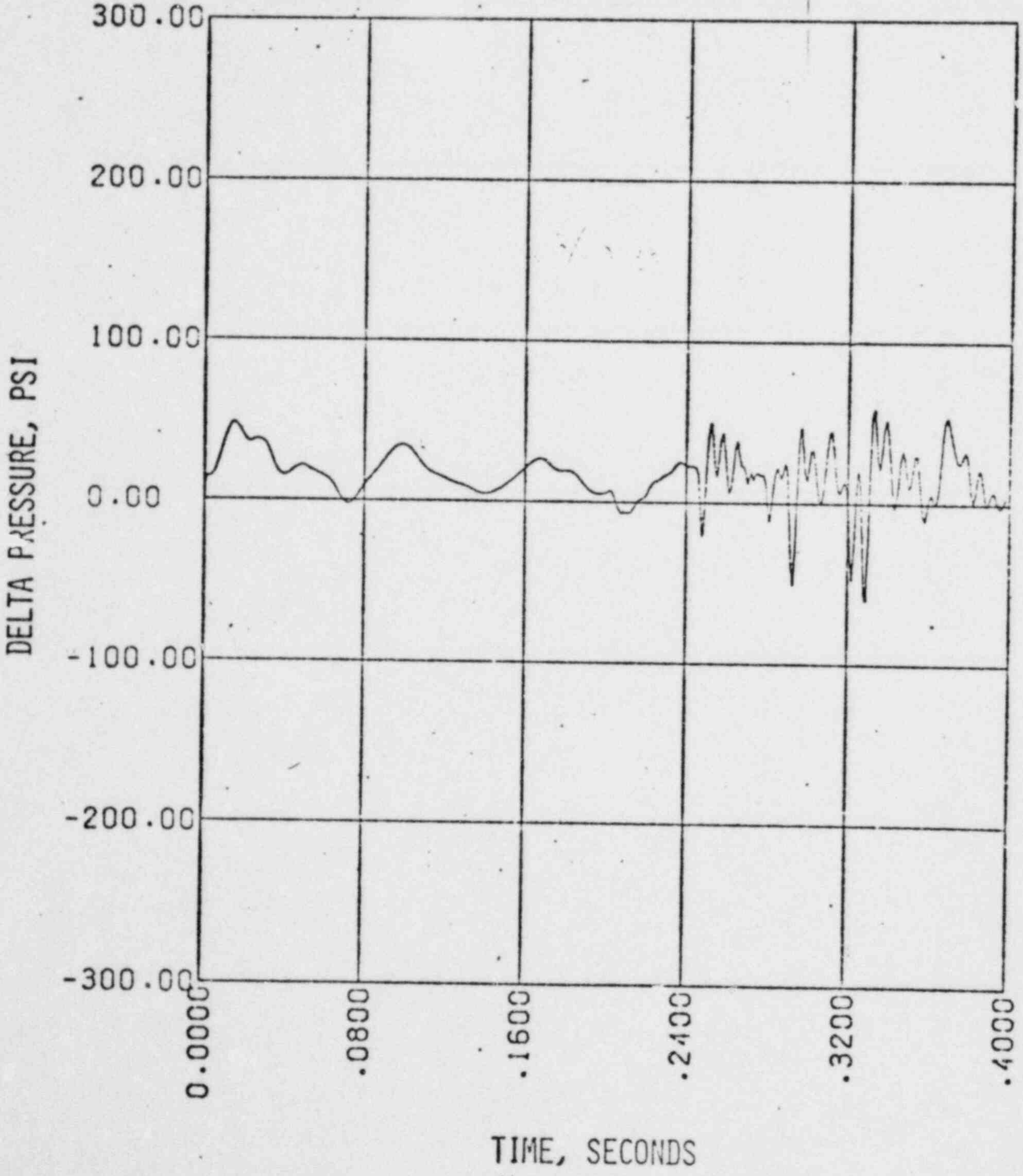


FIGURE 4.4.16

FT. CALHOUN PLANT SPECIFIC ANALYSIS
RV OUTLET BREAK AT 0°
CORE AXIAL PRESSURE DIFFERENCE



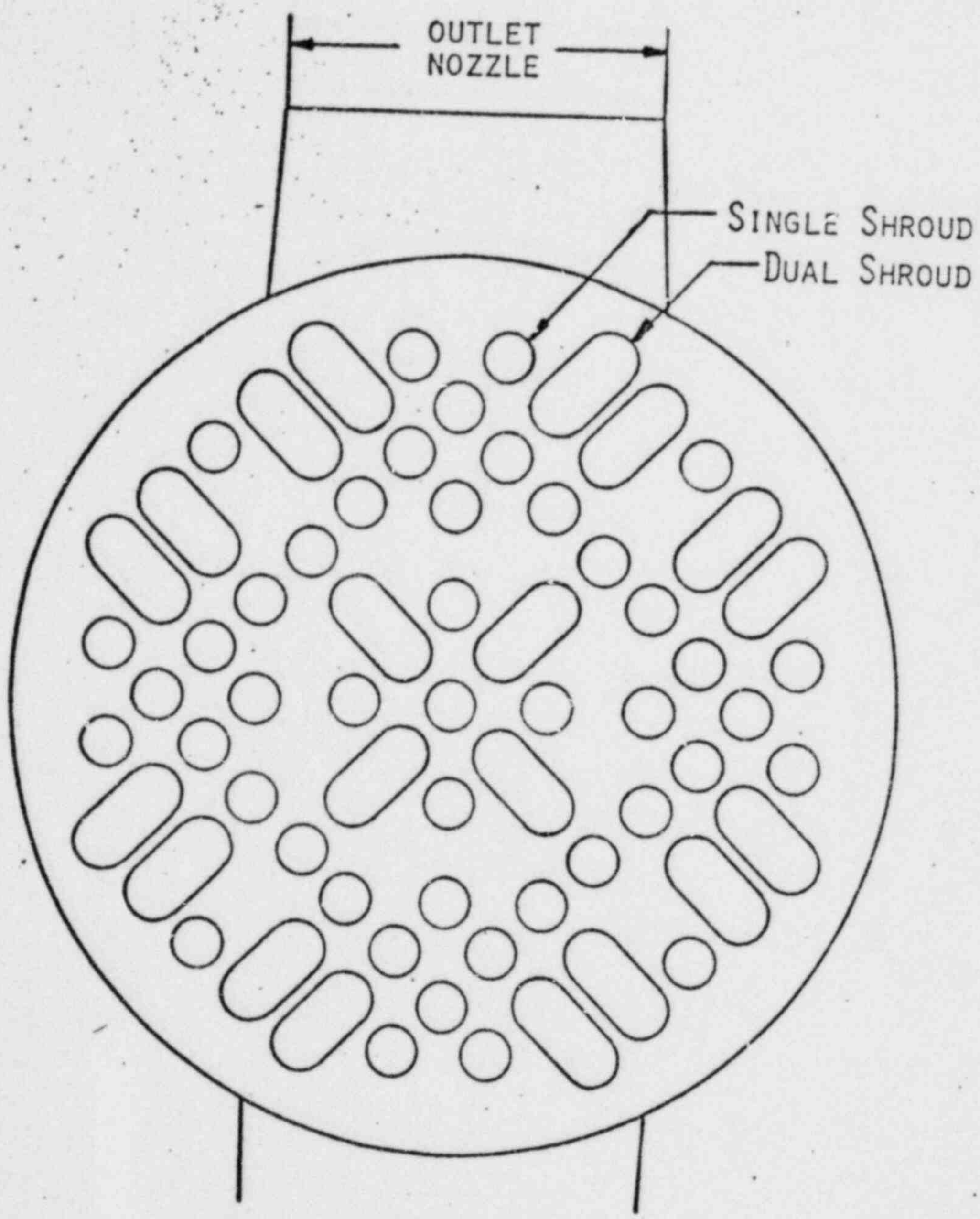


FIGURE 4.4.17

CALVERT CLIFFS UPPER GUIDE STRUCTURE
CEA SHROUD ARRANGEMENT

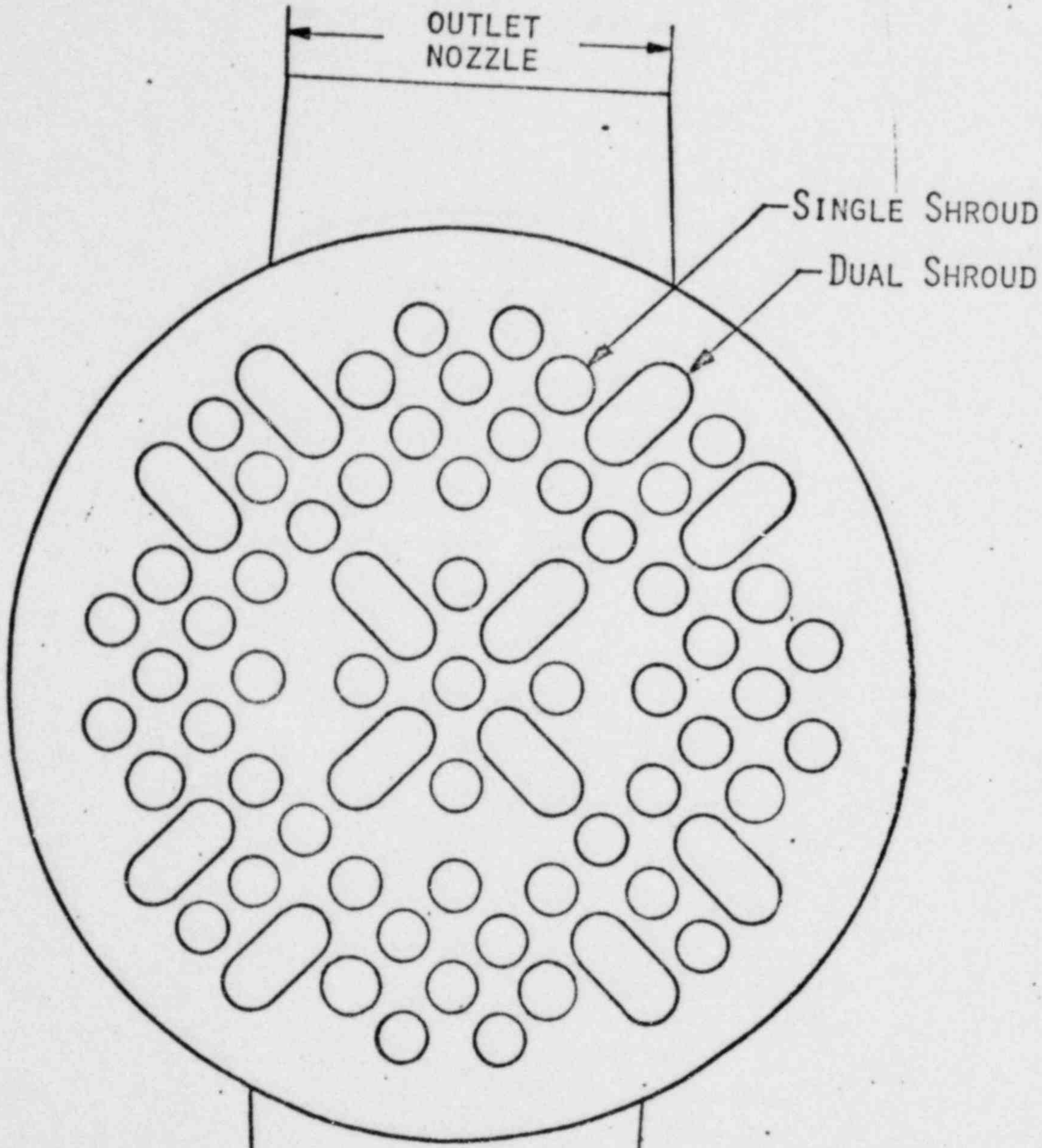


FIGURE 4.4.18

MILLSTONE 2 AND ST. LUCIE 1
UPPER GUIDE STRUCTURE
CEA SHROUD ARRANGEMENT

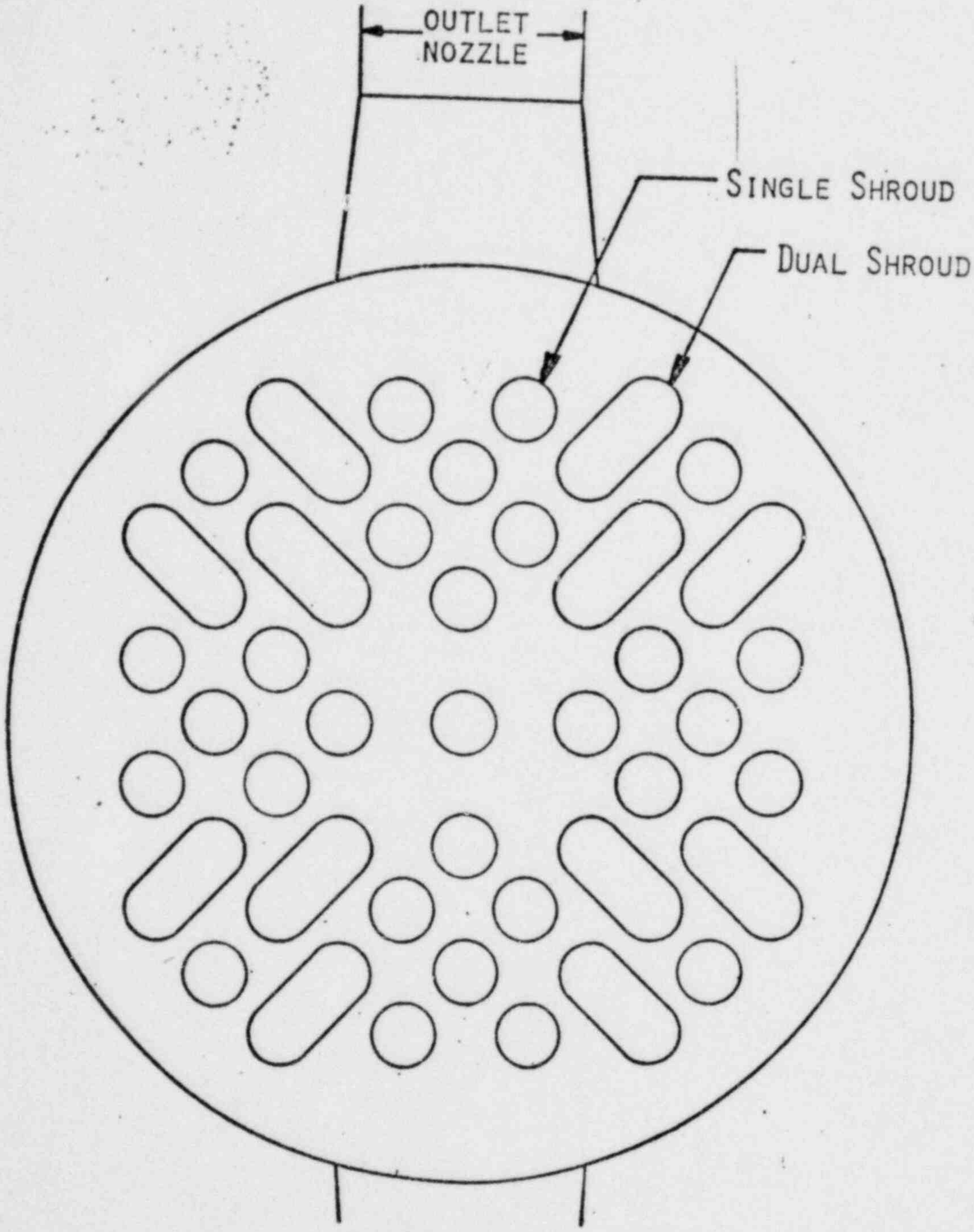


FIGURE 4.4.19

FT. CALHOUN UPPER GUIDE STRUCTURE
CEA SHROUD ARRANGEMENT

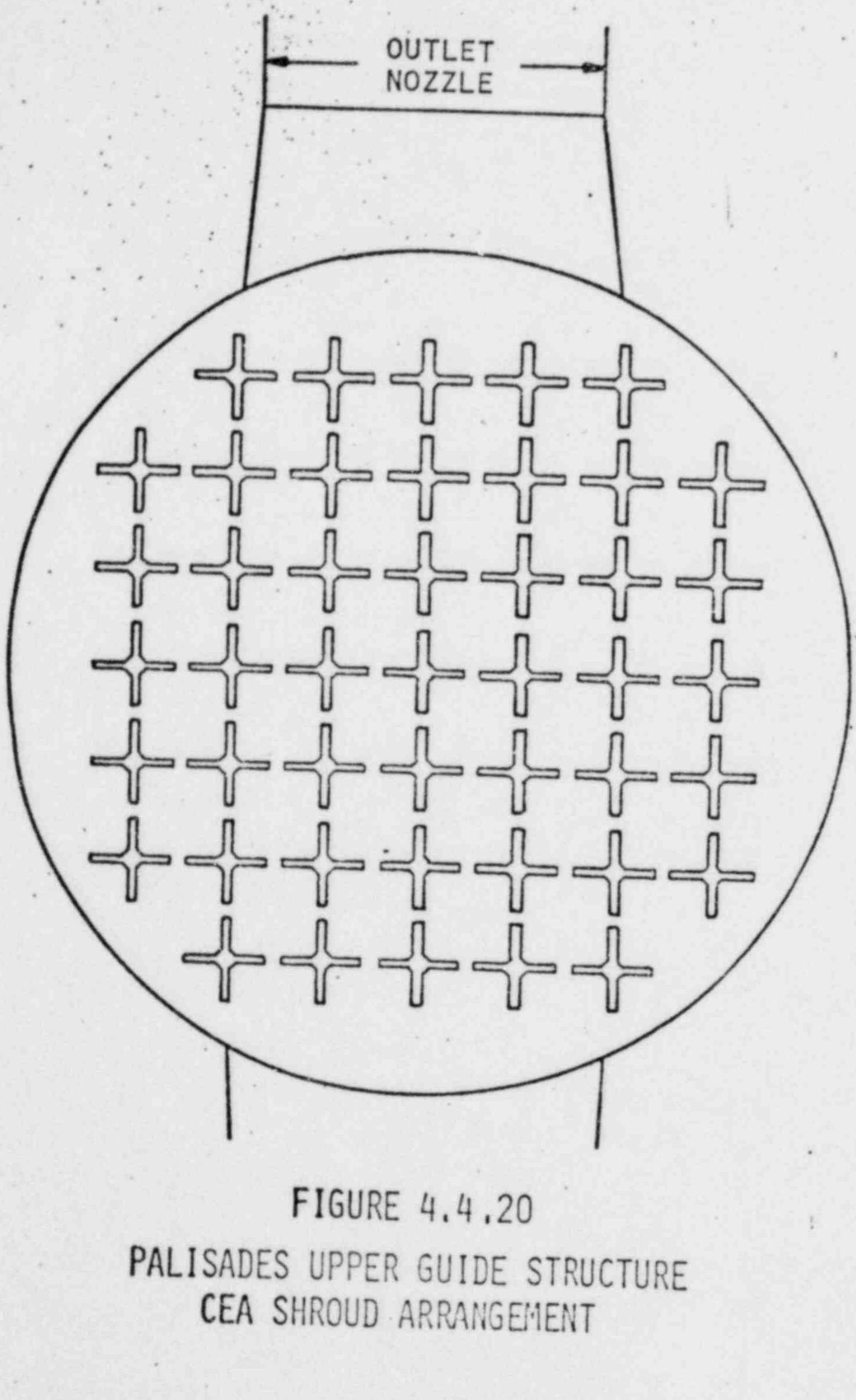


FIGURE 4.4.20

PALISADES UPPER GUIDE STRUCTURE
CEA SHROUD ARRANGEMENT