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Probability of Pipe Fracture in the Primary Coolant Loop of a PWR Plant

Volume 2: Primary Coolant Loop Model Load Combination Program Project I Final Report

A. C. Eberhardt, Sargent & Lundy Engineers, Chicago, IL

Prepared for
U.S. Nuclear Regulatory Commission

LAWRENCE LIVERMORE LABORATORY

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ABSTRACT

This report describes the Zion Station reactor coolant loop model developed by Sargent & Lundy Engineers for Lawrence Livermore National Laboratory as part of its Load Combination Program. This model was developed for use in performing seismic time history analyses of an actual pressurized water reactor (PWR) system. It includes all major items affecting the seismic response of a 4-loop Westinghouse nuclear steam supply system: the components, supports, and interconnecting piping. The model was further expanded to permit static analysis of dead weight, thermal, and internal pressure load conditions.

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EXECUTIVE SUMMARY

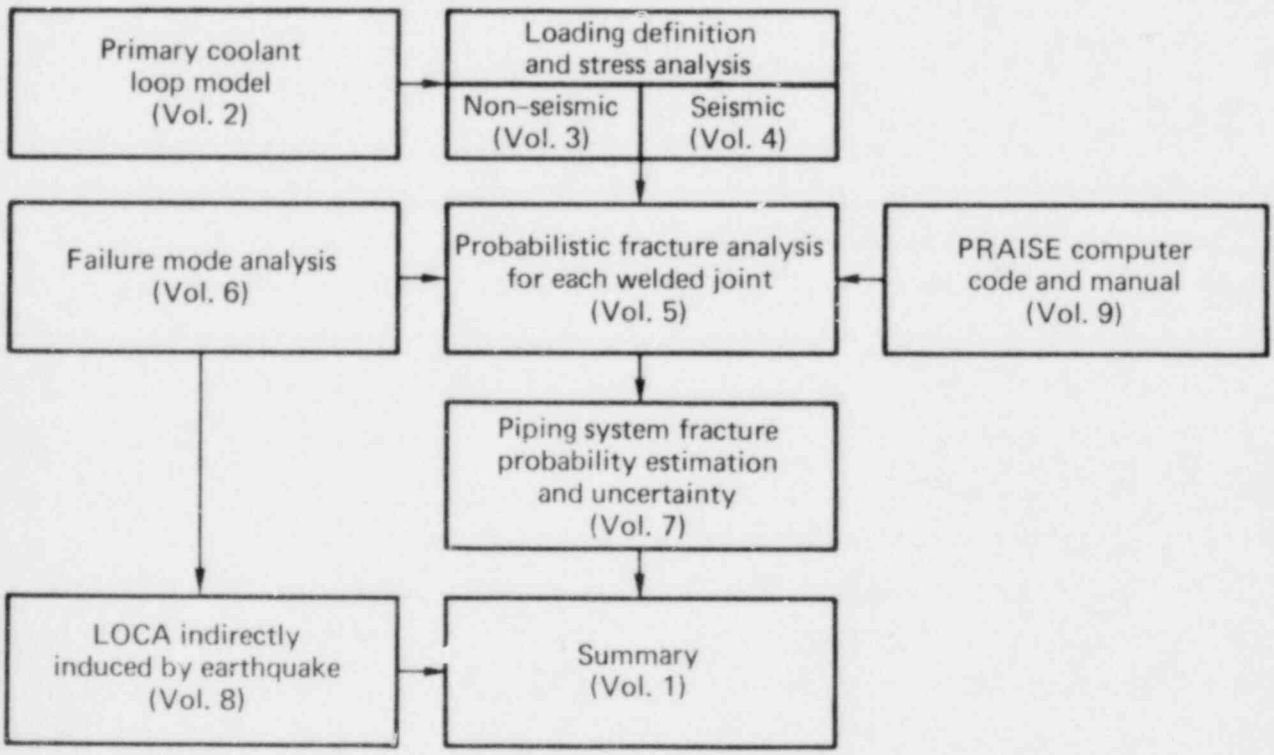
The Code of Federal Regulations requires that structures, systems, and components that affect the safe operation of nuclear power plants be designed to withstand combinations of loads that can be expected to result from natural phenomena, normal operating conditions, and postulated accidents. One load combinations requirement--the combination of the most severe LOCA (loss-of-coolant accident) load and SSE (safe shutdown earthquake) loads--has been controversial because both events occur with very low probabilities. This issue became more controversial in recent years because postulated large LOCA and SSE loads were each increased by a factor of 2 or more to account for such phenomena as asymmetric blowdown and because better techniques for defining loading have been developed.

The original objective of Load Combinations Project I was to estimate the joint probability of simultaneous occurrence of both events and to develop a technical basis for the NRC (Nuclear Regulatory Commission) to use in determining whether it could relax its requirement on the combination of SSE and large LOCA for nuclear power plants. However, in the process of probability estimation we have not only estimated the probability of simultaneous occurrence of a large LOCA and an earthquake, but also estimated the probability of a large LOCA caused by normal and abnormal loading conditions without an earthquake. The estimates provide very useful information on the likelihood of asymmetric blowdown, which is a subset of large LOCA. Also, the probabilistic fracture mechanics model that we developed can be used to estimate the probability of pipe rupture with or without prior leak. That is, we can estimate the proportion of pipes that will leak detectably before rupture under normal operation, accident, or upset conditions. We can also evaluate the piping reliability in general. After a sufficient parametric study is done, we will be able to recommend a more rational basis for postulating pipe rupture locations.

If earthquakes and large LOCAs are independent events, the probability of their simultaneous occurrence is small. However, this probability is expected to be greater if an earthquake can induce pipe failure that leads to a LOCA. This LOCA could result directly (i.e, ground motion causes a pipe break in the primary cooling system) or indirectly (e.g., an earthquake causes a structural, mechanical, or electrical failure that in turn causes a pipe break in the primary cooling system).

In the first-phase study reported in these nine volumes, we concentrated on determining the probability of a large LOCA in a PWR plant directly induced by an earthquake. The expert consensus is that such a directly induced LOCA is most likely to result from the growth of cracks formed in the pipes during fabrication. We selected a demonstration plant for study (Unit 1 of the Zion Nuclear Power Plant), modeled its primary cooling loop (Vol. 2), analyzed the best estimated responses of that piping system to non-seismic and seismic stresses (Vols. 3 and 4), developed a probabilistic fracture mechanics model of that piping system (Vols. 5, 6, and 7), analyzed failure mode (Vol. 6) and developed a computer code, PRAISE, to simulate the life history of a primary coolant system (Vol. 9). Finally, we examined the probability with which an earthquake can indirectly induce a LOCA (Vol. 8).

In Volume 2, we describe the Zion Station reactor coolant loop model developed by Sargent & Lundy Engineers. The relation between this volume and the rest of the report is shown in the following drawing:



I INTRODUCTION

This report describes the Zion Station reactor coolant loop model that has been developed for Lawrence Livermore National Laboratory as part of its Load Combination Program. The model which was developed fr[illegible]Zion Station Design Documents is to be used to perform seismic time history analyses of an actual pressurized water reactor (PWR) system. The model was further expanded to permit static analysis of dead weight, thermal, and internal pressure load conditions.

II SUMMARY AND RECOMMENDATIONS

A. Summary

The model described herein includes all major items affecting the seismic response of a 4-loop Westinghouse nuclear steam supply system (NSSS): the components, supports, and the interconnecting piping. The major components include one Reactor Pressure Vessel (RPV), four Steam Generators (SG), four Reactor Coolant Pumps (R.C. pump), and one Pressurizer. Each loop includes three sections of pipe. Coolant flows from the RPV to the SG through the hot leg, then through the crossover leg to the R.C. pump, and finally through the cold leg back to the RPV, thus closing one of the four loops. The surge line connects the pressurizer to the system as a branch from the hot leg in Loop 4.

B. Recommendations for Further Study

The model could be refined in a number of ways including determining nozzle flexibility and lug flexibility for major components such as the steam generator. It may also be beneficial to investigate the actual stiffness of several elbows in the main coolant loop system, particularly the elbows at the nozzles of the steam generator, R.C. pump, and RPV.

The effects of material nonlinearity and buckling of compression elements may most deserve further study. These aspects of system behavior may be significant if the model is used to analyze seismic loads that are much larger than the original design basis loads.

The system originally was designed to remain elastic under seismic loads. However, when seismic loads were combined with Loss of Coolant Accident (LOCA) loads, strains exceeding yield were allowed in limited, controlled areas of the component support system. The limiting criteria required that all piping stresses remain within allowable values.

The model presented in this report is detailed enough to permit incorporation of gap effects and one-way acting bumper characteristics. However, the model does not provide detailed representations of controlled areas where material nonlinear behavior may occur under LOCA loads. The sophistication of the model could be expanded to cover these effects, but the increase in the size of the model and its solution time would significantly reduce the overall favorability of this refinement.

The user of the model must carefully monitor stress levels in piping and force levels in component support members to insure that the assumed linear-elastic behavior of materials is not violated if very high seismic loads are applied to the model.

Displacements of the piping should also be monitored at the surge line and crossover leg pipe break restraints. The model should be revised to incorporate the crossover leg restraints if pipe displacements exceed the width of the gaps between the pipe and the restraints.

III GENERAL DESCRIPTION

The model has 391 nodes and 1833 degrees of freedom as listed in Table 1. The assignment of the nodes to components, component supports, and piping is given in Table 2. The node and member numbering schemes for all four loops are shown in

Exhibits 1 through 20. There is usually an increment of 100 for corresponding nodes in each of the four loops. Node numbers 1-99 are in Loop 1, 101-159 in Loop 2, 201-259 in Loop 3, and 301-359 are in Loop 4, while nodes 360-416 are in the surge line and pressurizer. Other nodes are used for the RPV and its supports.

All member numbers are shown in rectangular boxes. Member numbers preceded by the letter "B" indicate beam elements. The letter "T" indicates truss elements. The letter "M" indicates members having stiffness properties input directly in the form of member stiffness matrices in local coordinates. A number with no letter indicates a pipe element. In most cases there is an increment of 50 for pipe elements in the four loops of the model. Pipe elements 1-50 are in Loop 1, 51-100 in Loop 2, 101-150 in Loop 3, and 151-200 in Loop 4, while 201-240 are in the surge line and pressurizer. Other members are used for the RPV and its supports.

The model contains all main reactor coolant loop piping and the pressurizer surge line. The surge line connects the pressurizer to the system and is attached to a nozzle in the hot leg of Loop 4. Properties of the pipe are given in Tables 3 and 4. Coefficients of thermal expansion for thermal analysis are given in Appendix F. None of the other 84 branch lines are included in the model. However, nodes are provided in the model at each of the branch line nozzle attachment points for all lines 1 inch or greater in diameter. Table 5 provides node numbers corresponding to each nozzle. Tables 6, 7, 8, and 9 describe the function of each branch line for Loops 1, 2, 3, and 4.

As shown in Table 3, elbow wall thicknesses are always greater than straight pipe wall thicknesses. The greater wall thickness serves two purposes: a) the elbow will have a larger section modulus which in turn reduces stresses in the elbow; b) elbow sections normally are fabricated from sand castings, whereas the straight sections are seamless forged pipe. Elbows made from sand castings do not always meet the stringent tolerances used for seamless straight pipe. Therefore, the nominal wall thickness must be increased to insure that the minimum design requirements are satisfied.

Exhibit 1 provides a plan view of the first 59 nodes of the model which represent Loop 1. Exhibit 2 is a section view of the hot leg. Exhibit 3 is a section view of the steam generator model. This model, which has mass lumped at six nodes, is based on information contained in Reference 1.

Exhibit 4 shows the nodalization of the crossover leg and the R.C. pump. The R.C. pump model, which has mass lumped at two nodes, is also taken from Reference 1. The R.C. pump and cold leg are shown in Exhibit 5. Similar figures for the other 3 loops are given in Exhibits 6 through 20.

The RPV model, which is taken from Reference 2, is shown in Exhibit 21. The pressurizer and pressurizer surge line are shown in Exhibits 22 and 23. The pressurizer model is based on information contained in Reference 3.

The model is prepared in accordance with the format of the SAPIV computer program (Reference 4). A listing of the input data for the dynamic model is given in Appendix A. Appendix B provides a listing of the input data for the static model. Design engineering drawings referenced during preparation of the model are listed in Appendix C.

Spring rates or stiffness values for the component support members in the model are taken from two sources. Initially, the component support stiffness values were available in project design calculations for the Commonwealth Edison Company's Zion Power Station (Reference 5). Later Westinghouse Electric Corporation, in their letter (Reference 6) ST-PSE-377 to Lawrence Livermore National Laboratory, dated May 23, 1980, provided several revised stiffness coefficients for the steam generator, RPV, pressurizer and R.C. pump component supports.

The revised values provided by Westinghouse were obtained from calculations for plants similar to the Zion Station, as well as calculations for a recent loss-of-coolant accident reanalysis for the Zion Station, Unit 1. For completeness, both the original and the revised stiffness values are provided in Appendix D. It is Westinghouse's experience that their suggested revised support stiffnesses which use current state-of-the-art methods to calculate support stiffness represent the stiffness of recent component support structures similar to those in the Zion Power Station.

Appendix D also provides stiffness matrices for the reactor vessel shell-to-nozzle intersection. These matrices in local member coordinates were derived from global stiffness matrices provided by Westinghouse Electric Corporation in Reference 6.

IV MODELING ASSUMPTIONS AND LIMITATIONS

The following 10 assumptions and limitations have been used in the development of the model. To indicate their relative significance, they are grouped into three categories.

The first three items concern areas where further study may be warranted.

A. Other than those provided in Reference 6, stiffness coefficients for component and pipe supports consider the flexibility of the supports, including special auxiliary steel members, but primary structural concrete and steel members are assumed to be rigid compared to the support flexibility.

B. Local flexibilities of the components at their nozzles and support lugs are not considered in the model, unless they were represented in the original component models given in References 1, 2, 3, and 6.

C. Stiffness matrices for pipe elbows in the seismic model are calculated from normal beam theory. However, stiffness matrices in the models are modified using the formula contained in Reference 4 for the bend flexibility factor.

The validity of the next two assumptions should be checked after analytical results have been obtained.

D. Main loop pipe break restraints are not included in the model, because gaps between the restraints and the crossover leg shown in Exhibit 24 are assumed to be larger than the movement under seismic excitation.

E. Stress levels in all component supports are assumed to remain within the elastic limits of the steel materials. This permits the stiffness properties of an entire support system to be represented by a few SAPIV beam and truss elements with equivalent stiffness properties.

The remaining five items are of least concern as they have minimal impact on the accuracy of analytical results.

F. The material properties specified in Table 4 for components and piping are derived from Reference 7.

G. Properties of the motor-driven gate valves are derived from Reference 7.

H. Since the pressurizer has the same volume as the Westinghouse 1800 ft^3 pressurizer at the Byron Station, the pressurizer model is taken from information contained in the Westinghouse Electric Corporation letter (Reference 3) dated November 18, 1976, for the Byron Station.

I. Coolant in the reactor coolant system is assumed to be at an average temperature of 585°F and pressure of 2235 psi. Therefore, a coolant density of 45 pounds per cubic foot is used.

J. It is assumed that the model will be input to a version of the SAPIV computer program (Reference 4) containing an internal band-width minimizer. Therefore, for the user's convenience, nodes in the model have been numbered consecutively around each piping loop.

V COMPONENT SUPPORT DESCRIPTION

A. Reactor Pressure Vessel Supports

Four alternate reactor pressure vessel nozzles shown in Exhibit 25 act as the reactor support points. Each support nozzle has a seat which bears on a shoe. A structural steel frame shown in Exhibit 26 transfers loads from the shoe to the primary shield wall.

Vertical load transfer is accomplished through bearing of the shoe on the reactor pressure vessel support. Lateral loads are transferred in part through bearing on the sides of the shoes and in part through shear in the bolts between the shoe and the steel frame. Water flowing through two continuous steel angles on either side of the reactor support steel frame reduces the high temperature produced by the RPV nozzles in the lower part of the concrete-embedded frame. The steel frame is bolted to the primary shield wall at its base.

The reactor support system permits the reactor to expand radially but resists translational and torsional movement by the combined restraining action of all four supports.

B. Steam Generator Supports

Each steam generator is restrained laterally by an upper support at Elevation 615 ft-3 in. and a lower support at Elevation 588 ft-1-3/32 in. The upper lateral support includes a steel inner frame encircling the steam generator shell, hydraulic snubbers, and a structural steel outer frame, as shown in Exhibit 27. The steam generator and the steel inner frame interact through 12 bearing pads spaced around the steam generator. The outer frame is almost completely embedded in the operating level floor slab. The hydraulic snubbers permit radial thermal movement of the steam generators.

The lower lateral support for the steam generator, shown schematically in Exhibit 28, includes an inner frame and an outer frame. The four support feet of the steam generator are keyed and shimmed into the inner frame, which is a stiffened plate. The outer frame, which provides horizontal restraint and vertical support to the inner frame, is embedded in the secondary shield wall. The inner and outer frames interact through six bearing pads (12 in. x 12 in.) which act as guides and limit-stops to permit radial thermal movement of the steam generator. The lower lateral support is designed to restrain both torsional and translational displacements, while allowing guided radial thermal movement.

The steam generator is supported vertically at its lower support feet by four columns as shown in Exhibit 29. The universal pinned connections at both ends of the columns permit radial thermal movement of the steam generator.

C. Reactor Coolant Pump Supports

Two structural steel struts and one tension tie rod provide the lateral restraint for the reactor coolant pump as shown in Exhibit 30. The rod and struts are pinned to the pump lugs at one end and a steel embedment at the other end. The steel embedment connection is slotted to permit thermal movement of the pump. The pump is supported vertically by three universal pin-ended columns (Exhibit 31) which are bolted to a heavy triangular steel platform at Elevation 578 ft-3 in. The columns resist overturning and vertical movement while allowing free horizontal thermal movement.

D. Pressurizer Supports

The pressurizer is restrained laterally by an upper lateral support at Elevation 620 ft-6 in. and a lower lateral support at Elevation 594 ft-8 in.

The upper lateral support consists of four brackets which are embedded in the neighboring concrete walls and slab as shown in Exhibit 32. Each bracket has a five inch wide keyway which is shimmed to restrain translational and torsional movements, while allowing free radial and vertical thermal growth of the pressurizer.

The lower lateral support for the pressurizer is a ring beam which is attached to the secondary shield wall by a shear plate bordered by two I-shaped steel members; these steel members transmit axial load to the secondary shield wall as shown in Exhibit 33. Twenty-four 1-1/2 inch diameter bolts are used to connect the lower lateral support to the pressurizer skirt.

Vertical loads are carried by four steel wide-flange columns attached to the lower flange of the ring beam in the lower lateral support system (Exhibit 34).

VI NONLINEAR SUPPORT CHARACTERISTICS

A. RPV Support

The vertical RPV support members (truss members 15, 17, 19, 21) are to be modeled with an upward capacity equal to the operating weight of the RPV supported at that point. Once that weight is exceeded, the RPV nozzle will lift off the support and the support will become inactive until the RPV nozzle moves downward again, closing the gap. The horizontal supports are modeled as linear-elastic supports.

B. Steam Generator Supports

The horizontal members that act in a radial direction along the hot leg at the lower lateral support at Elevation 588 ft-1-3/32 in. (beam elements 9, 10, 11, and 12) are to be modeled as compression bumpers, i.e., these members will not carry tension loads. However, the beams exhibit linear-elastic behavior when subjected to torsional deformations. All other steam generator support members are modeled as linear-elastic supports.

C. R.C. Pump Supports

The horizontal members that act in the direction along the cold leg (beam elements 21, 22, 23, and 24) are to be modeled with a zero gap in compression and a two inch gap in tension. This gap occurs in slotted-hole, pinned connections that allow the cold leg to expand and move the pump two inches outward, away from the RPV. Therefore, in the operating condition, the radial support member is not effective in tension until the pump moves two inches inward.

D. Pressurizer Supports

All members representing the pressurizer supports are modeled as linear-elastic supports.

Surge Line Supports

There are a total of nine surge line supports: three flailing restraints, one variable support spring hanger, one threaded rod support, one constant support hanger, one sway strut assembly, and two hydraulic snubber restraints.

The three flailing restraints are represented by beam element numbers 29, 30, and 31, which connect to the surge line at node numbers 366, 369, and 372, respectively. These restraints provide vertical and horizontal restraint, but a gap allows for thermal movement. The restraints have a vertical stiffness of 9.475×10^7 lbs/ft. In the horizontal direction, the restraints have two different axial stiffnesses. The restraints have a stiffness of 2.47×10^9 lbs/ft when acting in compression and 2.83×10^8 lbs/ft when subjected to tension. As shown in Exhibit 35, the gaps are so large that the restraint is probably ineffective unless there is a pipe break in the surge line. Therefore, a zero stiffness member would be more appropriate for elastic analysis. In the input data listings given in Appendices A and B, member releases have been used to make beam elements 29, 30, and 31 inactive for static and seismic analysis.

A variable support spring hanger (Exhibit 36) is located at node 364. Since this spring hanger has a stiffness of 12,960 lbs/ft, which is very small compared to the stiffness of other restraints, it is not included in the model for seismic analysis. Under normal operating conditions this hanger carries a load of 5650 lbs.

The threaded rod support has a diameter of 1-1/2 inches and a length of 4 ft-1 in. as shown in Exhibit 37. Including the auxiliary support steel the support has a stiffness of 2.45×10^6 lbs/ft. Under normal operating conditions, the support carries a vertical dead load of 8373 lbs. The buckling load for the rod is high enough that the rod probably will not buckle under the maximum seismic uplift load. Therefore, the support is treated as a linear-elastic element and is modeled as truss element 11, which connects to the surge line at node 381.

The constant support hanger, shown in Exhibit 38, has a constant tensile load of 6800 lbs acting at pipe node 389. Since the constant support hanger has negligible stiffness, it is not included in the seismic model.

The sway strut assembly is represented by truss element 13 and is connected to the surge line at node 374. This support has a stiffness of 9.3×10^6 lbs/ft. As shown in Exhibit 39, the support has a slotted hole connection at one end, and therefore should not carry loads unless pipe movement is sufficient to close the gap in either direction.

Configurations of the two hydraulic snubber supports are shown in Exhibits 40 and 41. They are modeled as truss members 12 and 14 and are attached to the surge line at nodes 392 and 376. These supports are modeled as linear-elastic members having stiffnesses of 2.55×10^6 lbs/ft and 2.53×10^6 lbs/ft, respectively.

These stiffnesses are average values; when the piston is at the center of its stroke, the snubbers in compression are approximately 30% stiffer than the average value and in tension about 30% less stiff than the average value.

VII MAIN STEAM AND FEEDWATER LINES

A. Stiffness Matrices

To keep the size of the R.C. loop model within manageable limits, only the dynamic stiffness effects of the main steam lines and feedwater lines are represented. To accomplish this, each line was modeled from the nozzle on the steam generator to the first anchor point. Analyses were then performed to establish 12 x 12 stiffness matrices for each of the two lines. The data was then prepared in a format compatible with the Lawrence Livermore in-house version of the SAPIV computer program, which has an Element Type 10 for input of member stiffness matrices.

The local coordinate system for the member stiffness matrix is established in the same way as for the three-dimensional beam element. The user defines three nodes: I, J, and K. The local X-axis is defined by a line passing through I and J. The local Y-axis is defined by a line in the plane defined by I, J, and K and perpendicular to the X-axis. The Z-axis is placed perpendicular to the plane formed by the X and Y axes so as to form a right-handed coordinate system.

The relationship existing between the local and global coordinate systems is described in the following sentences. The local X-axis is parallel to the global X and has a positive projection in the same direction. The local Y-axis is parallel to the global Z-axis and has a positive projection in the same direction, i.e., both are vertical axes with positive projections in the upward direction. The local Z-axis is parallel to the global Y-axis and has a positive projection in the negative Y-direction. The global coordinate system is shown in Exhibit 42.

The I, J, and K nodes for the feedwater line in Loop 1 are 22, 65, and 66. Node 22 has the coordinates of the feedwater nozzle. To define the positive X-axis for the member, node 65 has the same coordinates as 22 except the X-coordinate is increased by 1 foot. To define the positive Y-direction, node 66 is given the coordinates of a point that is one foot directly above the feedwater nozzle. The direction of the Z-axis then follows by the right-hand rule. A similar procedure is used to define the direction cosines for the other three feedwater lines and the four main steam lines.

The eight stiffness matrices and a listing of the input computer data cards for the seismic model are given in Appendix E. As shown in the appendix, only the upper left quadrant of the 12 x 12 member stiffness matrix is input to the SAPIV computer program, implying that the program assumes the input stiffness matrix is for a member with no support points between the two ends of the member. This, of course, is not true for the main steam and feedwater lines. However, this program limitation is insignificant as long as the B node (far end) of the member is treated as a stationary point in the system and not as an input point for the seismic time histories that are to be used in the analysis.

B. Mass Matrices

Currently, no mass has been assigned to the feedwater and main steam nozzle nodes. This refinement has not been pursued at this time because of the several ways to approximate the effective mass. Some of the more precise methods are quite complex and time-consuming, and the overall effect of this refinement may be negligible. Therefore, it may be best to first try several arbitrary

assignments of mass to establish the relative importance of this refinement. This choice is currently left to the user. In any event, SAPIV is limited to input of diagonal mass terms only, so methods that would produce off-diagonal terms may be inappropriate.

VIII REFERENCES

1. Westinghouse Electric Corporation, "Commonwealth Edison Project, Zion Units 1 and 2, Reactor Coolant System Analysis", correspondence to Sargent & Lundy, CEW-1108, December 18, 1969.

2. Lawrence Livermore Laboratory, "RPV Lumped Mass Model", correspondence to Sargent & Lundy, SM79-327, October 30, 1979.

3. Westinghouse Electric Corporation, "Commonwealth Edison Company, Byron and Braidwood Stations - Units 1 and 2, CAE Pressurizer Model", correspondence to Sargent & Lundy, PE4-RCLA-1255, November 18, 1976.

4. Bathe, K. J., E. L. Wilson and F. E. Peterson, "SAP IV, A Structural Analysis Program for Static and Dynamic Response of Linear Systems", Earthquake Engineering Research Center Report No. EERC 73-11, University of California, Berkeley, June 1973.

5. Sargent & Lundy, "Commonwealth Edison Company, Zion Station - Units 1 and 2, Structural Department Calculations, Vol. 120, NSSS Support System Calculations", File No. RC-2527, 1968.

6. Westinghosue Electric Corporation, "Zion - Unit #1 - Primary Equipment Support Stiffness", correspondence to Lawrence Livermore Laboratory, ST-PSE-377, May 23, 1980.

7. Informal transmittal of information from Lawrence Livermore Laboratory, received at meeting on November 20, 1979.

TABLE 1
TOTAL NODAL POINTS AND DEGREES OF FREEDOM (DOF)

	Nodes		No.		Total Nodes		DOF/ Node		Total DOF
Hot Leg	10	x	4	=	40	x	6	=	240
Steam Generator	11	x	4	=	44	x	6	=	264
Steam Generator Lower Support	3	x	4	=	12	x	0	=	0
Steam Generator Upper Support	2	x	4	=	8	x	0	=	0
Crossover Leg	12	x	4	=	48	x	6	=	288
Reactor Coolant Pump	7	x	4	=	28	x	6	=	168
Reactor Coolant Pump Support	3	x	4	=	12	x	0	=	0
Cold Leg	12	x	4	=	48	x	6	=	288
Reactor Pressure Vessel Shell	21	x	1	=	21	x	6	=	126
Reactor Pressure Vessel Internals	1	x	1	=	1	x	1	=	1
Reactor Pressure Vessel Supports	8	x	1	=	8	x	0	=	0
Supplementary RPV Support Nodes	4	x	1	=	4	x	3	=	12
Pressurizer Surge Line	29	x	1	=	29	x	6	=	174
Surge Line Supports	9	x	1	=	9	x	0	=	0
Supplementary Surge Line Support Nodes	2	x	1	=	2	x	3	=	6
Pressurizer	11	x	1	=	11	x	6	=	66
Pressurizer Lower Support	3	x	1	=	3	x	0	=	0
Pressurizer Upper Support	3	x	1	=	3	x	0	=	0
TOTAL ACTIVE NODES AND DOF					331				1,633
SPARE NODES					85				
TOTAL NODES					416				

TABLE 2
NODAL POINT DISPOSITION

COMPONENT	NODE NUMBERS			
	Loop 1	Loop 2	Loop 3	Loop 4
Hot Leg	1-9, 64	101-109, 170	201-209, 264	301-309, 292
Steam Generator	13-17, 20-25	113-117 120-125	213-217, 220-225,	313-317, 320-325
Steam Generator Lower Support	10-12	110-112	210-212	310-312
Steam Generator Upper Support	18-19	118,119	218,219	318,319
Main Steam and Feedwater Lines (artificial nodes)	65-68	171-174	265-268	293-296
Crossover Leg	26-37	126-137	226-237	326-337
Reactor Coolant Pump	39,40 43-47	139,140 143-147	239,240 243-247	339,340 343-347
Reactor Coolant Pump Support	38,41,42	138,141,142	238,241,242	338,341,342
Cold Leg	48-59	148-159	248-259	348-359
Reactor Pressure Vessel	60,189 193,194	160,164-169 190,195,196	191,197 198,260	192,199, 200,297
Reactor Pressure Vessel Supports	62,63	162-163	262-263	299-300
Supplementary RPV Support Nodes	61	161	261	298
Pressurizer Surge Line				360-364 366,368,369,371 372,374,376,379 381-389,391,392 395-399
Surge Line Supports				365,367,370,373, 375,378,380,390, 394
Supplementary Surge Line Supports				377,393
Pressurizer				400-402 406-409, 413-416
Pressurizer Lower Support				403-405
Pressurizer Upper Support				410-412
Spare Nodes (Dummy-fixed)	69-100	175-188	269-291	

TABLE 3
PIPE SECTION PROPERTIES

	Outside Diameter Feet	Wall Thickness Feet	Weight/Unit Length* lbs./Foot
Hot Leg	2.833	0.2083	1091.0
Hot Leg Elbow	3.047	0.2734	1434.0
Cross-Over Leg	3.027	0.2217	1239.0
Cross-Over Leg Elbows	3.135	0.2760	1498.0
Cold Leg	2.688	0.1983	986.5
Cold Leg Elbows	2.796	0.2525	1216.6
Stop Valve Fitting	3.083	0.3333	1 63.6
Surge Line	1.167	0.1172	240.2

*Pipe Weight includes coolant and insulation.

TABLE 4
MODULUS OF ELASTICITY

Component	Modulus of Elasticity ($\times 10^3$ PSF)
Hot Leg	3.730
Hot Leg Stop Valve	3.860
S.G. Inlet Nozzle	3.790
Steam Generator	3.800
Cross-Over Leg	3.770
R.C. Pump Casing	3.770
R.C. Pump Motor	4.020
Cold Leg & Cold Leg Stop Valve	3.800
RPV	3.715
Pressurizer Surge Line	3.800
Pressurizer	3.800
Component Supports	4.000*

*Arbitrary value used to provide required support stiffnesses as given in Appendix D.

TABLE 5

BRANCH LINE NOZZLE LOCATIONS

Loop No. 1

Line No.	Node No.
1RC004-14"	4
1RC007-8"	4
1RC008-8"	6
1RC015-2"	7
1RC013-1"	8
1RC014-1"	8
1RC016-1"	8
1RC010-3/4"	-
1RC017-3"	33
1RC022-2"	32
1RC023-2"	34
1RC178-3/4"	-
1RC179-3/4"	-
1RC180-3/4"	-
1RC006-10"	52
1RC008-8"	48
1RC065-3"	55
1RC005-1½"	55
1RC011-1½"	52
1RC009-3/4"	-

Loop No. 2

Line No.	Node No.
1RC036-8"	104
1RC046-8"	106
1RC058-2"	107
1RC048-1"	108
1RC049-1"	108
1RC050-1"	108
1RC037-3/4"	104
1RC045-3/4"	-
1RC051-3"	133
1RC057-2"	134
1RC060-2"	132
1RC173-3/4"	-
1RC174-3/4"	-
1RC175-3/4"	-
1RC040-10"	152
1RC046-8"	148
1RC039-3"	155
1RC041-3"	152
1RC038-1½"	155
1RC044-1½"	152
1RC042-3/4"	-

Loop No. 3

Line No.	Node No.
1RC083-8"	204
1RC090-8"	206
1RC139-2"	207
1RC091-1"	208
1RC092-1"	208
1RC093-1"	208
1RC084-3/4"	204
1RC087-3/4"	-
1RC094-3"	233
1RC100-2"	232
1RC101-2"	234
1RC193-3/4"	-
1RC194-3/4"	-
1RC195-3/4"	-
1RC072-10"	252
1RC090-8"	248
1RC142-4"	253
1RC071-1½"	255
1RC088-1½"	252
1RC096-3/4"	-

Loop No. 4

Line No.	Node No.
1RC140-14"	360
1RC111-8"	304
1RC113-8"	306
1RC125-2"	307
1RC117-1"	308
1RC118-1"	308
1RC119-1"	308
1RC112-3/4"	-
1RC120-3"	333
1RC126-2"	334
1RC138-2"	332
1RC196-3/4"	-
1RC197-3/4"	-
1RC198-3/4"	-
1RC080-10"	352
1RC113-8"	348
1RC141-4"	353
1RC079-1½"	355
1RC116-1½"	352
1RC114-3/4"	-

TABLE 6
BRANCH LINES OF REACTOR COOLANT LOOP 1

LINE NO. - SIZE	LEG	FUNCTION
1RC004-14"	Hot Leg	To Res. Ht. Rem. (RHR)
1RC007-8"	Hot Leg	Fr. Safety Inj. (SI) Res. Ht. Ex.
1RC008-8"	Hot Leg	Bypass
1RC015-2"	Hot Leg	To Loop Drain Hdr. (LDH)
1RC013-1"	Hot Leg	To Resistance Temperature Detector (RTD)
1RC014-1"	Hot Leg	To RTD
1RC016-1"	Hot Leg	To RTD
*1RC010-3/4"	Hot Leg	Bypass
1RC017-3"	Cross Over Leg	Fr. RTD
1RC022-2"	Cross Over Leg	Fr. Loop Fill Hdr. (LFH)
1RC023-2"	Cross Over Leg	To LDH
*1RC178-3/4" (2 lines)	Cross Over Leg	To Waste Drain
*1RC179-3/4"	Cross Over Leg	To Waste Drain
*1RC180-3/4"	Cross Over Leg	To Waste Drain
1RC006-10"	Cold Leg	Fr. Acc. Tk-SI
1RC008-8"	Cold Leg	Bypass
1RC065-3"	Cold Leg	Fr. Reg. Ht. Ex. - Vol. Ctl. (VC)
1RC005-1-1/2"	Cold Leg	Fr. Boron Inj. Tk-SI
1RC011-1-1/2"	Cold Leg	Bypass
*1RC009-3/4"	Cold Leg	Bypass

*Branch connection is <u>not</u> shown on M-112.

TABLE 7
BRANCH LINES OF REACTOR COOLANT LOOP 2

LINE NO. - SIZE	LEG	FUNCTION
1RC036-8"	Hot Leg	Fr. SI Pump
1RC046-8"	Hot Leg	Bypass
1RC058-2"	Hot Leg	To LDH
1RC048-1"	Hot Leg	To RTD
1RC049-1"	Hot Leg	To RTD
1RC050-1"	Hot Leg	To RTD
1RC037-3/4"	Hot Leg	To Sample System
*1RC045-3/4"	Hot Leg	Bypass
1RC051-3"	Cross Over Leg	Fr. RTD
1RC057-2"	Cross Over Leg	To LDH
1RC060-2"	Cross Over Leg	Fr. LPH
*1RC173-3/4" (2 Lines)	Cross Over Leg	To Waste Drain
*1RC174-3/4"	Cross Over Leg	To Waste Drain
*1RC175-3/4"	Cross Over Leg	To Waste Drain
1RC040-10"	Cold Leg	Fr. Acc. Tk-SI
1RC046-8"	Cold Leg	Bypass
1RC039-3"	Cold Leg	Fr. Reg. Ht. Ex. - VC
1RC041-3"	Cold Leg	To Let Down Ht. Ex.
1RC038-1-1/2"	Cold Leg	Fr. Boron Inj. Tk-SI
1RC044-1-1/2"	Cold Leg	Bypass
*1RC042-3/4"	Cold Leg	Bypass

*Branch connection is not shown on M-112.

TABLE 8
BRANCH LINES OF REACTOR COOLANT LOOP 3

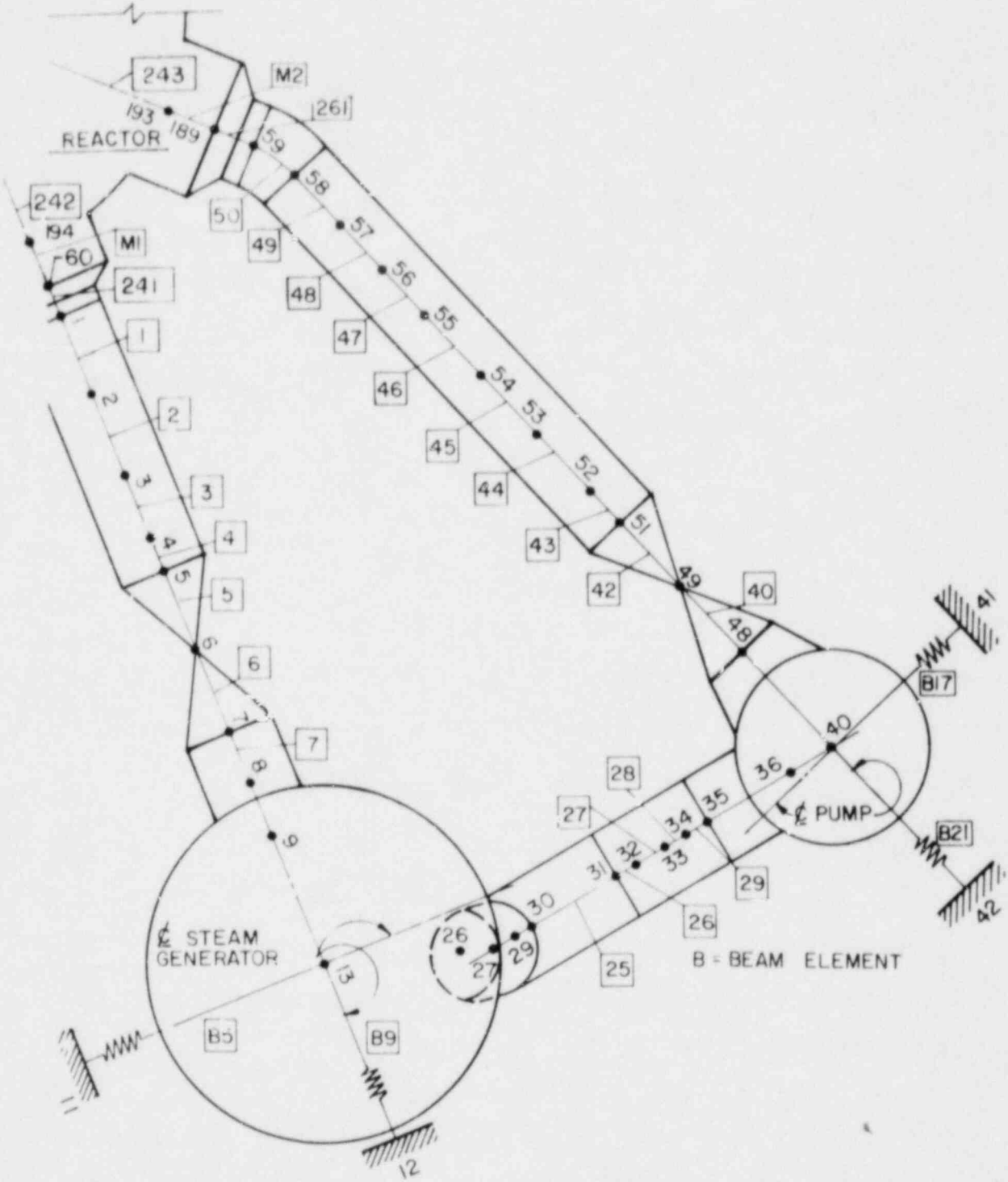
LINE NO. - SIZE	LEG	FUNCTION
1RC083-8"	Hot Leg	Fr. SI Res. Ht. Ex.
1RC090-8"	Hot Leg	Bypass
1RC139-2"	Hot Leg	To Loop Tk Drain Hdr.
1RC091-1"	Hot Leg	To RTD
1RC092-1"	Hot Leg	To RTD
1RC093-1"	Hot Leg	To RTD
1RC084-3/4"	Hot Leg	To Sample System
*1RC087-3/4"	Hot Leg	Bypass
1RC094-3"	Cross Over Leg	Fr. RTD
1RC101-2"	Cross Over Leg	To LDH
1RC200-2"	Cross Over Leg	Fr. LFH
*1RC193-3/4"	Cross Over Leg	To Waste Drain
*1RC194-3/4"	Cross Over Leg	To Waste Drain
*1RC195-3/4" (2 Lines)	Cross Over Leg	To Waste Drain
1RC072-10"	Cold Leg	Fr. Acc. Tk-SI
1RC090-8"	Cold Leg	Bypass
1RC142-4"	Cold Leg	To Pressurizer
1RC071-1-1/2"	Cold Leg	Fr. Boron Inj. Tk-SI
1RC088-1-1/2"	Cold Leg	Bypass
*1RC096-3/4"	Cold Leg	Bypass

*Branch connection is <u>not</u> shown on M-111.

TABLE 9
BRANCH LINES OF REACTOR COOLANT LOOP 4

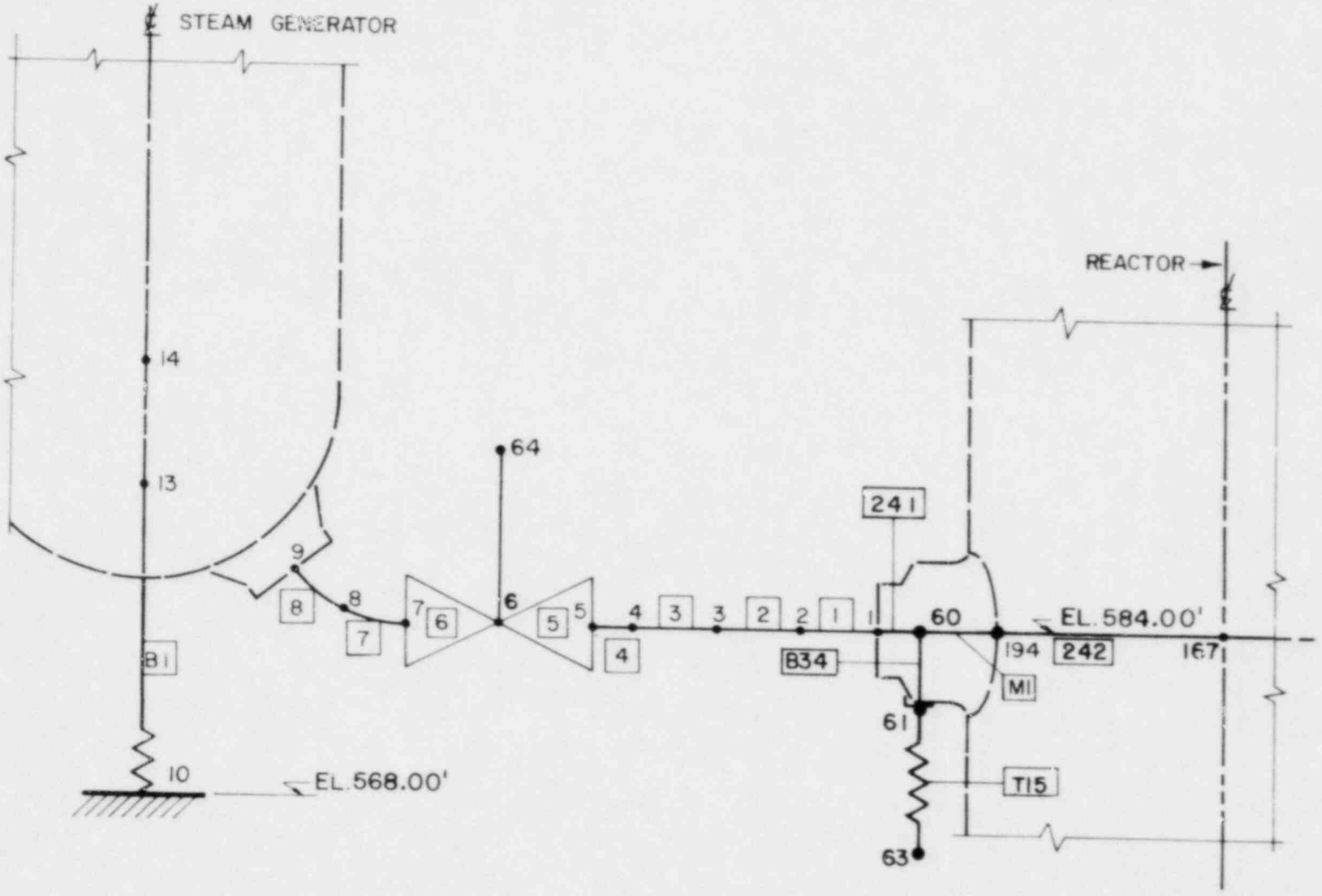
LINE NO. - SIZE	LEG	FUNCTION
1RC140-14"	Hot Leg	Pressurizer Surge Line
1RC111-8"	Hot Leg	Fr. SI Regs. Ht. Ex.
1RC113-8"	Hot Leg	Bypass
1RC125-2"	Hot Leg	To LDH
1RC117-1"	Hot Leg	To RTD
1RC118-1"	Hot Leg	To RTD
1RC119-1"	Hot Leg	To RTD
*1RC112-3/4"	Hot Leg	Bypass
1RC120-3"	Cross Over Leg	Fr. RTD
1RC126-2"	Cross Over Leg	To LDH
1RC138-2"	Cross Over Leg	Fr. LFH
*1RC196-3/4" (2 Lines)	Cross Over Leg	To Waste Drain
*1RC197-3/4"	Cross Over Leg	To Waste Drain
*1RC198-3/4"	Cross Over Leg	To Waste Drain
1RC080-10"	Cold Leg	Fr. Acc. TK.-SI
1RC113-8"	Cold Leg	Bypass
1RC141-4"	Cold Leg	To Pressurizer
1RC079-1-1/2"	Cold Leg	Fr. Boron Inj. Tk.-SI
1RC116-1-1/2"	Cold Leg	Bypass
*1RC114-3/4"	Cold Leg	Bypass

*Branch connection is not shown on M-111.



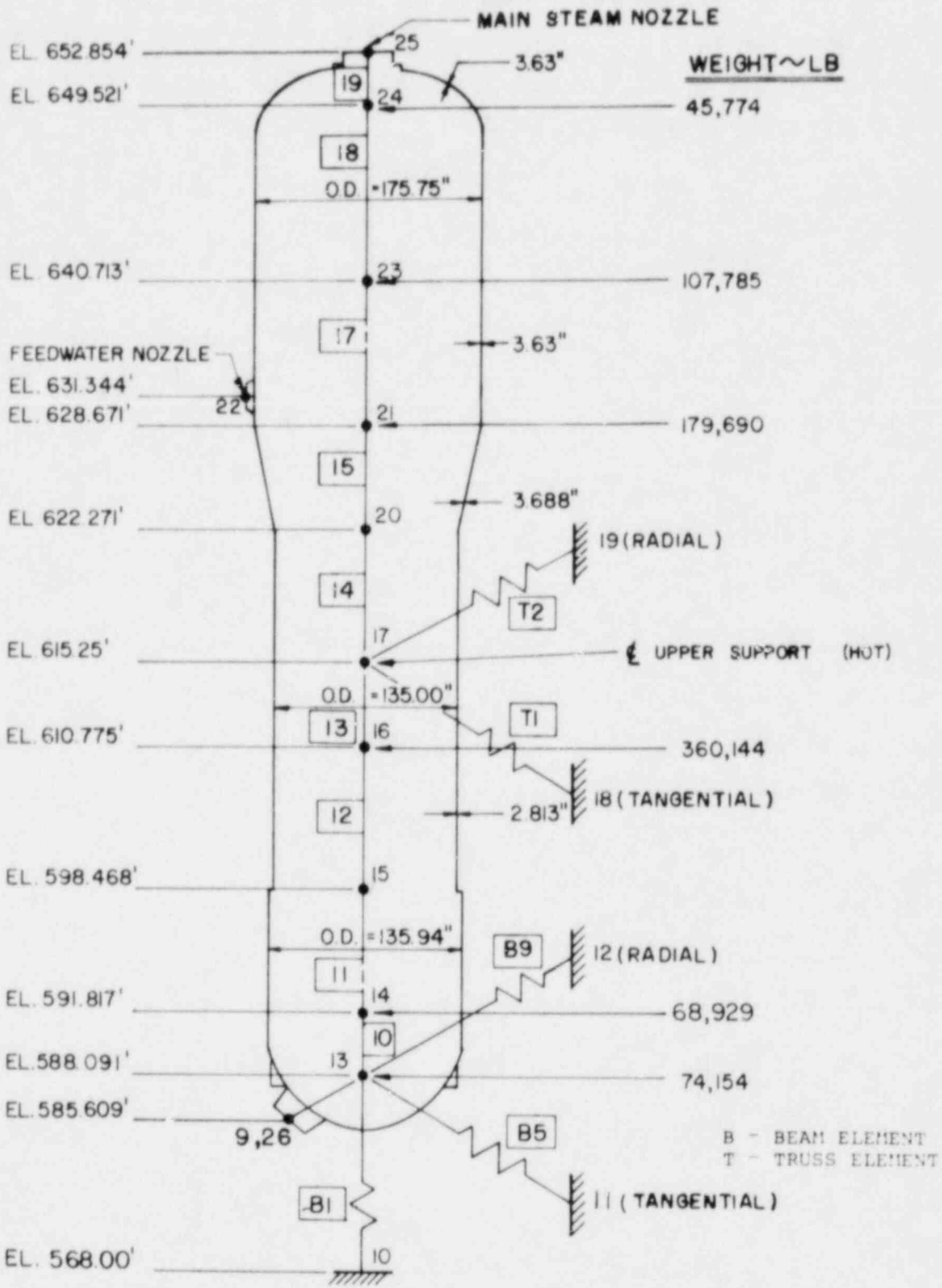
REACTOR COOLANT LOOP MODEL - LOOP 1

EXHIBIT 1



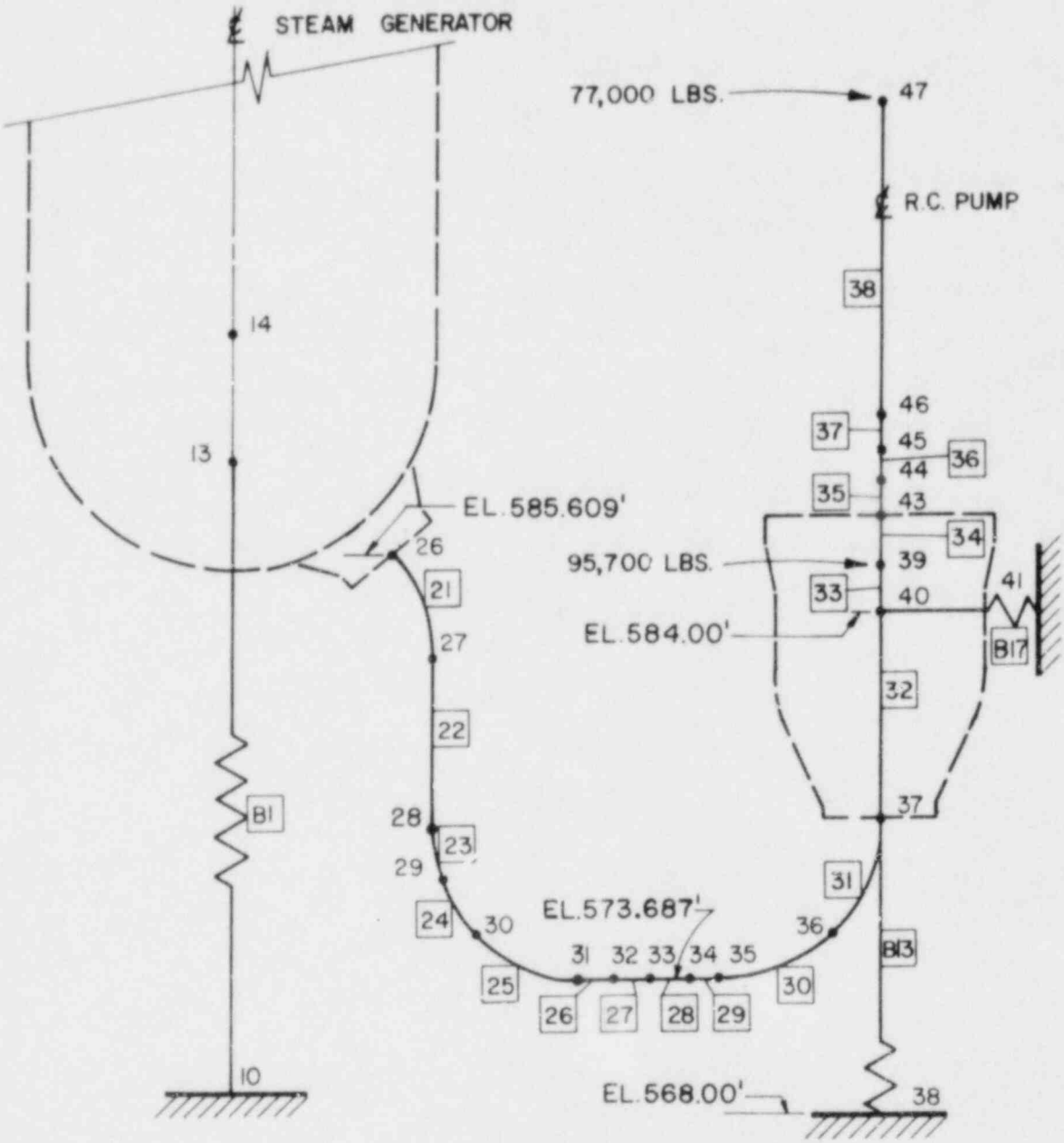
HOT LEG MODEL - LOOP 1

EXHIBIT 2



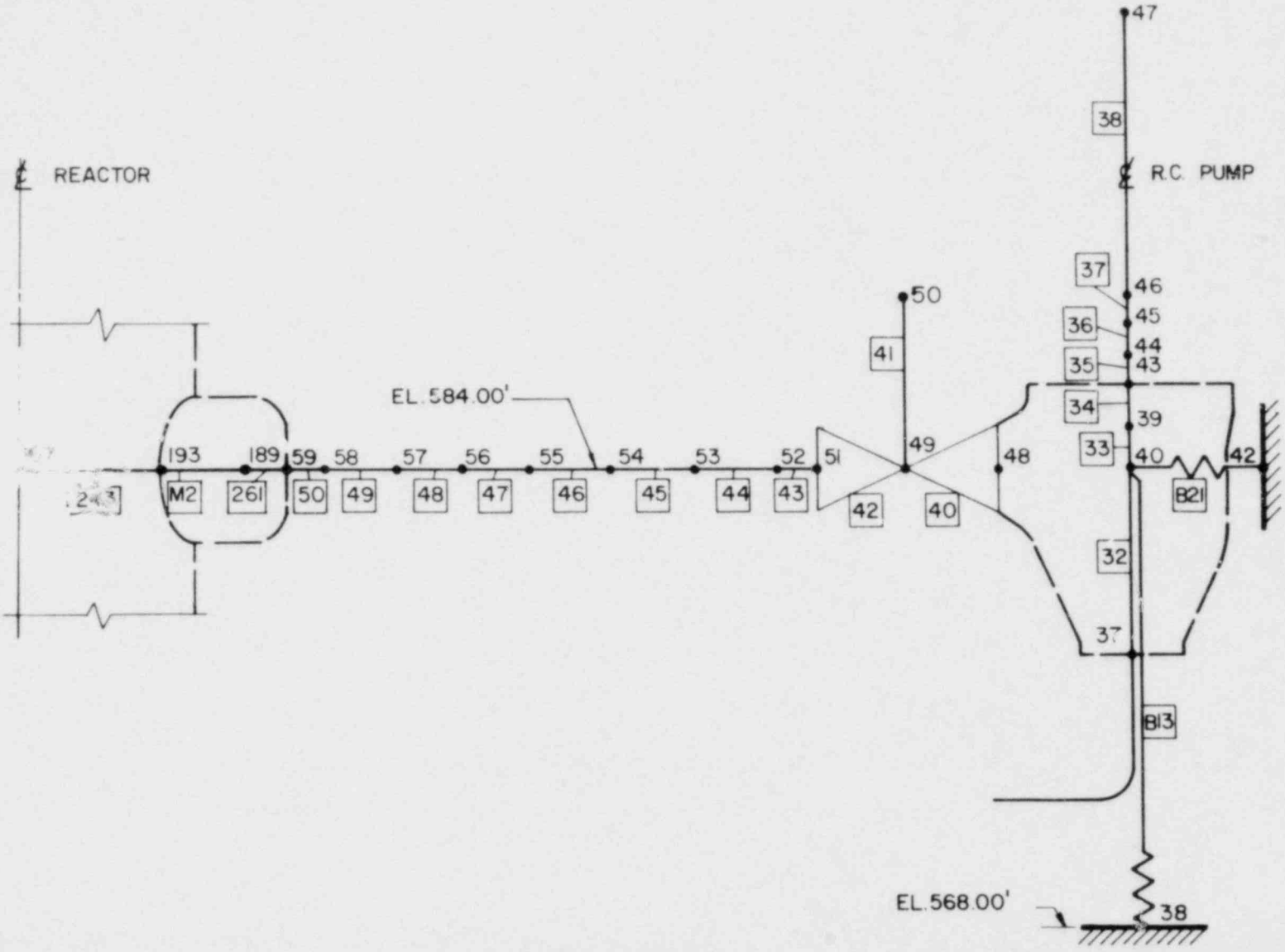
STEAM GENERATOR MODEL - LOOP 1

EXHIBIT 3

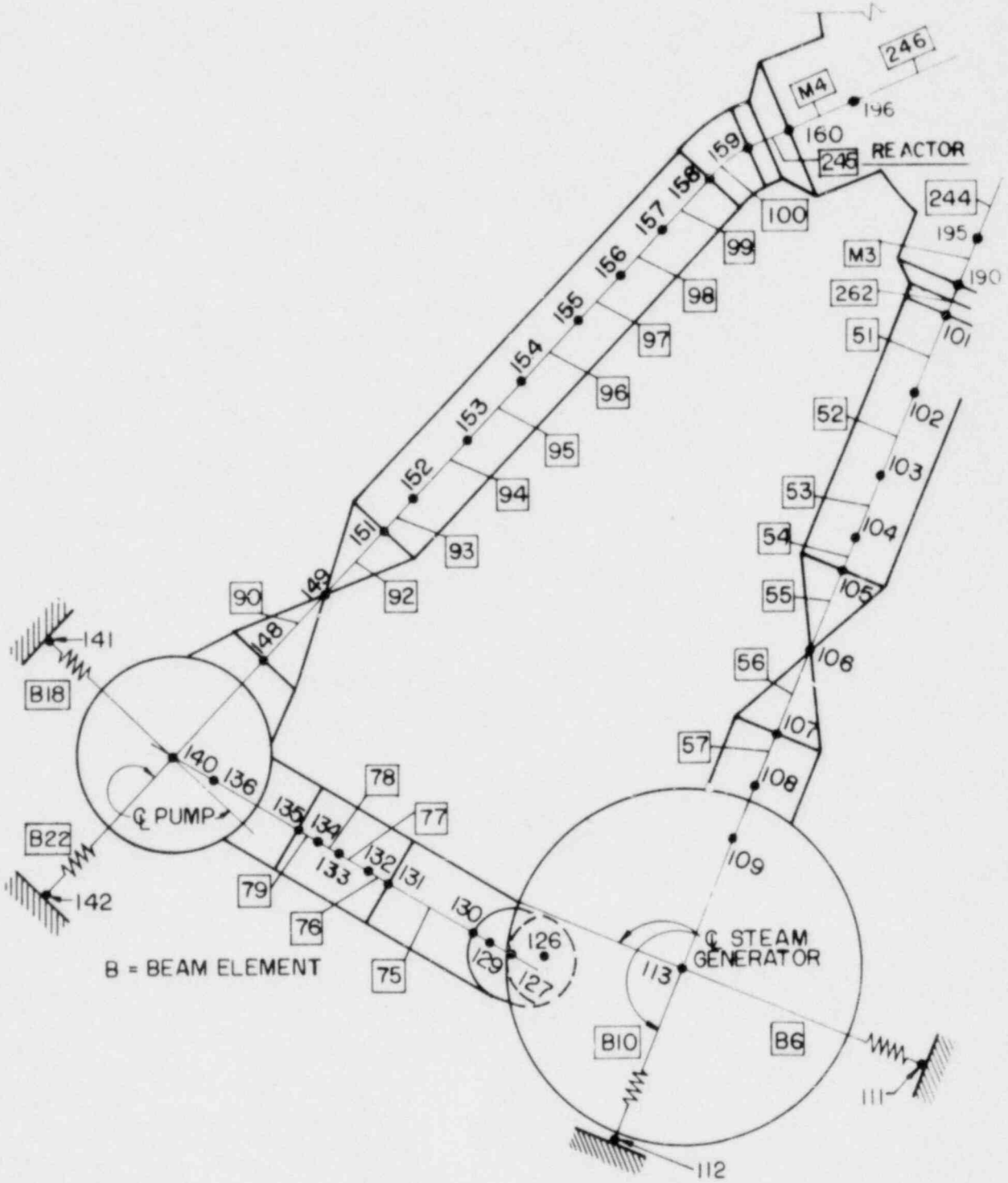


CROSSOVER LEG MODEL - LOOP 1

EXHIBIT 4

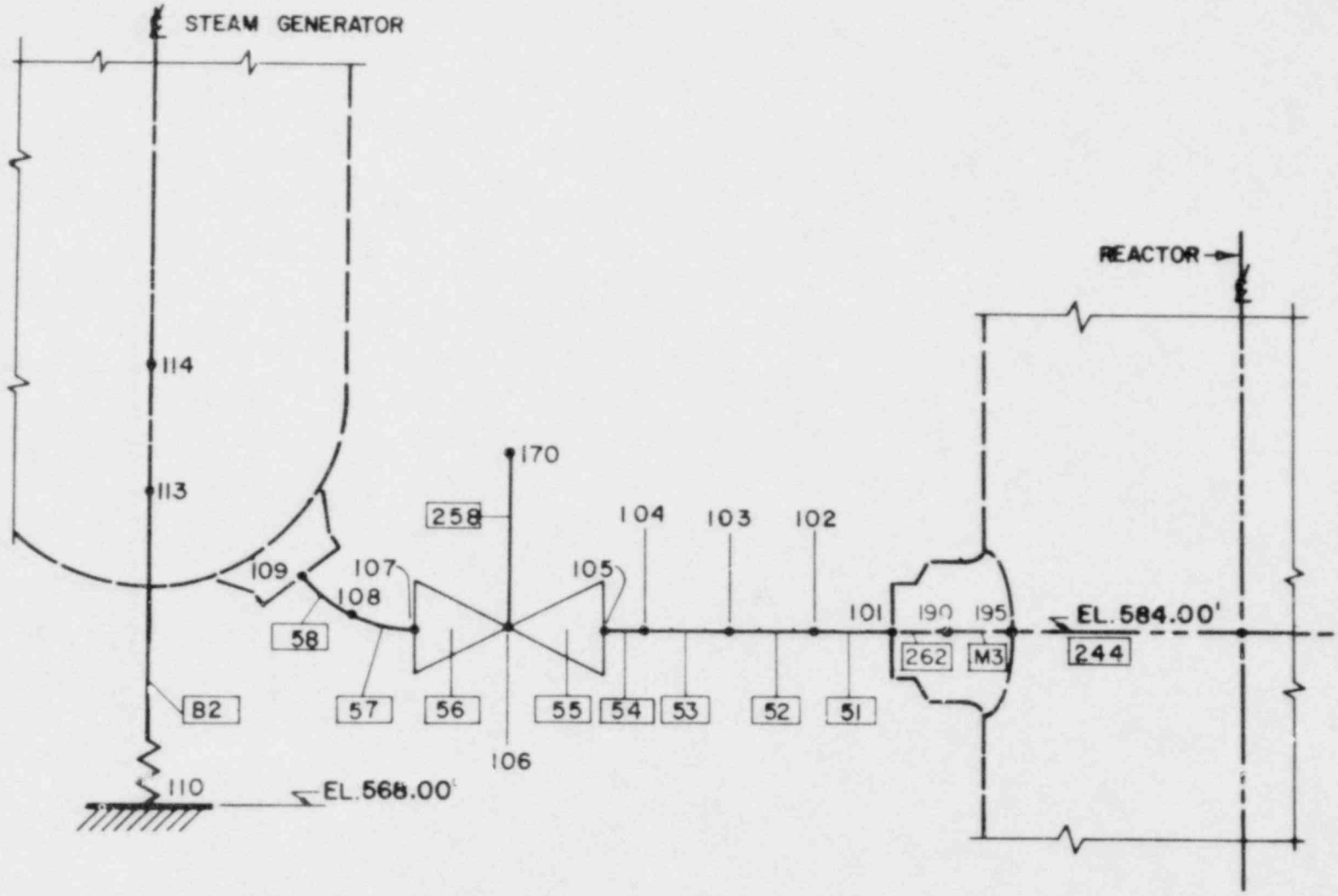


COLD LEG MODEL - LOOP 1
EXHIBIT 5

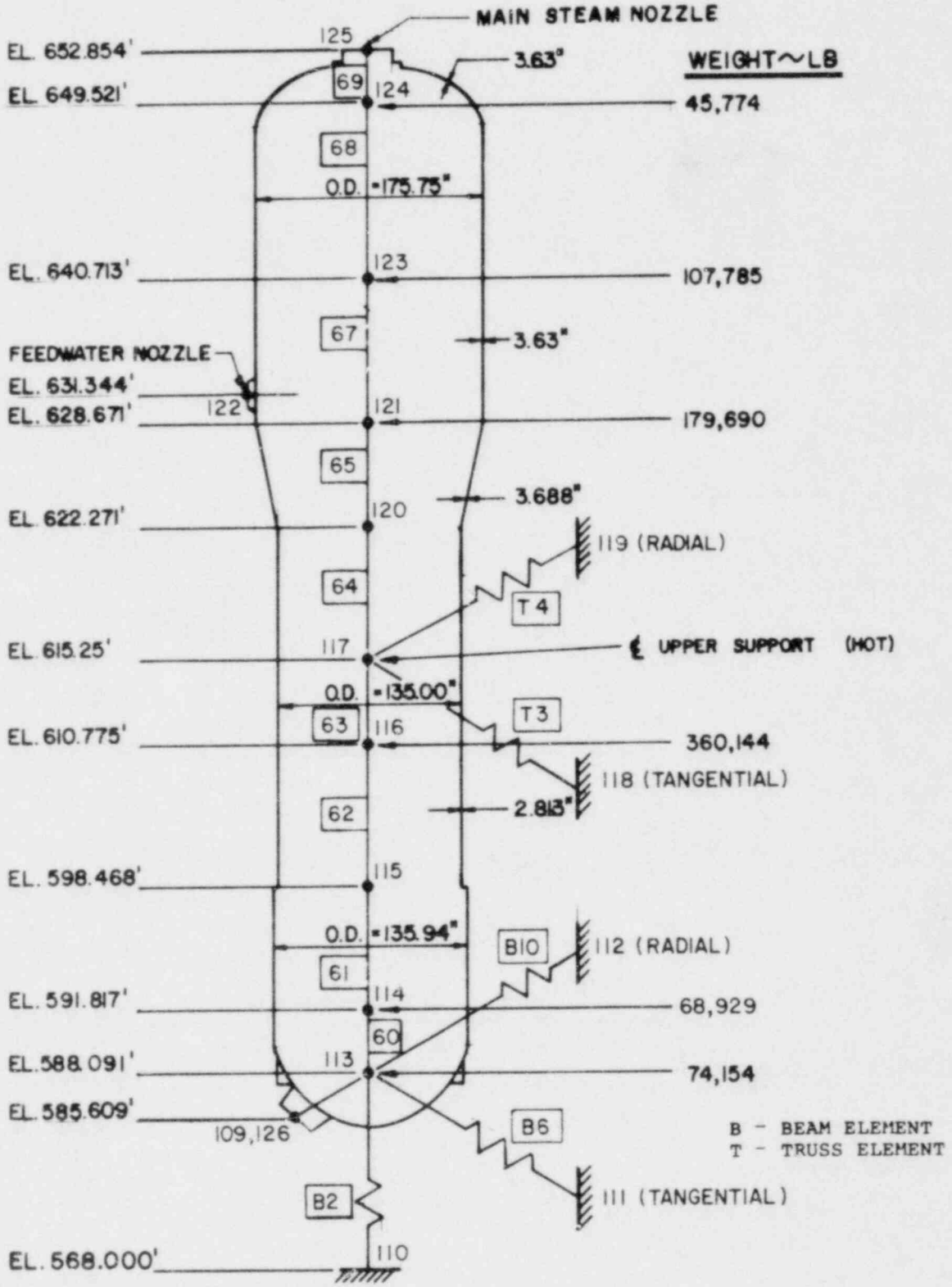


REACTOR COOLANT LOOP MODEL - LOOP 2

EXHIBIT 6

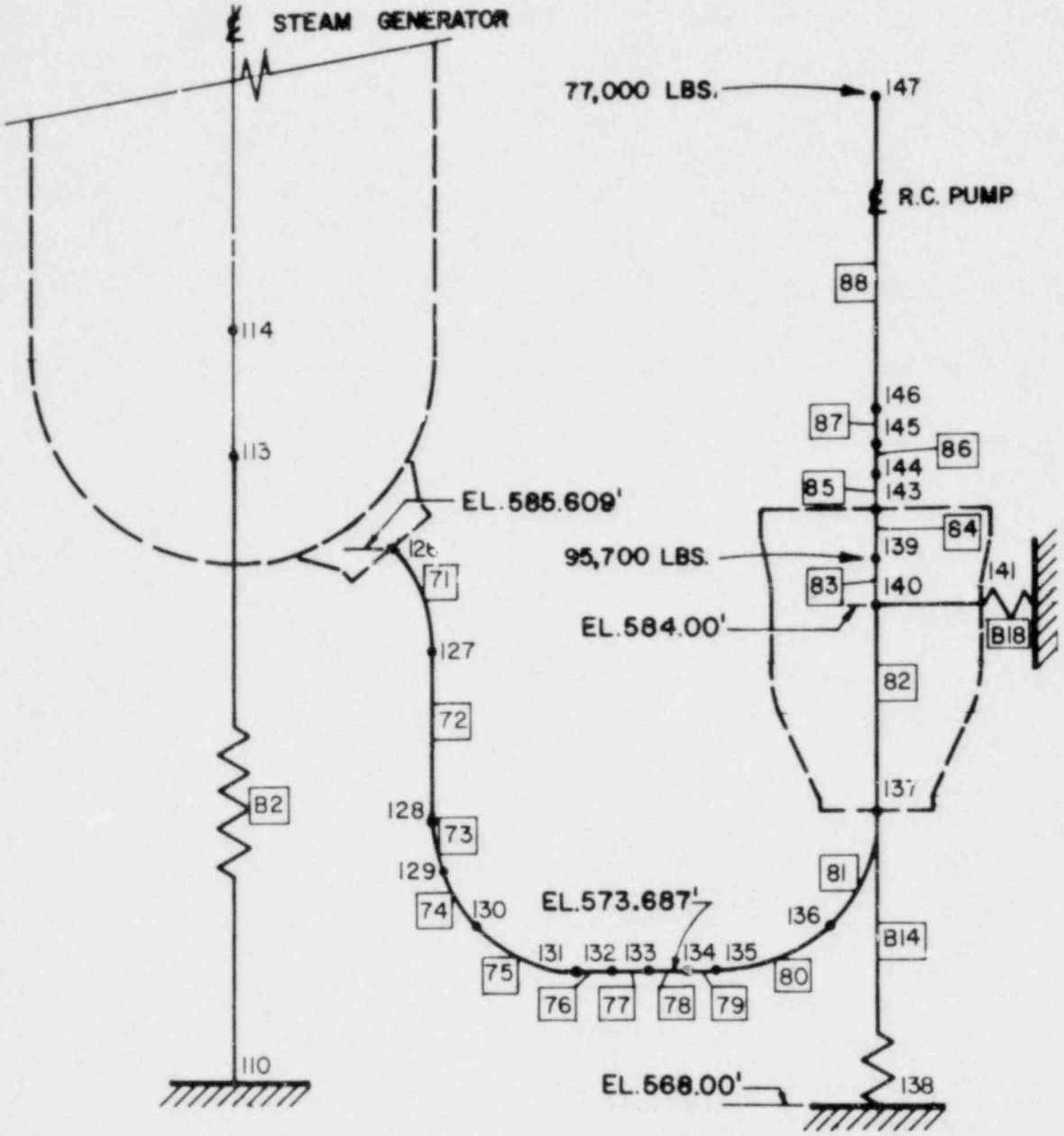


HOT LEG MODEL - LOOP 2
EXHIBIT 7



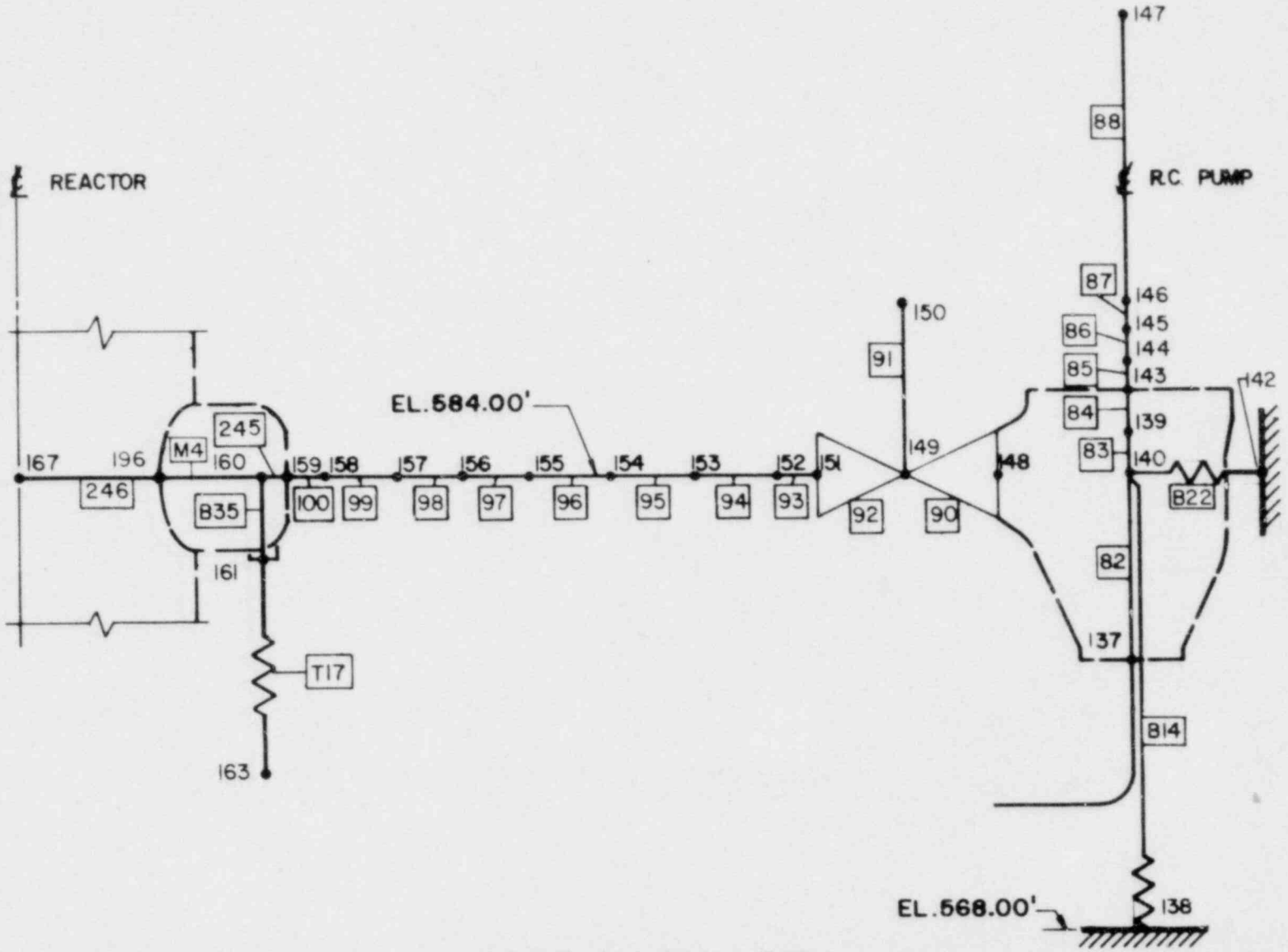
STEAM GENERATOR MODEL - LOOP 2

EXHIBIT 8

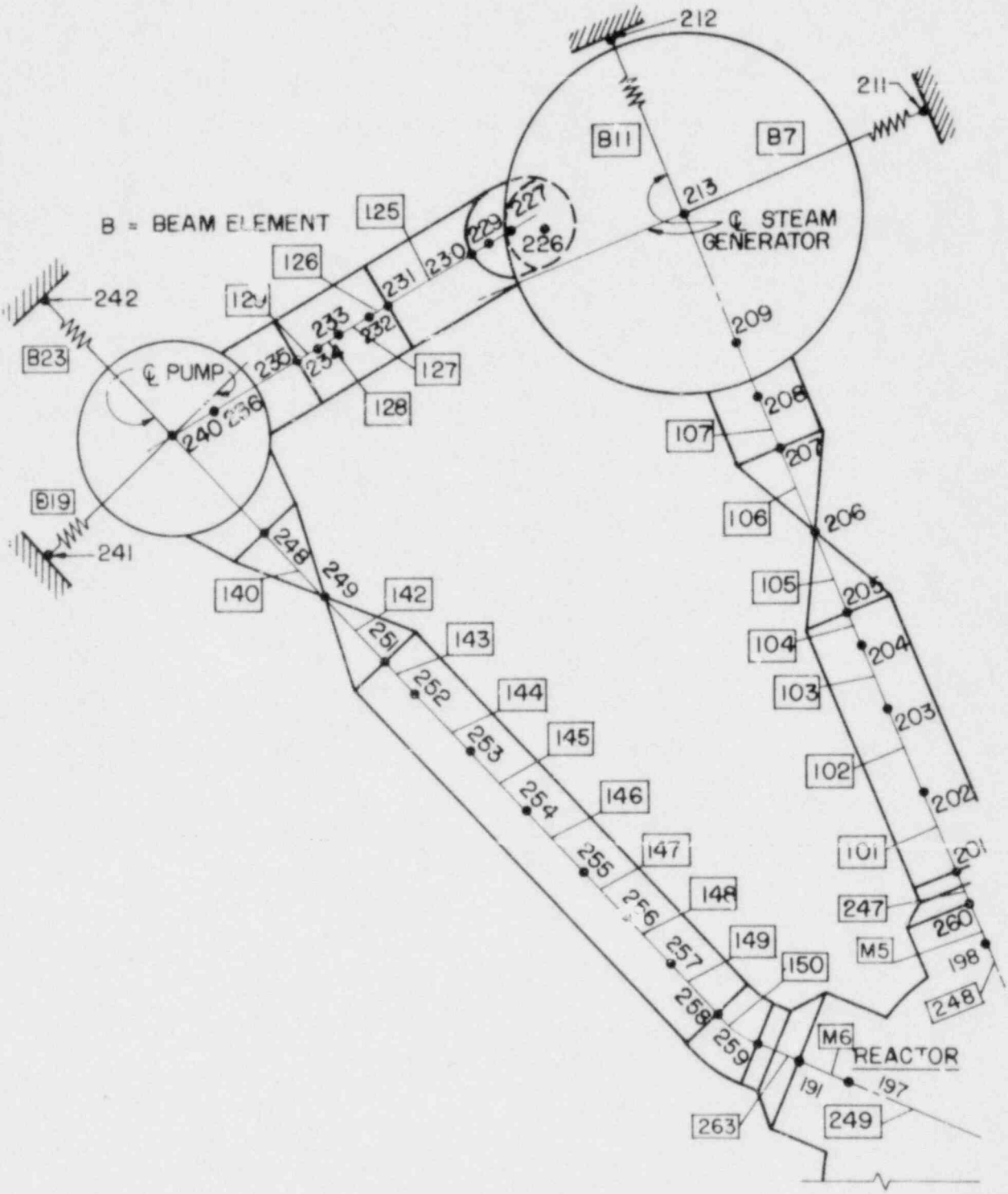


CROSSOVER LEG MODEL - LOOP 2

EXHIBIT 9

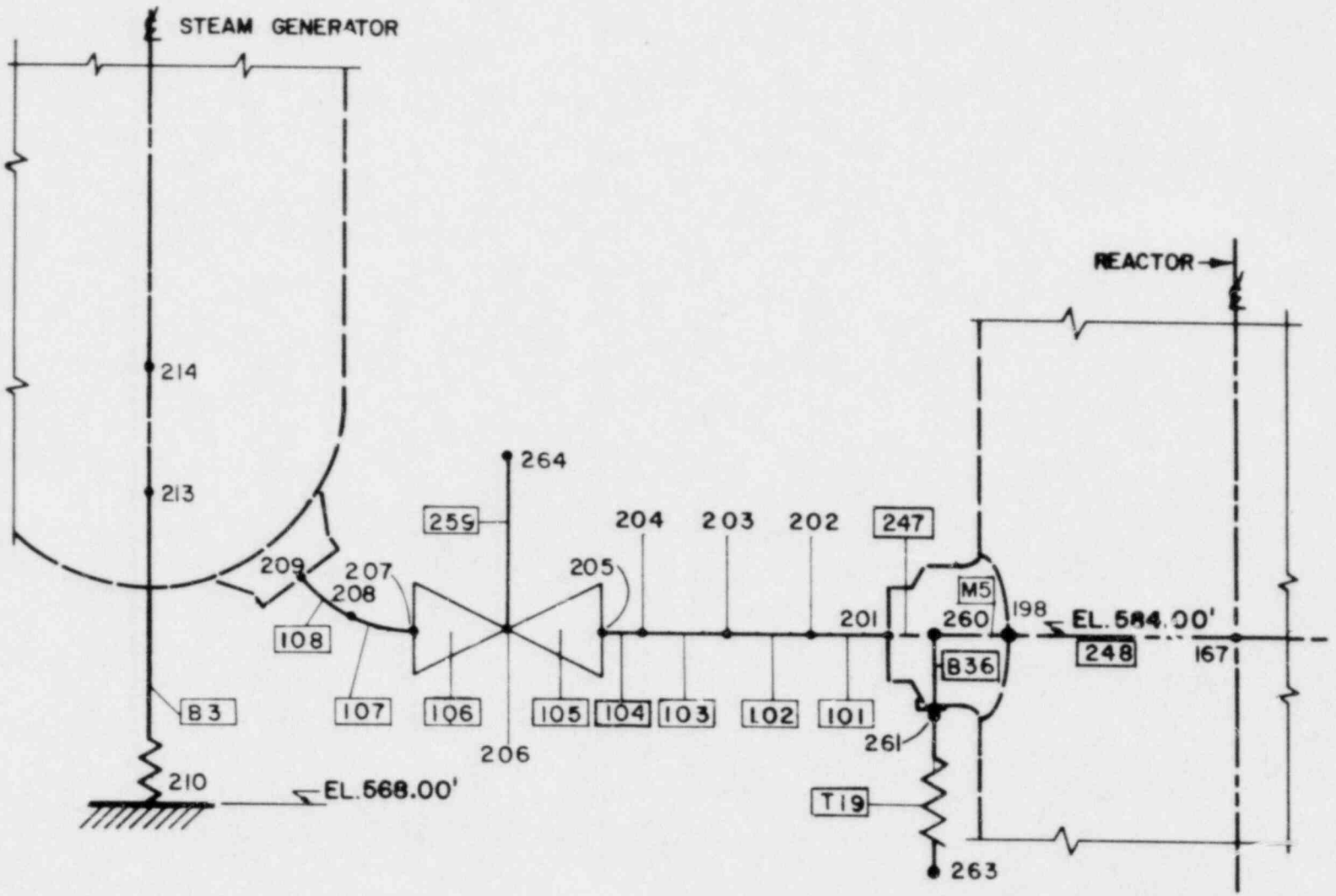


COLD LEG MODEL - LOOP 2
EXHIBIT 10

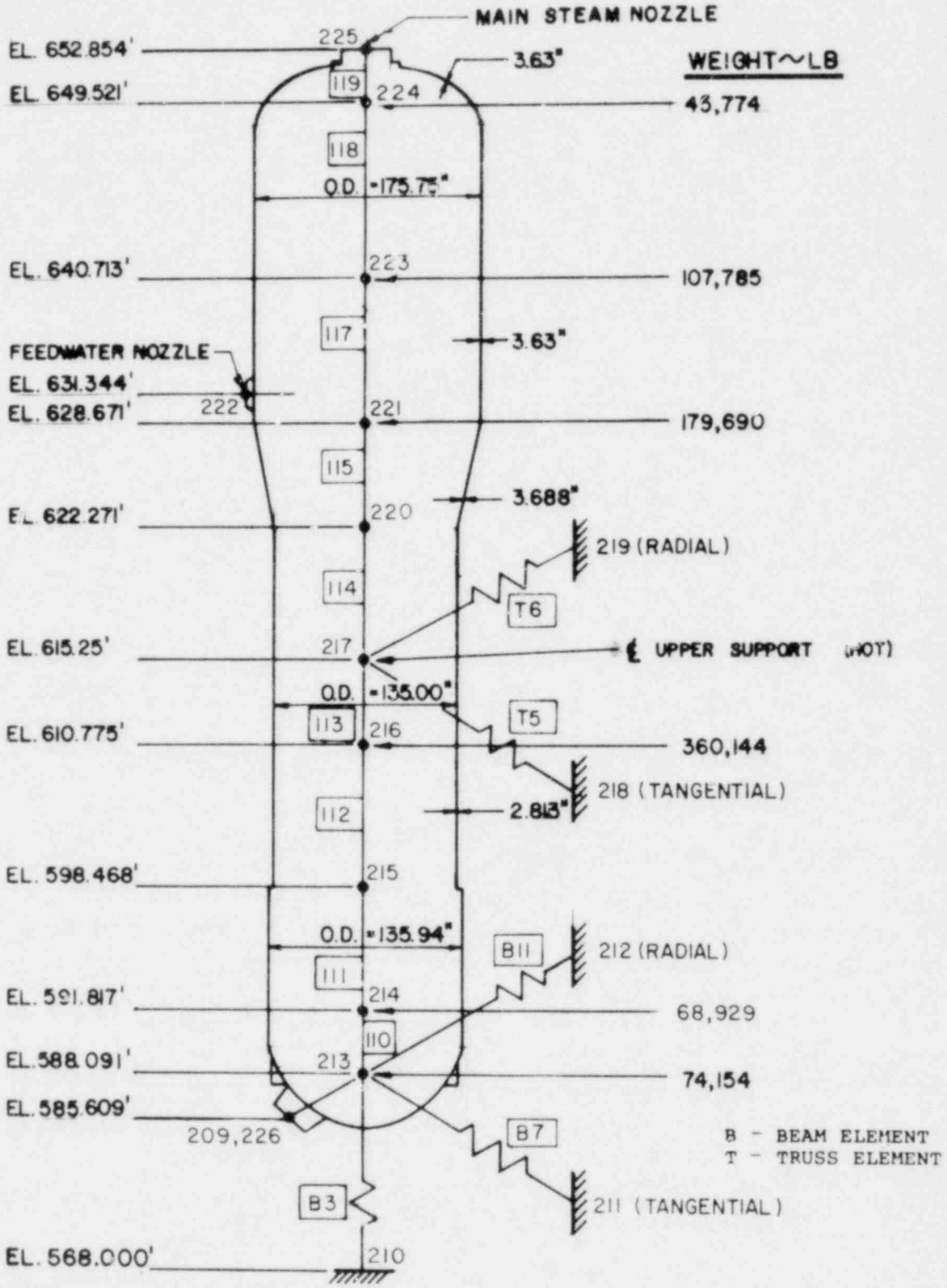


REACTOR COOLANT LOOP MODEL - LOOP 3

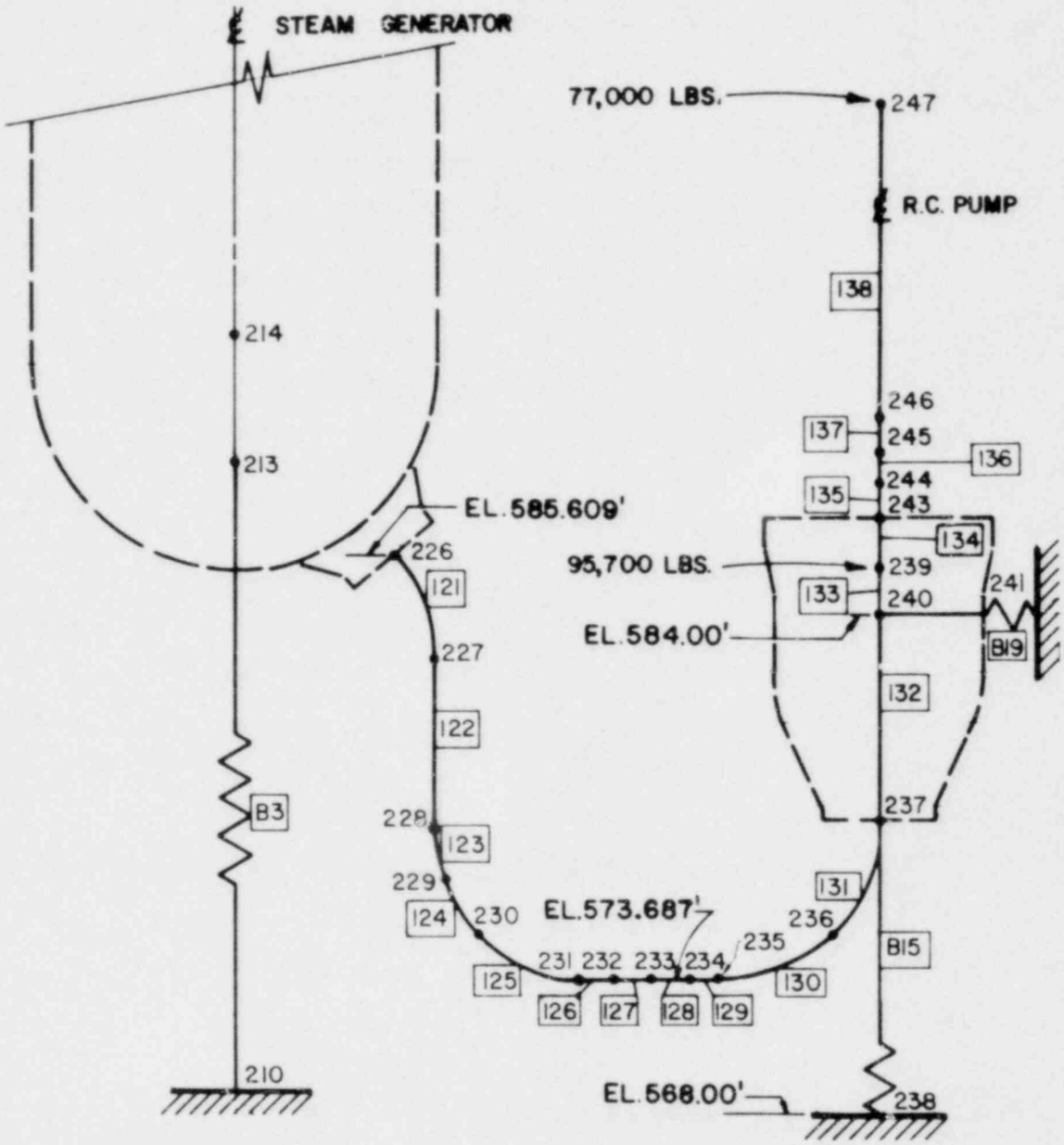
EXHIBIT 11



HOT LEG MODEL - LOOP 3
EXHIBIT 12

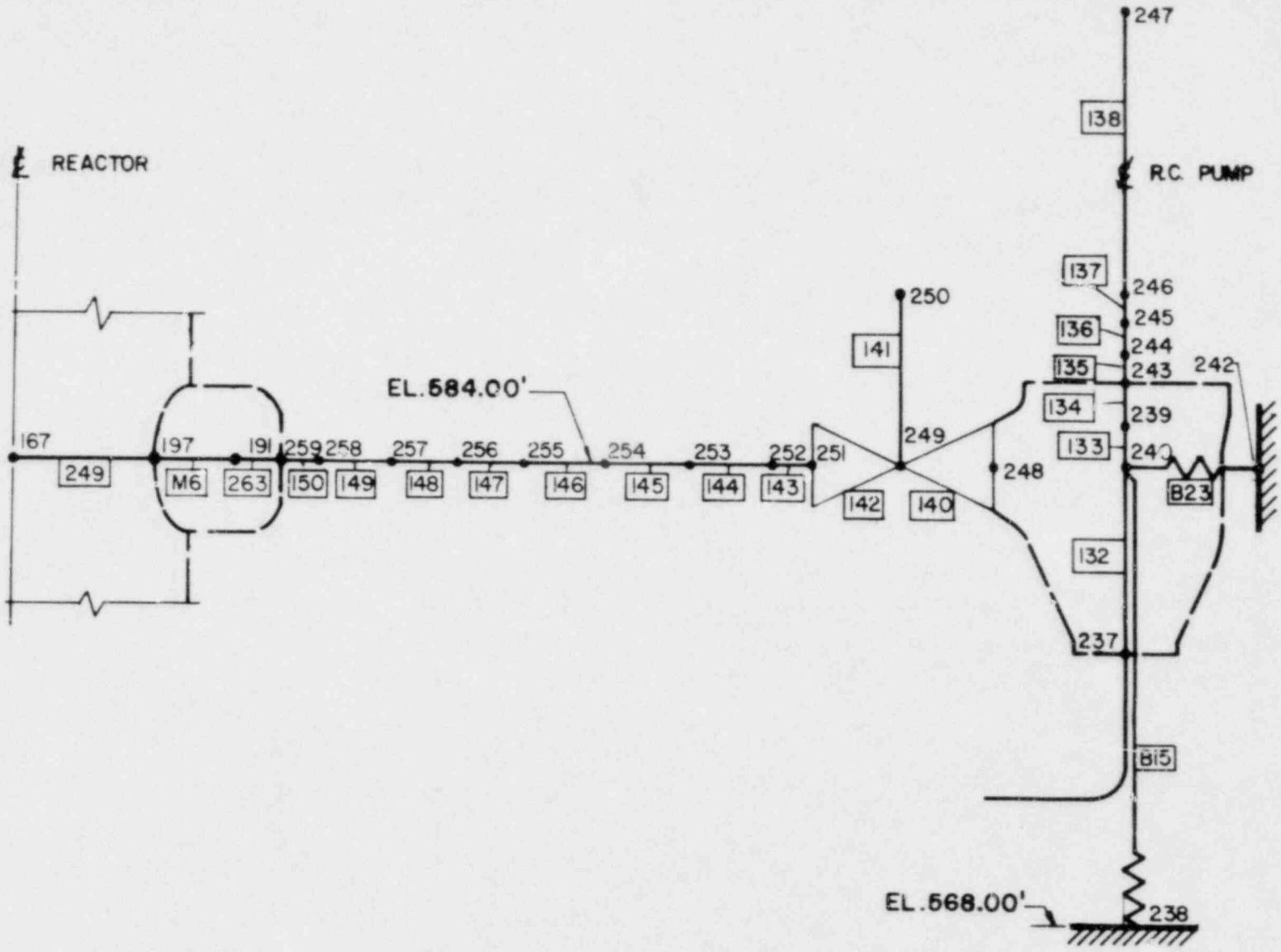


STEAM GENERATOR MODEL - LOOP 3
EXHIBIT 13

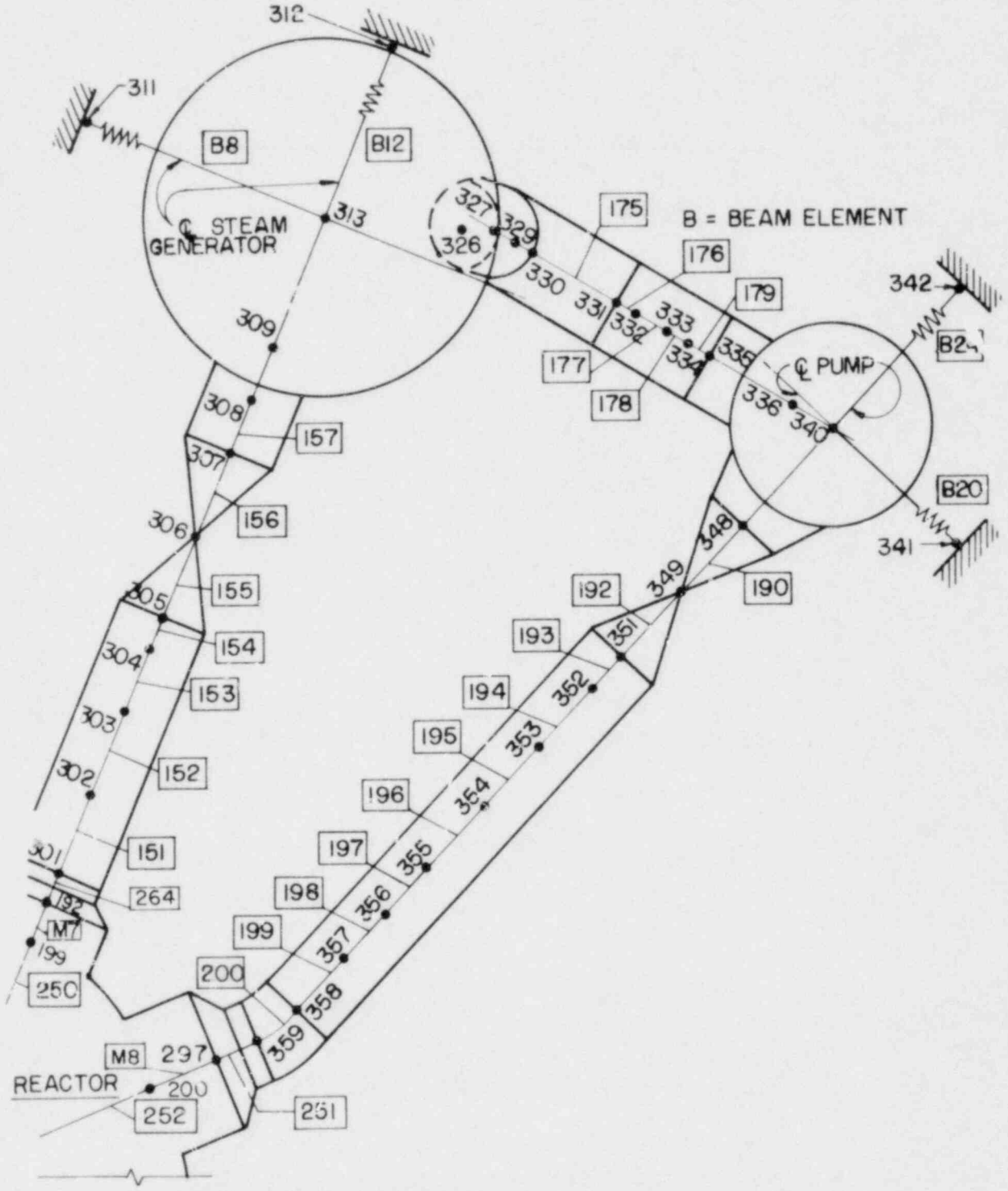


CROSSOVER LEG MODEL - LOOP 3

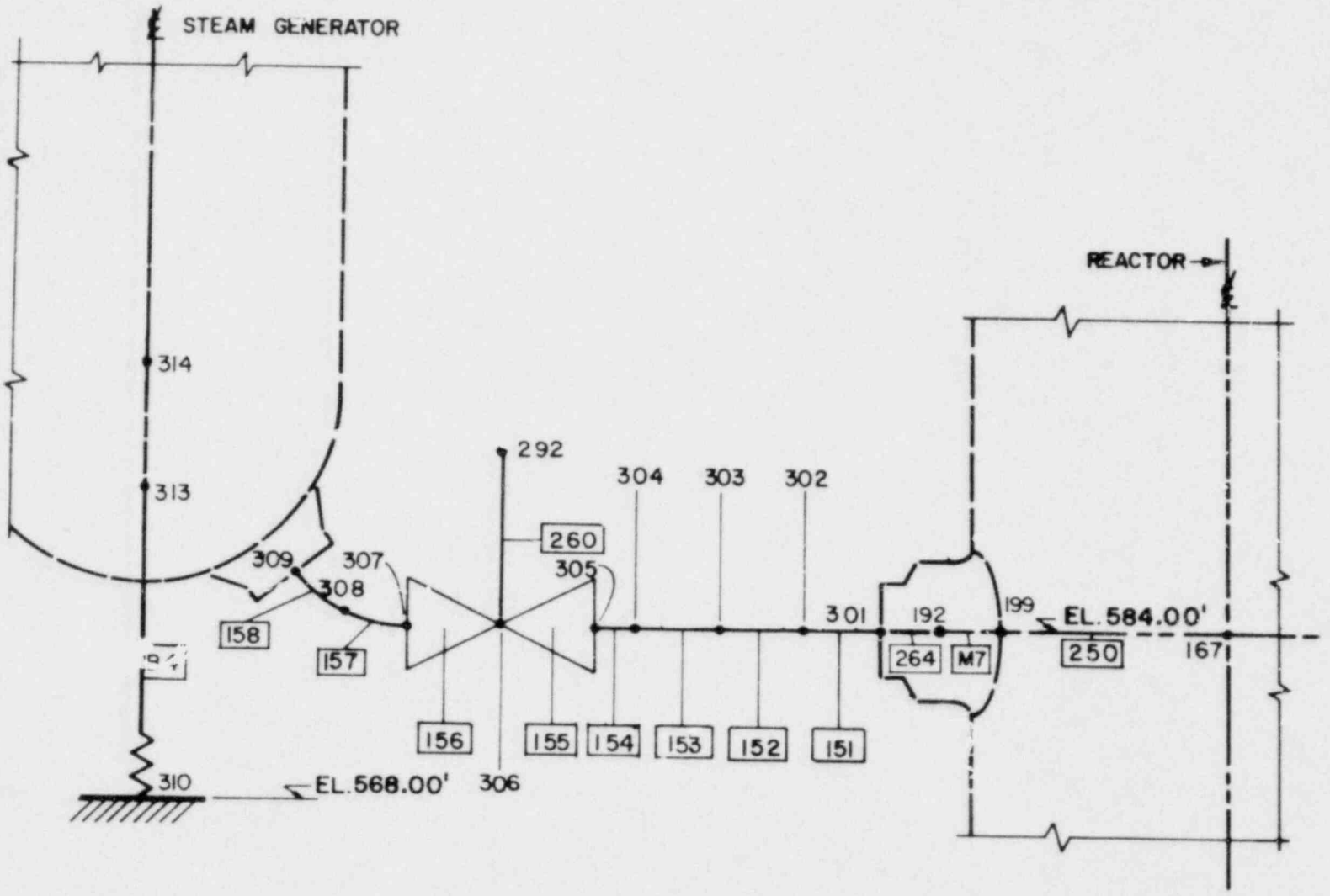
EXHIBIT 14



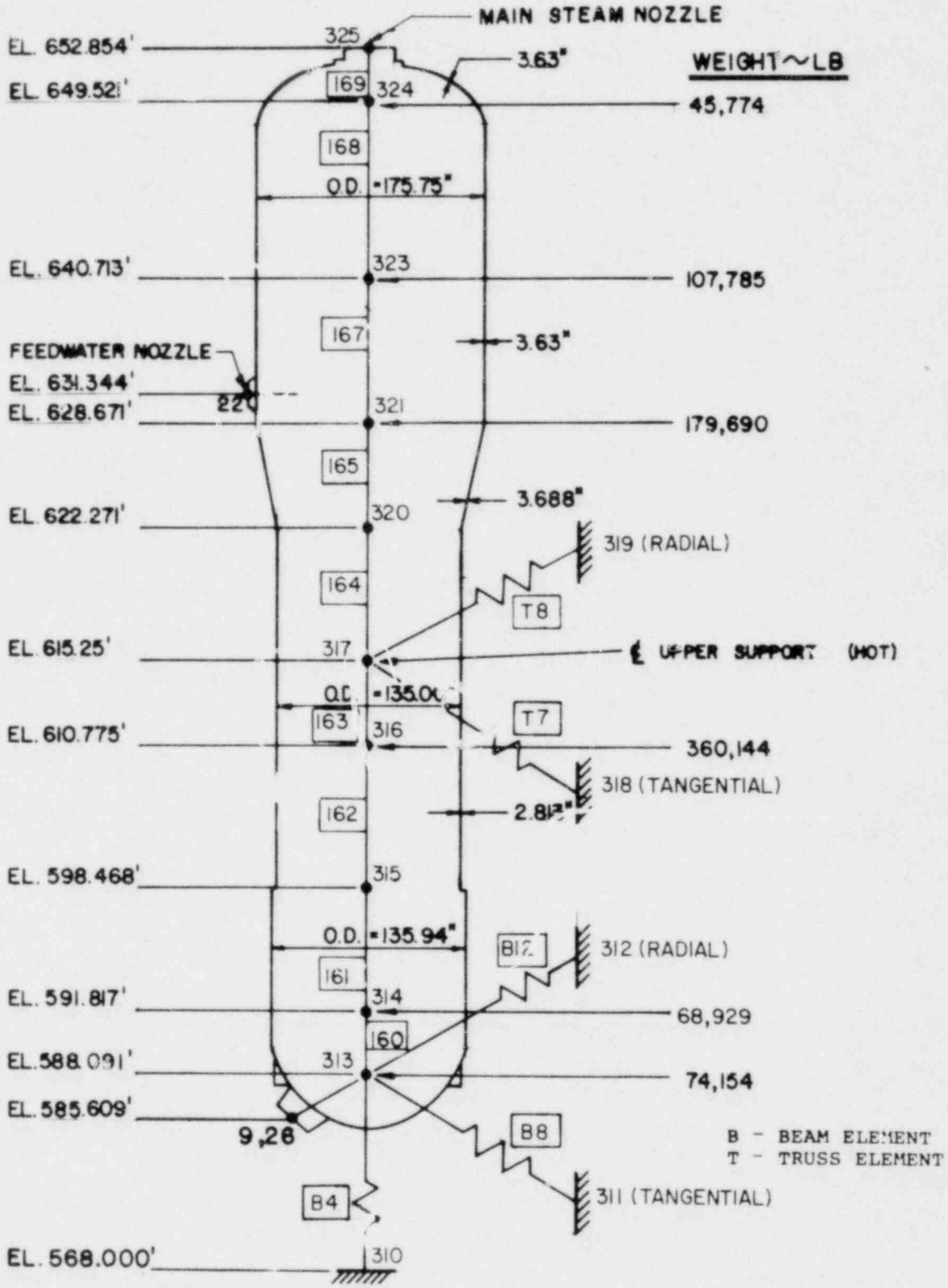
COLD LEG MODEL - LOOP 3
EXHIBIT 15



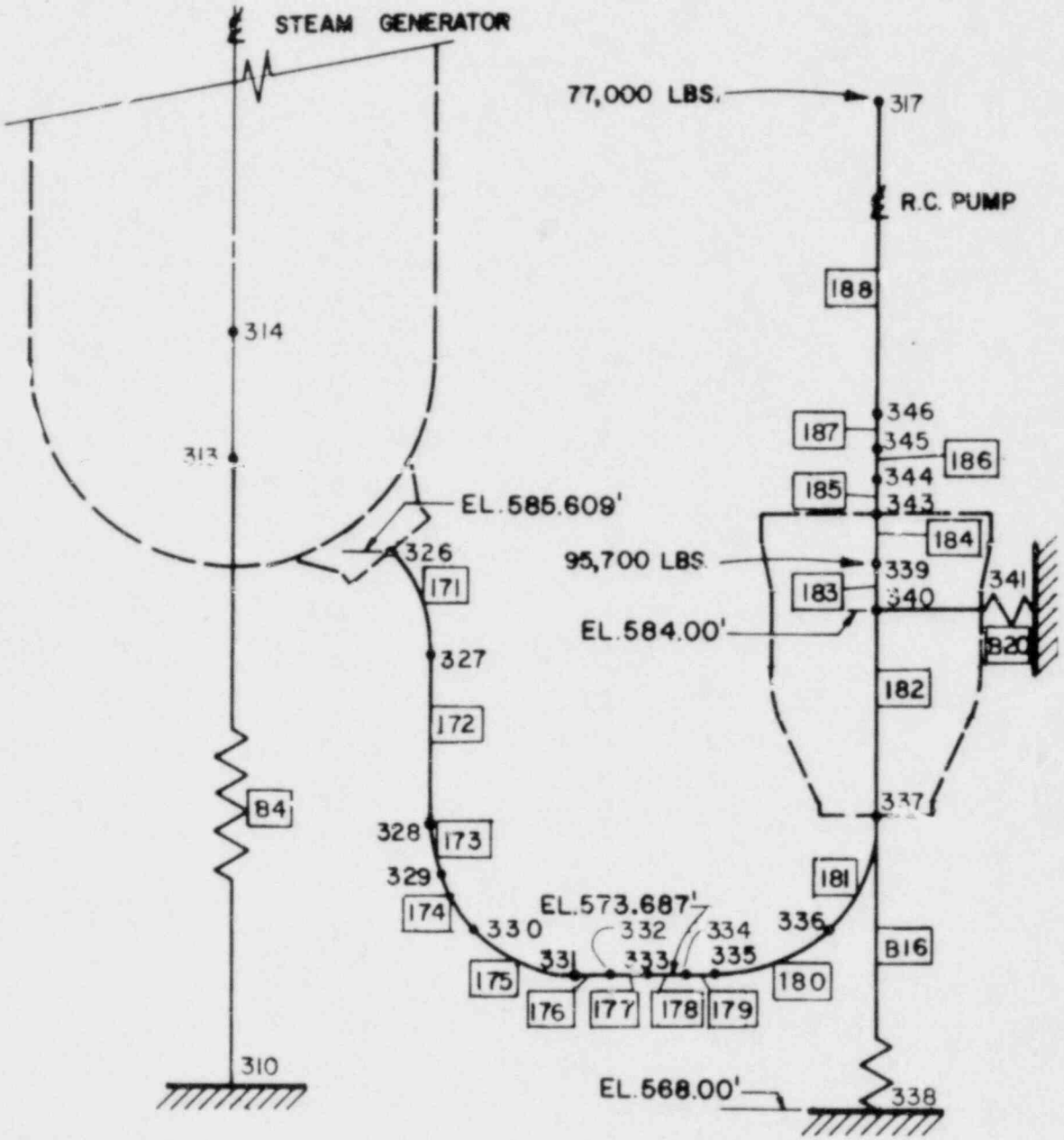
REACTOR COOLANT LOOP MODEL - LOOP 4
EXHIBIT 16



HOT LEG MODEL - LOOP 4
EXHIBIT 17

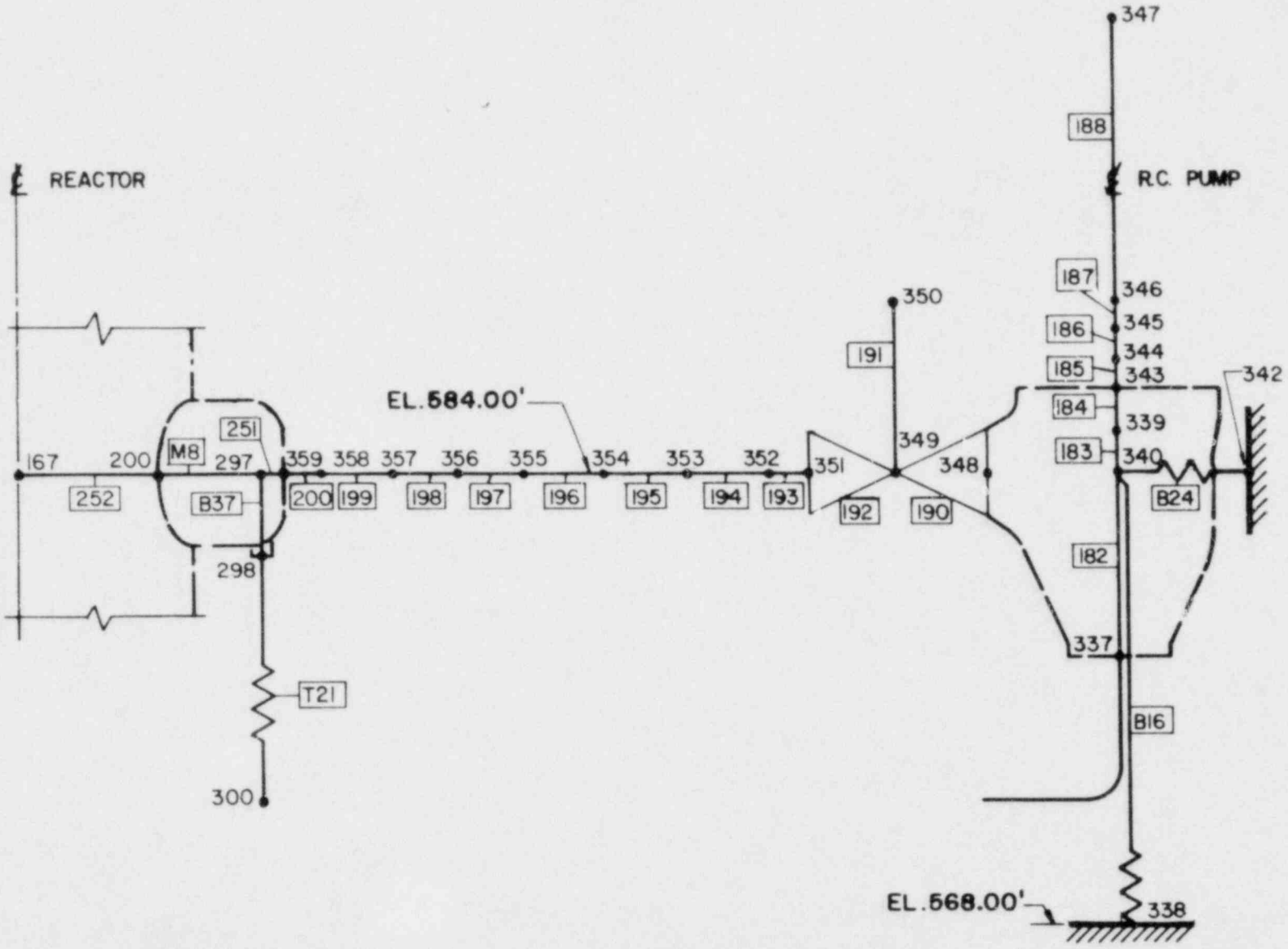


STEAM GENERATOR MODEL - LOOP 4
EXHIBIT 18

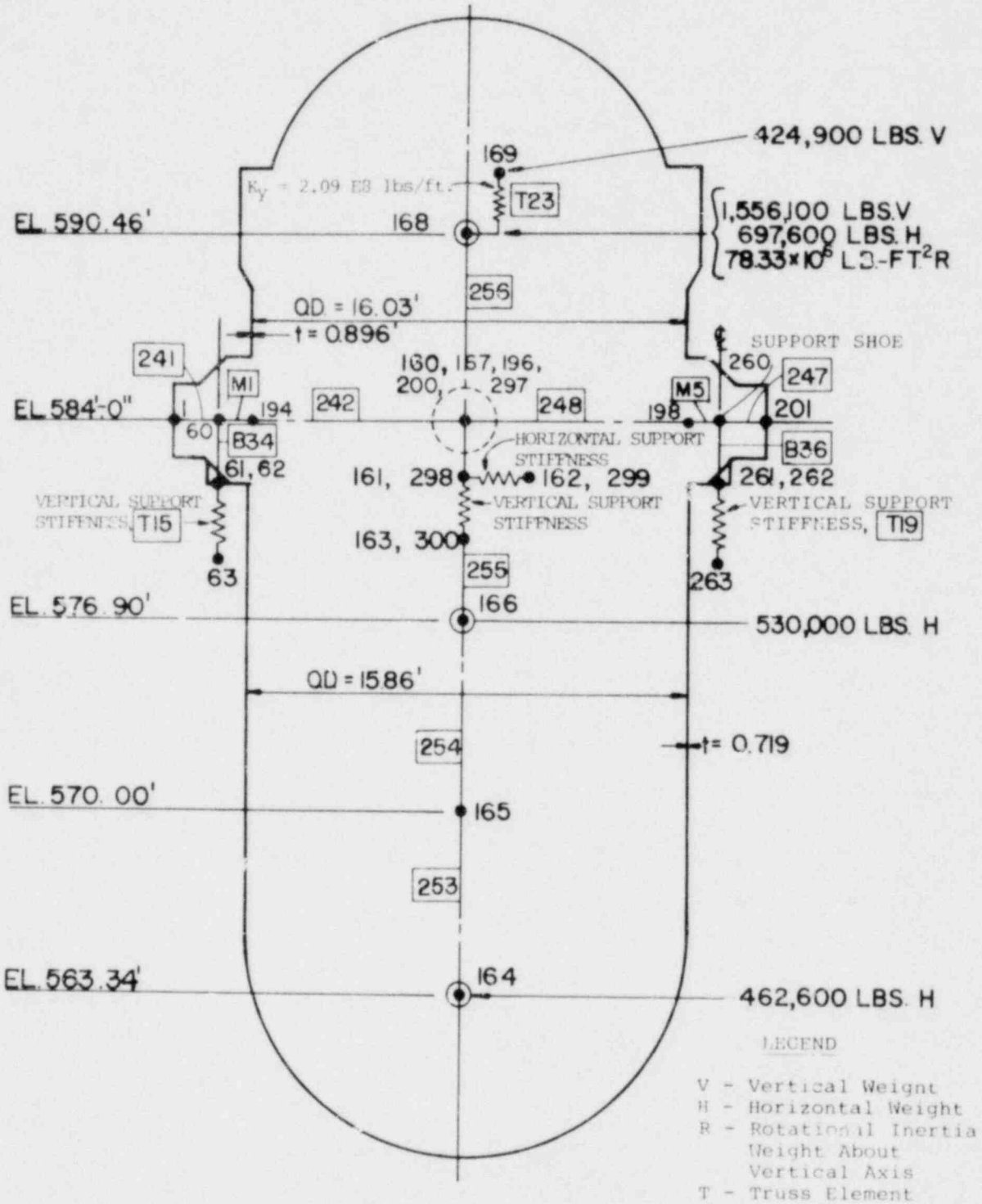


CROSSOVER LEG MODEL - LOOP 4

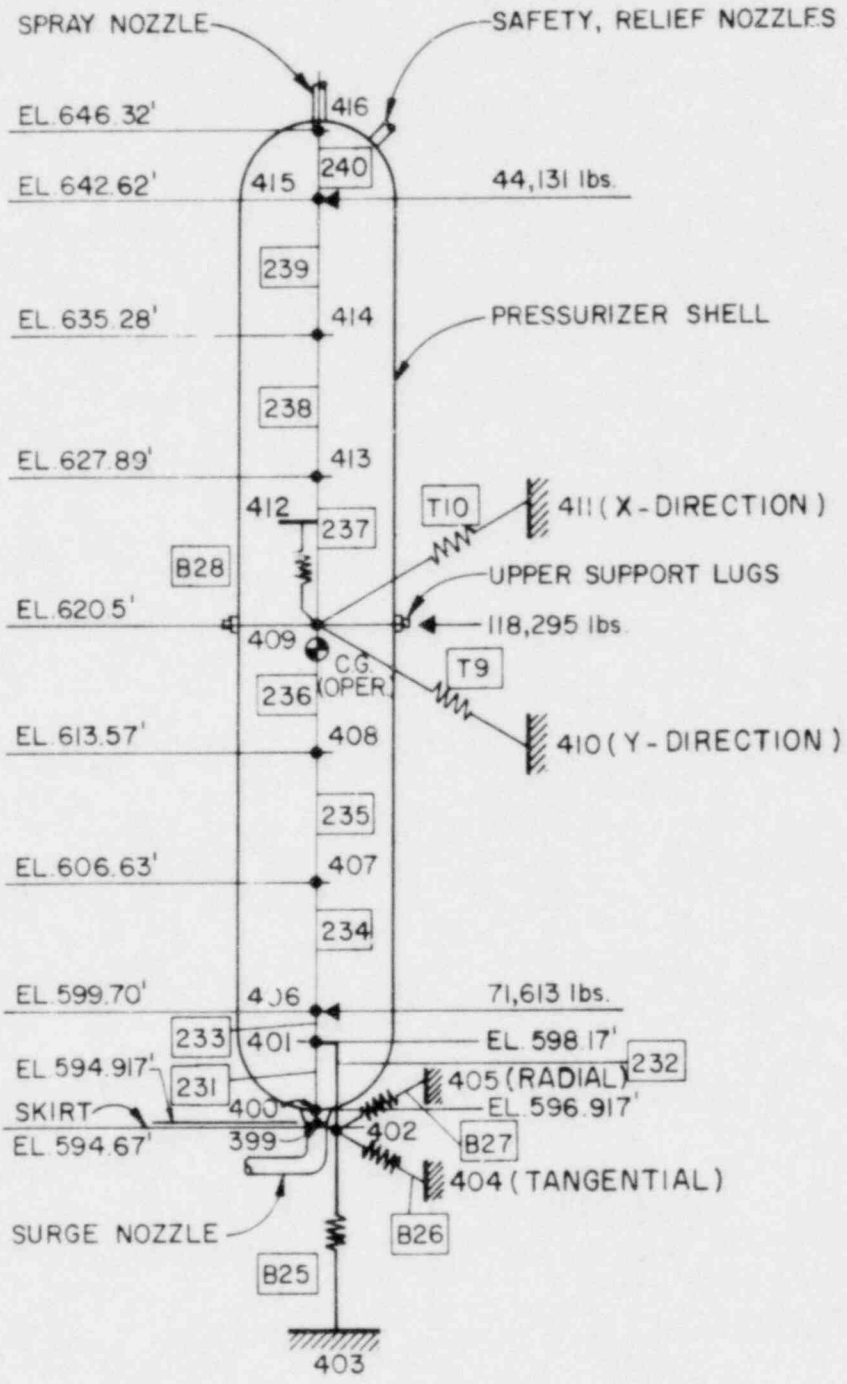
EXHIBIT 19



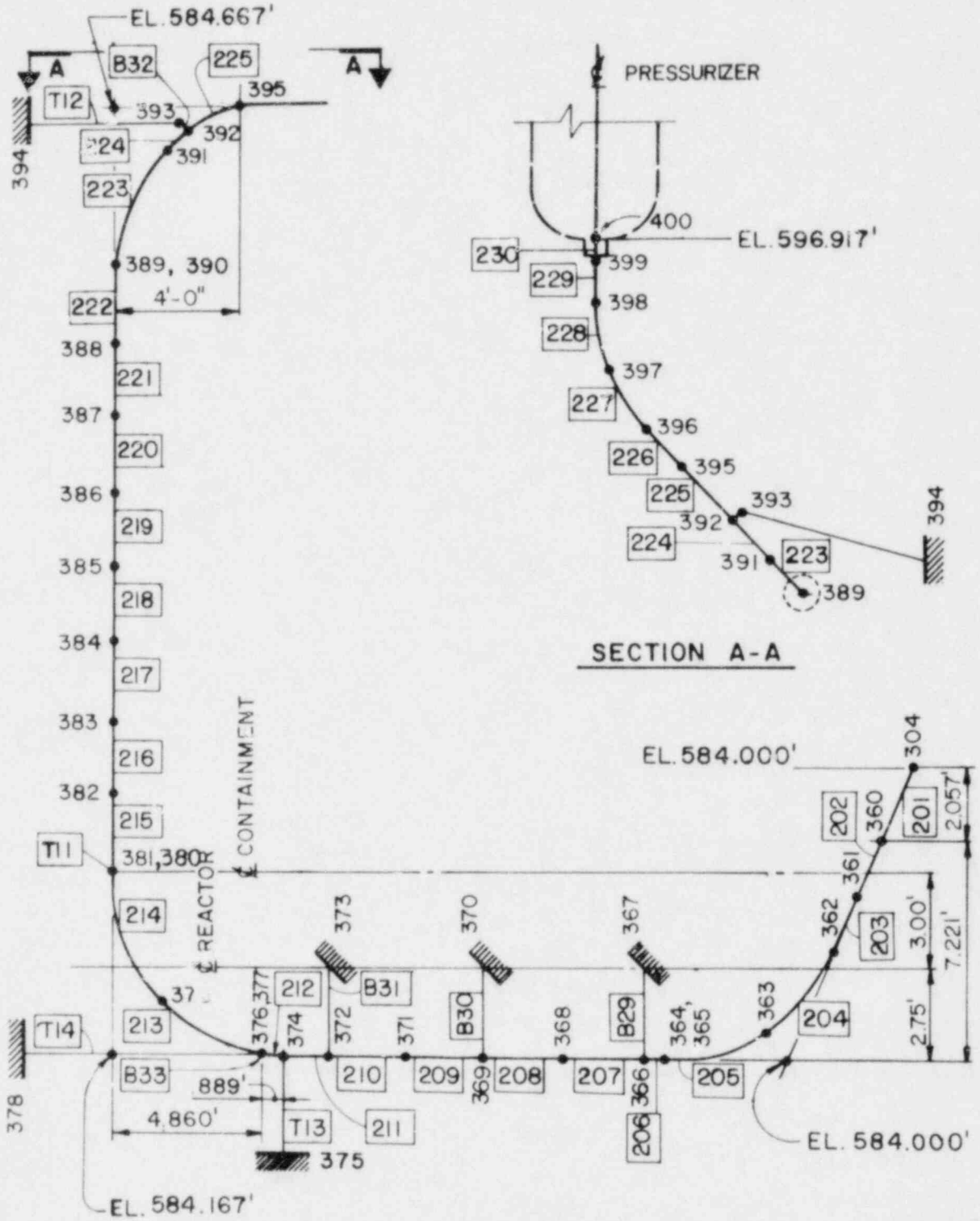
COLD LEG MODEL - LOOP 4
EXHIBIT 20



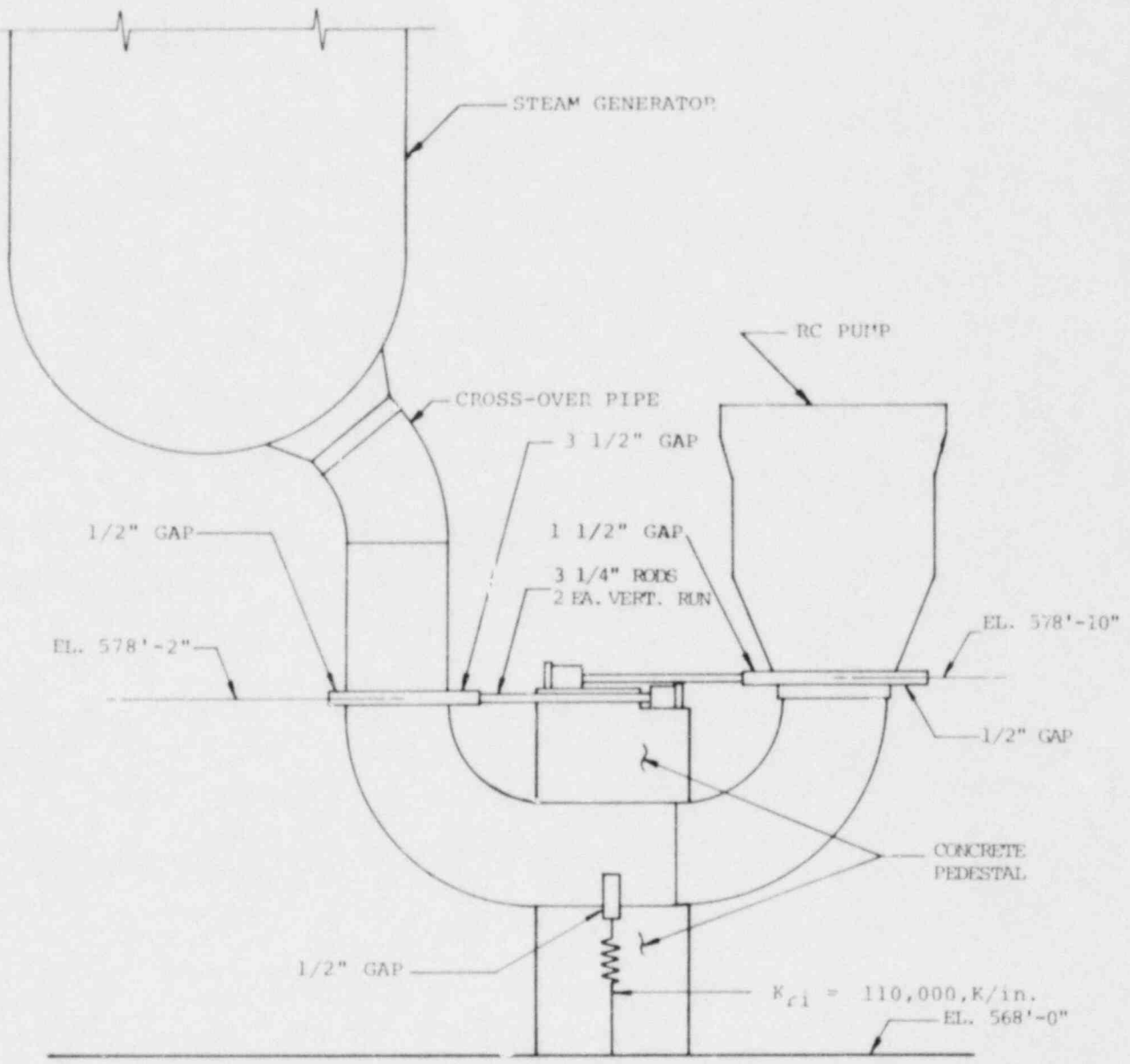
REACTOR PRESSURE VESSEL
EXHIBIT 21



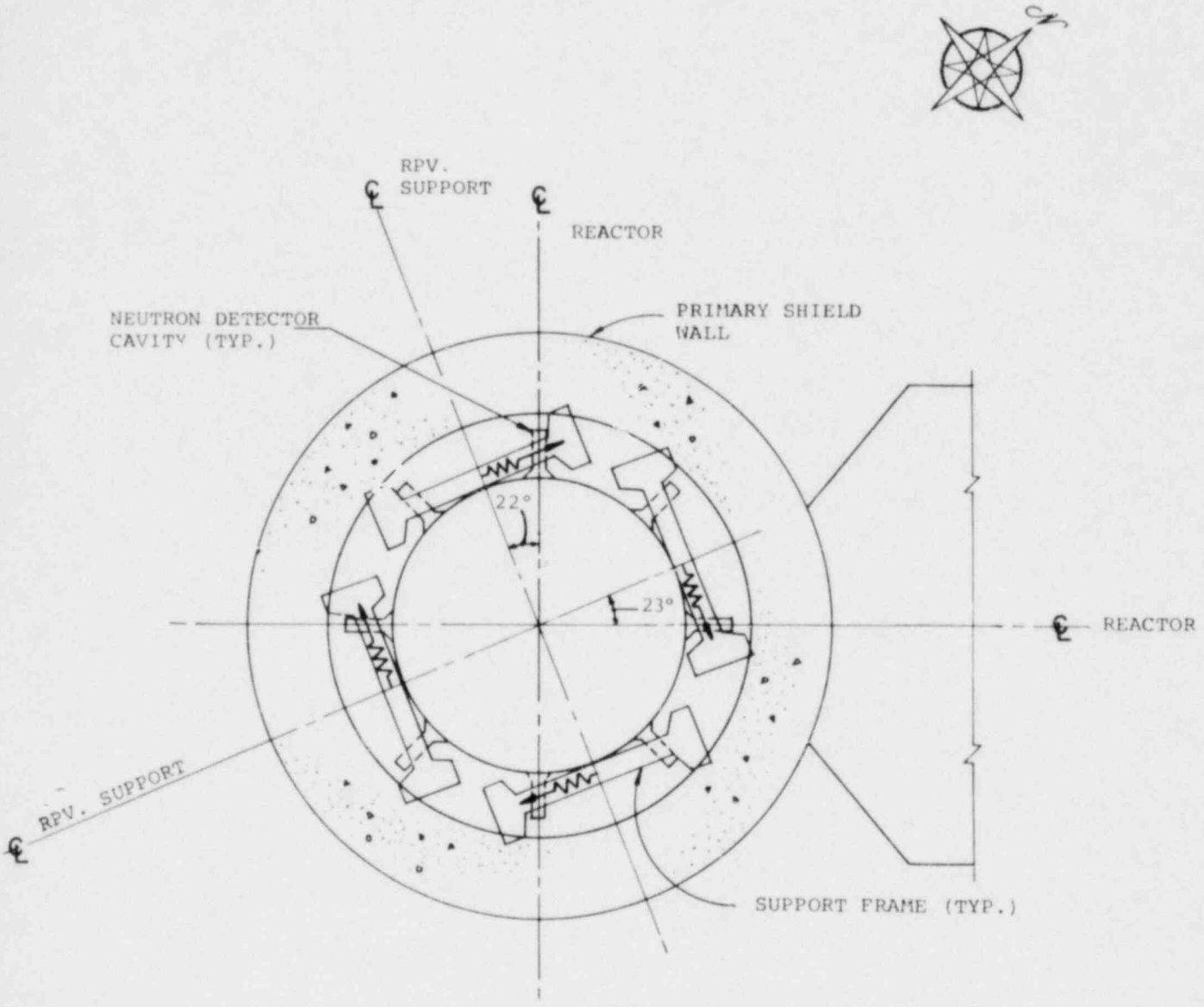
PRESSURIZER MODEL
EXHIBIT 22



PRESSURIZER SURGE LINE
EXHIBIT 23

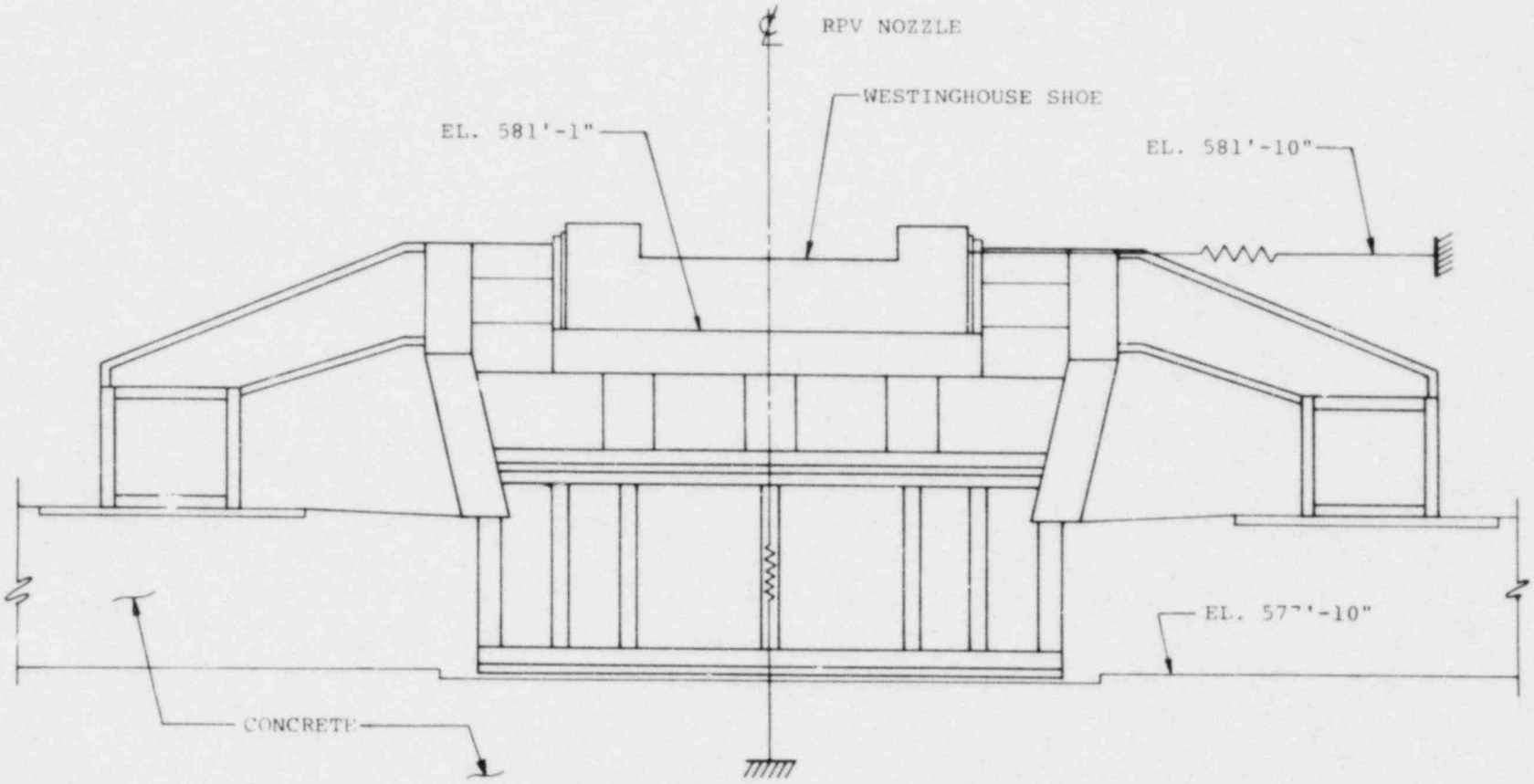


COOLANT PIPE RESTRAINT LOCATIONS
(NOT INCLUDED IN MODEL)
EXHIBIT 24



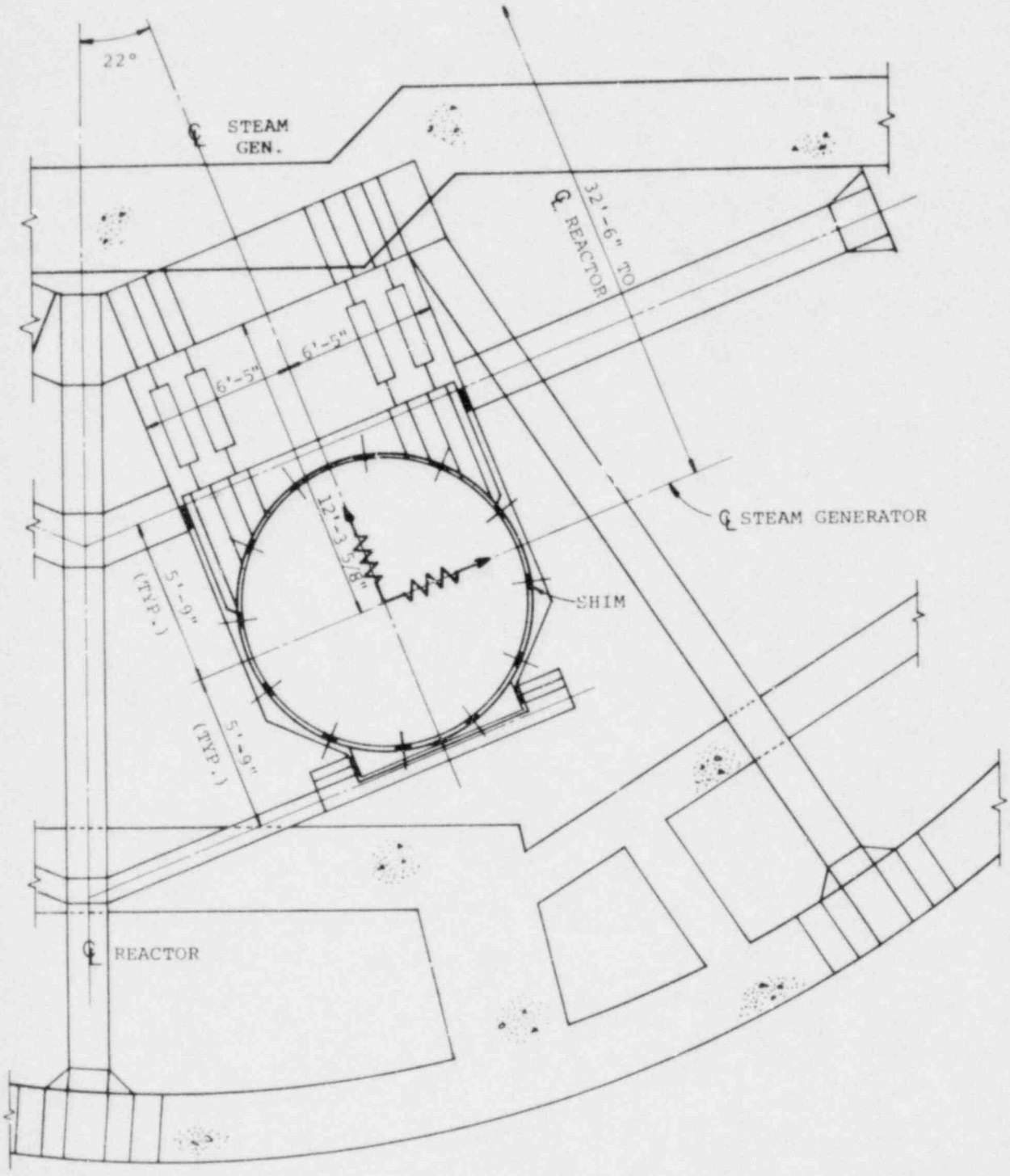
REACTOR PRESSURE VESSEL SUPPORTS PLAN
ELEVATION 581 FT. -10 IN.

EXHIBIT 25

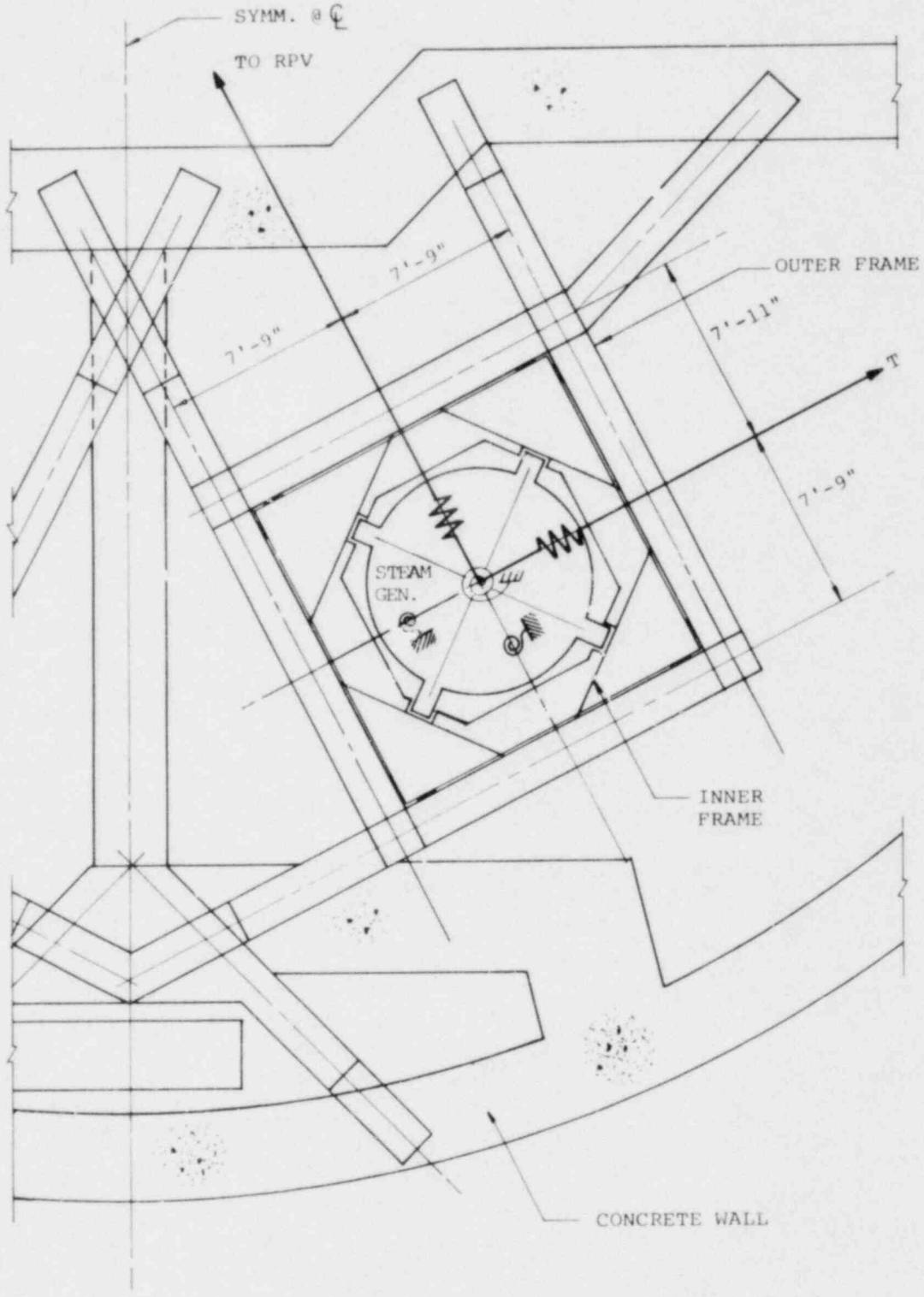


REACTOR PRESSURE VESSEL SUPPORT FRAME

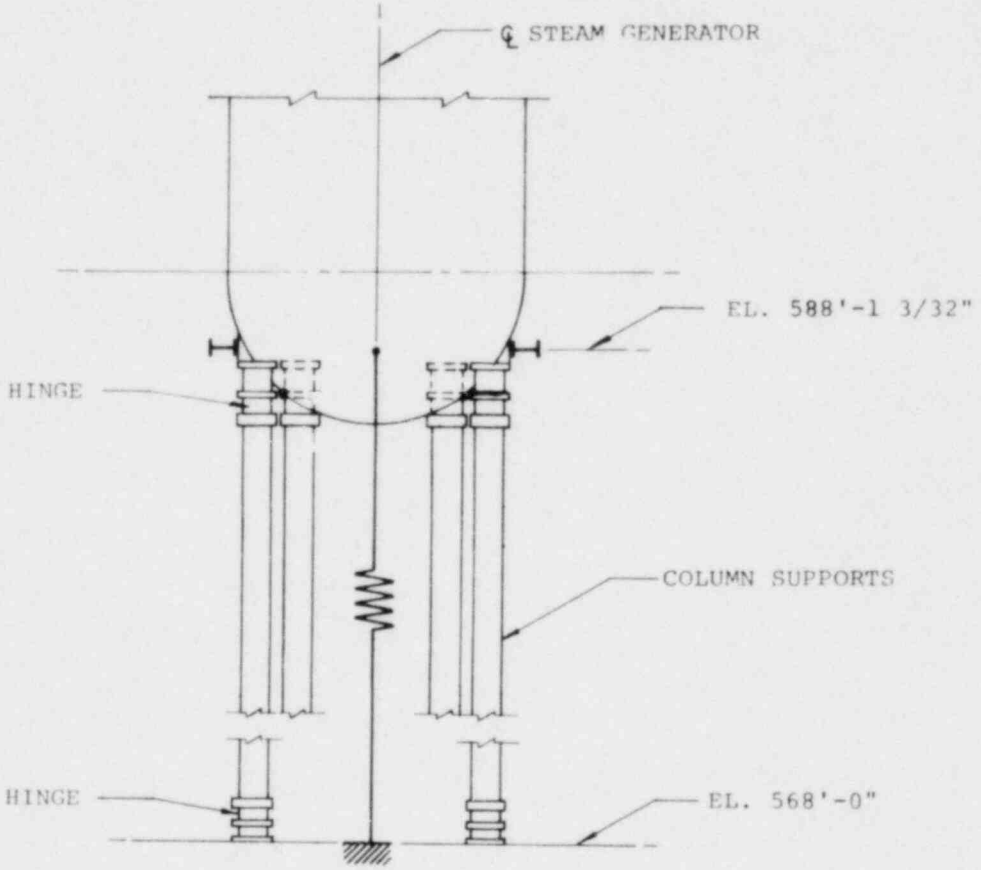
EXHIBIT 26



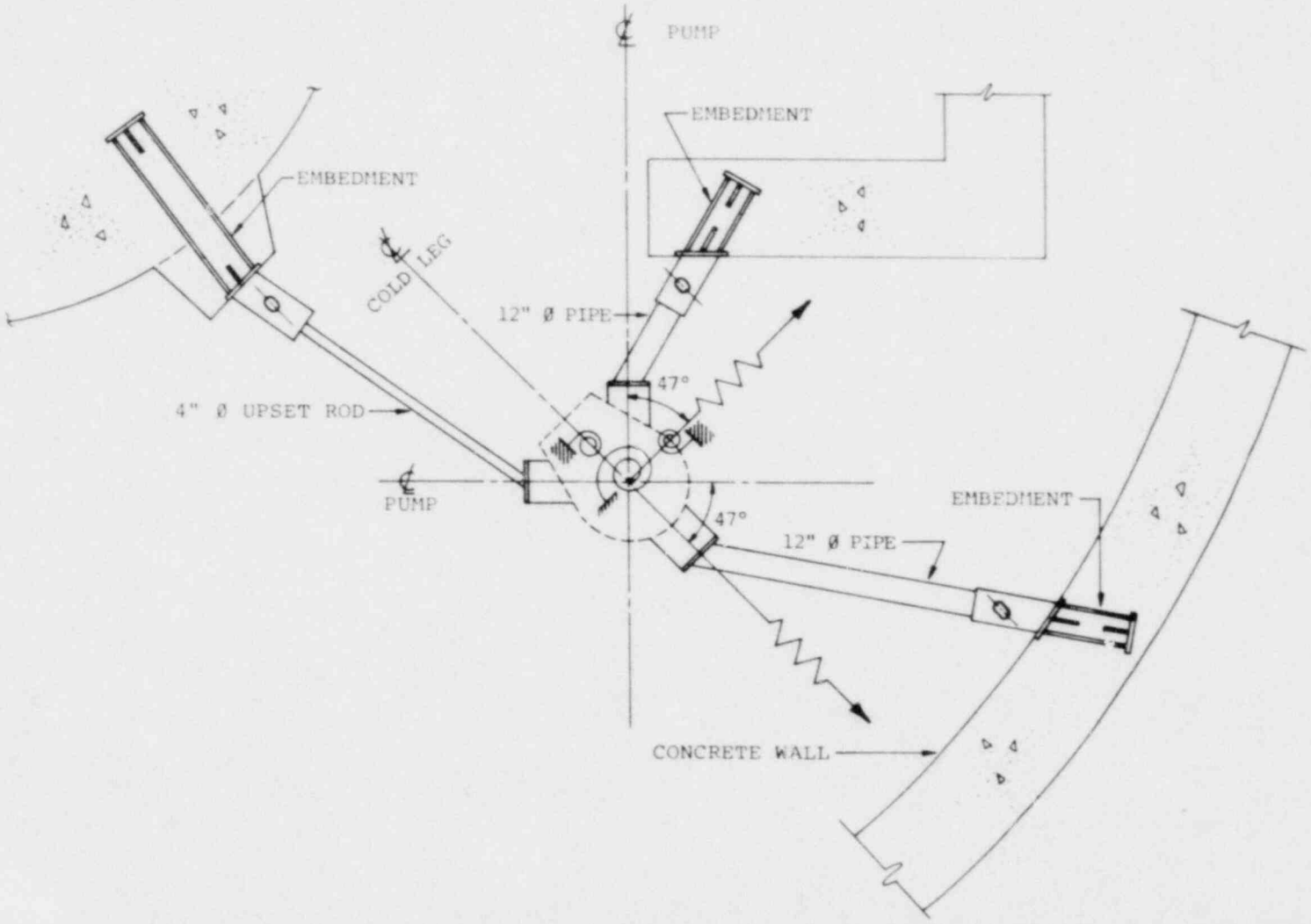
STEAM GENERATOR UPPER LATERAL SUPPORT STEEL
ELEVATION 615 FT. -3 IN.
EXHIBIT 27



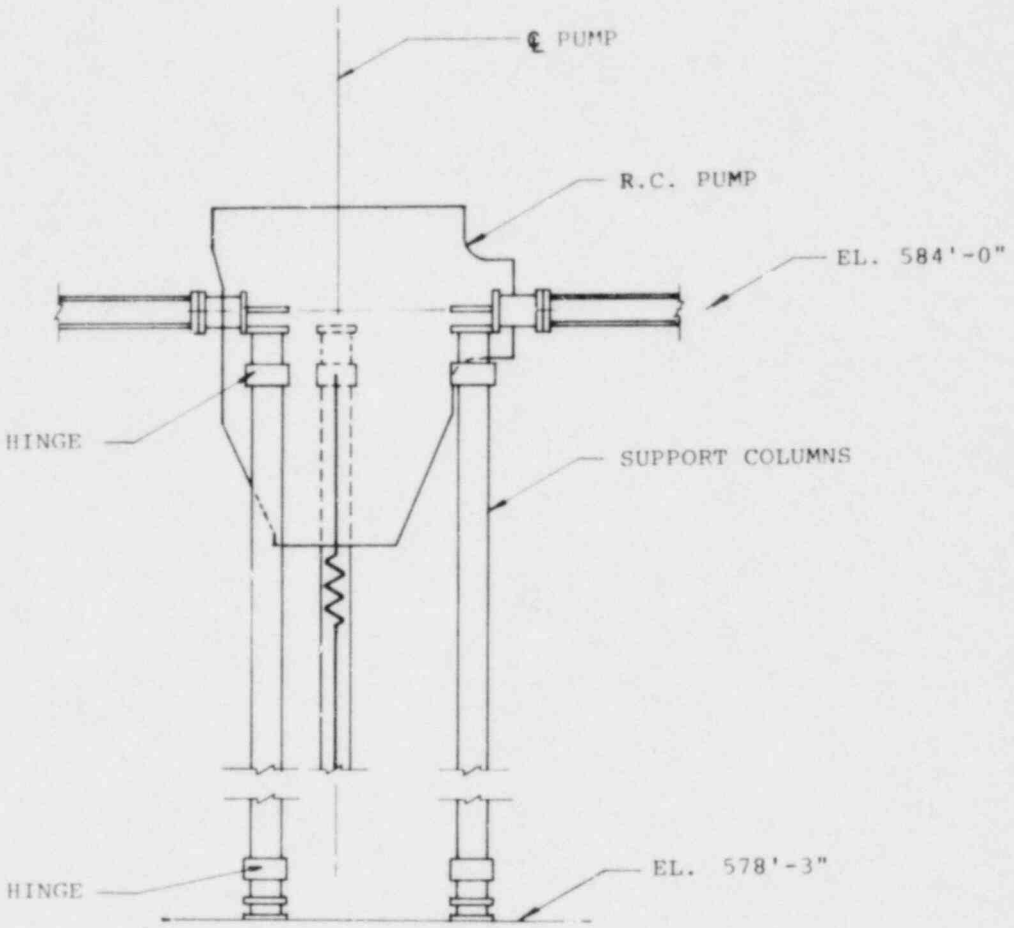
STEAM GENERATOR LOWER LATERAL SUPPORT STEEL
ELEVATION 588 FT. -1-3/32 IN.
EXHIBIT 28



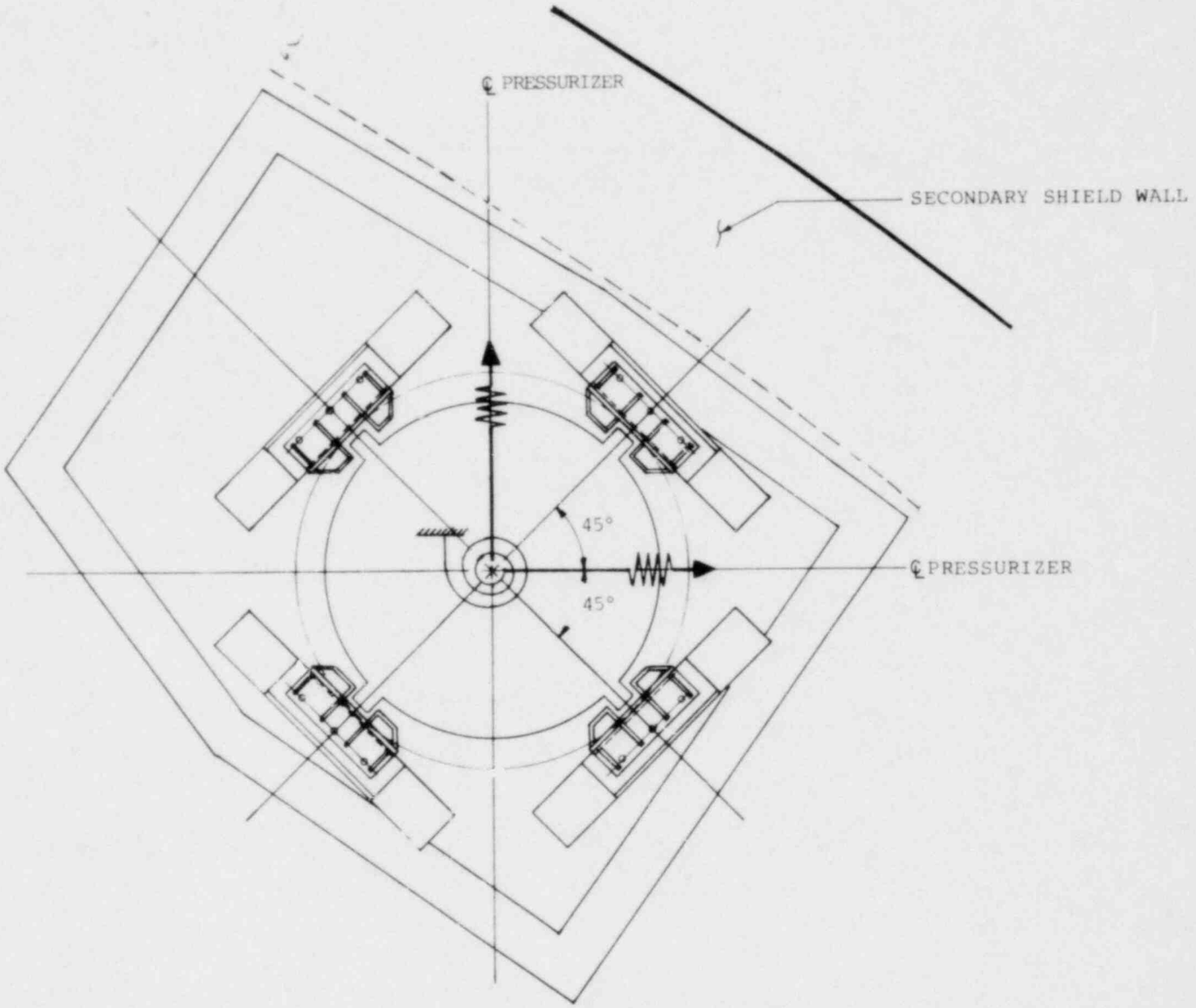
STEAM GENERATOR VERTICAL SUPPORT
EXHIBIT 29



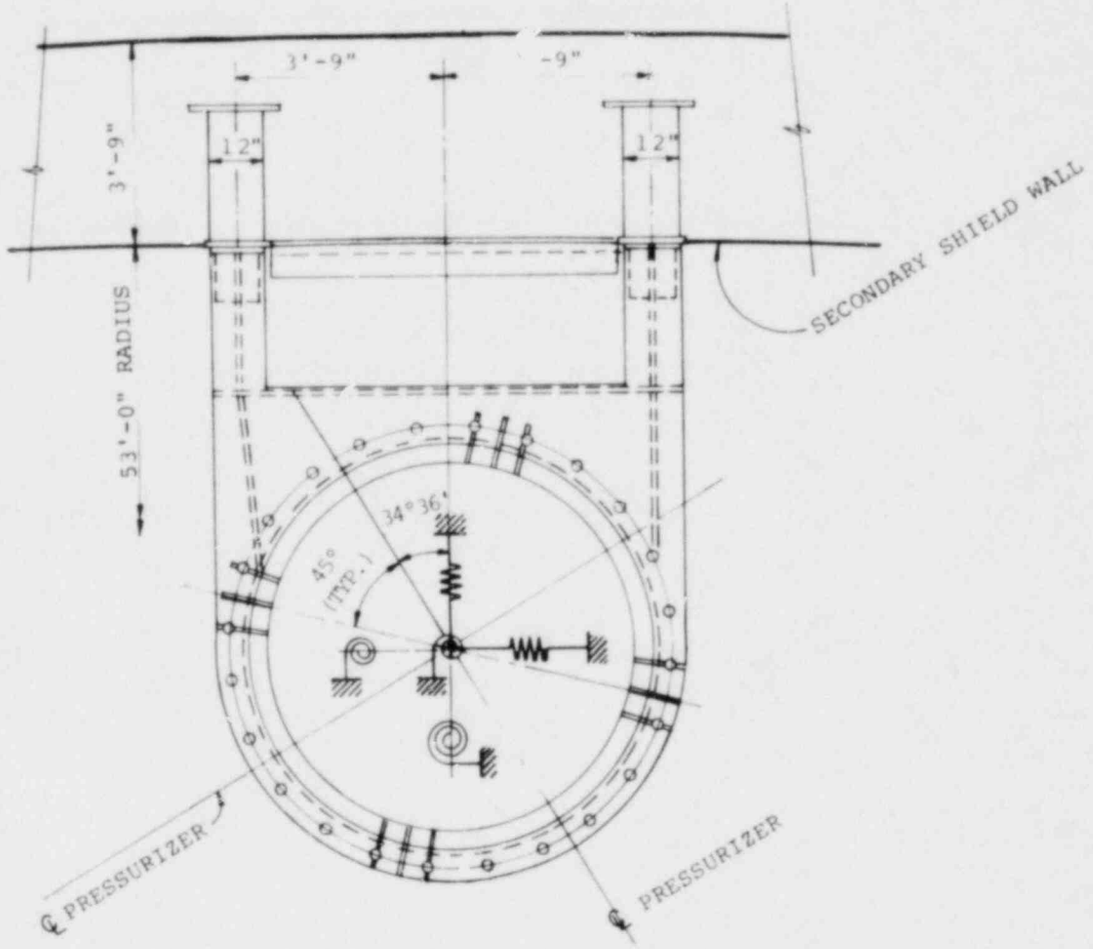
REACTOR COOLANT PUMP LATERAL SUPPORT
ELEVATION 584 FT. -0 IN.
EXHIBIT 30



REACTOR COOLANT PUMP VERTICAL SUPPORT
EXHIBIT 31

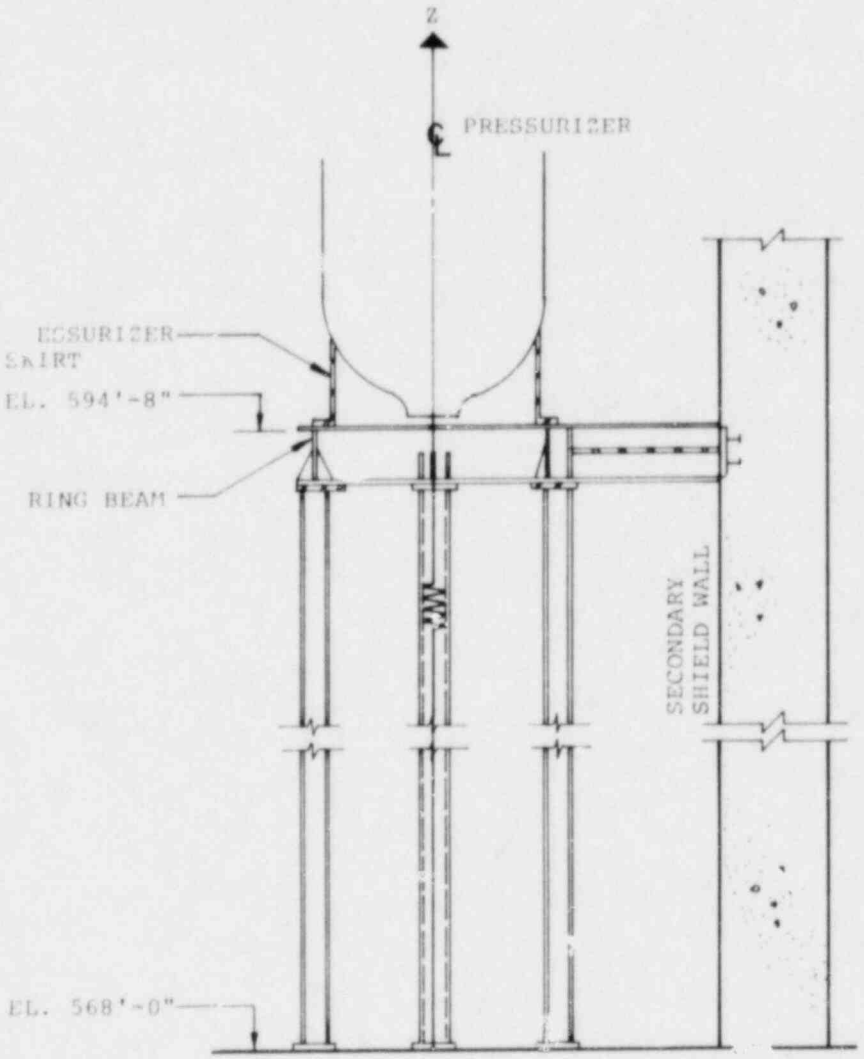


PRESSURIZER UPPER LATERAL SUPPORT
ELEVATION 620 FT. -6 IN.
EXHIBIT 32

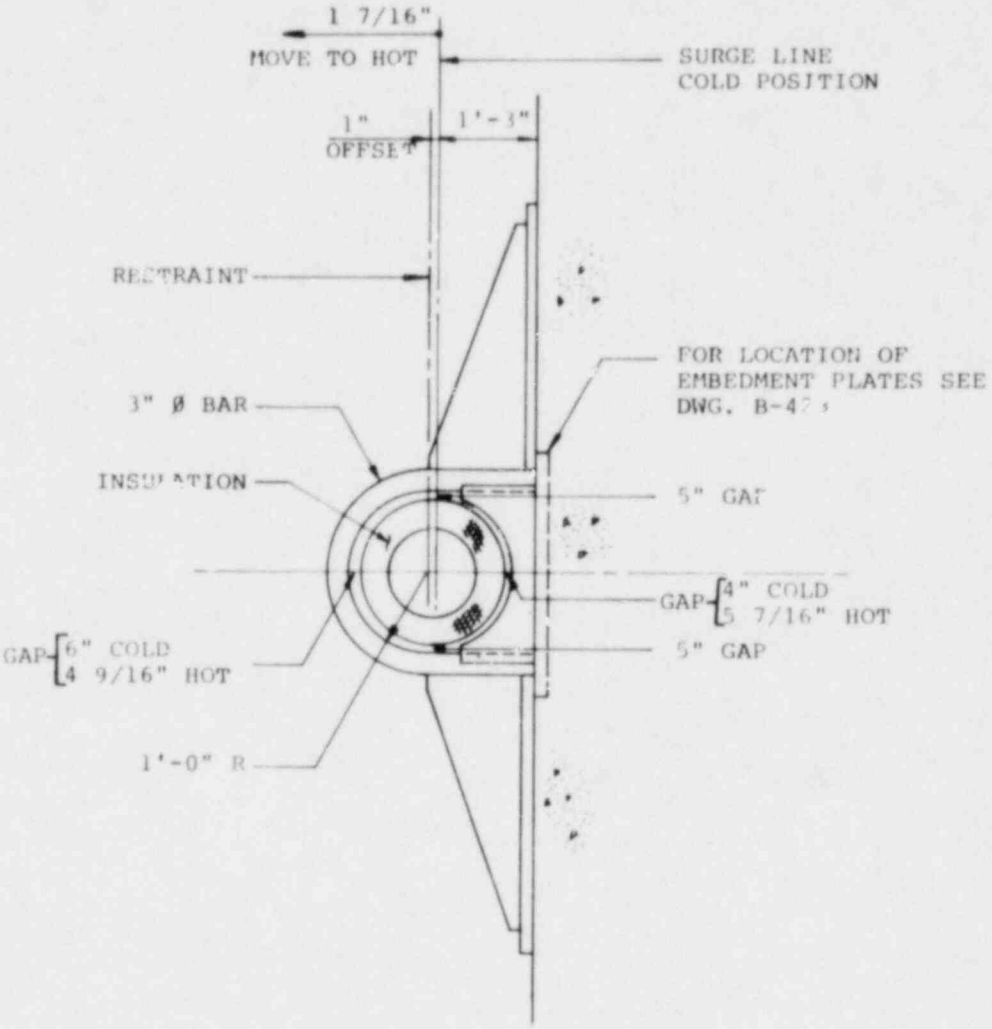


PRESSURIZER LOWER LATERAL SUPPORT
ELEVATION 594 FT. -8 IN.

EXHIBIT 33

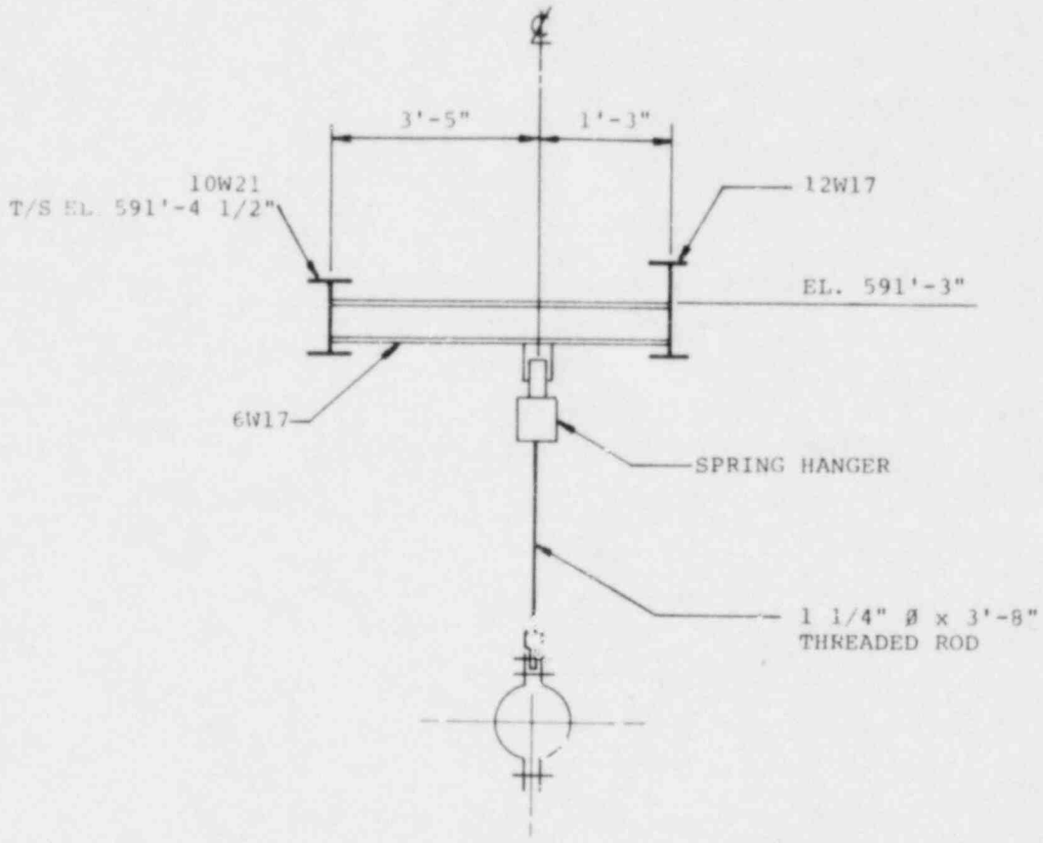


PRESSURIZER VERTICAL SUPPORT
EXHIBIT 34

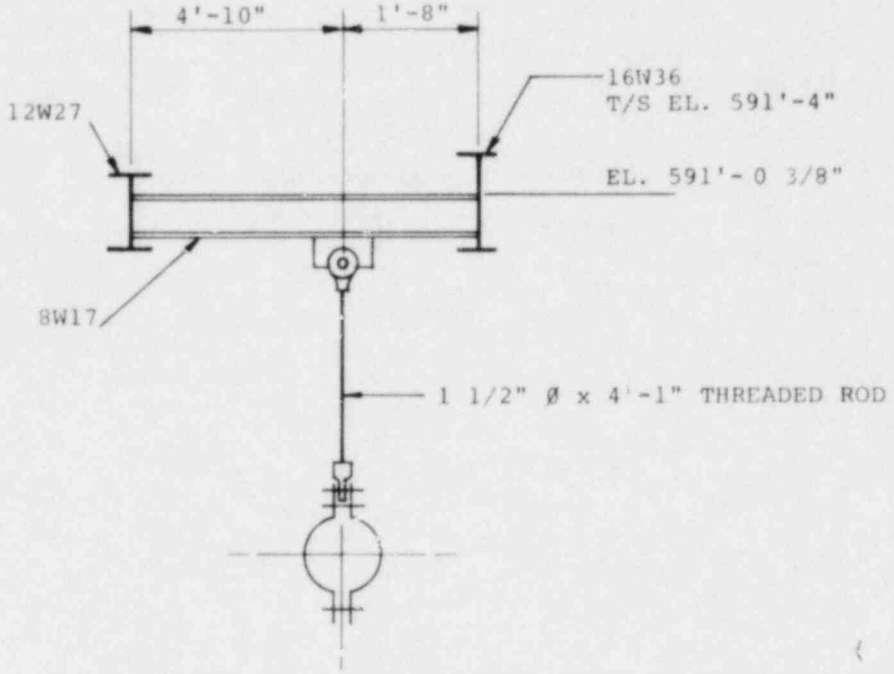


RESTRAINT	PIPE NODE	SUPPORT NODES
RCFR-110	372	373
RCFR-111	369	370
RCFR-112	366	367

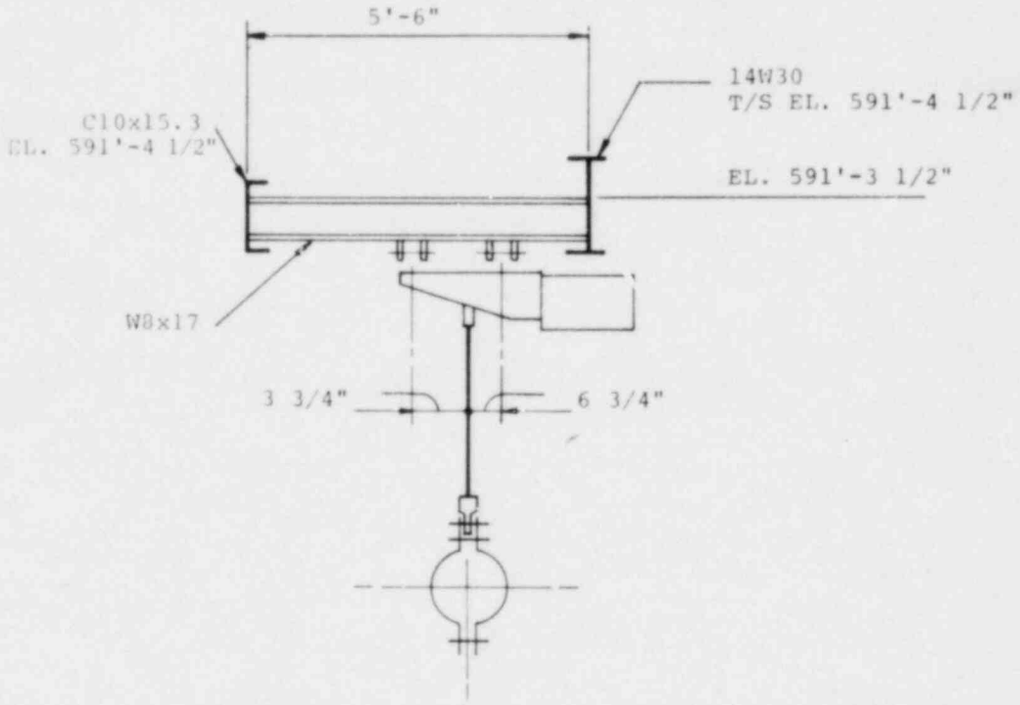
ELEVATION VIEW
SURGE LINE FLAILING RESTRAINTS
DESIGN FORCE = 279,000 LBS.
EXHIBIT 35



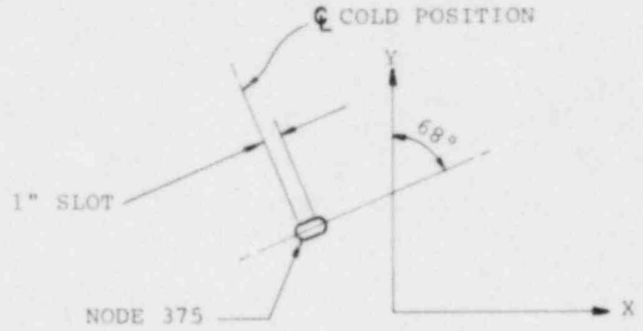
ELEVATION VIEW
VARIABLE SUPPORT HANGER RCH-1001
DESIGN LOAD = 5650 LBS. ± 10%
PIPE NODE 364, SUPPORT NODE 365
(NOT INCLUDED IN SEISMIC MODEL)
EXHIBIT 36



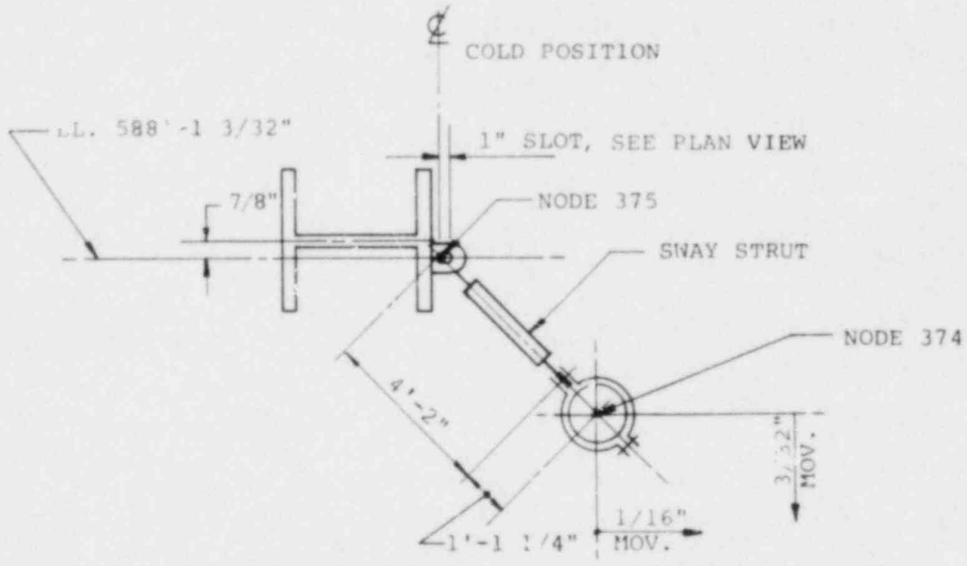
ELEVATION VIEW
STEEL ROD SUPPORT HANGER RCH-1002
DESIGN LOAD = 8373 LBS.
PIPE NODE 381, SUPPORT NODE 380
EXHIBIT 37



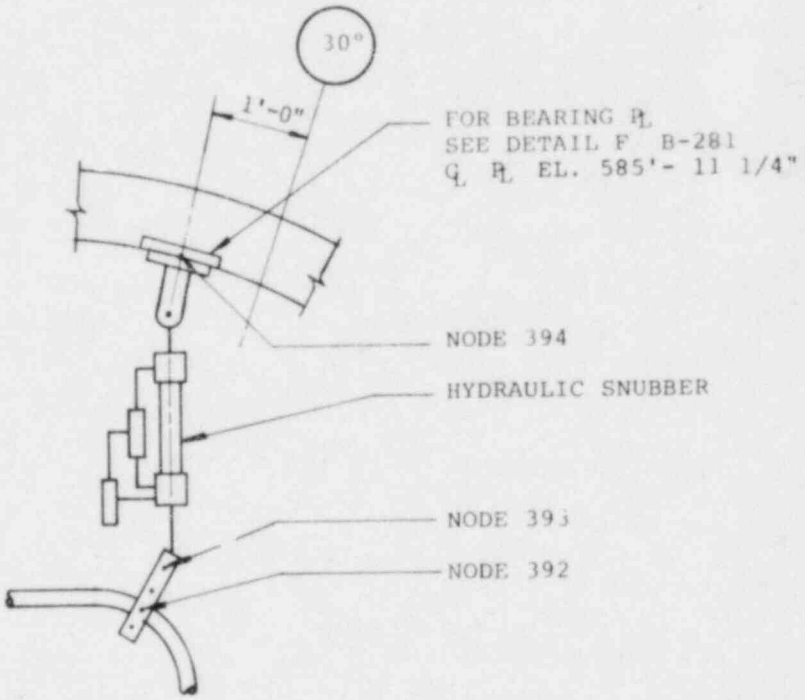
ELEVATION VIEW
CONSTANT SUPPORT HANGER RCH-1003
SUPPORT LOAD = 6800 LBS.
PIPE NODE 389, SUPPORT NODE 390
(NOT INCLUDED IN SEISMIC MODEL)
EXHIBIT 38



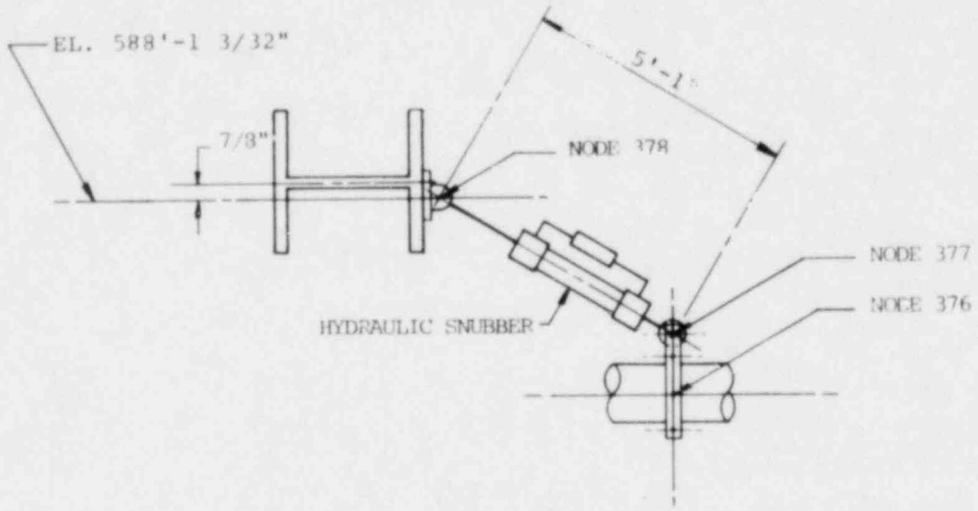
PLAN VIEW
ORIENTATION OF 1" SLOTTED CONNECTION



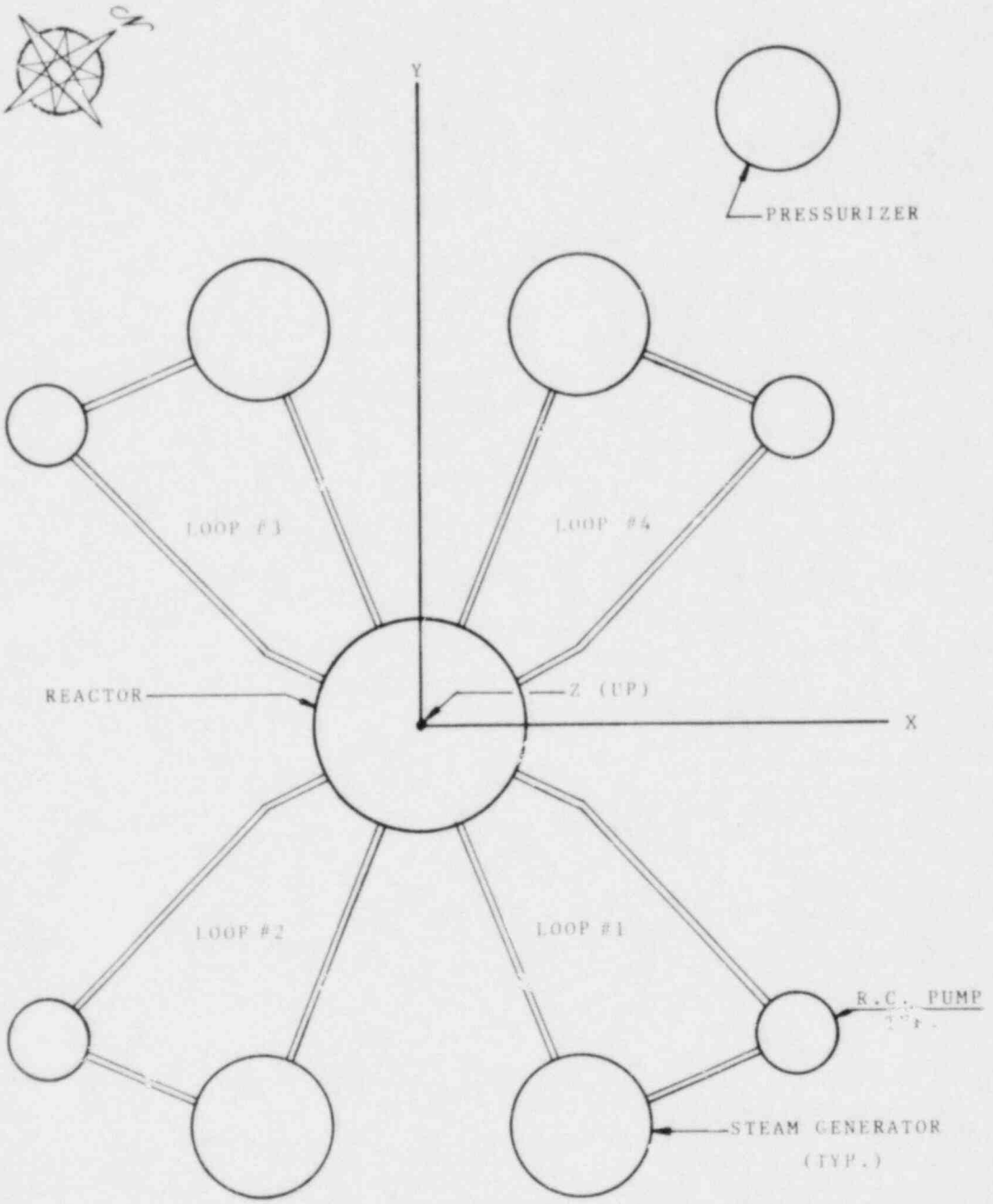
ELEVATION VIEW
SWAY STRUT ASSEMBLY RCRS-1008
SEISMIC DESIGN FORCE = 10,850 LBS.
EXHIBIT 39



PLAN VIEW
HYDRAULIC SEISMIC RESTRAINT RCRS-1007
SEISMIC DESIGN FORCE = 7800 LBS.
EXHIBIT 10



ELEVATION VIEW
HYDRAULIC SEISMIC RESTRAINT RCRS-1009
SEISMIC DESIGN FORCE = 9750 LBS.
EXHIBIT 41



KEY PLAN AND GLOBAL COORDINATE SYSTEM
EXHIBIT 42

APPENDIX A

DYNAMIC INPUT DATA LISTING

```
ACE*LLL(1).M2/R1
     1      DYNAMIC REACTOR COOLANT LOOP MODEL, ZION STATION, 8-01-80
     2        416    4    0   90    1    1
     3          1                                    3.842    -9.508   584.0
     4          2                                    4.737   -11.724   584.
     5          3                                    5.632   -13.940   584.
     6          4                                    6.660   -16.484   584.0
     7          5                                    7.089   -17.546   584.0
     8          6                                    8.1195  -20.096   584.0
     9          7                                    9.150   -22.646   584.0
    10          8                                    9.862   -24.4105  584.422
    11          9                                   10.441   -25.843   585.609
    12         10    1    1    1    1    1    1     12.112   -29.979   568.0
    13         11    1    1    1    1    1    1      0.0     -34.873   588.091
    14         12    1    1    1    1    1    1     17.006   -42.091   588.091
    15         13                                   12.112   -29.979   588.091
    16         14                                   12.112   -29.979   591.817
    17         15                                   12.112   -29.979   598.468
    18         16                                   12.112   -29.979   610.775
    19         17                                   12.112   -29.979   615.250
    20         18    1    1    1    1    1    1      0.0     -34.873   615.250
    21         19    1    1    1    1    1    1     17.006   -42.091   615.250
    22         20                                   12.112   -29.979   622.271
    23         21                                   12.112   -29.979   628.671
    24         22                                    5.988   -36.432   631.344
    25         23                                   12.112   -29.979   640.713
    26         24                                   12.112   -29.979   649.521
    27         25                                   12.112   -29.979   652.854
    28         26                                   16.556   -29.590   585.609
    29         27                                   17.604   -29.4985  582.716
    30         28                                   17.694   -29.4985  578.1875
    31         29                                   17.898   -29.333   576.4654
    32         30                                   18.734   -28.825   575.0055
    33         31                                   21.467   -27.196   573.6875
    34         32                                   22.112   -26.812   573.6875
    35         33                                   22.971   -26.300   573.6875
    36         34                                   23.673   -25.882   573.6875
    37         35                                   24.317   -25.498   573.6875
    38         36                                   27.051   -23.8687  575.0055
    39         37                                   28.183   -23.194   578.1875
    40         38    1    1    1    1    1    1     28.183   -23.194   568.000
    41         39                                   28.183   -23.194   584.958
    42         40                                   28.183   -23.194   584.0
    43         41    1    1    1    1    1    1     33.302   -18.420   584.0
    44         42    1         1    1    1    1     32.957   -28.313   584.0
    45         43                                   28.183   -23.194   586.917
    46         44                                   28.183   -23.194   587.890
    47         45                                   28.183   -23.194   588.608
    48         46                                   28.183   -23.194   589.442
    49         47                                   28.183   -23.194   598.450
    50         48                                   25.432   -20.244   584.0
    51         49                                   23.5565  -18.2325  584.0
    52         50                                   23.5565  -18.2325  589.4045
    53         51                                   21.681   -16.221   584.0
    54         52                                   20.772   -15.246   584.0
    55         53                                   19.123   -13.479   584.0
    56         54                                   17.333   -11.559   584.0
    57         55                                   15.543    -9.639   584.0
```

58	56								14.171	-8.168	584.
59	57								12.800	-6.697	584.
60	58								11.428	-5.226	584.0
61	59								10.065	-4.272	584.0
62	60								3.430	-8.1895	584.0
63	61					1	1	1	3.430	-8.4895	581.875
64	62	1	1	1	1	1	1		0.0	-9.875	581.875
65	63	1	1	1	1	1	1		3.430	-8.4895	579.750
66	64								8.1195	-20.096	584.262
67	65	1	1	1	1	1	1		6.988	-36.432	631.344
68	66	1	1	1	1	1	1		5.988	-36.432	632.344
69	67	1	1	1	1	1	1		13.112	-29.979	652.854
70	68	1	1	1	1	1	1		12.112	-29.979	653.854
71	69	1	1	1	1	1	1		0.0	-40.0	560.0
72	100	1	1	1	1	1	1		0.0	-40.	600.0
73	101								-3.842	-9.508	584.0
74	102								-4.737	-11.724	584.
75	103								-5.632	-13.940	584.
76	104								-6.7145	-16.619	584.0
77	105								-7.089	-17.546	584.0
78	106								-8.1195	-20.096	584.0
79	107								9.150	-22.646	584.0
80	108								-9.862	-24.4105	584.422
81	109								-10.441	-25.843	585.609
82	110	1	1	1	1	1	1		-12.112	-29.979	568.0
83	111	1	1	1	1	1	1		-0.0	-34.873	588.091
84	112	1	1	1	1	1	1		-17.006	-42.091	588.091
85	113								-12.112	-29.979	588.091
86	114								-12.112	-29.979	591.817
87	115								-12.112	-29.979	558.468
88	116								-12.112	-29.979	610.775
89	117								-12.112	-29.979	615.250
90	118	1	1	1	1	1	1		-0.0	-34.873	615.250
91	119	1	1	1	1	1	1		-17.006	-42.091	615.250
92	120								-12.112	-29.979	622.271
93	121								-12.112	-29.979	629.671
94	122								-20.003	-34.087	631.344
95	123								-12.112	-29.979	640.713
96	124								-12.112	-29.979	649.521
97	125								-12.112	-29.979	652.854
98	126								-16.556	-29.590	585.609
99	127								-17.604	-29.4985	582.716
100	128								-17.604	-29.4985	578.1875
101	129								-17.898	-29.323	576.4654
102	130								-18.734	-28.825	575.0055
103	131								-21.467	-27.196	573.6875
104	132								-22.112	-26.812	573.6875
105	133								-22.971	-26.300	573.6875
106	134								-23.673	-25.882	573.6875
107	135								-24.317	-25.498	573.6875
108	136								-27.051	-23.8687	575.0055
109	137								-28.183	-23.194	578.1875
110	138	1	1	1	1	1	1		-28.183	-23.194	568.000
111	139								-28.183	-23.194	584.958
112	140								-28.183	-23.194	584.0
113	141	1	1	1	1	1			-33.302	-18.420	584.0
114	142	1	1	1	1	1	1		-32.957	-28.313	584.0
115	143								-28.183	-23.194	586.9[illegible]

116	144							-28.183	-23.194	587.890
117	145							-28.183	-23.194	588.608
118	146							-28.183	-23.194	589.442
119	147							-28.183	-23.194	598.450
120	148							-25.432	-20.244	584.0
121	149							-23.5565	-18.2325	584.0
122	150							-23.5565	-18.2325	589.4045
123	151							-21.681	-16.221	584.0
124	152							-20.772	-15.246	584.0
125	153							-19.123	-13.479	584.0
126	154							-17.333	-11.559	584.0
127	155							-15.543	-9.639	584.0
128	156							-14.171	-8.168	584.
129	157							-12.800	-6.697	584.
130	158							-11.428	-5.226	584.0
131	159							-10.065	-4.272	584.0
132	160							-8.428	-3.578	584.
133	161				1	1	1	8.428	-3.578	581.875
134	162	1	1	1	1	1	1	-9.947	0.0	581.875
135	163	1	1	1	1	1	1	-8.428	3.578	579.750
136	164							0.0	0.0	563.34
137	165							0.0	0.0	570.0
138	166							0.0	0.0	576.90
139	167							0.0	0.0	584.0
140	168							0.0	0.0	590.46
141	169	1	1		1	1	1	0.0	0.0	591.46
142	170							-8.1195	-20.096	588.262
143	171	1	1	1	1	1	1	-19.003	-34.087	631.344
144	172	1	1	1	1	1	1	-20.003	-34.087	632.344
145	173	1	1	1	1	1	1	-11.112	-29.979	652.854
146	174	1	1	1	1	1	1	-12.112	-29.979	653.854
147	175	1	1	1	1	1	1	0.0	-40.0	560.0
148	188	1	1	1	1	1	1	0.0	-40.0	560.0
149	189							8.428	-3.578	584.0
150	190							-3.430	-8.4895	584.0
151	191							-8.428	3.578	584.0
152	192							3.430	8.4895	584.0
153	193							7.364	-3.126	584.0
154	194							3.000	-7.417	584.0
155	195							-3.000	-7.417	584.0
156	196							-7.364	-3.126	584
157	197							-7.364	3.126	584.0
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159	199							3.000	7.417	584.0
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161	201							-3.842	9.508	584.0
162	202							-4.737	11.724	584.
163	203							-5.632	13.940	584.
164	204							-6.7145	16.619	584.0
165	205							-7.089	17.546	584.0
166	206							-8.1195	20.096	584.0
167	207							-9.150	22.646	584.0
168	208							-9.862	24.4105	584.422
169	209							-10.441	25.843	585.609
170	210	1	1	1	1	1	1	-12.112	29.979	568.0
171	211	1	1	1	1	1	1	-0.0	34.873	588.091
172	212	1	1	1	1	1	1	-17.006	42.091	583.091
173	213							-12.112	29.979	588.091

174	214							-12.112	29.979	591.817
175	215							-12.112	29.979	598.468
176	216							-12.112	29.979	610.775
177	217							-12.112	29.979	615.250
178	218	1	1	1	1	1	1	-0.0	34.873	615.250
179	219	1	1	1	1	1	1	-17.006	42.091	615.250
180	220							-12.112	29.979	622.271
181	221							-12.112	29.979	628.671
182	222							-18.347	36.324	631.544
183	223							-12.112	29.979	640.713
184	224							-12.112	29.979	649.521
185	225							-12.112	29.979	652.254
186	226							-16.556	29.590	585.609
187	227							-17.604	29.4985	582.716
188	228							-17.604	29.4985	578.1875
189	229							-17.898	29.323	576.4654
190	230							-18.734	28.825	575.0055
191	231							-21.467	27.196	573.6875
192	232							-22.112	26.812	573.6875
193	233							-22.971	26.300	573.6875
194	234							-23.673	25.882	573.6875
195	235							-24.317	25.498	573.6875
196	236							-27.051	23.8687	575.0055
197	237							-28.183	23.194	578.1875
198	238	1	1	1	1	1	1	-28.183	23.194	568.000
199	239							-28.183	23.194	584.958
200	240							-28.183	23.194	584.0
201	241	1	1	1	1	1	1	-33.302	18.420	584.0
202	242	1	1	1	1	1	1	-32.557	28.313	584.0
203	243							-28.183	23.194	586.917
204	244							-28.183	23.194	587.890
205	245							-28.183	23.194	588.608
206	246							-28.183	23.194	589.442
207	247							-28.183	23.194	590.450
208	248							-25.432	20.244	584.0
209	249							-23.5565	18.2325	584.0
210	250							-23.5565	18.2325	580.4045
211	251							-21.681	16.221	584.0
212	252							-20.772	15.246	584.0
213	253							-19.123	13.479	584.0
214	25							-17.333	11.559	584.0
215	255							-15.543	9.639	584.0
216	256							-14.171	8.168	584.
217	257							-12.800	6.697	584.
218	258							-11.428	5.226	584.0
219	259							-10.065	4.272	584.0
220	260							-3.430	8.4895	584.
221	261				1	1	1	-3.430	8.4895	581.875
222	262	1	1	1	1	1	1	0.0	9.875	581.875
223	263	1	1	1	1	1	1	-3.430	8.4895	579.750
224	264							-8.1195	20.096	588.262
225	265	1	1	1	1	1	1	-17.347	36.324	631.344
226	266	1	1	1	1	1	1	-18.347	36.324	632.344
227	267	1	1	1	1	1	1	-11.112	29.979	652.854
228	268	1	1	1	1	1	1	-12.112	29.979	653.854
229	269	1	1	1	1	1	1	0.0	40.0	560.0
230	291	1	1	1	1	1	1	0.0	40.	600.0
231	292							-8.1195	20.096	588.262

232	293	1	1	1	1	1	1	5.083	33.809	631.344
233	294	1	1	1	1	1	1	4.083	33.809	632.344
234	295	1	1	1	1	1	1	13.112	29.979	652.854
235	296	1	1	1	1	1	1	12.112	29.979	653.854
236	297							8.428	3.578	584.
237	298				1	1	1	8.428	3.578	581.875
238	299	1	1	1	1	1	1	9.947	0.0	581.875
239	300	1	1	1	1	1	1	3.428	3.578	579.750
240	301							3.842	9.508	584.0
241	302							4.737	11.724	584.
242	303							5.632	13.940	584.
243	304							6.527	16.156	584.0
244	305							7.089	17.546	584.0
245	306							8.1195	20.096	584.0
246	307							9.150	22.646	584.0
247	308							9.862	24.4105	584.422
[illegible]	309							10.441	25.843	585.609
249	310	1	1	1	1	1	1	12.112	29.979	568.0
250	311	1	1	1	1	1	1	0.0	34.873	588.091
251	312	1	1	1	1	1	1	17.006	42.091	588.091
252	313							12.112	29.979	588.091
253	314							12.112	29.979	591.817
254	315							12.112	29.979	598.468
255	316							12.112	29.979	610.775
256	317							12.112	29.979	615.250
257	318	1	1	1	1	1	1	0.0	34.873	615.250
258	319	1	1	1	1	1	1	17.006	42.091	615.250
259	320							12.112	29.979	622.271
260	321							12.112	29.979	628.671
261	322							4.083	33.809	631.344
262	323							12.112	29.979	640.713
263	324							12.112	29.979	649.521
264	325							12.112	29.979	652.854
265	326							13.556	29.590	585.609
266	327							17.604	29.4985	582.716
267	328							17.604	29.4985	578.1875
268	329							17.898	29.323	576.4654
269	330							18.734	28.825	575.0055
270	331							21.467	27.196	573.6875
271	332							22.112	26.812	573.6875
272	333							22.971	26.300	573.6875
273	334							23.673	25.882	573.6875
274	335							24.317	25.498	573.6875
275	336							27.051	23.8687	575.0055
276	337							28.183	23.194	578.1875
277	338	1	1	1	1	1	1	28.183	23.194	568.000
278	339							28.183	23.194	584.958
279	340							28.183	23.194	584.0
280	341	1	1	1	1	1	1	33.302	18.420	584.0
281	342	1	1	1	1	1	1	32.957	28.313	584.0
282	343							28.183	23.194	586.917
283	344							28.183	23.194	587.890
284	345							28.183	23.194	588.608
285	346							28.183	23.194	589.442
286	347							28.183	23.194	598.450
287	348							25.432	20.244	584.0
288	349							23.5565	18.2325	584.0
289	350							23.5565	18.2325	589.4045

290	351							21.681	16.221	584.0
291	352							20.772	15.246	584.0
292	353							19.123	13.479	584.0
293	354							17.333	11.559	584.0
294	355							15.543	9.639	584.0
295	356							14.171	8.168	584.
296	357							12.800	6.697	584.
297	358							11.428	5.226	584.0
298	359							10.065	4.272	584.0
299	360							4.470	16.987	584.0
300	361							2.684	17.7085	584.0
301	362							0.898	18.430	584.0
302	363							-1.753	20.5766	584.008
303	364							-2.750	23.8386	584.030
304	365	1	1	1	1	1	1	-2.750	23.8386	591.250
305	366							-2.750	24.500	584.035
306	367	1	1	1	1	1	1	0.0	24.500	584.035
307	368							-2.750	27.000	584.054
308	369							-2.750	29.500	584.0735
309	370	1	1	1	1	1	1	0.0	29.500	584.0735
310	371							-2.750	32.000	584.093
311	372							-2.750	34.500	584.112
312	373	1	1	1	1	1	1	0.0	34.500	584.112
313	374							-2.750	35.861	584.1125
314	375	1	1	1	1	1	1	-6.25	35.961	588.091
315	376							-2.681	36.750	584.1294
316	377				1	1	1	-2.681	36.750	585.1815
317	378	1	1	1	1	1	1	-2.681	40.918	588.091
318	379							-1.066	39.927	584.179
319	380	1	1	1	1	1	1	3.0	41.611	591.0
320	381							3.0	41.611	594.263
321	382							5.285	41.611	584.301
322	383							7.570	41.611	584.339
323	384							9.855	41.611	584.378
324	385							12.139	41.611	584.416
325	386							14.424	41.611	584.454
326	387							16.709	41.611	584.492
327	388							18.994	41.611	584.531
328	389							21.279	41.611	584.569
329	390	1	1	1	1	1	1	21.279	41.611	591.0
330	391							25.428	40.420	585.8294
331	392							26.027	39.922	586.338
332	393				1	1	1	26.852	40.437	585.9375
333	394	1	1	1	1	1	1	26.759	43.152	585.9375
334	395							27.112	37.496	588.7915
335	396							27.112	36.653	589.625
336	397							27.112	35.3884	591.5172
337	398							27.112	34.944	593.7496
338	399							27.112	34.944	594.917
339	400							27.112	34.944	596.917
340	401							27.112	34.944	598.170
341	402							27.112	34.944	594.67
342	403	1	1	1	1	1	1	27.112	34.944	568.0
343	404	1	1	1	1	1	1	31.227	32.104	594.67
344	405	1	1	1	1	1	1	29.952	33.059	594.67
345	406							27.112	34.944	599.70
346	407							27.112	34.944	606.63
347	408							27.112	34.944	613.57

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348   409                                                  27.112   34.944   620.50
349   410   1   1   1   1   1   1                        27.112   29.944   620.50
350   411   1   1   1   1   1   1                        32.112   34.944   620.50
351   412   1   1   1   1   1   1                        27.112   34.944   625.50
352   413                                                27.112   34.944   627.89
353   414                                                27.112   34.944   635.28
354   415                                                27.112   34.944   642.62
355   416                                                27.112   34.944   646.32
356     1   23   11
357     1   4.00E09          15.22          0.405                          SGUS RADIAL
358     2   4.00E09          15.22          1.803                          SGUS TANGENTIAL
359     3   4.00E09          15.22          0.195                          PULS TRANSLATE
360     4   4.00E09          15.22        0.00413                          PH RCH-1002
361     5   4.00E09          15.22        0.00173                          HS RCRS-1007
362     6   4.00E09          15.22         0.0123                          RS RCRS-1008
363     7   4.00E09          15.22        0.00322                          HS RCRS-1009
364     8   4.00E09          15.22          0.406                          RPV VERT SUPT
365     9   4.00E09          15.22          0.665                          RPV HORZ OUTLET
366    10   4.00E09          15.22          0.699                          RPV HORZ INLET
367    11   4.00E09            0.0          0.0522                         RPV VERT SPRING
368
369
370
371
372     1   17   18   2
373     2   17   19   1
374     3  117  113   2
375     4  117  119   1
376     5  217  218   2
377     6  217  219   1
378     7  317  318   2
379     8  317  319   1
380     9  409  410   3
381    10  409  411   3
382    11  380  381   4
383    12  393  394   5
384    13  374  375   6
385    14  377  378   7
386    15   61   63   8
387    16   61   62   9
388    17  161  162   8
389    18  161  162  10
390    19  261  263   8
391    20  261  262   9
392    21  238  300   8
393    22  298  299  10
394    23  168  169  11
395     2   37   13   0   2
396     1   4.00E09  0.26       15.22          15.22
397     2   4.00E09  0.26
398     1   1.125                             191.2        0.1        0.1
399     2   0.532                              35.4        0.1        0.1
400     3   0.454                              35.4        0.1        0.1
401     4   0.361                              45.3        0.1        0.1
402     5   0.306                              6.09        0.1        0.1
403     6   0.175                              6.09        0.1        0.1
404     7   0.481                             904.1        0.1        0.1
405     8   0.336                             1.626        0.1        0.1
```

```
  9   1.500                                            1.626      0.1        0.1
 10   0.001                                           10.37       0.1        0.1
 11   0.195                                            0.1642     0.1642     0.1642
 12   0.0417                                           0.000386   0.000778   0.000386
 13  20.3                                              7.6       28.7       28.7



  1   10   13   12   1   1                                            11     11
  2  110  113  112   1   1                                            11     11
  3  210  213  212   1   1                                            11     11
  4  310  313  312   1   1                                            11     11
  5   11   13   14   1   2                                            11     11
  6  111  113  114   1   2                                            11     11
  7  211  213  214   1   2                                            11     11
  8  311  313  314   1   2                                            11     11
  9   12   13   14   1   3                                            11     11
 10  112  113  114   1   3                                            11     11
 11  212  213  214   1   3                                            11     11
 12  312  313  314   1   3                                            11     11
 13   38   40   55   1   4                                            1,     11
 14  138  140  155   1   4                                            11     11
 15  238  240  255   1   4                                            11     11
 16  338  340  355   1   4                                            11     11
 17   40   41   47   1   5                                            11     11
 18  140  141  147   1   5                                             :     11
 19  240  241  247   1   5                                             1     11
 20  340  341  347   1   5                                            11     11
 21   40   42   47   1   6                                            11     11
 22  140  142  147   1   6                                            11     11
 23  240  242  247   1   6                                            11     11
 24  340  342  347   1   6                                            11     11
 25  402  403  405   1   7                                            11     11
 26  402  404  409   1   8                                            11     11
 27  402  405  409   1   9                                            11     11
 28  409  412  405   1  10                                        1   11     11
 29  266  267  364   2  11                                        111111
 30  364  370  371   2  11                                        111111
 31  372  373  374   2  11                                        111111
 32  392  393  391   1  12                                               111
 33  376  377  378   1  12                                               111
 34   60   64  200   1  13                                               111
 35  160  161  297   1  13                                               111
 36  260  261   60   1  13                                               111
 37  297  298  160   1  13                                               111
  9  264    7    1  25           1
  1        STM GEN, COLD LEG, SURGE LN + PRESS
             3.80E09   0.25
  2      1 RPV SHELL
             3.715E09   0.25
  3        HOT LEG
             3.73E09   0.25
  4        HOT LEG VALVE
              .86E09   0.25
  5        S. G. INLET NOZZLE
             3.79E09   0.25
  6        CROSS OVER LEG
             3.77E09   0.25
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464          7       P. C. PUMP MOTOR
465                    4.02E09   0.25
466          1    2.833     0.2083                          33.880   HOT LEG
467          2    3.027     0.2217                          38.476   CROSS-OVER LEG
 68          3    2.688     0.1983                          30.637   COLD LEG
469          4   11.328     0.3017                           0.0     STEAM GEN.-1
470          5   11.250     0.2344                           0.0     STEAM GEN.-2
471          6   12.948     0.3073                           0.0     STEAM GEN.-3
472          7   14.646     0.3025                           0.0     STEAM GEN.-4
473          8    8.740     0.3025                           0.0     STEAM GEN.-5
474          9    5.833     0.5000                           0.0     R C PUMP CASING
475         10    3.950     0.1205                           0.0     PUMP MOTOR STAND
476         11    4.000     0.1667                           0.0     PUMP MOTOR STAND
477         12    1.167     0.1172                           7.459   PRESSURE SURGE LINE
478         13    7.25      0.125                            0.0     PRESSURIZER SKIRT
479         14    7.50      0.250                            0.0     PRESURE LOWER HEAD
480         15    7.625     0.3125                           0.0     PRESSURIZER SHELL
481         16   16.033     0.8958                           0.0     RPV HEAD
482         17   15.858     0.7192                           0.0     RPV SHELL
483         18    3.083     0.3333                          51.663   STOP VALVE - HORZ
484         19    3.250     0.1667                                   STOP VALVE - VERT
485         20    3.047     0.2734                          44.538   HOT LEG ELBOW
486         21    3.135     0.2760                          46.509   CROSSOVER ELBOWS
487         22    7.372     0.5000                                   SG NOZZLE
488         23    6.500     0.4167                                   PUMP OUTLET
489         24    2.796     0.2525                          37.782   COLD LEG ELBOW
490         25   27.500     0.8923   200.                    0.0     RPV RADIAL MEMBERS
491
492
493
494
495
496        1T     1    2    3    1          3.1800.
497        2T     2    3    3    1          321800.
498        3T     3    4    3    1          321800.
499        4T     4    5    3    1          321800.
500        5T     5    6    3   18
501        6T     6    7    3   18
502        7B     7    8    3   20          321800.
503     4.5043    CC   9.150    -22.646     588.5043    0.04
504        8B     8    9    3   20          321800.
505     4.5043    CC   9.150    -22.646     588.5043    0.04
506        9T     9   13    5   22
507       10T    13   14    5    4
508       11T    14   15    1    4
509       12T    15   16    1    5
510       13T    15   17    1    5
511       14T    17   20    1    5
512       15T    20   21    1    6
513       16T    21   22    1   22
514       17T    21   23    1    7
515       18T    23   24    1    7
516       19T    24   25    1    8
517       20T    13   26    1   22
518       21B    26   27    6   21          321800.
519      4.500    TI  17.604    -23.4985    584.354     0.04
520       22T    27   28    6    2          321800.
521       23B    28   29    6   21          321800.
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522	22T	27	28	6	2		321800.	
523	23B	28	29	6	2		321800.	
524	4.500		CC	21.467		-27.196	578.1875	0.04
525	24B	29	30	6	21		321800.	
526	4.500		CC	21.467		-27.196	578.1875	0.04
527	25B	30	31	6	21		321800.	
528	4.500		CC	21.467		-27.196	578.1875	0.04
529	26T	31	32	6	2		321800.	
530	27T	32	33	6	2		321800.	
531	28T	33	34	6	2		321800.	
532	29T	34	35	6	2		321800.	
533	30B	35	36	6	21		321800.	
534	4.5		CC	24.317		-25.498	578.1875	0.04
535	31B	36	37	6	21		321800.	
536	4.5		CC	24.317		-25.498	578.1875	0.04
537	32T	37	40	6	9			
538	33T	40	39	6	9			
539	34T	39	43	6	9			
540	35T	43	44	7	10			
541	36T	44	45	7	11			
542	37T	45	46	7	10			
543	38T	46	47	7	9			
544	39T	40	48	8	23			
545	40T	48	49	8	18			
546	41T	49	50	8	19			
547	42T	49	51	8	18			
548	43T	51	52	8	3		321800.	
549	44T	52	53	8	3		321800.	
550	45T	53	54	8	3		321800.	
551	46T	54	55	8	3		321800.	
552	47T	55	56	8	3		321800.	
553	48T	56	57	8	3		321800.	
554	49T	57	58	8	3		321800.	
555	50B	58	59	8	24		321800.	
556	4.005		CC	8.500		-7.359	584.0	0.04
557	51T	101	102	3	1		321800.	
558	52T	102	103	3	1		321800.	
559	53T	103	104	3	1		321800.	
560	54T	104	105	3	1		321800.	
561	55T	105	106	3	18			
562	56T	106	107	3	18			
563	57B	107	108	3	20		321800.	
564	4.5043		CC	-9.150		-22.646	588.5043	0.04
565	58B	108	109	3	20		321800.	
566	4.5043		CC	-9.150		-22.646	588.5043	0.04
567	59T	109	113	5	22			
568	60T	113	114	1	4			
569	61T	114	115	1	4			
570	62T	115	116	1	5			
571	63T	116	117	1	5			
572	64T	117	120	1	5			
573	65T	120	121	1	6			
574	66T	121	122	1	22			
575	67T	121	123	1	7			
576	68T	123	124	1	7			
577	69T	124	125	1	8			
578	70T	113	126	1	22			
579	71B	126	127	6	21		321800.	

3306

580		73B	128	129	6	21		321800.	
581		4.500		CC	-21.467		-27.196	578.1875	0.04
582		74B	129	130	6	21		321800.	
583		4.500		CC	-21.467		-27.196	578.1875	0.04
584		75B	130	131	6	21		321800.	
585		4.500		CC	-21.467		-27.196	578.1875	0.04
586		76T	131	132	6	2		321800.	
587		77T	132	133	6	2		321800.	
588		78T	133	134	6	2		321800.	
589		79T	134	135	6	2		321800.	
590		80B	135	136	6	21		321800.	
591		4.5		CC	-24.317		-25.498	578.1875	0.04
592		81B	136	137	6	21		321800.	
593		4.5		CC	-24.317		-25.498	578.1875	0.04
594		82T	137	140	6	9			
595		83T	140	139	6	9			
596		84T	139	143	6	9			
597		85T	143	144	7	10			
598		86T	144	145	7	11			
599		87T	145	146	7	10			
600		88T	146	147	7	9			
601		89T	140	148	1	2[illegible]			
602		90T	148	149	1	18			
603		91T	149	150	1	19			
604		92T	149	151	1	18			
605		93T	151	152	1	3		321800.	
606		94T	152	153	1	3		321800.	
607		95T	153	154	1	3		321800.	
608		96T	154	155	1	3		321800.	
609		97T	155	156	1	3		321800.	
610		98T	156	157	1	3		321800.	
611		99T	157	158	1	3		321800.	
612		100B	158	159	1	24		321800.	
613		4.005		CC	-8.500		-7.959	584.	0.04
614		101T	201	202	3	1		321800.	
615		102T	202	203	3	1		321800.	
616		103T	203	204	3	1		321800.	
617		104T	204	205	3	1		321800.	
618		105T	205	206	3	18			
619		106T	206	207	3	18			
620		107B	207	208	3	20		321800.	
621		4.5043		CC	-9.150		22.646	588.5043	0.04
622		108B	208	209	3	20		321800.	
623		4.5043		CC	-9.150		22.646	588.5043	0.04
624		109T	209	213	5	22			
625		110T	212	214	1	4			
626		111T	214	215	1	4			
627		112T	215	216	1	5			
628		113T	216	217	1	5			
629		114T	217	220	1	5			
630		115T	220	221	1	6			
631		116T	221	222	1	22			
632		117T	221	223	1	7			
633		118T	223	224	1	7			
634		119T	224	225	1	8			
635		120T	213	226	1	22			
636		121B	226	227	6	21		321800.	
637		4.500		TI	-17.604		29.4985	584.354	0.04

522	4.500		CC	21.467		-27.196	578.1875	0.04
523	24B	29	30	6	21		321800.	
524	4.500		CC	21.467		-27.196	578.1875	0.04
525	25B	30	31	6	21		321800.	
526	4.500		CC	21.467		-27.196	578.1875	0.04
527	26T	31	32	6	2		321800.	
528	27T	32	33	6	2		321800.	
529	28T	33	34	6	2		321800.	
530	29T	34	35	6	2		321800.	
531	30B	35	36	6	21		321800.	
532	4.5		CC	24.317		-25.498	578.1875	0.04
533	31B	36	37	6	21		321800.	
534	4.5		CC	24.317		-25.498	578.1875	0.04
535	32T	37	40	6	9			
536	33T	40	39	6	9			
537	34T	39	43	6	9			
538	35T	43	44	7	10			
539	36T	44	45	7	11			
540	37T	45	46	7	10			
541	38T	46	47	7	9			
542	39T	40	48	1	23			
543	40T	48	49	1	18			
544	41T	49	50	1	19			
545	42T	49	51	1	18			
546	43T	51	52	1	3		321800.	
547	44T	52	53	1	3		321800.	
548	45T	53	54	1	3		321800.	
549	46T	54	55	1	3		321800.	
550	47T	55	56	1	3		321800.	
551	48T	56	57	1	3		321800.	
552	49T	57	58	1	3		321800.	
553	50B	58	59	1	24		321800.	
554	4.005		CC	8.500		-7.959	584.0	0.04
555	51T	101	102	3	1		321800.	
556	52T	102	103	3	1		321800.	
557	53T	103	104	3	1		321800.	
558	54T	104	105	3	1		321800.	
559	55T	105	106	3	18			
560	56T	106	107	3	18			
561	57B	107	108	3	20		321800.	
562	4.5043		CC	-9.150		-22.646	588.5043	0.04
563	58B	108	109	3	20		321800.	
564	4.5043		CC	-9.150		-22.646	588.5043	0.04
565	59T	109	113	5	22			
566	60T	113	114	1	4			
567	61T	114	115	1	4			
568	62T	115	116	1	5			
569	63T	116	117	1	5			
570	64T	117	120	1	5			
571	65T	120	121	1	6			
572	66T	121	122	1	22			
573	67T	121	123	1	7			
574	68T	123	124	1	7			
575	69T	124	125	1	8			
576	70T	113	126	1	22			
577	71B	126	127	6	21		321800.	
578	4.500		TI	-17.604		-29.4985	584.254	0.04
579	72T	127	128	6	2		321800.	

580	4.500		TI	-17.604		-29.4985	584.354	0.04
581	72T	127	128	6	2		321800.	
582	73B	128	129	6	21		321800.	
583	4.500		CC	-21.467		-27.196	578.1875	0.04
584	74B	129	130	6	21		321800.	
585	4.500		CC	-21.467		-27.196	578.1875	0.04
586	75B	130	131	6	21		321800.	
587	4.500		CC	-21.467		-27.196	578.1875	0.04
588	76T	131	132	6	2		321800.	
589	77T	132	133	6	2		321800.	
590	78T	133	134	6	2		321800.	
591	79T	134	135	6	2		321800.	
592	80B	135	136	6	21		321800.	
593	4.5		CC	-24.317		-25.498	578.1875	0.04
594	81B	136	137	6	21		321800.	
595	4.5		CC	-24.317		-25.498	578.1875	0.04
596	82T	137	140	6	9			
597	83T	140	139	6	9			
598	84T	139	143	6	9			
599	85T	143	144	7	10			
600	86T	144	145	7	11			
601	87T	145	146	7	10			
602	88T	146	147	7	9			
603	89T	140	148	8	23			
604	90T	148	149	8	18			
605	91T	149	150	8	19			
606	92T	149	151	8	18			
607	93T	151	152	8	3		321800.	
608	94T	152	153	8	3		321800.	
609	95T	153	154	8	3		321800.	
610	96T	154	155	8	3		321800.	
611	97T	155	156	8	3		321800.	
612	98T	156	157	8	3		321800.	
613	99T	157	158	8	3		321800.	
614	100B	158	159	8	24		321800.	
615	4.005		CC	-8.500		-7.959	584.0	0.04
616	101T	201	202	3	1		321800.	
617	102T	202	203	3	1		321800.	
618	103T	203	204	3	1		321800.	
619	104T	204	205	3	1		321800.	
620	105T	205	206	3	18			
621	106T	206	207	3	18			
622	107B	207	208	3	20		321800.	
623	4.5043		CC	-9.150		22.646	588.5043	0.04
624	108B	208	209	3	20		321800.	
625	4.5043		CC	-9.150		22.646	588.5043	0.04
626	109T	209	213	5	22			
627	110T	213	214	1	4			
628	111T	214	215	1	4			
629	112T	215	216	1	5			
630	113T	216	217	1	5			
631	114T	217	220	1	5			
632	115T	220	221	1	6			
633	116T	221	222	1	22			
634	117T	221	223	1	7			
635	118T	223	224	1	7			
636	119T	224	225	1	8			
637	120T	213	226	1	22			

3306

638	122T	227	228	6	2		321800.		
639	123B	228	229	6	21		321800.		
640	4.500		CC	-21.467		27.196	578.1875	0.04	
641	124B	229	230	6	21		321800.		
642	4.500		CC	-21.467		27.196	578.1875	0.04	
643	125B	230	231	6	21		321800.		
644	4.500		CC	-21.467		27.196	578.1875	0.04	
645	126T	231	232	6	2		321800.		
646	127T	232	233	6	2		321800.		
647	128T	233	234	6	2		321800.		
648	129T	234	235	6	2		321800.		
649	130B	235	236	6	21		321800.		
650	4.5		CC	-24.317		25.498	578.1875	0.04	
651	131B	236	237	6	21		321800.		
652	4.5		CC	-24.317		25.498	578.1875	0.04	
653	132T	237	240	6	9				
654	133T	240	239	6	9				
655	134T	239	243	6	9				
656	135T	243	244	7	10				
657	136T	244	245	7	11				
658	137T	245	246	7	10				
659	138T	246	247	7	9				
660	139T	240	248	1	23				
661	140T	248	249	1	18				
662	141T	249	250	1	19				
663	142T	249	251	1	18				
664	143T	251	252	1	3		321800.		
665	144T	252	253	1	3		321800.		
666	145T	253	254	1	3		321800.		
667	146T	254	255	1	3		321800.		
668	147T	255	256	1	3		321800.		
669	148T	256	257	1	3		321800.		
670	149T	257	258	1	3		321800.		
671	150B	258	259	1	24		321800.		
672	4.005		CC	-8.500		7.959	584.0	0.04	
673	151T	301	302	3	1		321800.		
674	152T	302	303	3	1		321800.		
675	153T	303	304	3	1		321800.		
676	154T	304	305	3	1		321800.		
677	155T	305	306	3	18				
678	156T	306	307	3	18				
679	157B	307	308	3	20		321800.		
680	4.5043		CC	9.150		22.646	588.5043	0.04	
681	158B	308	309	3	20		321800.		
682	4.5043		CC	9.150		22.646	588.5043	0.04	
683	159T	309	313	5	22				
684	160T	313	314	1	4				
685	161T	314	315	1	4				
686	162T	315	316	1	5				
687	163T	316	317	1	5				
688	164T	317	320	1	5				
689	165T	320	321	1	6				
690	166T	321	322	1	22				
691	167T	321	323	1	7				
692	168T	323	324	1	7				
693	169T	324	325	1	8				
694	170T	313	326	1	22				
695	171B	326	327	6	21		321800.		

696	4.500	TI	17.604	29.4985	584.354	0.04
697	172T 327	328	6 2		321800.	
698	173B 328	329	6 21		321800.	
699	4.500	CC	21.467	27.196	578.1875	0.04
700	174B 329	330	6 21		321800.	
701	4.500	CC	21.467	27.196	578.1875	0.04
702	175B 330	331	6 21		321800.	
703	4.500	CC	21.467	27.196	578.1875	0.04
704	176T 331	332	6 2		321800.	
705	177T 332	333	6 2		321800.	
706	178T 333	334	6 2		321800.	
707	179T 334	335	6 2		321800.	
708	180B 335	336	6 21		321800.	
709	4.5	CC	24.317	25.498	578.1875	0.04
710	181B 336	337	6 21		321800.	
711	4.5	CC	24.317	25.498	578.1875	0.04
712	182T 337	340	6 9			
713	183T 340	339	6 9			
714	184T 339	343	6 9			
715	185T 343	344	7 10			
716	186T 344	345	7 11			
717	187T 345	346	7 10			
718	188T 346	347	7 9			
719	189T 340	348	1 23			
720	190T 348	349	1 18			
721	191T 349	350	1 19			
722	192T 349	351	1 18			
723	193T 351	352	1 3		321800.	
724	194T 352	353	1 3		321800.	
725	195T 353	354	1 3		321800.	
726	196T 354	355	1 3		321800.	
727	197T 355	356	1 3		321800.	
728	198T 355	357	1 3		321800.	
729	199T 357	358	1 3		321800.	
730	200B 358	359	1 24		321800.	
731	4.005	CC	8.500	7.959	584.0	0.04
732	201T 304	360	1 12		321800.	
733	202T 360	361	1 12		321800.	
734	203T 361	362	1 12		321800.	
735	204B 362	363	1 12		321800.	
736	5.833	CC	3.083	23.8386	584.048	0.07
737	205B 363	364	1 12		321800.	
738	5.833	CC	3.083	23.8386	584.048	0.07
739	206T 364	366	1 12		321800.	
740	207T 366	368	1 12		321800.	
741	208T 368	369	1 12		321800.	
742	209T 369	371	1 12		321800.	
743	210T 371	372	1 12		321800.	
744	211T 372	374	1 12		321800.	
745	212B 374	376	1 12		321800.	
746	5.750	CC	3.000	35.861	584.209	0.07
747	213B 376	379	1 12		321800.	
748	5.75	CC	3.0	35.861	584.209	0.07
749	214B 379	381	1 12		321800.	
750	5.75	CC	3.0	35.861	584.209	0.07
751	215T 381	382	1 12		321800.	
752	216T 382	383	1 12		321800.	
753	217T 383	384	1 12		321800.	

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754      218T  384  385    1   12                321800.
755      219T  385  386    1   12                321800.
756      220T  386  387    1   12                321800.
757      221T  387  388    1   12                321800.
758      222T  388  389    1   12                321800.
759      223B  389  391    1   12                321800.
760        5.83333   CC  21.279     37.486  588.694      0.07
761      224B  391  392    1   12                321800.
762        5.83333   CC  21.279     37.486  588.694      0.07
763      225B  392  395    1   12                321800.
764        5.83333   CC  21.279     37.486  588.694      0.07
765      226T  395  396    1   12                321800.
766      227B  396  397    1   12                321800.
767        5.83333   CC  27.112     40.77733 593.7496    0.07
768      228B  397  398    1   12                321800.
769        5.83333   CC  27.112     40.77733 593.7496    0.07
770      229T  398  399    1   12                321800.
771      230T  399  400    1   12                321800.
772      231T  400  401    1   14
773      232T  401  402    1   13
774      233T  401  405    1   14
775      234T  406  407    1   15
776      235T  407  408    1   15
777      236T  408  409    1   15
778      237T  409  413    1                321800.    15
779      238T  413  414    1   15
780      239T  414  415    1   15
781      240T  415  416    1   15
782      241T    1   60    2    1
783      242T  194  167    2   25
784      243T  193  167    2   25
785      244T  195  167    2   25
786      245T  159  160    2    3
787      246T  196  167    2   25
788      247T  201  260    2    1
789      248T  198  167    2   25
790      249T  197  167    2   25
791      250T  199  167    2   25
792      251T  359  297    2    3
793      252T  200  167    2   25
794      253T  164  165    2   17
795      254T  165  166    2   17
796      255T  166  167    2   17
797      256T  167  168    2   16
798      257T    6   64    4   19
799      258T  106  170    4   19
800      259T  206  264    4   19
801      260T  306  292    4   19
802      261T   59  189    2    3
803      262T  101  190    2    1
804      263T  259  191    2    3
805      264T  301  292    2    1
806        10   16   16    0
807         ;   60  194  168
808          3.460E08        0.0          0.0          0.0          0.0          0.0
809          0.0             1.200E10     0.0          0.0          0.0          0.0
810          0.0             0.0          1.200E10     0.0          0.0          0.0
811          0.0             0.0          0.0          8.333E10     0.0          0.0
```

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812      0.0           0.0           0.0           0.0           3.663E09      0.0
813      0.0           0.0           0.0           0.0           0.0           4.757E09
814    2  189  193  168
815      3.460E08      0.0           0.0           0.0           0.0           0.0
816      0.0           1.200E10      0.0           0.0           0.0           0.0
817      0.0           0.0           1.200E10      0.0           0.0           0.0
818      0.0           0.0           0.0           8.333E10      0.0           0.0
819      0.0           0.0           0.0           0.0           4.225E09      0.0
820      0.0           0.0           0.0           0.0           0.0           5.868E09
821    3  190  195  168
822      3.460E08      0.0           0.0           0.0           0.0           0.0
823      0.0           1.200E10      0.0           0.0           0.0           0.0
824      0.0           0.0           1.200E10      0.0           0.0           0.0
825      0.0           0.0           0.0           8.333E10      0.0           0.0
826      0.0           0.0           0.0           0.0           3.663E09      0.0
827      0.0           0.0           0.0           0.0           0.0           4.757E09
828    4  160  196  168
829      3.460E08      0.0           0.0           0.0           0.0           0.0
830      0.0           1.200E10      0.0           0.0           0.0           0.0
831      0.0           0.0           1.200E10      0.0           0.0           0.0
832      0.0           0.0           0.0           8.333E10      0.0           0.0
833      0.0           0.0           0.0           0.0           4.225E09      0.0
834      0.0           0.0           0.0           0.0           0.0           5.868E09
835    5  260  198  168
836      3.460E08      0.0           0.0           0.0           0.0           0.0
837      0.0           1.200E10      0.0           0.0           0.0           0.0
838      0.0           0.0           1.200E10      0.0           0.0           0.0
839      0.0           0.0           0.0           8.333E10      0.0           0.0
840      0.0           0.0           0.0           0.0           3.663E09      0.0
841      0.0           0.0           0.0           0.0           0.0           4.757E09
842    6  191  197  168
843      3.460E08      0.0           0.0           0.0           0.0           0.0
844      0.0           1.200E10      0.0           0.0           0.0           0.0
845      0.0           0.0           1.200E10      0.0           0.0           0.0
846      0.0           0.0           0.0           8.333E10      0.0           0.0
847      0.0           0.0           0.0           0.0           4.225E09      0.0
848      0.0           0.0           0.0           0.0           0.0           5.868E09
849    7  192  199  168
850      3.460E08      0.0           0.0           0.0           0.0           0.0
851      0.0           1.200E10      0.0           0.0           0.0           0.0
852      0.0           0.0           1.200E10      0.0           0.0           0.0
853      0.0           0.0           0.0           8.333E10      0.0           0.0
854      0.0           0.0           0.0           0.0           3.663E09      0.0
855      0.0           0.0           0.0           0.0           0.0           4.757E09
856    8  297  200  168
857      3.460E08      0.0           0.0           0.0           0.0           0.0
858      0.0           1.200E10      0.0           0.0           0.0           0.0
859      0.0           0.0           1.200E10      0.0           0.0           0.0
860      0.0           0.0           0.0           8.333E10      0.0           0.0
861      0.0           0.0           0.0           0.0           4.225E09      0.0
862      0.0           0.0           0.0           0.0           0.0           5.868E09
863    9   22   65   66
864    19404.        20580.        6492.         -58212.       178788.       -48808.
865    20580.        56808.        108.          -135898.      72900.        -674780.
866    6492.         108.          29544.        -171116.      588484.       13518.
867    -58212.       -135898.      -171116.      5908900.      -3263300.     1589600.
868    178788.       72900.        588484.       -3263300.     14891000.     -102600.
869    -48808.       -674780.      13518.        1589600.      -102600.      14531900.
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870	10 122	171 172				
871	12768.	18984.	-1980	-35804.	14210.	235910.
872	18984.	165684.	-22440.	-187978.	-92180.	-586549.
873	-1980.	-22440.	15468.	-309986.	53412.	102876.
874	-35804.	-187978.	-309986.	12901200.	-1227100.	174400.
875	14210.	-92180.	53412.	-1227100.	4169960	1108800.
876	235910.	-586549.	102876.	174400.	1108800.	14050000.
877	11 222	265 266				
878	13188.	15444.	1236.	42012.	-18570.	323694.
879	15444.	169080.	24924.	170180.	52218.	-246888.
880	1236.	24924.	16728.	-336704.	22126.	-72802.
881	42012.	170180.	-336704.	13932300.	-577600.	651050.
882	-18570.	52218.	22126.	-577600.	4123400.	-845000.
883	323694.	-246888.	-72802.	651050.	-845000.	13939400.
884	12 322	293 294				
885	20676.	23652.	-8664.	127478.	-256200.	-6380.
886	23652.	93480.	12564.	396780.	29522.	-845712.
887	-8664.	12564.	44268.	-219800.	712090.	-130176.
888	127478.	396780.	-219800.	8604200.	-3814800.	-3611600.
889	-256200.	29522.	712090.	-3814800.	15377100.	-1731100.
890	-6380.	-845712.	-130176.	-3611600.	-1731100.	14553700.
891	13 25	67 68				
892	91860.	66876.	-13644.	-429214.	858576.	1503722.
893	66876.	554148.	-234396.	-2154049.	1859586.	82476.
894	-13644.	-234396.	144180.	228710.	-430212.	-3012.
895	-429214.	-2154049.	228710.	31110600.	-11929300.	-530500.
896	858576.	1859586.	-430212.	-11929300.	30302000.	12537000.
897	1503722.	82476.	-3012.	-530500.	12537000.	42928800.
898	14 125	173 174				
899	153408.	267468.	-22944.	351478.	-10806.	-736684.
900	267468.	828180.	-63960.	626594.	-394224.	-4860490.
901	-22944.	-63960.	87216.	-1317422.	1111702.	269682.
902	351478.	626594.	-1317422.	40066700.	-14747800.	-1867800.
903	-10806.	-394224.	1111702.	-14747800.	29753900.	1786900.
904	-736684.	-4860490.	269682.	-1867800.	1786900.	53506900.
905	15 225	267 268				
906	127320.	207876.	30648.	-174980.	-208898.	-385678.
907	207876.	876912.	125028.	-226622.	613482.	-5187196.
908	30648.	125028.	114788.	-1605012.	1160124.	-672490.
909	-174980.	-226622.	-1605012.	46219800.	-15418900.	880200.
910	-208898.	613482.	1160124.	-15418900.	31729300.	-4835200.
911	-385678.	-5187196.	-672490.	880200.	-4835200.	58224100.
912	16 325	295 296				
913	99132.	93984.	27708.	547512.	-1050592.	1630488.
914	93984.	273180.	83736.	1590514.	-1132078.	487414.
915	27708.	83736.	96912.	-514292.	-394402.	124126.
916	547512.	1590514.	-514292.	37382800.	-6585600.	2842600.
917	-1050592.	-1132078.	-394402.	-6585600.	36358300.	-14342400.
918	1630488.	487414.	124126.	2842600.	-14342400.	47589000.
919	6	120.9	120.9	120.9		
920	13	2302.9	2302.9	2302.9		
921	14	2140.65	2140.65	2140.65		
922	16	11184.6	11184.6	11184.6		
923	21	5580.4	5580.4	5580.4		
924	23	3347.4	3347.4	3347.4		
925	24	1421.55	1421.55	1421.55		
926	39	2972.	2972.	2972.		
927	47	2391.	2391.	2391.		

928	49	111.7	111.7	111.7	
929	50	414.84	414.84	414.84	
930	64	438.1	438.1	438.1	
931	106	120.9	120.9	120.9	
932	113	2302.9	2302.9	2302.9	
933	114	2140.65	2140.65	2140.65	
934	116	11184.6	11184.6	11184.6	
935	121	5580.4	5580.4	5580.4	
936	123	3347.4	3347.4	3347.4	
937	124	1421.55	1421.55	1421.55	
938	139	2972.	2972.	2972.	
939	147	2391.	2391.	2391.	
940	149	111.7	111.7	111.7	
941	150	414.84	414.84	414.84	
942	164	14366.	14366.	0.0	
943	166	16460.	16460.	0.0	
944	168	21665.	21665.	48326.	2432712
945	169	0.0	0.0	13196.	
946	170	438.1	438.1	438.1	
947	206	120.9	120.9	120.9	
948	213	2302.9	2302.9	2302.9	
949	214	2140.65	2140.65	2140.65	
950	216	11184.6	11184.6	11184.6	
951	221	5580.4	5580.4	5580.4	
952	223	3347.4	3347.4	3347.4	
953	224	1421.55	1421.55	1421.55	
954	239	2972.	2972.	2972.	
955	247	2391.	2391.	2391.	
956	249	111.7	111.7	111.7	
957	250	414.84	414.84	414.84	
958	264	438.1	438.1	438.1	
959	292	438.1	438.1	438.1	
960	306	120.9	120.9	120.9	
961	313	2302.9	2302.9	2302.9	
962	314	2140.65	2140.65	2140.65	
963	316	11184.6	11184.6	11184.6	
964	321	5580.4	5580.4	5580.4	
965	323	3347.4	3347.4	3347.4	
966	324	1421.55	1421.55	1421.55	
967	339	2972.	2972.	2972.	
968	347	2391.	2391.	2391.	
969	349	111.7	111.7	111.7	
970	350	414.84	414.84	414.84	
971	406	2224.0	2224.0	2224.0	
972	409	3673.76	3673.76	3673.76	
973	415	1370.5	1370.5	1370.5	
974					
975					
976	1		50.0		
977					
978					

APPENDIX B

STATIC INPUT DATA LISTING

```
ACE*LLL(1).WT2/R1
     1       STATIC REACTOR COOLANT LOOP MODEL. ZION STATION. 8-01-80
     2         416   4     3     0     0     0                                  75000
     3           1                                  3.842     -9.508   584.0          524.2
     4           2                                  4.737    -11.724   584.           524.2
     5           3                                  5.632    -13.940   584.           524.2
     6           4                                  6.660    -16.484   584.0          524.2
     7           5                                  7.089    -17.546   584.0          524.2
     8           6                                  8.1195   -20.096   584.0          524.2
     9           7                                  9.150    -22.646   584.0          524.2
    10           8                                  9.862    -24.4105  584.422        524.2
    11           9                                 10.441    -25.843   585.609        492.2
    12          10   1     1     1     1     1     1 12.112   -29.979   568.0
    13          11   1     1     1     1     1     1  0.0     -34.873   588.091
    14          12   1     1     1     1     1     1 17.006   -42.091   588.091
    15          13                                 12.112    -29.979   588.091        492.2
    16          14                                 12.112    -29.979   591.817        492.2
    17          15                                 12.112    -29.979   598.468        492.2
    18          16                                 12.112    -29.979   610.775        492.2
    19          17                                 12.112    -29.979   615.250        492.2
    20          18   1     1     1     1     1     1  0.0     -34.873   615.250
    21          19   1     1     1     1     1     1 17.006   -42.091   615.250
    22          20                                 12.112    -29.979   622.271        492.2
    23          21                                 12.112    -29.979   628.671        492.2
    24          22                                  5.988    -35.432   631.344        492.2
    25          23                                 12.112    -29.979   640.713        492.2
    26          24                                 12.112    -29.979   649.521        492.2
    27          25                                 12.112    -29.979   652.854        492.2
    28          26                                 16.556    -29.590   585.609        492.2
    29          27                                 17.604    -29.4985  582.716        460.2
    30          28                                 17.604    -29.4985  573.1875       460.2
    31          29                                 17.898    -29.323   576.4654       460.2
    32          30                                 18.734    -28.825   575.0055       460.2
    33          31                                 21.467    -27.196   573.6875       460.2
    34          32                                 22.112    -26.812   573.6875       460.2
    35          33                                 22.971    -26.300   573.6875       460.2
    36          34                                 23.673    -25.882   573.6875       460.2
    37          35                                 24.317    -25.498   573.6875       460.2
    38          36                                 27.051    -23.8687  575.0055       460.2
    39          37                                 28.183    -23.194   578.1875       460.2
    40          38   1     1     1     1     1     1 28.183   -23.194   568.000
    41          39                                 28.183    -23.194   584.958        460.2
    42          40                                 28.183    -23.194   584.0          460.2
    43          41   1     1     1     1     1     1 33.302   -18.420   584.0
    44          42   1     1     1     1     1     1 32.957   -28.313   584.0
    45          43                                 28.183    -23.194   586.917        460.2
    46          44                                 28.183    -23.194   587.890         70.0
    47          45                                 28.183    -23.194   588.608         70.0
    48          46                                 28.183    -23.194   589.442         70.0
    49          47                                 28.183    -23.194   598.450         70.0
    50          48                                 25.432    -20.244   584.0          460.2
    51          49                                 23.5565   -18.2325  584.0          460.2
    52          50                                 23.5565   -18.23    589.4045       460.2
    53          51                                 21.681    -16.221   584.0          460.2
    54          52                                 20.772    -15.246   584.0          460.2
    55          53                                 19.123    -13.479   584.0          460.2
    56          54                                 17.333    -11.559   584.0          460.2
    57          55                                 15.543     -9.639   584.0          460.2
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58	56							14.171	-8.168	584.		460.2
59	57							12.800	-6.697	584.		460.2
60	58							11.428	-5.226	584.0		460.2
61	59							10.065	-4.272	584.0		460.2
62	60							3.430	-8.4895	584.0		460.2
63	61				1	1	1	3.430	-8.4895	581.875		460.2
64	62	1	1	1	1	1	1	0.0	-9.875	581.875		
65	63	1	1	1	1	1	1	3.430	-8.4895	579.750		
66	64							8.1195	-20.096	588.262		
67	65	1	1	1	1	1	1	5.988	-36.432	631.344		
68	66	1	1	1	1	1	1	5.988	-36.432	632.344		
69	67	1	1	1	1	1	1	13.112	-29.979	652.854		
70	68	1	1	1	1	1	1	12.112	-29.979	653.854		
71	69	1	1	1	1	1	1	0.0	-40.0	560.0		
72	100	1	1	1	1	1	1	0.0	-40.	600.0	1	
73	101							-3.842	-9.508	584.0		524.2
74	102							-4.737	-11.724	584.		524.2
75	103							5.632	-13.940	584.		524.2
76	104							-6.7145	-16.619	584.0		524.2
77	105							-7.089	-17.546	584.0		524.2
78	106							-8.1195	-20.096	584.0		524.2
79	107							-9.150	-22.646	584.0		524.2
80	108							-9.862	-24.4105	584.422		524.2
81	109							10.441	-25.843	585.609		492.2
82	110	1	1	1	1	1	1	-12.112	-29.979	568.0		
83	111	1	1	1	1	1	1	-0.0	-34.873	588.091		
84	112	1	1	1	1	1	1	-17.006	-42.091	588.091		
85	113							-12.112	-29.979	588.091		492.2
86	114							-12.112	-29.979	591.817		492.2
87	115							-12.112	-29.979	598.468		492.2
88	116							-12.112	-29.979	610.775		492.2
89	117							-12.112	-29.979	615.250		492.2
90	118	1	1	1	1	1	1	-0.0	-34.873	615.250		
91	119	1	1	1	1	1	1	-17.006	-42.091	615.250		
92	120							-12.112	-29.979	622.271		492.2
93	121							-12.112	-29.979	628.671		492.2
94	122							-20.003	-34.087	631.344		492.2
95	123							-12.112	-29.979	640.713		492.2
96	124							-12.112	-29.979	649.521		492.2
97	125							-12.112	-29.979	652.854		492.2
98	126							-16.556	-29.590	585.609		492.2
99	127							-17.604	-29.4985	582.716		460.2
100	128							-17.604	-29.4985	578.1875		460.2
101	129							-17.898	-29.323	576.4654		460.2
102	130							-18.734	-28.825	575.0055		460.2
103	131							-21.467	-27.196	573.6875		460.2
104	132							-22.112	-26.812	573.6875		460.2
105	133							-22.971	-26.300	573.6875		460.2
106	134							-23.673	-25.882	573.6875		460.2
107	135							-24.317	-25.498	573.6875		460.2
108	136							-27.051	-23.8687	575.0055		460.2
109	137							-28.183	-23.194	578.1875		460.2
110	138	1	1	1	1	1	1	-28.183	-23.194	568.000		
111	139							-28.183	-23.194	584.958		460.2
112	140							-28.183	-23.194	584.0		460.2
113	141	1	1	1	1	1	1	-33.302	-18.420	584.0		
114	142	1	1	1	1	1	1	-32.957	-28.313	584.0		
115	143							-28.183	-23.194	586.917		460.2

116	144							-28.183	-23.194	587.890		70.0
117	145							-28.183	-23.194	588.608		70.0
118	146							-28.183	-23.194	589.442		70.0
119	147							-28.183	-23.194	598.450		70.0
120	148							-25.432	-20.244	584.0		460.2
121	149							-23.5565	-18.2325	584.0		460.2
122	150							-23.5565	-18.2325	589.4045		460.2
123	151							-21.681	-16.221	584.0		460.2
124	152							-20.772	-15.246	584.0		460.2
125	153							-19.123	-13.479	584.0		460.2
126	154							-17.333	-11.559	584.0		460.2
127	155							-15.543	-9.639	584.0		460.2
128	156							-14.171	-8.168	584.		460.2
129	157							-12.800	-6.697	584.		460.2
130	158							-11.428	-5.226	584.0		460.2
131	159							-10.065	-4.272	584.0		460.2
132	160							-8.428	-3.578	584.		460.2
133	161				1	1	1	-8.428	-3.578	581.875		460.2
134	162	1	1	1	1	1	1	-9.947	0.0	581.875		
135	163	1	1	1	1	1	1	-8.428	-3.578	579.750		
136	164							0.0	0.0	563.34		460.2
137	165							0.0	0.0	570.0		460.2
138	166							0.0	0.0	576.90		460.2
139	167							0.0	0.0	584.0		460.2
140	168							0.0	0.0	590.46		460.2
141	169	1	1		1	1	1	0.0	0.0	591.46		460.2
142	170							-8.1195	-20.096	588.262		
143	171	1	1	1	1	1	1	-19.003	-34.087	631.344		
144	172	1	1	1	1	1	1	-20.003	-34.087	632.344		
145	173	1	1	1	1	1	1	-11.112	-29.979	652.854		
146	174	1	1	1	1	1	1	-12.112	-29.979	653.854		
147	175	1	1	1	1	1	1	0.0	-40.0	560.0		
148	188	1	1	1	1	1	1	0.0	-40.0	560.0	1	
149	189							8.428	-3.578	584.0		460.2
150	190							-3.430	-8.4895	584.0		524.2
151	191							-8.428	3.578	584.0		460.2
152	192							3.430	8.4895	584.0		524.2
153	193							7.364	-3.126	584.0		460.2
154	194							3.000	-7.417	584.0		460.2
155	195							-3.000	-7.417	584.0		460.2
156	196							-7.364	-3.126	584.0		460.2
157	197							-7.364	3.126	584.0		460.2
158	198							-3.000	7.417	584.0		460.2
159	199							3.000	7.417	584.0		460.2
160	200							7.364	3.126	584.0		460.2
161	201							-3.842	9.508	584.0		524.2
162	202							-4.737	11.724	584.		524.2
163	203							-5.632	13.940	584.		524.2
164	204							-6.7145	16.619	584.0		524.2
165	205							-7.089	17.546	584.0		524.2
166	206							-8.1195	20.096	584.0		524.2
167	207							-9.150	22.646	584.0		524.2
168	208							9.862	24.4195	584.422		524.2
169	209							-10.441	25.843	585.609		492.2
170	210	1	1	1	1	1	1	-12.112	29.979	568.0		
171	211	1	1	1	1	1	1	-0.0	34.873	588.091		
172	212	1	1	1	1	1	1	-17.006	42.091	588.091		
173	213							-12.112	29.979	588.091		492.2

174	214							-12.112	29.979	591.817		492.2
175	215							-12.112	29.979	598.468		492.2
176	216							-12.112	29.979	610.775		492.2
177	217							-12.112	29.979	615.250		492.2
178	218	1	1	1	1	1	1	-0.0	34.873	615.250		
179	219	1	1	1	1	1	1	-17.006	42.091	615.250		
180	220							-12.112	29.979	622.271		492.2
181	221							-12.112	29.979	628.671		492.2
182	222							-18.347	36.324	631.344		492.2
183	223							-12.112	29.979	640.713		492.2
184	224							-12.112	29.979	649.521		492.2
185	225							-12.112	29.979	652.854		492.2
186	226							-16.556	29.590	585.609		492.2
187	227							-17.604	29.4985	582.716		460.2
188	228							-17.604	29.4985	578.1875		460.2
189	229							-17.898	29.323	576.4654		460.2
190	230							-18.734	28.825	575.0055		460.2
191	231							-21.467	27.196	573.6875		460.2
192	232							-22.112	26.812	573.6875		460.2
193	233							-22.971	26.300	573.6875		460.2
194	234							-23.673	25.882	573.6875		460.2
195	235							-24.317	25.498	573.6875		460.2
196	236							-27.051	23.8687	575.0055		460.2
197	237							28.183	23.194	578.1875		460.2
198	238	1	1	1	1	1	1	-28.183	23.194	568.000		
199	239							-28.183	23.194	584.958		460.2
200	240							-28.183	23.194	584.0		460.2
201	241	1	1	1	1	1	1	-33.302	18.420	584.0		
202	242	1	1	1	1	1	1	-32.957	28.313	584.0		
203	243							-28.183	23.194	586.917		460.2
204	244							-28.183	23.194	587.890		70.0
205	245							-28.183	23.194	588.608		70.0
206	246							-28.183	23.194	589.442		70.0
207	247							-28.183	23.194	598.450		70.0
208	248							-25.432	20.244	584.0		460.2
209	249							-23.5565	18.2325	584.0		460.2
210	250							-23.5565	18.2325	589.4045		460.2
211	251							-21.681	16.221	584.0		460.2
212	252							-20.772	15.246	584.0		460.2
213	253							-19.123	13.479	584.0		460.2
214	254							-17.333	11.559	584.0		460.2
215	255							-15.543	9.639	584.0		460.2
216	256							-14.171	8.168	584.		460.2
217	257							-12.800	6.697	584.		460.2
218	258							-11.428	5.226	584.0		460.2
219	259							-10.065	4.272	584.0		460.2
220	260							-3.430	8.4895	584.		460.2
221	261				1	1	1	-3.430	8.4895	581.875		460.2
222	262	1	1	1	1	1	1	0.0	9.875	581.875		
223	263	1	1	1	1	1	1	-3.430	8.4895	579.750		
224	264							-8.1195	20.096	588.262		
225	265	1	1	1	1	1	1	-17.347	36.324	631.344		
226	266	1	1	1	1	1	1	-18.347	36.324	632.344		
227	267	1	1	1	1	1	1	-11.112	29.979	652.854		
228	268	1	1	1	1	1	1	-12.112	29.979	653.854		
229	269	1	1	1	1	1	1	0.0	40.0	560.0		
230	291	1	1	1	1	1	1	0.0	40	600.0	1	
231	292							8.1195	20.096	588.262		

232	293	1	1	1	1	1	1	5.083	33.809	631.344	
233	294	1	1	1	1	1	1	4.083	33.809	632.344	
234	295	1	1	1	1	1	1	13.112	29.979	652.854	
235	296	1	1	1	1	1	1	12.112	29.979	653.854	
236	297							8.428	3.578	584.	460.2
237	298				1	1	1	8.428	3.578	581.875	460.2
238	299	1	1	1	1		1	9.947	0.0	581.875	
239	300	1	1	1	1	1	1	8.428	3.578	579.750	
240	301							3.842	9.508	584.0	524.2
241	302							4.737	11.724	584.	524.2
242	303							5.632	13.940	584.	524.2
243	304							6.527	16.156	584.0	524.2
244	305							7.089	17.546	584.0	524.2
245	306							8.1195	20.096	584.0	524.2
246	307							9.150	22.646	584.0	524.2
247	308							9.862	24.4105	584.422	524.2
248	309							10.441	25.843	585.609	492.2
249	310	1	1	1	1	1	1	12.112	29.979	568.0	
250	311	1	1	1	1	1	1	0.0	34.873	588.091	
251	312	1	1	1	1	1	1	17.006	42.091	588.091	
252	313							12.112	29.979	588.091	492.2
253	314							12.112	29.979	591.817	492.2
254	315							12.112	29.979	598.468	492.2
255	316							12.112	29.979	610.775	492.2
256	317							12.112	29.979	615.250	492.2
257	318	1	1	1	1	1	1	0.0	34.873	615.250	
258	319	1	1	1	1	1	1	17.006	42.091	615.250	
259	320							12.112	29.979	622.271	492.2
260	321							12.112	29.979	628.671	492.2
261	322							4.083	33.809	631.344	492.2
262	323							12.112	29.979	640.713	492.2
263	324							12.112	29.979	649.521	492.2
264	325							12.112	29.979	652.854	492.2
265	326							16.556	29.590	585.609	492.2
266	327							17.604	29.4985	582.716	460.2
267	328							17.604	29.4985	578.1875	460.2
268	329							17.898	29.323	576.4654	460.2
269	330							18.734	28.825	575.0055	460.2
270	331							21.467	27.196	573.6875	460.2
271	332							22.112	26.812	573.6875	460.2
272	333							22.971	26.300	573.6875	460.2
273	334							23.673	25.882	573.6875	460.2
274	335							24.317	25.498	573.6875	460.2
275	336							27.051	23.8687	575.0055	460.2
276	337							28.183	23.194	578.1875	460.2
277	338	1	1	1	1	1	1	28.183	23.194	568.000	
278	339							28.183	23.194	584.958	460.2
279	340							28.183	23.194	584.0	460.2
280	341	1	1	1	1	1	1	33.302	18.420	584.0	
281	342	1	1	1	1	1	1	32.957	28.313	584.0	
282	343							28.183	23.194	586.917	460.2
283	344							28.183	23.194	587.890	70.0
284	345							28.183	23.194	588.608	70.0
285	346							28.183	23.194	589.442	70.0
286	347							28.183	23.194	598.450	70.0
287	348							25.432	20.244	584.0	460.2
288	349							23.5565	18.2325	584.0	460.2
289	350							23.5565	18.2325	589.4045	460.2

290	351							21.681	16.221	584.0	460.2
291	352							20.772	15.246	584.0	460.2
292	353							19.123	13.479	584.0	460.2
293	354							17.333	11.559	584.0	460.2
294	355							15.543	9.639	584.0	460.2
295	356							14.171	8.168	584.	460.2
296	357							12.800	6.697	584.	460.2
297	358							11.428	5.226	584.0	460.2
298	359							10.065	4.272	584.0	460.2
299	360							4.470	16.987	584.0	524.2
300	361							2.684	17.7085	584.0	524.2
301	362							0.898	18.430	584.0	524.2
302	363							-1.753	20.5766	584.008	524.2
303	364							-2.750	22.8386	584.030	524.2
304	365	1	1	1	1	1	1	-2.750	23.8386	591.250	
305	366							-2.750	24.500	584.035	524.2
306	367	1	1	1	1	1	1	0.0	24.500	584.035	
307	368							-2.750	27.000	584.054	524.2
308	369							-2.750	29.500	584.0735	524.2
309	370	1	1	1	1	1	1	0.0	29.500	584.0735	
310	371							-2.750	32.000	584.093	524.2
311	372							-2.750	34.500	584.112	524.2
312	373	1	1	1	1	1	1	0.0	34.500	584.112	
313	374							-2.750	35.861	584.1125	524.2
314	375	1	1	1	1	1	1	-6.25	35.861	588.091	
315	376							-2.681	36.750	584.1294	524.2
316	377				1	1	1	-2.681	36.750	585.1815	524.2
317	378	1	1	1	1	1	1	-2.681	40.918	588.091	
318	379							-1.066	39.927	584.179	524.2
319	380	1	1	1	1	1	1	3.0	41.611	591.0	
320	381							3.0	41.611	584.263	524.2
321	382							5.285	41.611	584.301	524.2
322	383							7.570	41.611	584.339	524.2
323	384							9.855	41.611	584.378	524.2
324	385							12.139	41.611	584.416	524.2
325	386							14.424	41.611	584.454	524.2
326	387							16.709	41.611	584.492	524.2
327	388							18.994	41.611	584.531	524.2
328	389							21.279	41.611	584.569	524.2
329	390	1	1	1	1	1	1	21.279	41.611	591.0	
330	391							25.428	40.420	585.8294	524.2
331	392							26.027	39.922	586.338	524.2
332	393				1	1	1	26.852	40.437	585.9375	524.2
333	394	1	1	1	1	1	1	26.759	43.152	585.9375	
334	395							27.112	37.486	588.7915	524.2
335	396							27.112	36.653	589.625	524.2
336	397							27.112	35.3884	591.5172	524.2
337	398							27.112	34.544	593.7496	524.2
338	399							27.112	34.944	594.917	524.2
339	400							27.112	34.944	596.917	524.2
340	401							27.112	34.944	598.170	524.2
341	402							27.112	34.944	594.67	
342	403	1	1	1	1	1	1	27.112	34.944	568.0	
343	404	1	1	1	1	1	1	31.227	32.104	594.67	
344	405	1	1	1	1	1	1	29.952	39.059	594.67	
345	406							27.112	34.944	599.70	524.2
346	407							27.112	34.944	606.63	524.2
347	408							27.112	34.944	613.57	524.2

```
348     409                                                  27.112    34.944    620.50          524.2
349     410     1     1     1     1     1     1              27.112    29.944    620.50
350     411     1     1     1     1     1     1              32.112    34.944    620.50
351     412     1     1     1     1     1     1              27.112    34.944    625.50
352     413                                                  27.112    34.944    627.89          524.2
353     414                                                  27.112    34.944    635.28          524.2
354     415                                                  27.112    34.944    642.62          524.2
355     416                                                  27.112    34.944    646.32          524.2
356       1    23    11
357       1                                  15.22      0.405                                  SGUS RADIAL
358       2    4.00E09                       15.22      1.803                                  SGUS TANGENTIAL
359       3    4.00E09                       15.22      0.195                                  PULS TRANSLATE
360       4    4.00E09                       15.22    0.00413     490.                        PH RCH-1002
361       5                                  15.22    0.00173     490.                        HS RCRS-1007
362       6                                  15.22     0.0123     490.                        RS RCRS-1008
363       7                                  15.22    0.00322     490.                        HS RCRS-1009
364       8    4.00E09                        15.22     0.406                                  RPV VERT SUPT
365       9    4.00E09                        15.22     0.665                                  RPV HORZ OUTLET
366      10    4.00E09                        15.22     0.699                                  RPV HORZ INLET
367      11    4.00E09                          0.0     0.0522                                 RPV VERT SPRING
368
369
370     -1 0
371
372       1    17    18     2
373       2    17    19     1
374       3   117   118     2
375       4   117   119     1
376       5   217   218     2
377       6   217   219     1
378       7   317   318     2
379       8   317   319     1
380       9   409   410     3
381      10   409   411     3
382      11   380   381     4
383      12   393   394     5
384      13   374   375     6
385      14   377   378     7
386      15    61    63     8
387      16    61    62     9
388      17   161   163     8
389      18   161   162    10
390      19   261   263     8
391      20   261   262     9
392      21   298   300     8
393      22   298   299    10
394      23   168   169    11
395       2    37    13     0     2
396       1    4.00E09   0.26
397       2    4.00E09   0.26          15.22      15.22
398       1    1.125                              191.2      0.1       0.1
399       2    0.532                               35.4      0.1       0.1
400       3    0.454                               35.4      0.1       0.1
401       4    0.361                               45.3      0.1       0.1
402       5    0.306                               6.09      0.1       0.1
403       6    0.175                               6.09      0.1       0.1
404       7    0.481                              904.1      0.1       0.1
405       8    0.336                              1.626      0.1       0.1
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406          9    1.500                                    1.626       0.1         0.1
407         10    0.001                                   10.37        0.1         0.1
408         11    0.195                                    0.1642      0.1642      0.1642
409         12    0.0417                                   0.000386    0.000778    0.000386
410         13   20.3                                      7.6        28.7        28.7
411
412
413        -32.2
414          1    10    13    12     2     1                                      11      11
415          2   110   113   112     2     1                                      11      11
416          3   210   213   212     2     1                                      11      11
417          4   310   313   312     2     1                                      11      11
418          5    11    13    14     1     2                                      11      11
419          6   111   113   114     1     2                                      11      11
420          7   211   213   214     1     2                                      11      11
421          8   311   313   314     1     2                                      11      11
422          9    12    13    14     1     3                                  1   11      11
423         10   112   113   114     1     3                                  1   11      11
424         11   212   213   214     1     3                                  1   11      11
425         12   312   313   314     1     3                                  1   11      11
426         13    38    40    55     2     4                                      111     11
427         14   138   140   155     2     4                                      111     11
428         15   238   240   255     2     4                                      111     11
429         16   338   340   355     2     4                                      111     11
430         17    40    41    47     1     5                                  1   11      11
431         18   140   141   147     1     5                                  1   11      11
432         19   240   241   247     1     5                                  1   11      11
433         20   340   341   347     1     5                                  1   11      11
434         21    40    42    47     1     6                                      11      11
435         22   140   142   147     1     6                                  1   11      11
436         23   240   242   247     1     6                                  1   11      11
437         24   340   342   347     1     6                                  1   11      11
438         25   402   403   405     2     7                                      11      11
439         26   402   404   409     1     8                                      11      11
440         27   402   405   409     1     9                                      11      11
441         28   409   412   405     1    10                                  1   11      11
442         29   366   367   364     1    11                                  111111
443         30   369   370   371     1    11                                  111111
444         31   372   373   374     1    11                                  111111
445         32   392   393   391     2    12                                              111
446         33   376   377   378     2    12                                              111
447         34    60    61   260     1    13                                              111
448         35   160   161   297     1    13                                              111
449         36   260   261    60     1    13                                              111
450         37   297   298   160     1    13                                              111
451          9   264     8     1    25          1
452          1        STEAM GEN. & PRESSURIZER
453                    3.80E09    0.25        7.18E-6
454          2     1 RPV SHELL
455                    3.715E09   0.25        9.74E-6
456          3        HOT LEG + SURGE LINE
457                    3.73E09    0.25        9.52E-6
458          4        HOT LEG VALVE
459                    3.86E09    0.25        9.47E-6
460          5        S. G. INLET NOZZLE
461                    3.79E09    0.25        7.18E-6
462          6        CROSS OVER LEG + PUMP CASING
463                    3.77E09    0.25        9.74E-6
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464          7       R. C. PUMP MOTOR
465                    4.02E09    0.25        6.19E-6
466          8       COLD LEG & COLD LEG VALVE
467                    3.80E09    0.25        9.74E-5
468          1     2.833      0.2083                1091.      33.880   HOT LEG
469          2     3.027      0.2217                1239.      38.476   CROSS-OVER LEG
470          3     2.688      0.1983                986.5      30.637   COLD LEG
471          4    11.328      0.3017                           0.0      STEAM GEN.-1
472          5    11.250      0.2344                           0.0      STEAM GEN.-2
473          6    12.948      0.3073                           0.0      STEAM GEN.-3
474          7    14.646      0.3025                           0.0      STEAM GEN.-4
475          8     8.740      0.3025                           0.0      STEAM GEN.-5
476          9     5.833      0.5000                           0.0      R C PUMP CASING
477         10     3.950      0.1205                           0.0      PUMP MOTOR STAND
478         11     4.000      0.1667                           0.0      PUMP MOTOR STAND
479         12     1.167      0.1172                240.2      7.459    PRESSURE SURGE LINE
480         13      7.25       0.125                           0.0      PRESSURIZER SKIRT
481         14      7.50       0.250                           0.0     PRESURE LOWER HEAD
482         15     7.625      0.3125                           0.0      PRESSURIZER SHELL
483         16    16.033      0.8958                           0.0      RPV HEAD
484         17    15.858      0.7192                           0.0      RPV SHELL
485         18     3.083      0.3333                1663.6     51.663   STOP VALVE - HORZ
486         19     3.250      0.1667                                     STOP VALVE - VERT
487         20     3.047      0.2734                1434.      44.538   HOT LEG ELBOW
488         21     3.135      0.2760                1498.      46.509   CROSSOVER ELBOWS
489         22     7.372      0.5000                                     SG NOZZLE
490         23     6.500      0.4167                                     PUMP OUTLET
491         24     2.796      0.2525                1216.6     37.782   COLD LEG ELBOW
492         25    27.500      0.8923    200.                 0.0      RPV RADIAL MEMBERS
493
494
495       -1.0
496                    1.0
497                              1.0
498       1T     1     2     3     1                321800.
499       2T     2     3     3     1                321800.
500       3T     3     4     3     1                321800.
501       4T     4     5     3     1                321800.
502       5T     5     6     3    18
503       6T     6     7     3    18
504       7B     7     8     3    20                321800.
505     4.5043       CC    9.150      -22.646      588.5043     0.04
506       8B     8     9     3    20                321800.
507     4.5043       CC    9.150      -22.646      588.5043     0.04
508       9T     9    13     5    22
509      10T    13    14     1     4
510      11T    14    15     1     4
511      12T    15    16     1     5
512      13T    16    17     1     5
513      14T    17    20     1     5
514      15T    20    21     1     6
515      16T    21    22     1    22
516      17T    21    23     1     7
517      18T    23    24     1     7
518      19T    24    25     1     8
519      20T    13    26     1    22
520      21B    26    27     6    21                321800.
521     4.500        TI   17.604      -29.4985     584.354      0.04
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522	22T	27	28	6	2		321800.	
523	23B	28	29	6	21		321800.	
524	4.500		CC	21.467		-27.196	578.1875	0.04
525	24B	29	30	6	21		321800.	
526	4.500		CC	21.467		-27.196	578.1875	0.04
527	25B	30	31	6	21		321800.	
528	4.500		CC	21.467		-27.196	578.1875	0.04
529	26T	31	32	6	2		321800.	
530	27T	32	33	6	2		321800.	
531	28T	33	34	6	2		321800.	
532	29T	34	35	6	2		321800.	
533	30B	35	36	6	21		321800.	
534	4.5		CC	24.317		-25.498	578.1875	0.04
535	31B	36	37	6	21		321800.	
536	4.5		CC	24.317		-25.498	578.1875	0.04
537	32T	37	40	6	9			
538	33T	40	39	6	9			
539	34T	39	43	6	9			
540	35T	43	44	7	10			
541	36T	44	45	7	11			
542	37T	45	46	7	10			
543	38T	46	47	7	9			
544	39T	40	48	8	23			
545	40T	48	49	8	18			
546	41T	49	50	8	19			
547	42T	49	51	8	18			
548	43T	51	52	8	3		321800.	
549	44T	52	53	8	3		321800.	
550	45T	53	54	8	3		321800.	
551	46T	54	55	8	3		321800.	
552	47T	55	56	8	3		321800.	
553	48T	56	57	8	3		321800.	
554	49T	57	58	8	3		321800.	
555	50B	58	59	8	24		321800.	
556	4.605		CC	8.500		-7.959	584.0	0.04
557	51T	101	102	3	1		321800.	
558	52T	102	103	3	1		321800.	
559	53T	103	104	3	1		321800.	
560	54T	104	105	3	1		321800.	
561	55T	105	106	3	18			
562	56T	106	107	3	19			
563	57B	107	108	3	20		321800.	
564	4.5043		CC	-9.150		-22.646	588.5043	0.04
565	58B	108	109	3	20		321800.	
566	4.5043		CC	-9.150		-22.646	588.5043	0.04
567	59T	109	113	5	22			
568	60T	113	114	1	4			
569	61T	114	115	1	4			
570	62T	115	116	1	5			
571	63T	116	117	1	5			
572	64T	117	120	1	5			
573	65T	120	121	1	6			
574	66T	121	122	1	22			
575	67T	121	123	1	7			
576	68T	123	124	1	7			
577	69T	124	125	1	8			
578	70T	113	126	1	22			
579	71B	126	127	6	21		321800.	

580		4.500		TI	-17.604		-29.4985	584.354	0.04
581	72T	127	128		6	2		321800.	
582	73B	128	129		6	21		321800.	
583		4.500		CC	-21.467		-27.196	578.1875	0.04
584	74B	129	130		6	21		321800.	
585		4.500		CC	-21.467		-27.196	578.1875	0.04
586	75B	130	131		6	21		321800.	
587		4.500		CC	-21.467		-27.196	578.1875	0.04
588	76T	131	132		6	2		321800.	
589	77T	132	133		6	2		321800.	
590	78T	133	134		6	2		321800.	
591	79T	134	135		6	2		321800.	
592	80B	135	136		6	21		321800.	
593		4.5		CC	-24.317		-25.498	578.1875	0.04
594	81B	136	137		6	21		321800.	
595		4.5		CC	-24.317		-25.498	578.1875	0.04
596	82T	137	140		6	9			
597	83T	140	139		6	9			
598	84T	139	143		6	9			
599	85T	143	144		7	10			
600	86T	144	145		7	11			
601	87T	145	146		7	10			
602	88T	146	147		7	9			
603	89T	140	148		8	23			
604	90T	148	149		8	18			
605	91T	149	150		8	19			
606	92T	149	151		8	18			
607	93T	151	152		8	3		321800.	
608	94T	152	153		8	3		321800.	
609	95T	153	154		8	3		321800.	
610	96T	154	155		8	3		321800.	
611	97T	155	156		8	3		321800.	
612	98T	156	157		8	3		321800.	
613	99T	157	158		8	3		321800.	
614	100B	158	159		8	24		321800.	
615		4.005		CC	-8.500		-7.959	584.0	0.04
616	101T	201	202		3	1		321800.	
617	102T	202	203		3	1		321800.	
618	103T	203	204		3	1		321800.	
619	104T	204	205		3	1		321800.	
620	105T	205	206		3	18			
621	106T	205	207		3	18			
622	107B	207	208		3	20		321800.	
623		4.5043		CC	-9.150		22.646	588.5043	0.04
624	108B	208	209		3	20		321800.	
625		4.5043		CC	-9.150		22.646	588.5043	0.04
626	109T	209	213		5	22			
627	110T	213	214		1	4			
628	111T	214	215		1	4			
629	112T	215	216		1	5			
630	113T	216	217		1	5			
631	114T	217	220		1	5			
632	115T	220	221		1	6			
633	116T	221	222		1	22			
634	117T	221	223		1	7			
635	118T	223	224		1	7			
636	119T	224	225		1	8			
637	120T	213	226		1	22			

638	121B	226	227	6	21		321800.	
639	4.500		TI	-17.604		29.4985	584.354	0.04
640	122T	227	228	6	2		321800.	
641	123B	228	229	6	21		321800.	
642	4.500		CC	-21.467		27.196	578.1875	0.04
643	124B	229	230	6	21		321800.	
644	4.500		CC	-21.467		27.196	578.1875	0.04
645	125B	230	231	6	21		321800.	
646	4.500		CC	-21.467		27.196	578.1875	0.04
647	126T	231	232	6	2		321800.	
648	127T	232	233	6	2		321800.	
649	128T	233	234	6	2		321800.	
650	129T	234	235	6	2		321800.	
651	130B	235	236	6	21		321800.	
652	4.5		CC	-24.317		25.498	578.1875	0.04
653	131B	236	237	6	21		321800.	
654	4.5		CC	-24.317		25.498	578.1875	0.04
655	132T	237	240	6	9			
656	133T	240	239	6	9			
657	134T	239	243	6	9			
658	135T	243	244	7	10			
659	136T	244	245	7	11			
660	137T	245	246	7	10			
661	138T	246	247	7	9			
662	139T	240	248	8	23			
663	140T	248	249	8	18			
664	141T	249	250	8	19			
665	142T	249	251	8	18			
666	143T	251	252	8	3		321800.	
667	144T	252	253	8	3		321800.	
668	145T	253	254	8	3		321800.	
669	146T	254	255	8	3		321800.	
670	147T	255	256	8	3		321800.	
671	148T	256	257	8	3		321800.	
672	149T	257	258	8	3		321800.	
673	150B	258	259	8	24		321800.	
674	4.005		CC	-8.500		7.959	584.0	0.04
675	151T	301	302	3	1		321800.	
676	152T	302	303	3	1		321800.	
677	153T	303	304	3	1		321800.	
678	154T	304	305	3	1		321800.	
679	155T	305	306	3	18			
680	156T	306	307	3	18			
681	157B	307	308	3	20		321800.	
682	4.5043		CC	9.150		22.646	588.5043	0.04
683	158B	309	309	3	20		321800.	
684	4.5043		CC	9.150		22.646	588.5043	0.04
685	159T	309	313	5	22			
686	160T	313	314	1	4			
687	161T	314	315	1	4			
688	162T	315	316	1	5			
689	163T	316	317	1	5			
690	164T	317	320	1	5			
691	165T	320	321	1	6			
692	166T	321	322	1	22			
693	167T	321	323	1	7			
694	168T	323	324	1	7			
695	169T	324	325	1	8			

696	170T	313	326	1	22			
697	171B	326	327	6	21		321800.	
698	4.500		TI	17.604		29.4985	584.354	0.04
699	172T	327	328	6	2		321800.	
700	173B	328	329	6	21		321800.	
701	4.5		CC	21.467		27.196	578.1875	0.04
702	174B	329	330	6	21		321800.	
703	4.500		CC	21.467		27.196	578.1875	0.04
704	175B	330	331	6	21		321800.	
705	4.500		CC	21.467		27.196	578.1875	0.04
706	176T	331	332	6	2		321800.	
707	177T	332	333	6	2		321800.	
708	178T	333	334	6	2		321800.	
709	179T	334	335	6	2		321800.	
710	180B	335	336	6	21		321800.	
711	4.5		CC	24.317		25.498	578.1875	0.04
712	181B	336	337	6	21		321800.	
713	4.5		CC	24.317		25.498	578.1875	0.04
714	182T	337	340	6	9			
715	183T	340	339	6	9			
716	184T	339	343	6	9			
717	185T	343	344	7	10			
718	186T	344	345	7	11			
719	187T	345	346	7	10			
720	188T	346	347	7	9			
721	189T	340	348	8	23			
722	190T	348	349	8	18			
723	191T	349	350	8	19			
724	192T	349	351	8	18			
725	193T	351	352	8	3		321800.	
726	194T	352	353	8	3		321800.	
727	195T	353	354	8	3		321800.	
728	196T	354	355	8	3		321800.	
729	197T	355	356	8	3		321800.	
730	198T	356	357	8	3		321800.	
731	199T	357	358	8	3		321800.	
732	200B	358	359	8	24		321800.	
733	4.005		CC	8.500		7.959	584.0	0.04
734	201T	304	360	3	12		321800.	
735	202T	360	361	3	12		321800.	
736	203T	361	362	3	12		321800.	
737	204B	362	363	3	12		321800.	
738	5.833		CC	3.083		23.8386	584.048	0.07
739	205B	363	364	3	12		321800.	
740	5.833		CC	3.083		23.8386	584.048	0.07
741	206T	364	366	3	12		321800.	
742	207T	366	368	3	12		321800.	
743	208T	368	369	3	12		321800.	
744	209T	369	371	3	12		321800.	
745	210T	371	372	3	12		321800.	
746	211T	372	374	3	12		321800.	
747	212B	374	376	3	12		321800.	
748	5.750		CC	3.000		35.861	584.209	0.07
749	213B	376	379	3	12		321800.	
750	5.75		CC	3.0		35.861	584.209	0.07
751	214B	379	381	3	12		321800.	
752	5.75		CC	3.0		35.861	584.209	0.07
753	215T	381	382	3	12		321800.	

```
754      216T  382  383    3   12          321800.
755      217T  383  384    3   12          321800.
756      218T  384  385    3   12          321800.
757      219T  385  386    3   12          321800.
758      220T  386  387    3   12          321800.
759      221T  387  388    3   12          321800.
760      222T  388  389    3   12          321800.
761      223B  389  391    3   12          321800.
762        5.83333   CC  21.279     37.486  588.694     0.07
763      224B  391  392    3   12          321800.
764        5.83333   CC  21.279     37.486  588.694     0.07
765      225B  392  395    3   12          321800.
766        5.83333   CC  21.279     37.486  588.694     0.07
767      226T  395  396    3   12          321800.
768      227B  396  397    3   12          321800.
769        5.83333   CC  27.112     40.77733 593.7496   0.07
770      228B  397  398    3   12          321800.
771        5.83333   CC  27.112     40.77733 593.7496   0.07
772       9T   398  399    3   12          321800.
773      230T  399  400    3   12          321800.
774      231T  400  401    1   14
775      232T  401  402    1   13
776      233T  401  406    1   14
777      234T  406  407    1   15
778      235T  407  408    1   15
779      236T  408  409    1   15
780      237T  409  413    1   15
781      238T  413  414    1   15
782      239T  414  415    1   15
783      240T  415  416    1   15
784      241T    1   60    2    1
785      242T  194  167    2   25
786      243T  193  167    2   25
787      244T  195  167    2   25
788      245T  159  160    2    3
789      246T  196  167    2   25
790      247T  201  260    2    1
791      248T  198  167    2   25
792      249T  197  167    2   25
793      250T  199  167    2   25
794      251T  359  297    2    3
795      252T  200  167    2   25
796      253T  164  165    2   17
797      254T  165  166    2   17
798      255T  166  167    2   17
799      256T  167  168    2   16
800      257T    6   64    4   19
801      258T  106  170    4   19
802      259T  206  264    4   19
803      260T  306  292    4   19
804      261T   59  189    2    3
805      262T  101  190    2    1
806      263T  259  191    2    3
807      264T  301  192    2    1
808       10    8    8    0
809        1   60  194  168
810          3.460E08      0.0          0.0         0.0         0.0         0.0
811          0.0           1.200E10     0.0         0.0         0.0         0.0
```

```
812      0.0          0.0          1.200E10     0.0          0.0          0.0
813      0.0          0.0          0.0          8.333E10     0.0          0.0
814      0.0          0.0          0.0          0.0          3.663E09     0.0
815      0.0          0.0          0.0          0.0          0.0          4.757E09
816    2  189  193  168
817      3.460E08     0.0          0.0          0.0          0.0          0.0
818      0.0          1.200E10     0.0          0.0          0.0          0.0
819      0.0          0.0          1.200E10     0.0          0.0          0.0
820      0.0          0.0          0.0          8.333E10     0.0          0.0
821      0.0          0.0          0.0          0.0          4.225E09     0.0
822      0.0          0.0          0.0          0.0          0.0          5.868E09
823    3  190  195  168
824      3.460E08     0.0          0.0          0.0          0.0          0.0
825      0.0          1.200E10     0.0          0.0          0.0          0.0
826      0.0          0.0          1.200E10     0.0          0.0          0.0
827      0.0          0.0          0.0          8.333E10     0.0          0.0
828      0.0          0.0          0.0          0.0          3.663E09     0.0
829      0.0          0.0          0.0          0.0          0.0          4.757E09
830    4  160  196  168
831      3.460E08     0.0          0.0          0.0          0.0          0.0
832      0.0          1.200E10     0.0          0.0          0.0          0.0
833      0.0          0.0          1.200E10     0.0          0.0          0.0
834      0.0          0.0          0.0          8.333E10     0.0          0.0
835      0.0          0.0          0.0          0.0          4.225E09     0.0
836      0.0          0.0          0.0          0.0          0.0          5.868E09
837    5  260  198  168
838      3.460E08     0.0          0.0          0.0          0.0          0.0
839      0.0          1.200E10     0.0          0.0          0.0          0.0
840      0.0          0.0          1.200E10     0.0          0.0          0.0
841      0.0          0.0          0.0          8.333E10     0.0          0.0
842      0.0          0.0          0.0          0.0          3.663E09     0.0
843      0.0          0.0          0.0          0.0          0.0          4.757E09
844    6  191  197  168
845      3.460E08     0.0          0.0          0.0          0.0          0.0
846      0.0          1.200E10     0.0          0.0          0.0          0.0
847      0.0          0.0          1.200E10     0.0          0.0          0.0
848      0.0          0.0          0.0          8.333E10     0.0          0.0
849      0.0          0.0          0.0          0.0          4.225E09     0.0
850      0.0          0.0          0.0          0.0          0.0          5.868E09
851    7  192  199  168
852      3.460E08     0.0          0.0          0.0          0.0          0.0
853      0.0          1.200E10     0.0          0.0          0.0          0.0
854      0.0          0.0          1.200E10     0.0          0.0          0.0
855      0.0          0.0          0.0          8.333E10     0.0          0.0
856      0.0          0.0          0.0          0.0          3.663E09     0.0
857      0.0          0.0          0.0          0.0          0.0          4.757E09
858    8  297  200  168
859      3.460E08     0.0          0.0          0.0          0.0          0.0
860      0.0          1.200E10     0.0          0.0          0.0          0.0
861      0.0          0.0          1.200E10     0.0          0.0          0.0
862      0.0          0.0          0.0          8.333E10     0.0          0.0
863      0.0          0.0          0.0          0.0          4.225E09     0.0
864      0.0          0.0          0.0          0.0          0.0          5.868E09
865      6    1                    -3893.                                      70
866      6    3                    -3893.
867     16    1                   -836476.
868     16    3                   -836476.
869     39    1                    -95700.
```

870	39	3	-95700.
871	47	1	-77000.
872	47	3	-77000.
873	49	1	-3597.
874	49	3	-3597.
875	50	1	-13358.
876	50	3	-13358.
877	64	1	-14107.
878	64	3	-14107.
879	106	1	-3893.
880	106	3	-3893.
881	116	1	-836476.
882	116	3	-836476.
883	139	1	-95700.
884	139	3	-95700.
885	147	1	-77000.
886	147	3	-77000.
887	149	1	-3597.
888	149	3	-3597.
889	150	1	-13358.
890	150	3	-13358.
891	168	1	-1556100.
892	168	3	-1556100.
893	169	1	-424900.
894	169	3	-424900.
895	170	1	-14107.
896	170	3	-14107.
897	206	1	-3893
898	206	3	-3893.
899	216	1	-836476.
900	216	3	-836476.
901	239	1	-95700.
902	239	3	-95700.
903	247	1	-77000.
904	247	3	-77000.
905	249	1	-3597.
906	249	3	-3597.
907	250	1	-13358.
908	250	3	-13358.
909	264	1	-14107.
910	264	3	-14107.
911	292	1	-14107.
912	292	3	-14107.
913	306	1	-3893.
914	306	3	-3893.
915	316	1	-836476.
916	316	3	-836476.
917	339	1	-95700.
918	339	3	-95700.
919	347	1	-77000.
920	347	3	-77000.
921	349	1	-3597.
922	349	3	-3597.
923	350	1	-13358.
924	350	3	-13358.
925	364	1	5650
926	364	3	5650
927	389	1	6800.

928	389	3		6800.
929	406	1		-71613.
930	406	3		-71613.
931	409	1		-118295.
932	409	3		-118295.
933	415	1		-44131.
934	415	3		-44131.
935				
936	1.0			
937			1.0	
938	1.0		1.0	
939				
940				

APPENDIX C

REFERENCE DRAWINGS FROM ZION STATION

REFERENCE DRAWINGS FROM ZION STATION

Design Engineering drawings from Zion Station Units 1 and 2, Commonwealth Edison Company, referenced during the performance of this work are listed below. Revision letters listed are current as of November 1, 1979.

MECHANICAL		STRUCTURAL	
No.	Rev.	No.	Rev.
M-52	P	B-264	X
M-53	S	B-266	DD
M-110	M	B-281	R
M-111	B	B-423	E
M-112	C	B-771	F
M-113	C	B-772	D
M-115	G	B-773	E
M-129	S	B-774	G
M-131	P	B-775	D
M-136	R	B-776	B
M-400	F	B-777	E
M-404A	A	B-778	B
M-420F	B	B-779	C
		B-780	F
		B-781	G
		B-782	F
		B-783	F
		B-784	G
		B-785	H

APPENDIX D

COMPONENT SUPPORT SPRING CONSTANTS

COMPONENT SUPPORT SPRING CONSTANTS

Component support spring constants are given in Table D1. Figures D1 through D3 show the locations of the support springs. The support spring stiffness values listed under the heading 'Initial' are from the Commonwealth Edison Company Zion Power Station Project Design Calculations[5]. The stiffness values listed under the heading of 'Revised' are from Westinghouse Electric Corporation[6].

Location	Elevation	Spring Stiffness		Spring No.	Fig. Ref.
		Original	Revised*		
R.C. Pump Translation	584'-0"	1.00×10^5 k/ft	(6)	KT1	
R.C. Pump Translation	584'-0"	1.75×10^5 k/ft	(6)	KT2	
S.G. Translation	588'-1 3/32"	7.74×10^4 k/ft	1.63×10^5 k/ft	KT3	D1
S.G. Translation	588'-1 3/32"	8.60×10^4 k/ft	1.39×10^5 k/ft	KT4	
S.G. Translation	615'-3"	8.00×10^4 k/ft	5.52×10^5 k/ft	KT5	
S.G. Translation	615'-3"	2.48×10^4 k/ft	1.92×10^5 k/ft(1) 1.24×10^5 k/ft(2)	KT6	
RPV Translation	581'-10"	9.50×10^4 k/ft	7.19×10^5 k/ft(4)	KT7	D2
Press. Translation	620'-6"	4.44×10^5 k/ft	1.56×10^5 k/ft(3)	KT8	
Press. Translation	620'-6"	4.44×10^5 k/ft	1.56×10^5 k/ft(3)	KT9	D3
Press. Translation	594'-8"	1.20×10^6 k/ft	(5)	KT10	
Press. Translation	594'-8"	2.69×10^5 k/ft	(5)	KT11	
R.C. Pump Rotation about Tang. Axis	584'-0"	7.00×10^5 k-ft/rad	1.38×10^6 k-ft/rad	KR1	
R.C. Pump Rotation about Radial Axis	584'-0"	3.50×10^5 k-ft/rad	1.38×10^6 k-ft/rad	KR2	
R.C. Pump Rotation about Vert.	584'-0"	4.50×10^6 k-ft/rad	(6)	KR3	D1
S.G. Rotation about Vert.	588'-1 3/32"	3.40×10^6 k-ft/rad	1.51×10^7 k-ft/rad	KR4	
S.G. Rotation about both Horiz. Axes	588'-1 3/32"	4.30×10^6 k-ft/rad	(6)	KR5	
Press. Rotation about Vert.	620'-6"	2.22×10^7 k-ft/rad	3.29×10^6 k-ft/rad(3)	KR6	
Press. Rotation about Vert.	594'-8"	5.38×10^7 k-ft/rad	(5)	KR7	D3
Press. Rotation about Radial Axis	594'-8"	5.16×10^5 k-ft/rad	(5)	KR8	
Press. Rotation about Tang. Axis	594'-8"	5.16×10^5 k-ft/rad	(5)	KR9	
R.C. Pump Vert.	--	6.00×10^4 k/ft	9.02×10^4 k/ft	KV1	D1
S.G. Vertical	--	2.24×10^5 k/ft	(6)	KV2	
RPV Vertical	--	7.72×10^5 k/ft	7.64×10^5 k/ft(4)	KV3	D2
Pressurizer Vert.	--	7.72×10^4 k/ft	(5)	KV4	D3

NOTES:

(1) For movement toward RPV
(2) For movement away from RPV
(3) Values include tangential lug flexibility
(4) Values include nozzle flexibility
(5) Pressurizer lower support stiffness was not reviewed by Westinghouse
(6) No revision to original value

*Revised by Westinghouse

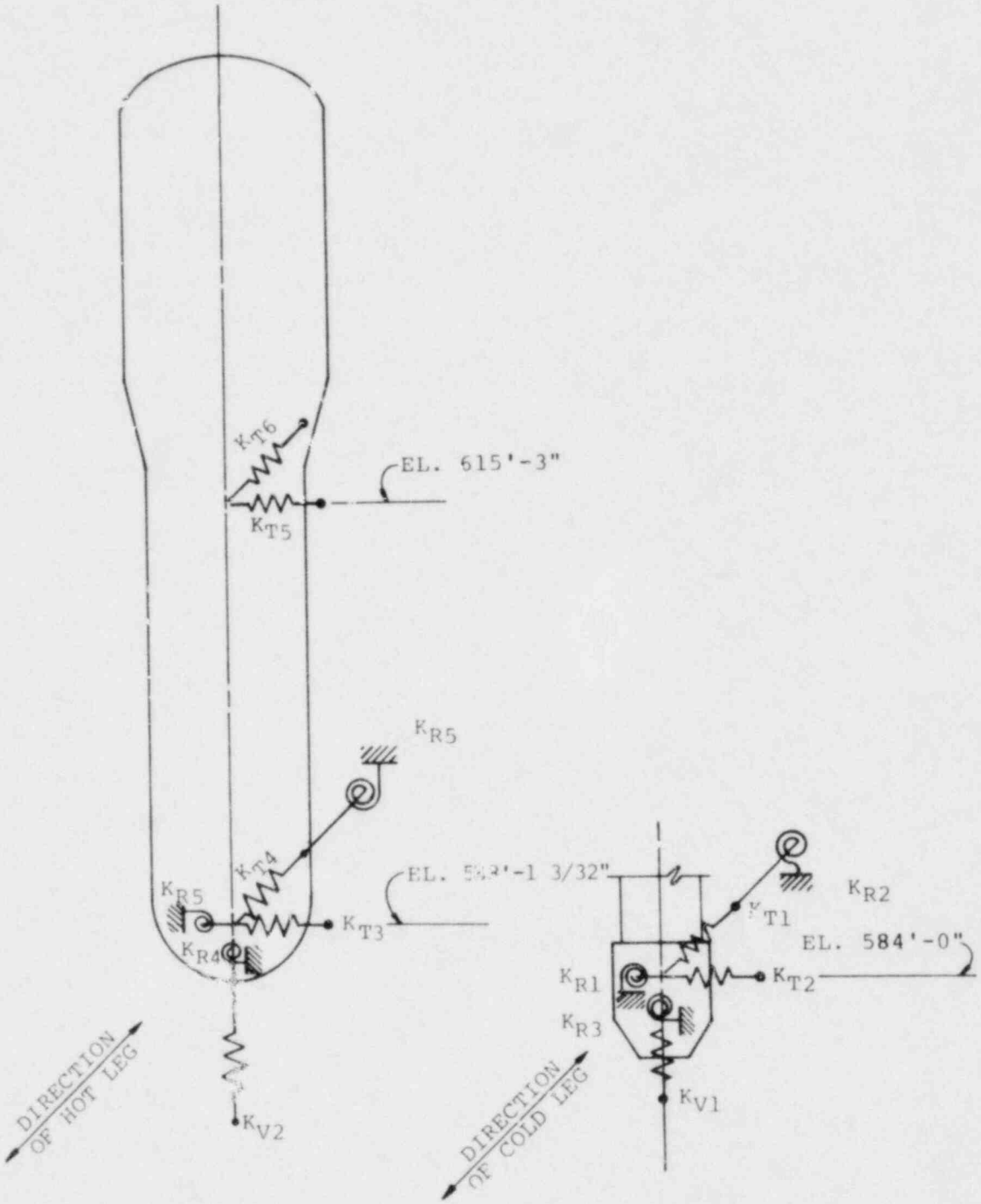


FIGURE D1
STEAM GENERATOR AND R.C. PUMP SUPPORT SPRING CONSTANTS

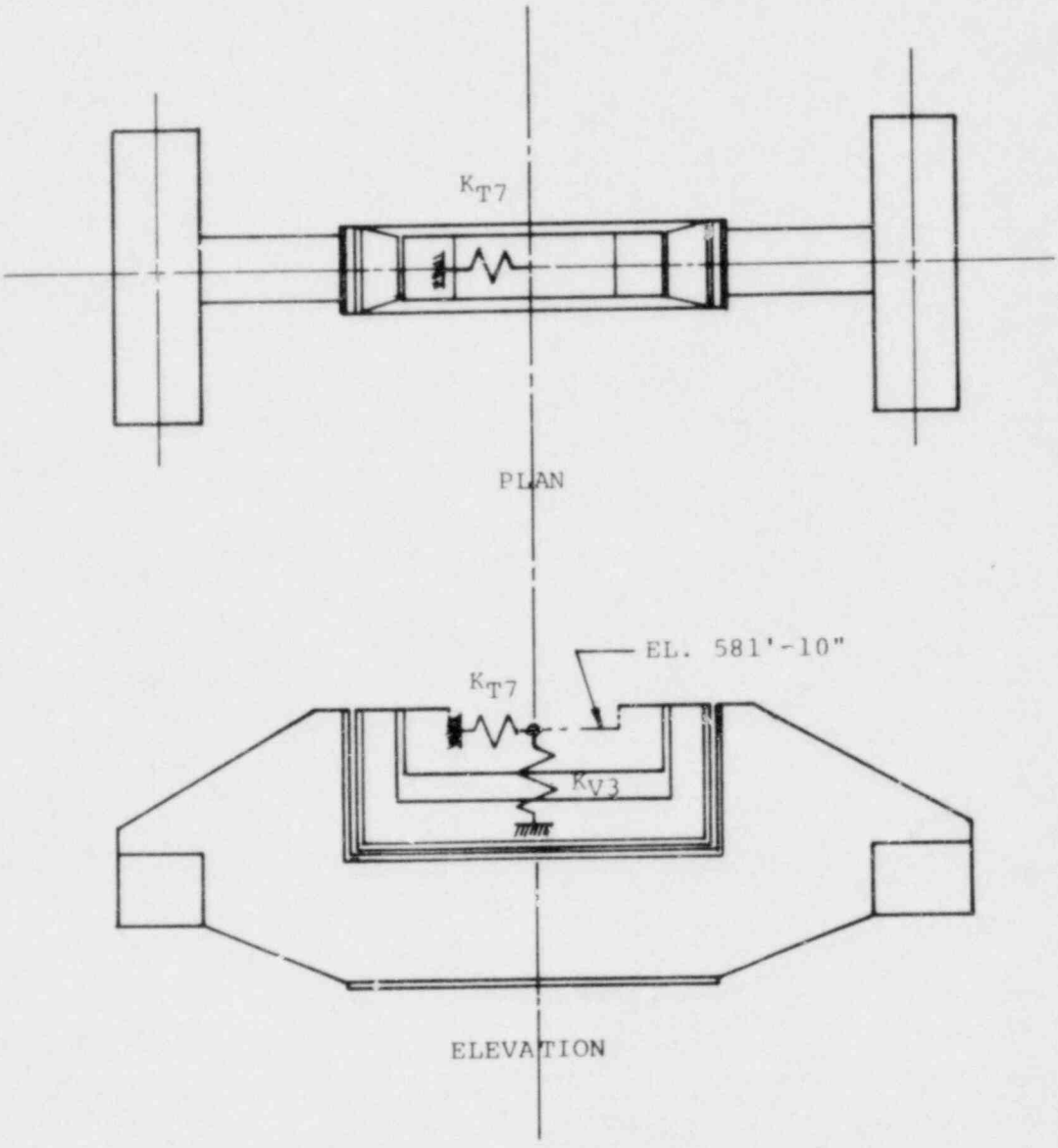


FIGURE D2
RPV SUPPORT SPRING CONSTANTS

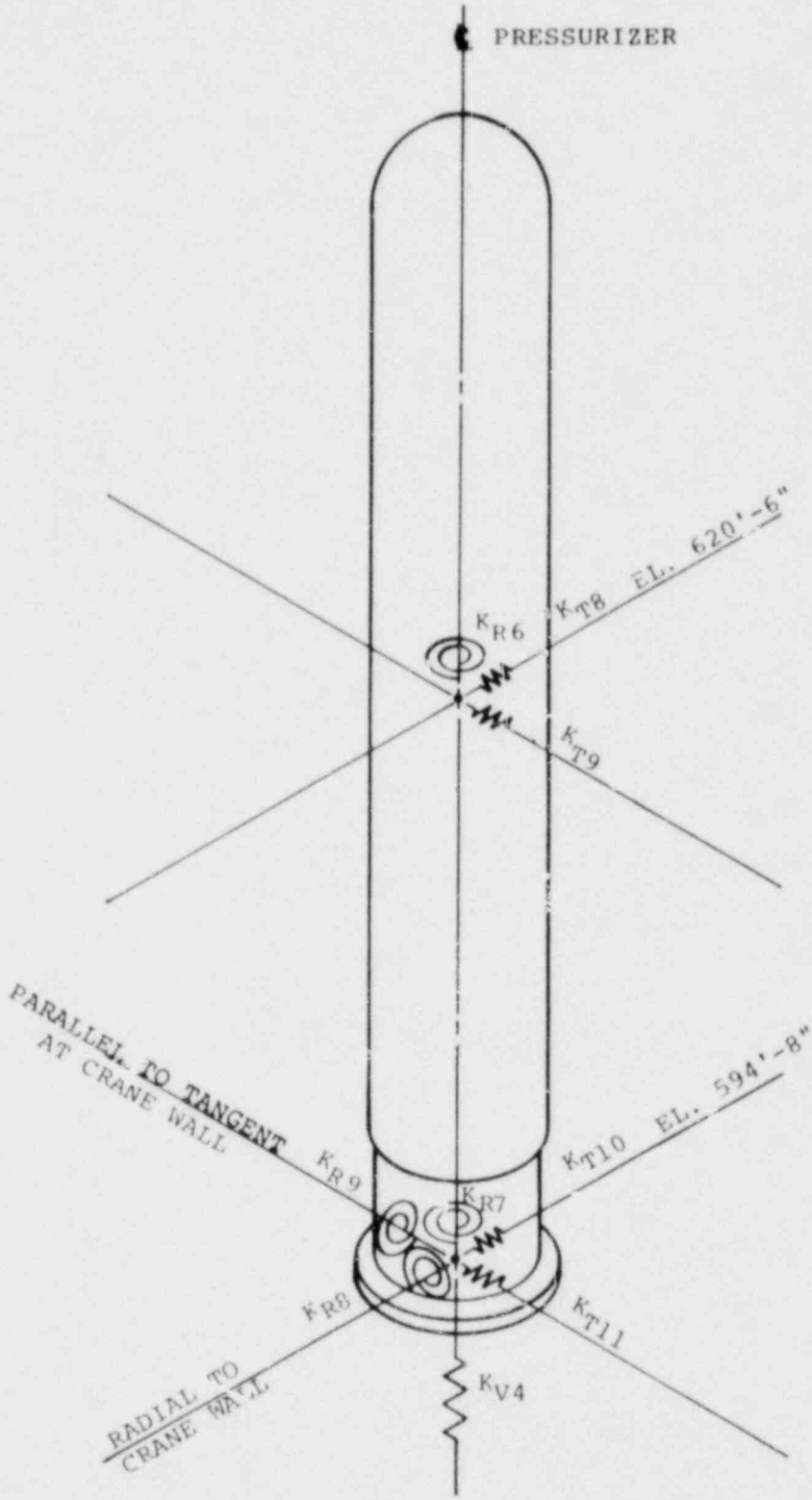


FIGURE D3
PRESSURIZER SUPPORT SPRING CONSTANTS

APPENDIX E

MAIN STEAM AND FEEDWATER STIFFNESS MATRICES

MAIN STEAM AND FEEDWATER STIFFNESS MATRICES

Main steam and feedwater stiffness matrices are shown in Figures E1 through E8. Figure E9 provides a listing of the input computer data cards. These cards are also shown in Appendix A. Figures E10 and E11 show the orientation of the feedwater and main steam lines, respectively.

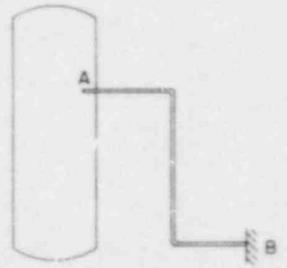
19404	20580	6492	-58200	178800	-48800	-20952	18900	-6768	-17500	57200	120300
20580	56808	108	-136900	72900	-674800	-10440	8952	-1692	-11900	26000	62500
6492	108	29544	-171100	588500	13500	-8520	912	1704	28800	16700	-39900
-58224	-136896	-171132	5908900	-3263300	1589600	-31428	36864	197640	141800	-219200	-36200
178776	72900	588468	-3263300	14891000	-102600	-172848	98712	230892	400800	51100	-129300
-48816	-674760	13536	1589600	-102600	14531900	8424	-2412	-52980	-37100	58800	45200
-20952	-10440	-8520	-31400	-172800	8400	1391364	-3264	1050132	-144800	-11291400	206800
18900	8952	912	36900	98700	-2400	-3264	2274312	43776	11757500	-56900	7607700
-6768	-1692	1704	197600	230900	-57000	1050132	43776	888588	78400	-7966700	95700
-17484	-11868	28848	141800	400800	-37100	-144780	11757468	78360	76804500	211600	45981600
57192	26052	16716	-219200	51100	58800	-11291388	-56880	-7966692	211600	10611800	-606900
120300	62508	-39924	-36200	-129300	45200	206784	7607736	95652	45981600	-606900	35784000

X_A
Y_A
Z_A
θX_A
θY_A
θZ_A
X_B
Y_B
Z_B
θX_B
θY_B
θZ_B

NOTE:

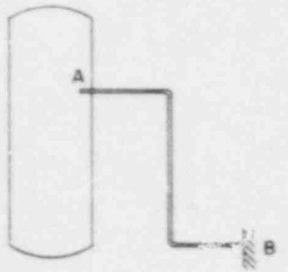
All forces are in lbs.
Displacements are in ft.
Moments are in ft-lbs.
Rotations are in radians

FIGURE E1
FW-01, LOOP 1



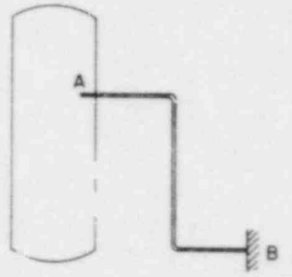
20[illegible]6	23652	-8664	127500	-256200	-6400	-23592	19260	[illegible]48	-800	-58300	108100	$XA
23652	93480	12564	396800	29500	-845700	-15372	13116	-1212	5500	-34000	85400	$YA
-8664	12564	44268	-219800	12100	-130200	4644	3264	8256	36600	1000	90400	$ZA
127476	396756	-219780	8604200	-3814800	-3611600	-9528	-31200	179040	93400	-232100	5700	ΘXA
-256200	29544	7[illegible]2080	-3814800	15377100	-1731100	141084	-105816	331500	468800	-64200	317700	ΘYA
-6360	-845724	-130152	-3611600	-1731100	14553700	11892	-22272	107964	60300	-9940	-8500	ΘZA
-23592	-15372	4644	-9500	141100	11900	1767828	2808	-1073556	120300	12855700	25[illegible]00	$XB
19260	13116	3264	-31200	-105800	-22300	2808	2506548	-47448	-13312400	62200	6745700	$YB
3348	-1212	8256	179000	331500	108000	-1073556	-47448	744240	102900	-7179900	-68300	$ZB
-804	5460	36612	93400	468800	60300	120324	-13312392	102864	88612200	156400	-41948[illegible]00	ΘXB
-58260	-33984	1020	-232100	-64200	-99400	12855744	62184	-[illegible]179876	156400	109401400	661100	ΘYB
108096	85428	90408	5700	317700	-8500	252204	6745692	-68304	-41948500	661100	27451000	ΘZB

FIGURE E2
FW-02, LOOP 4



12768	18984	-1980	-35800	14200	235900	-20412	20844	10896	-28000	29300	143300	$XA
18984	165684	-22440	-188000	-92200	-586500	-50496	363060	17376	788200	86100	531300	$YA
-1980	-22440	15468	-310000	53400	102900	-14424	-21576	-12024	-95500	48800	43300	$ZA
-35808	-187956	-309972	12901200	-1227100	174400	257112	-693720	131472	-1022000	-752000	-1761000	θXA
14220	-9[illegible]60	53424	-1227100	4169900	1108800	192024	-77460	-114000	-800700	-259000	860900	θYA
235920	-586548	102852	174400	1108800	14059000	-94020	-1526688	236928	-4029900	-131400	-1132400	θZA
-20412	-50496	-14424	257100	192000	-94000	1933740	-45708	914064	-204700	-12481000	95500	$xB
20844	363060	-21576	-693700	-77500	-1526700	-45708	2408880	20772	12206600	70700	7958500	$YB
10896	17376	-12024	131500	-114000	236900	914064	20772	526800	-57200	-7259[illegible]00	188100	$ZB
-28008	788[illegible]	95460	-1[illegible]2000	800700	-4029900	-204672	12206640	-57252	78141700	531000	47062600	θXB
29280	86076	48816	-752000	-259000	-131400	-12480996	70728	-7259796	531000	108358200	-477900	θYB
143328	531396	43296	-1761000	860900	-1132400	95520	7958[illegible]6	188064	47062600	-477900	36385800	θZB

FIGURE E3
FW-03, LOOP 2



13188	15444	1236	42000	-18600	323700	-21456	[illegible]3840	-11424	30800	-36100	150900	$XA
15444	169080	24924	170200	52200	-246900	-45936	373872	-21276	-858500	-81000	448100	$YA
1236	24924	16728	-336700	22100	-72800	13284	24324	-12588	-91500	45500	-40900	$ZA
42024	170160	-336708	13932300	-577600	651000	-239112	714324	167098	-1245100	-748300	1631700	θXA
-18540	52236	22152	-577600	4123400	-845000	-220716	45168	-103956	-542800	-381700	-807700	θYA
323688	-246876	-72804	651100	-845000	[illegible]3939400	-233004	-773928	-291084	2496700	-195300	485100	θZA
-21436	-45936	13284	-239100	-220700	-233000	2140488	-41136	-786192	192100	13363900	142300	$XB
15840	373872	24324	714300	45200	-773900	-41136	2482332	-22392	-13222300	-68600	6752200	$YB
-11424	-21276	-12588	167100	-104000	-291100	-786192	-22392	[illegible]8316	-24200	-6068800	-175200	$ZB
30840	-858468	-91536	-1245100	-542800	2496700	[illegible]2084	-13222284	-24168	88264300	471700	-42038100	θXB
-36072	-80964	45468	-748300	-387100	-195300	13363872	-68604	-60687[illegible]	471700	10922536[illegible]	534500	θYB
150924	448140	-40884	163[illegible]700	-807700	485100	142344	6752208	-175164	-42038100	534500	27269400	θZB

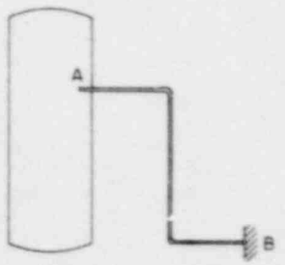


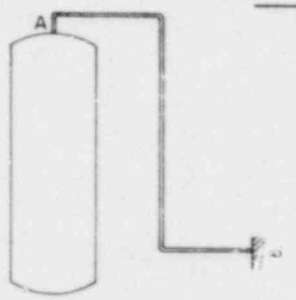
FIGURE E4
FW-04, LOOP 3

91860	66876	-13644	-429200	858600	1503700	7920	-2460	-10488	-19000	-4200	8900	δXA
66876	554148	-234396	-2154100	1859500	82500	-100392	19800	87024	312200	166200	-316400	δYA
-13644	-234396	144180	228700	-430200	-39600	29976	-1800	-9240	-90900	-90900	125000	δZA
-429228	-2154048	228720	31110600	-11929300	-530500	643392	-127284	-559368	2000800	-1061200	2024600	θXA
858552	1859472	-430224	-11929300	30302000	1253760	141996	8964	30228	-50900	-612400	152700	θYA
1503744	82452	-3024	-530500	12537000	42728800	123180	-48948	-205800	-157500	39700	-163600	θZA
7920	-100392	29976	643440	142000	123200	3767076	-151068	1539576	-1885400	-40061100	1649600	δXB
-2460	19800	-1800	-127300	9000	-49000	-151068	5027868	82740	41081900	368800	26609300	δYB
-10488	87024	-9240	-559400	30200	-205800	1539576	82740	963504	-240300	-22490900	1056100	δZB
-15020	312156	-90924	-2000800	-50900	-157500	-1885356	41081928	-240264	454617200	7734600	263773600	θXB
-4188	166212	-90852	-1061200	-612400	39700	-40061076	368772	-22490904	7734600	611754900	-8849100	θYB
8880	-316368	125028	2024600	1527600	-163600	1649628	26609268	1056096	263773600	-8849100	219210300	θZB

NOTE

All forces are in lbs.
Displacements are in ft.
Moments are in ft-lbs.
Rotations are in radians

FIGURE E5
MS-01, LOOP 1



99132	93984	27708	547500	-1050600	1630500	5712	-2784	10908	8600	500	-5900	X_A
93984	273180	83736	1590500	-1132100	487400	-46620	16176	-65400	-200	-43900	131800	Y_A
27708	83736	96912	-514300	-394400	124100	-26520	1608	-7596	26600	-74900	-39100	Z_A
547524	1590528	-514284	37382800	-6585600	2842600	-269628	94740	-382764	3100	-246300	780100	θ_{XA}
-1050588	-1132056	-394404	-6585600	36358300	24342400	-70728	-44196	157920	265900	-499800	160600	θ_{YA}
1630476	487428	124152	2842600	-14342400	47588000	118272	-67872	264732	171300	-55100	-218400	θ_{ZA}
5712	-46620	-26520	-269600	-70700	118300	6306504	-189408	-2215764	2009400	60474000	2394500	X_B
-2784	16176	1608	94700	-44200	-67900	-189408	7885032	-119424	-61986800	-424800	31518900	Y_B
10908	-65400	-7596	-382800	157900	264700	-2215764	-119424	1132956	-99600	-27522500	-1171100	Z_B
8592	-168	-26640	3100	265900	171300	2009352	-61986852	-99624	647071100	6809400	-301482900	θ_{XB}
492	-43908	-74856	-246300	-499800	-55100	60473964	-424848	-27522492	6809400	788885000	9887700	θ_{YB}
-5940	131844	-39108	780100	160600	-218400	2394516	31518888	-1171056	-301482900	9887700	208674500	θ_{ZB}

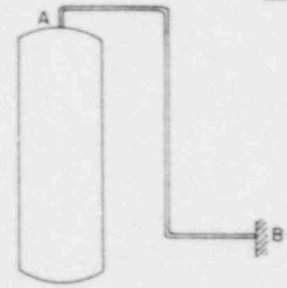


FIGURE E6
MS-02, LOOP 4

153408	267468	-22944	351500	-10800	-736700	15804	288876	63864	1155800	-218500	632300
267468	828180	-63960	626600	-394200	-4860500	-8580	881964	165528	3394500	-377300	2137100
-22944	-63[illegible]	87216	-1317400	1111700	269700	-38676	-85224	29328	-240300	74900	-341500
351456	626592	-1317444	40066700	-14747800	-1867800	217644	736104	122328	1537000	-1133100	3779300
-10812	-394248	1111704	-14747800	29753900	1786900	-588840	-739380	1079772	-3970500	-428700	59700
-736668	4860480	269664	-1867800	1786900	53506900	194880	-5126800	-1033116	-19397100	1815600	-12938600
15804	-8580	-38676	217600	-588800	194900	2544012	3468	2048148	-1070300	-36549800	1676900
288876	881964	-85224	736100	-739400	-5126800	3468	3719184	-38388	36009700	81800	23274000
63864	165528	29328	122300	1079800	-1033100	2048148	-38388	2094636	-989600	-27139900	1203200
1155768	3394476	-240312	1537000	-3970500	-19397100	-1070316	36009660	-989616	434577900	6533200	251332300
-218448	-377268	74880	-1133100	-428700	1815600	-36549768	81840	-27139920	6533200	609164600	-9375800
632328	2137116	-341544	3779300	-59700	-12938600	1676916	23273964	1203240	251332300	-9375800	209881100

δXA
δYA
δZA
θXA
θYA
θZA
δXB
δYB
δZB
θZB
θYB
θZB

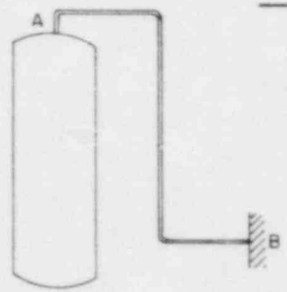


FIGURE E7
MS-03, LOOP 2

127320	207976	30648	-175000	-208900	-385700	27716	285600	-59892	-1014000	176000	343600	δXA
207876	876912	125028	-226600	613500	-5187200	13884	1190712	-195660	-3985100	375400	1908300	δYA
30648	125028	115788	-1605000	1160100	-672500	48336	192972	27840	-582800	112800	432900	δZA
-174960	-226644	-1605074	46219800	-15418900	880200	-401004	-451740	-151368	611700	-1070500	-2490400	θXA
-208896	613464	1160148	-15418900	31729[illegible]	-4835200	306564	1191108	1259076	-5375800	-1107300	-817500	θYA
-385656	-5187192	-672480	880200	-4835200	58224100	-4176	-6991056	1299384	22865700	-2202300	-12248300	θZA
22716	13884	48336	-401000	306600	-4200	5045736	-4692	-3134796	1243100	57857700	2400900	δXB
285600	1190712	192972	-451700	1191100	-6991100	-4692	6320016	1128	-56865000	-17400	28789000	δYB
-59892	-195660	27840	-151400	1259100	1299400	-3134796	1128	2351604	-674900	-32614100	-1315100	δZB
-1014000	-3985092	-582840	611700	-5375800	22865700	1243092	-56865000	-674880	630046000	5245400	-29313440[illegible]	θXB
175968	375444	112848	-1070500	-1107300	-2202300	57857688	-17400	-32614164	5745400	788827800	10150600	θYB
343572	1908324	432888	-2490400	-817500	-12248300	2400936	28789032	-1315116	-293134400	101506[illegible]	202636200	θZB

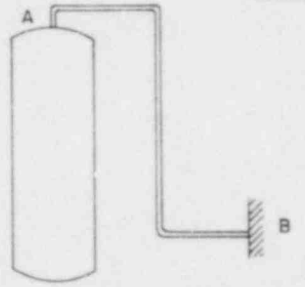


FIGURE E8
MS-04, LOOP 3

```
 9   22   65   66
 19404.       20580.        6492.       -58212.      178788.      -48808.
 20580.       56808.         108.      -136898.       72900.     -674780.
  6492.         108.       29544.      -171116.      588484.       13518.
-58212.     -136898.     -171116.       5908900.    -3263300.     1589600.
178788.       72900.      588484.      -3263300.    14891000.     -102600.
-48808.     -674780.       13518.       1589600.     -102600.    14531900.
10   122  171  172
 12768.       18984.       -1980.       -35804.       14210.      235910.
 18984.      165684.      -22440.      -187978.      -92180.     -586549.
-1980.       -22440.       15468.      -309986.       53412.      102876.
-35804.     -187978.     -309986.      12901200.    -1227100.      174400.
 14210.      -92180.       53412.      -1227100.     4169900.     1108800.
235910.     -586549.      102876.       174400.     1108800.    14050000.
11   222  265  266
 13188.       15444.        1236.       42012.       -18570.      323694.
 15444.      169080.       24924.      170180.       52218.     -246888.
  1236.       24924.       16728.      -336704.       22126.      -72802.
 42012.      170180.     -336704.      13932300.    -577600.      651050.
-18570.       52218.       22126.      -577600.     4123400.     -845000.
323694.     -246888.      -72802.       651050.     -845000.    13939400.
12   322  293  294
 20676.       23652.       -8664.       127478.     -256200.       -6380.
 23652.       93480.       12564.       396780.       29522.     -845712.
-8664.        12564.       44268.      -219800.      712090.     -130176.
 127478.     396780.      -219800.       8604200.    -3814800.    -3611600.
-256200.      29522.       712090.      -3814800.    15377100.    -1731100.
-6380.      -845712.     -130176.      -3611600.    -1731100.    14553780.
13   25   67   68
 91860.       66876.      -13644.      -429214.      858576.      1503722.
 66876.      554148.      -234396.     -2154049.     1859586.       82476.
-13644.      -234396.      144180.       228710.     -430212.       -3012.
-629214.    -2154049.      228710.      31110600.   -11929300.     -530500.
 858576.     1859586.     -430212.     -11929300.    30302000.    12537000.
1503722.       82476.       -3012.      -530500.     12537000.    42928800.
14   125  173  174
 153408.      267468.      -22944.       351478.      -10806.      -736684.
 267468.      828180.      -63960.       626594.     -394224.     -4860490.
-22944.      -63960.       87216.      -1317422.      1111702.      269682.
 351478.     626594.     -1317422.      40066700.   -14747800.    -1867800.
-10806.     -394224.      1111702.     -14747800.    29753900.     1786900.
-736684.    -4860490.      269682.      -1867800.     1786900.    53506900.
15   225  267  268
 127320.      207876.       30648.      -174980.     -208898.      -385678.
 207876.      876912.      125028.      -226622.      613482.     -5187196.
 30648.       125028.      115788.      -1605012.     1160124.      -672490.
-174980.     -226622.     -1605012.      46219800.   -15418900.      880200.
-208898.      613482.      1160124.     -15418900.    41729300.     -4835200.
-385678.    -5187196.     -672490.       880200.     -4835200.    58224100.
16   325  295  296
 99132.       93984.       27708.       547512.     -1050592.     1630488.
 93984.      273180.       83736.      1590514.     -1132078.      487414.
 27708.       83736.       96912.      -514292.      -394402.      124126.
 547512.     1590514.     -514292.      37782800.    -6585600.     2842600.
-1050592.   -1132078.     -394402.      -6585600.    36358300.    -14342400.
1630488.      487414.      124126.       2842600.    -14342400.    47589000.
```

FIGURE E9
STIFFNESS MATRIX INPUT DATA

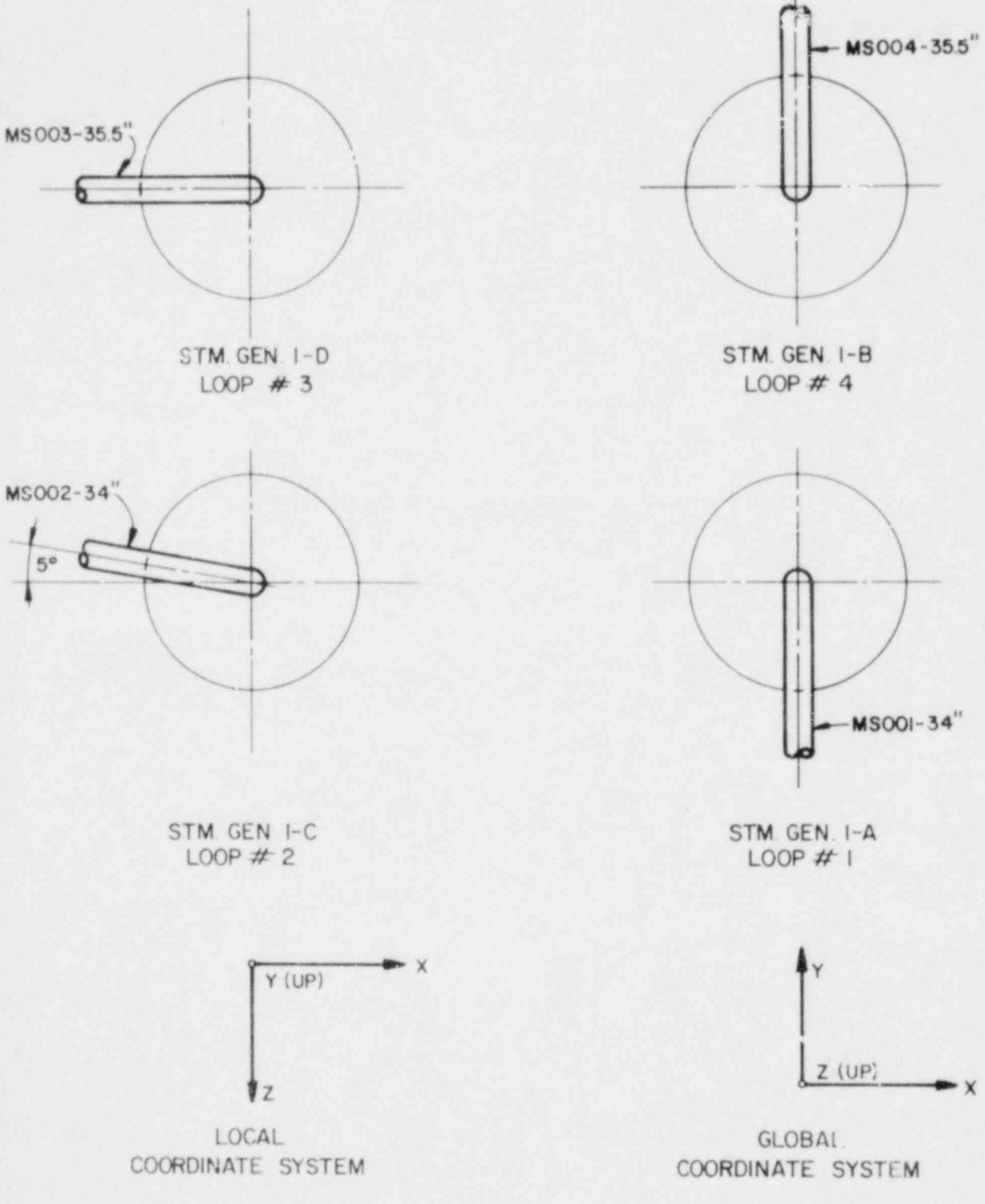


FIGURE E11
ORIENTATION OF MAIN STEAM NOZZLES

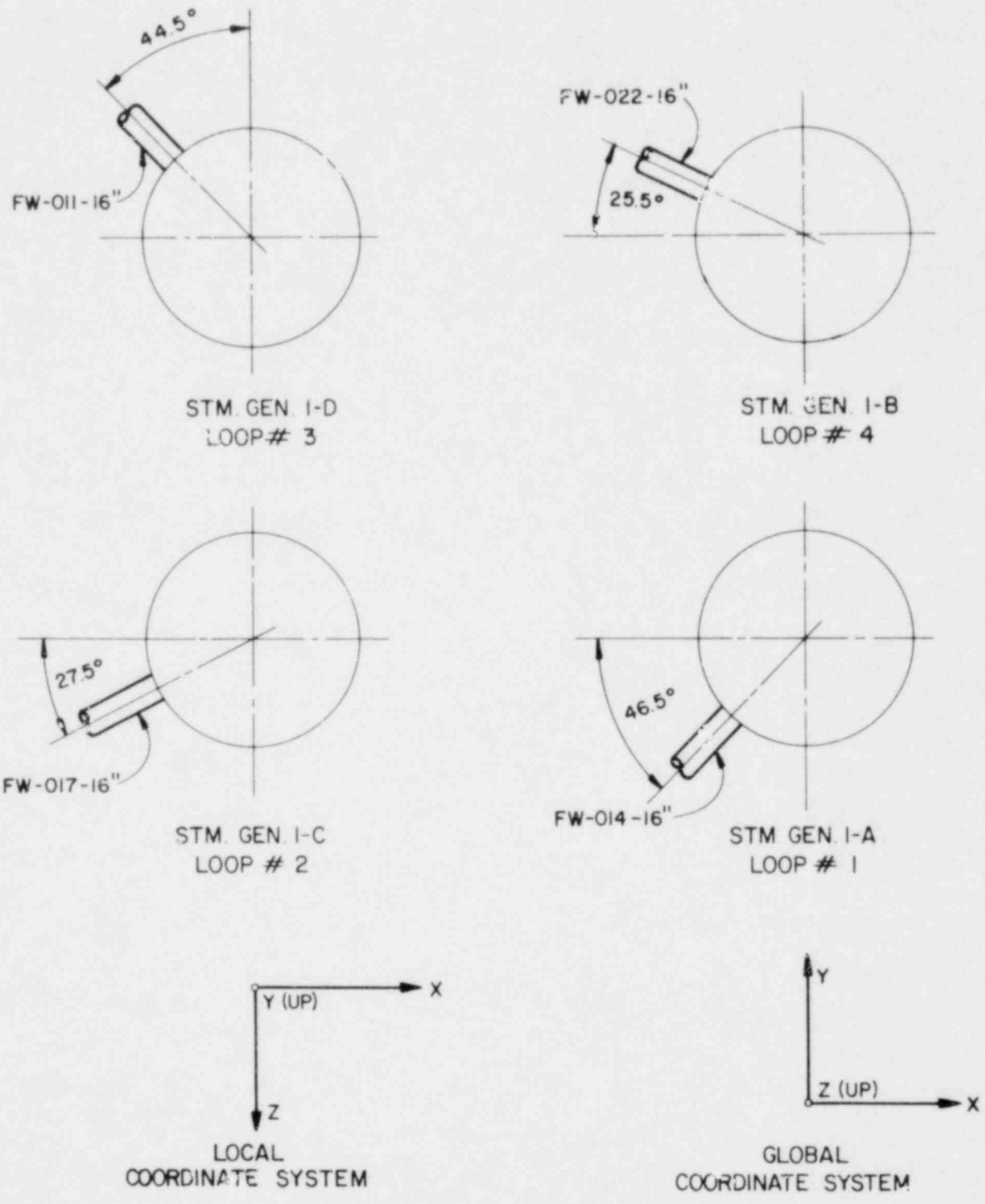


FIGURE E10
ORIENTATION OF FEEDWATER NOZZLES

APPENDIX F

STATIC MODEL FOR WEIGHT AND THERMAL LOADINGS

STATIC MODEL FOR WEIGHT AND THERMAL LOADINGS

This appendix describes the model changes required to convert the Zion Reactor Coolant Loop Seismic Model to a Zion Reactor Coolant Loop Model for weight and thermal load analysis.

1. Master Control Card

   The number of load cases was changed to 3. The first case is weight load, the second is thermal load, and the third is weight plus thermal. An optional fourth case is pressure load.

2. Joint Coordinate Cards

   To provide a test case for model checking, preliminary values for normal operating temperature have been added in columns 71-80. Final values are to be input by the user.

3. Truss Elements

   Modulus of Elasticity (columns 6-15) on four material property cards were taken out. This has the effect of making the corresponding supports inactive (zero stiffness). These changes make all snubber supports inactive for all static loads. Member property 1 represents the snubbers acting in the radial direction at the steam generator upper lateral support. Member properties 5, 6 and 7 represent surge line seismic supports RCRS-1007, RCRS-1008, and RCRS-1009, respectively. RCRS-1008 is a seismic sway strut. A slotted hole connection is provided at one end of the strut to insure that the support does not carry static loads.

4. Beam Elements

4.1 Material Property Cards

A second material property card has been added so that supports may be separated into two categories. Material Property 1 is for weightless supports, and Material Property 2 is for supports with effective weight. In many cases, lateral supports are cantilevered off a wall, and do not cause static loads to act on the Reactor Coolant System. The weight of vertical supports are included for completeness, but may be excluded as described below.

4.2 Element Load Factors

A factor of -1.0 is placed in columns 1-10 of the third card for gravity load in the +Z direction. The weight of vertical supports may be taken out of the analysis simply by setting this factor equal to zero.

4.3 Beam Element Data Cards

Dead weight of component supports is considered in the analysis for steam generator columns (Beam Nos. 1, 2, 3 and 4), Reactor Coolant Pump columns (Nos. 13, 14, 15 and 16), Pressurizer columns (No. 25), and pipe clamps on the surge line (Nos. 32 and 33). All other supports modeled as beam elements are considered to be weightless for static analysis.

Axial stiffness of several beam elements was made inactive by adding member releases (place a 1 in column 51). The steam generator lower lateral support is inactive in the radial direction (Beam Nos. 9, 10, 11 and 12). Both the tangential and the radial Reactor Coolant Pump supports (Nos. 17 through 24) are provided with slotted end connections to make them inactive for static loads.

The torsional stiffness in the Reactor Coolant Pump columns (Nos. 13-16) becomes zero (place a 1 in column 54) because this stiffness is actually provided by the lateral supports which are inactive for static loads.

Finally, the surge line flailing restraints are completely isolated by large gaps, and thus are totally released at the pipe and fixed at the wall.

5. Pipe Elements

5.1 Material Property Cards

Material Properties are reorganized into eight groups for static analysis, as shown in Table F1. These values were taken from information provided by Lawrence Livermore

Laboratory, with the exception that the coefficients of thermal expansion for the RPV, Pressurizer and Pressurizer Surge Line were selected based on material type and normal operating temperature.

5.2 Section Property Cards

The weight per unit length in pounds per lineal foot was added in columns 36-45 for all straight pipes, elbows, and horizontal valve sections. All remaining weights are input as concentrated nodal loads.

5.3 Element Load Case Multipliers

A factor of -1.0 is placed in columns 1-10 on the third card so that Z-direction gravity loads will be applied in Element Load Case A. A factor of 1.0 is placed in columns 11-20 on the fourth card so that thermal loads will be applied in Element Load Case B. A factor of 1.0 is placed in columns 21-30 on the fifth card so that internal pressure loads will be applied in Element Load Case C.

5.4 Pipe Element Cards

The average internal operating pressure of 321800 psf (2235 psi) has been entered in columns 36-45 on element data cards for all straight pipe and elbows. Also, the section property identification number (column 25) for cold leg and cold leg valve element data cards has been changed to 8. These element data card numbers are 39-50, 89-100, 139-150, and 189-200.

6. Concentrated Nodal Load Data Cards

Equipment weights and preset hanger loads are input to the model as concentrated loads. These loads are itemized in Table F2. All loads are entered twice so that they are considered in both load combination 1 (weight, and combination 3 (weight plus thermal).

7. Element Load Multiplier Cards

Three cards are provided, one for each loading condition. The first card contains a multiplier of 1.0 in columns 1-10, meaning that load case 1 will include 100 percent of element load case A (member gravity loads). The second card contains a multiplier of 1.0 in columns 11-20, meaning that load case 2 will include 100 percent of element load case B (member thermal loads). The third card contains the multiplier 1.0 in both columns 1-10 and 11-20, meaning that 100 percent of gravity loads and thermal loads are to be included in load case 3. The effects of internal pressure

in pipe elements can be included in any or all of these three load cases simply by placing a multiplier of 1.0 in columns 21-30 on the load multiplier card corresponding to each of the load cases in which internal pressure is to be considered.

Property No.	Component Name	Modulus of Elasticity ($X10^9$ psf)	Coefficient of Thermal Expansion ($X10^{-6}$ in./in. °F)
1	Steam Generator & Pressurizer	3.800	7.18
2	Reactor Pressure Vessel	3.715	9.74
3	Hot Leg & Surge Line	3.730	9.82
4	Hot Leg Valve	3.860	9.47
5	Steam Generator Inlet Nozzle	3.790	7.18
6	Crossover Leg & Reactor Coolant Pump Casing	3.770	9.74
7	Reactor Coolant Pump Motor	4.020	6.19
8	Cold Leg & Cold Leg Valve	3.800	9.74

TABLE F1
MATERIAL PROPERTIES

Equipment	Node	Weight (lbs.)
Hot Leg Valve	6, 106, 206, 306	3,893
Steam Generator	16, 116, 216, 316	836,476
Reactor Coolant Pump	39, 139, 239, 339	95,700
Reactor Coolant Pump Motor	47, 147, 247, 347	77,000
Cold Leg Valve	49, 149, 249, 349	3,597
Cold Leg Valve Motor	50, 150, 250, 350	13,358
Hot Leg Valve Motor	64, 170, 264, 292	14,107
RPV Shell	168	1,556,100
RPV Internals	169	424,900
Pressurizer Lower Head	406	71,613
Pressurizer Shell	409	118,295
Pressurizer Upper Head	415	44,131
Preset Hanger Loads*		
RCH-1001	364	5,650
RCH-1003	389	6,800

*Note: Gravity loads act in the negative Z direction. Preset hanger loads act in the positive Z direction opposite to gravity loads.

TABLE F2
EQUIPMENT WEIGHTS AND PRESET HANGER LOADS

GLOSSARY

Artificial accelerogram

A numerically simulated acceleration time-history plot of an earthquake's ground motion.

Aspect ratio

Half-length-to-depth ratio of a semi-elliptical surface crack, $b/a = \beta$ The half length is measured along the surface of the pipe.

Availability

The percent of time that the reactor plant is actually in operation during its 40-yr life. For Zion, the estimated availability is 70%.

Boundary integral equation (BIE) technique

A mathematical solution of three-dimensional elasticity problems which divides a body's surface into elements and provides displacements and tractions at surface nodal points. Results are a set of simultaneous linear equations that are solved for the unknown nodal displacements or tractions.

BWR

Boiling water reactor.

Cold leg

Portion of the primary coolant loop piping which connects reactor coolant pump to reactor pressure vessel.

Conditional probability

If A and B are any two events, the conditional probability of A relative to B is the probability that A will occur given that B has occurred or will occur.

Confidence interval (estimator)

An interval estimator with a given probability (the confidence coefficient) that it will contain the parameter it is intended to estimate.

Containment

A concrete shell designed to house the NSSS, the polar crane, and other internal systems and components of a nuclear power plant.

Correlation

The relation between two or more variables.

Couple

To combine, to connect for consideration together.

Covariance

The expected value of the product of the deviations of two random variables from their respective means. The covariance of two independent random variables is zero, but a zero covariance does not imply independence.

Crossover leg

Portion of the primary coolant loop piping which connects the steam generator to the reactor coolant pump.

Cumulative distribution function (cdf)

A function that gives the probability that a random variable, X, is less than or equal to a real value, x.

DEPB

Double-ended pipe break.

Decouple

The opposite of couple; disconnecting two events.

EPFM

Elastic-plastic fracture mechanics.

Estimate

A number or an interval, based on a sample, that is intended to approximate a parameter of a mathematical model.

Estimator

A real-valued function of a sample used to estimate a parameter.

Fatigue crack growth

Growth of cracks due to cyclic stresses.

Flow stress

The average of the yield strength and ultimate tensile strength of a material. Approximate stress at which gross plastic flow occurs.

Fracture

See pipe fracture.

Girth butt weld

Circumferential weld connecting adjacent pipe ends. The girth butt welds referred to in this report are in the primary coolant loop piping.

Hazard curve (seismic)

The probability that one earthquake will generate a specified value of the peak ground acceleration in a time interval of specified length, usually one year.

Hot leg

Portion of the primary coolant loop piping which connects the reactor pressure vessel to steam generator.

Independent events

Two events are independent if, and only if, the probability that they will both occur equals the product of the probabilities that each one, individually, will occur. If two events are not independent, they are dependent.

Independent random variables

Two or more random variables are independent if, and only if, the values of their joint distribution function are given by the products of the corresponding values of their individual (marginal) distribution functions. If random variables are not independent, they are dependent.

LEFM

Linear-elastic fracture mechanics.

Large LOCA

Large loss-of-coolant accident. For the purpose of this report the large LOCA is equivalent to a pipe fracture in the primary coolant loop pipe. (See pipe fracture).

Leak-before-break situation

A pipe defect that grows to become a through-wall crack but is of insufficient length to result immediately in a complete pipe severance.

Load-controlled stress

Stress upon a pipe that cannot be relaxed by displacement. As such, the load is not relieved by crack extension. In this analysis pressure, dead weight, and seismic stresses are assumed to be load controlled.

Mean

(1). A measure of the center of a set of data. The sample mean of n numbers is their sum divided by n. (2). A population mean is a measure of the center of the probability density function. This is also called the mathematical expectation.

NSSS

Nuclear steam supply system.

OBE

Operating basis earthquake.

Operating stress

Stress in the piping due to normal operating loads, e. g., dead weight, pressure, start ups, etc.

Pipe fracture

A double-ended guillotine pipe break; also referred to in this report as a LOCA and a large LOCA. Refers to a circumferential pipe fracture in which pipe sections on either side of the fracture are completely severed from each other.

Pipe severance

See pipe fracture.

Poisson process

A random process, continuous in time, for which the probability of the occurrence of a certain kind of event during a small time interval t is approximately λt, the probability of occurrence of more than one such event during the same time interval is negligible, and the probability of what happened during such a small time interval does not depend on what happened before.

PRAISE

A computer code, Piping Reliability Analysis Including Seismic Events, developed to estimate the time to first failure for individual joints in a piping system. It is used to analyze the Zion 1 primary coolant loop. PRAISE is written in FORTRAN.

Primary cooling loop

Cold leg, hot leg, and crossover leg.

Probability density function (pdf)

A non-negative, real-valued function whose integral from a to b (a less than or equal to b) gives the probability that a corresponding random variable assumes a value on the interval from a to b.

PWR

Pressurized water reactor.

Radial gradient thermal stress

Axisymmetric stress in the pipe arising from temperature variations through the pipe wall thickness. In this report, the radial gradient thermal stress is a result of temperature transients in the reactor coolant.

Random variable

A real-valued function defined over a sample space.

Response spectrum analysis

A response analysis that estimates the maximum response from response spectra.

RCL

Reactor coolant loop.

RCP

Reactor coolant pump.

Risk

Expected loss.

RPV

Reactor pressure vessel.

Sample space

A set of points that represent all possible outcomes of an experiment.

S factor

Stress factor used for fatigue analysis to account for multiple stress cycles.

Seismic hazard curve

See hazard curve.

SG

Steam generator.

Simulation

Numerical technique employed to simulate a random event, artificial generation of a random process. The PRAISE computer code uses Monte Carlo Simulation to estimate the probability of failure in nuclear reactor piping.

Soil impedance functions

Forces required to oscillate the foundation through unit displacements in different directions.

SSE

Safe shutdown earthquake.

Standard deviation

(1). A measure of the variation of a set of data. The sample standard deviation of a sample of size n is given by the square root of the sum of the deviations from the mean divided by (n-1). (2). A measure of the variability of a random variable. The population standard deviation is the square root of the variance; the mean of the square of the random variable minus its mean.

Statistically dependent

Two events are statistically dependent if they do not fit the criterion for statistical independence.

Statistically independent

See independent events.

Stratified random sampling

A method of sampling in which portions of the total sample are allocated to individual subpopulations and randomly selected from these strata. The principal purpose of this kind of sampling is to guarantee that population subdivisions of interest are represented in the sample, and to improve the precision of whatever estimates are to be made from the sample data.

Stress corrosion cracking

Cracking due to the combined effects of stress and corrosion.

Stress intensity factor

A fracture mechanics parameter that describes the state of steam at the tip of a crack.

Surge line

Piping that connects pressurizers to the reactor coolant loop. In the Zion I PWR the surge line is a branch from the hot leg in Loop 4.

Time-history response analysis

A response analysis that estimates the maximum response from response spectra.

Transient

An event in the operation of the PWR that gives rise to a load in the piping over a specified length of time.

Uncertainty

Absence of certainty due to randomness of a random variable or lack of knowledge of the edf of a random variable.

Uniform hazard method (uhm)

A procedure for estimating frequency of occurrence distributions for various ground motion parameters.

UT

Ultrasonic testing.

Variance

The mean of the squares of the deviations from the mean of a random variable.

ZPGA

Zero period ground acceleration; defines the size of an earthquake.

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This report describes the Zion Station reactor coolant loop model developed by Sargent & Lundy Engineers for Lawrence Livermore National Laboratory as part of its Load Combination Program. This model was developed for use in performing seismic time history analyses of an actual pressurized water reactor (PWR) system. It includes all major items affecting the seismic response of a 4-loop Westinghouse nuclear steam supply system: the components, supports, and interconnecting piping. The model was further expanded to permit static analysis of dead weight, thermal, and internal pressure load conditions.

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