LIMERICK GENERATING STATION UNITS 1 & 2

DESIGN ASSESSMENT REPORT

REVISION 1 PAGE CHANGES

The attached pages, tables, and figures are considered part of a controlled copy of the Limerick Generating Station DAR. This material should be incorporated into the DAR by following the instructions below.

REMOVE	INSERT
VOLUME 1	
Pages S-i, -iii, -iv, -v	Pages S-i, -iii, -iv, -v
Pages 1.4-1 & -2	Pages 1.4-1 & -2
Figure 1.4-3	Figure 1.4-3
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Table 4.2-4	Table 4.2-4
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Figure 4.2-16	Figure 4.2-16
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Pages 7.2-1 thru -3	Pages 7.2-1 thru -6
Figure 7.2-1	Figure 7.2-1
---- (after tab for Chapter 8)	Tab "Response to NRC Questions" thru tab 600
VOLUME 2	
Figure B.1-5	Figure B.1-5
Figures B.2-71 thru -82	Figures B.2-71 thru -82
Page D-1	Pages D-ii thru Figure D.1-25

LGS DAR Revision 1 Page Change Instructions

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Pages E-i & E-1	Pages E-i thru Figure E.1-29

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1.4 PLANT DESCRIPTION

The Limerick Generating Station (Units 1 and 2) is located on the east bank of the Schuylkill River in Limerick Township of Montgomery County, Pennsylvania, approximately 1.7 miles southeast of the limits of the Borough of Pottstown and approximately 20.7 miles northwest of the Philadelphia city limits.

Each of the LGS units employs a General Electric Company boiling-water reactor (BWR) designed to operate at a rated core thermal power of 3293 MWt (100% steam flow) with a corresponding gross electrical output of 1092 MWe. Approximately 37 MWe are used for auxiliary power, resulting in a net electrical output of 1055 MWe.

Commercial operation of LGS Unit 1 is scheduled for April 1985 and Unit 2 for October 1987.

1.4.1 PRIMARY CONTAINMENT

The containment is a reinforced concrete structure consisting of a cylindrical suppression chamber beneath a truncated conical drywell. Figures 1.4-1 and 1.4-2 show the cross section of the containment and suppression chamber (including pedestal), respectively. The conical portion of the primary containment (drywell) encloses the reactor vessel, reactor coolant recirculation loops, and associated components of the reactor coolant system. The drywell is separated from the wetwell, i.e, the pressure suppression chamber and pool, by the drywell floor, also named the diaphragm slab. The cone and cylinder form a structurally integrated reinforced concrete vessel, lined with steel plate and closed at the top of the drywell with a steel domed head. The carbon steel liner plate is anchored to the concrete by structural steel members embedded in the concrete and welded to the liner plate.

The entire containment is structurally separated from the surrounding reactor enclosure except at the base foundation slab (a reinforced concrete mat, top lined with a carbon steel liner plate) where a seismic gap filled with roloform is provided between the two adjoining foundation slabs. The containment structure dimensions and parameters are listed in Tables 1.4-1 and 1.4-2.

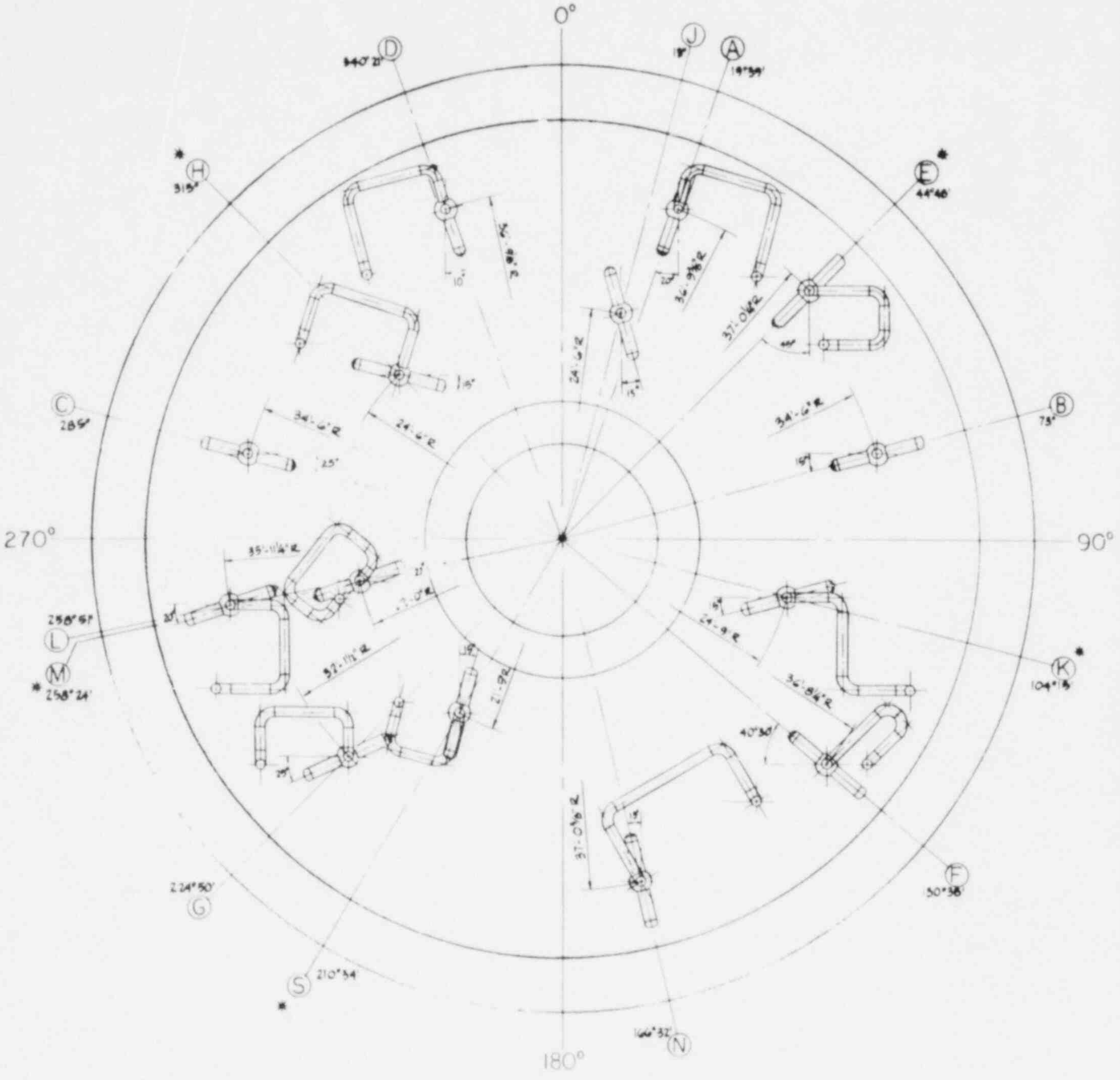
Major systems and components in the containment include the vent pipe system (downcomers) connecting the drywell and wetwell, vacuum relief system, containment cooling system, and main steam relief valve (MSRV) discharge piping and associated quencher components. Figure 1.4-3 shows the locations and orientation of the quenchers and discharge piping.

1.4.1.1 Penetrations

Services and communications between the inside and the outside of the containment are performed through penetrations. Basic penetration types include pipe penetrations, electrical penetrations, and access hatches (equipment hatches, personnel lock, suppression chamber access hatches, and control rod drive (CRD) removal hatch). Each penetration consists of a pipe sleeve with an annular ring welded to it. The ring is embedded in the concrete wall and provides an anchorage for the penetration to resist normal operating and accident loads. The pipe sleeve is also welded to the containment liner plate to provide a leaktight penetration.

1.4.1.2 Internal Structures

The internal structures consist of reinforced concrete and structural steel and have the major functions of supporting and shielding the reactor vessel, supporting the piping and equipment, and forming the pressure suppression boundary. These structures include the diaphragm slab, the reactor pedestal (a concentric cylindrical reinforced concrete shell resting on the containment base foundation slab and supporting the reactor vessel; Figure 1.4-2 shows pedestal cross section), the reactor shield wall, the suppression chamber columns (hollow steel pipe columns supporting the diaphragm slab), the drywell platforms, the seismic trusses, the quencher supports, and the reactor steam supply system supports.



PLAN AT EL 181'-11"

* A.D.S. VALVES H,M,K,E,S

LIMERICK GENERATING STATION
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QUENCHER LOCATIONS
AND ORIENTATION

FIGURE 1.4-3

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CHAPTER 2

SUMMARY

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CHAPTER 2

SUMMARY

2.1 SRV LOAD DEFINITION SUMMARY

2.1.1 SRV LOAD DEFINITION SUMMARY

Hydrodynamic loads resulting from SRV actuation fall into two categories: loads on the SRV system itself (the discharge line and the discharge quencher device), and the loads on the suppression pool walls and submerged structures.

Loads on the SRV system during SRV actuation include loads on the SRV piping due to effects of steady backpressure, transient water slug clearing, and SRV line temperature. Determination of loading on the quencher body, arms, and support is based on transients resulting from valve opening (water clearing and air clearing), valve closing, and operation of an adjacent quencher.

Air clearing loads are examined for four loading cases: symmetric (all-valve) SRV actuation, asymmetric adjacent SRV actuation, single SRV actuation, and automatic depressurization system (ADS-five valves) actuation. Dynamic forcing functions for loading of the containment walls, pedestal, basemat, and submerged structures are developed using techniques discussed in Section 4.1. Loads on the SRV system due to SRV actuation are discussed in Section 4.1.3, and loads on suppression pool walls and submerged structures due to SRV actuation are discussed in Section 4.1.4. A full-scale, unit cell test program was conducted at the KWU laboratories to verify these SRV loading specifications. These tests are described in Chapter 8.

Adjacent structures indirectly affected by SRV loads include the reactor enclosure, control structure, and associated equipment and components. The assessment methodology used in determining the SRV load effect on these adjacent structures is described in Section 7.1.1.2.

2.1.2 LOCA LOAD DEFINITION SUMMARY

The spectrum of LOCA-induced loads acting on the LGS containment structure is characterized by LOCA loads associated with poolswell and condensation oscillation and chugging, as well as long-term and secondary LOCA loads.

The LOCA loads associated with poolswell result from short duration transients and include downcomer clearing loads, water jet loads, poolswell impact and drag loads, pool fallback drag loads, poolswell air bubble loads, and loads due to drywell and wetwell temperature and pressure transients. Techniques used to evaluate these loads are described in Section 4.2.1.

Condensation oscillations result from mixed flow (air/steam) and pure steam flow effects in the suppression pool. Chugging loads result from low mass flux pure steam condensation. The load definitions from these phenomena are contained in Section 4.2.2.

Long-term LOCA loads result from those wetwell and drywell pressure and temperature transients associated with design basis accidents (DBA), intermediate break accidents (IBA), and small break accidents (SBA). Their load definitions are contained in Section 4.2.4.

Structures directly affected by LOCA loads include the drywell walls and floor, wetwell walls, RPV pedestal, basemat, liner plate, columns, downcomers, downcomer bracing system, and wetwell piping. Their loading conditions are described in Section 4.2.5.

Adjacent structures indirectly affected by LOCA loads include the reactor enclosure, control structure, and associated equipment and components. The assessment methodology used in determining the LOCA load effect on these adjacent structures is described in Section 7.1.1.2.

2.2 DESIGN ASSESSMENT SUMMARY

Design assessment of the LGS structures and components is achieved by analyzing the response of the structures and components to the load combinations explained in Chapter 5. In Chapter 7, predicted stresses and responses (from the loads defined in Chapter 4 and combined as described in Chapter 5) are compared with the applicable code allowable values identified in Chapter 6.

2.2.1 CONTAINMENT STRUCTURE, REACTOR ENCLOSURE, AND CONTROL STRUCTURE ASSESSMENT SUMMARY

2.2.1.1 Containment Structure Assessment Summary

The primary containment walls, base slab, diaphragm slab, reactor pedestal and reactor shield are analyzed for the effects of SRV and LOCA in accordance with Table 5.2-1. The ANSYS finite element program is used for the dynamic analysis of structures.

Response spectra curves are developed at various locations within the containment structure to assess the adequacy of components. Stress resultants due to dynamic loads are combined with other loads in accordance with Table 5.2-1 to evaluate rebar and concrete stresses. Design safety margins are defined by comparing the actual concrete and rebar stresses at critical sections with the code allowable values. The assessment methodology of the containment structure is given in Section 7.1.1.1.

The containment mode shapes, modal frequencies, and hydrodynamic response spectra are given in Appendix A.

The results of the structural assessment of the containment structure are given in Appendix D.

2.2.1.2 Reactor Enclosure and Control Structure Assessment Summary

The reactor enclosure and control structures are assessed for the effects of SRV and LOCA loads in accordance with Table 5.2-1 and Table 5.3-1.

Pressure time histories in the wetwell are used to investigate the reactor enclosure and control structure response to SRV and LOCA loads. Maximum time history force responses and broadened response spectra curves are approximately used to assess the adequacy of associated structural components. The assessment methodology of the reactor enclosure and control structure is presented in Section 7.1.1.2.

The mode shapes, modal frequencies, and hydrodynamic response spectra of the reactor enclosure and control structure are presented in Appendix B.

The results of the structural assessment are summarized in Appendix E.

2.2.2 CONTAINMENT SUBMERGED STRUCTURES ASSESSMENT SUMMARY

Load combinations for the downcomer bracing and suppression chamber columns are presented in Table 5.3-1. Load combinations for the downcomers are presented in Table 5.5-1. The hydrodynamic design assessment methodology for the downcomers, bracing, and columns is presented in Sections 7.1.2 and 7.1.4. The results of the analysis are presented in Appendix D.

The suppression pool liner plate loads are combined in accordance with Table 5.2-1. Results from the analysis indicate that no structural modification is required (see Sections 7.1.3 and 7.2.1.5).

2.2.3 PIPING SYSTEMS ASSESSMENT SUMMARY

Containment and reactor enclosure piping systems are being analyzed by the methods presented in Section 7.1.5. The load combinations for piping are described in Table 5.6-1. The results of the analysis are presented in Appendix F.

2.2.4 NSSS ASSESSMENT SUMMARY

To be provided later.

2.2.5 EQUIPMENT ASSESSMENT SUMMARY

Non-NSSS safety related equipment in the containment, reactor enclosure, and control structure are assessed by the methods contained in Section 7.1.7. Loads are combined as shown in Table 5.8-1. The results of the analysis are presented in Appendix H.

2.2.6 ELECTRICAL RACEWAY SYSTEM ASSESSMENT SUMMARY

Electrical raceway system loads are combined in accordance with Table 5.9-1. The assessment methodology and analysis results are presented in Chapter 7.

2.2.7 HVAC DUCT SYSTEM ASSESSMENT SUMMARY

HVAC duct system loads are combined in accordance with Table 5.10-1. The assessment methodology and analysis results are presented in Chapter 7.

2.2.8 SUPPRESSION POOL TEMPERATURE MONITORING SYSTEM (SPTMS) ASSESSMENT SUMMARY

SPTMS adequacy assessment and suppression pool temperature response to SRV discharge are presented in Appendix I.

CHAPTER 4

TABLES

When the jet is predicted to dissipate, the sphere is traveling at the final jet velocity at the point of maximum jet penetration. This condition is used as the final load calculation point. The final jet velocity is that of the jet front just before the last particle leaving the vent reaches the jet front. The velocity of the last particle is disregarded.

The largest water jet loads on affected components are given in Table 4.2-5.

4.2.1.4 Boundary-Loads During Poolswell

During the poolswell transient, the high pressure air bubble that forms in the vicinity of the vent exit creates an increase in pressure on all suppression pool boundaries below the vent exit as well as those walls with which it is in direct contact. Boundaries that are between the bubble location and the point of maximum pool elevation also experience increased pressure loads corresponding to the increased pressure in the wetwell airspace, as well as the hydrostatic contribution of the water slug.

Reference 1.3-1, section 4.2.5, and Reference 1.3-5, section 2.1.2.5, describe the methodology for specification of these boundary loads. The poolswell analytical model is used to determine the maximum values of bubble pressure and wetwell airspace pressure. The analysis takes the maximum pool elevation as 1.5 times the initial submergence. Using this data, a static loading is applied to the containment structure as follows:

a. For the basemat - uniform pressure equal to the maximum bubble pressure superimposed on the hydrostatic load corresponding to a submergence from vent exit to the basemat

b. For the containment walls below the vent exit - maximum bubble pressure plus hydrostatic head corresponding to vertical distance from vent exit.

c. For the containment walls between the vent exit and maximum pool elevation - linear variation between maximum bubble pressure and maximum wetwell airspace pressure

d. For the containment walls above maximum pool elevation - maximum wetwell airspace pressure.

The pressure distribution used for the LGS analysis is shown in Figure 4.2-2.

4.2.1.5 Poolwell Asymmetric Air Bubble Load

The methodology used in Section 4.2.1.4 assumes that the air flow rate in each downcomer is equal, leading to a symmetric loading of the containment boundary. Concern has been expressed (Reference 1.3-2, subsection III.B.3.e) that circumferential variations in the downcomer air flow rate can occur, due to drywell air/steam mixture variation, that would result in variations in the bubble pressure load on the wetwell wall. This asymmetric loading condition is calculated by statically applying the maximum air bubble pressure, obtained from the PSAM computer code, to half of the submerged boundary and statically applying the hydrostatic pressure of the water column to the other half of the submerged boundary. The pressure load on the basemat and wetwell walls below the vent exit is the sum of the air pressure and the hydrostatic pressure. For the portion of the wall above the vent exit, the pressure increase due to the air bubble is linearly attenuated from the bubble pressure at the vent exit to zero at the pool surface. This increase is then added to the local hydrostatic pressure to obtain the total pressure. The time period of application of the load is from the termination of vent clearing until the maximum swell height is reached.

These loading conditions are conservative with respect to the NRC's long-term criteria for asymmetric bubble loads (Ref. 1.3-5, Appendix A).

4.2.1.6 Poolswell Impact Load

As the pool rises during poolswell, structures located between the initial suppression pool surface and the peak poolswell height are subject to the poolswell impact load. The poolswell maximum elevation is determined by the poolswell analytical model with polytropic exponent of 1.2 for wetwell air compression t a maximum swell height which is the greater of 1.5 times the maximum vent submergence or the elevation corresponding to the drywell floor uplift pressure of 2.5 psid (Ref. 1.3-1 and 1.3-5). For LGS, Reference 1.3-1 separates all impacted structures into two classes:

a. Impact loads on small structures (one dimension < 20 in.)

b. Impact loads on large structures (both dimensions > 20 in.). These structures are treated on a case-by-case basis.

Poolswell impact loads on small structures are determined as specified in Reference 1.3-5, Appendix A.

The PSAM computer runs summary is provided on Figures 4.2-3 through 4.2-7. These graphs present various poolswell plant-unique characteristics, including pressure-time, ΔP-time, velocity-time, velocity-height, and height-time parameters.

4.2.1.7 LOCA Air Bubble Submerged Structure Load

During the drywell air purge phase of a LOCA, an expanding bubble is created at the downcomer exits. These rapidly expanding bubbles create three-dimensional velocity and acceleration fields.

To determine the drag loads, the system was modeled acoustically by the inhomogeneous wave equation (Reference 4.2-8). A bubble source was developed from 4T test data and qualitative information. Table 4.2-7 presents major LOCA air bubble loads.

4.2.1.8 Poolswell Drag Load

Subsequent to bubble contact, all bubbles are assumed to coalesce into a blanket of air, and the poolswell drag loads are due to the slug of water rapidly accelerating upward. The loads act in the vertical direction only (except for lift forces that act in the transverse direction to the flow). The one-dimensional poolswell model is used to predict the velocity and acceleration at the structure location. As recommended in References 1.3-5 and 1.3-2 and consistent with Section 4.2.3.5 of Reference 1.3-1, the velocity is increased by 10% for additional conservatism to account for possible bubble asymmetry. Once the flow field is known, the drag forces are calculated by the methods of Appendix C. This methodology conservatively estimates a standard drag coefficient for unsteady flow. This drag load applies to any structure located between the elevation of the vent exit and the peak poolswell height. The duration of the drag load begins when the vent clears, except for structures that are originally not submerged. For structures that are not submerged, the drag load duration is based on the slug transient time (Reference 4.2-6, page 4-78, step 3). Friction drag forces on vertical piping, downcomers, and columns are given in Table 4.2-8.

4.2.1.9 Poolswell Fallback Load

After the termination of poolswell, the slug of water falls under the influence of gravity, causing drag forces on structures located between the peak poolswell height and the vent exit. The motion of the water is described by the following equations:

$$H(t) = H_{max} - \frac{1}{2} gt^2 \qquad (4.2\text{-}3)$$

$$V_{FB}(t) = gt$$

$$\dot{V}_{FB} = g$$

where:

g = the acceleration of gravity

H t) = the height above initial water level at time t

Hmax = the maximum swell height

t = the time (starting with t=0) at maximum swell height

The drag load is then calculated from the methods of Appendix C. The loading stops when H(t) has fallen below the structure or when H(t) has returned to the normal water level, whichever is calculated to occur first.

TABLE 4.2-4

INPUT DATA FOR LGS LOCA TRANSIENTS

Drywell free air volume (including downcomers)	248,950 ft^3
Wetwell free air volume	149,425 ft^3
Maximum downcomer submergence	12.25 ft
Downcomer flow area (total)	256.5 ft^2
Downcomer loss coefficient	2.11
Initial drywell pressure	14.8 psia
Initial wetwell pressure	15.45 psia
Initial drywell humidity	100%
Initial pool temperature	90°F
Estimated DBA break size	3.538 ft^2
Number of vents	87
Minimum suppression pool mass	5.83 x 10^6 lb
Initial vessel pressure	1,055 psia
Vessel and internals mass	2,940,300 lb
Vessel and internals overall heat	484.9 Btu/sec °F
Vessel and internals specific heat	0.123 Btu/lb

TABLE 4.2-6

DELETED

TABLE 4.2-7

POOLSWELL AIR BUBBLE LOADS

Water volume in downcomers	3142.16 ft^3
Pool surface area (outside pedestal)	4973.89 ft^2
Maximum poolswell after water discharge	18.88 ft
Height of downcomer water in the pool	7.58 in.(0.632 ft)
Maximum poolswell height (18.88 + 0.632 ft)	19.51 ft
Basemat hydrostatic pressure	10.51 psig
Downcomer tip hydrostatic pressure	5.20 psig
Maximum air bubble pressure	48.25 psia
Maximum pressure at basemat	58.76 psia
Maximum pressure at downcomer tip	48.25 psia
Maximum poolswell inside the pedestal	212 ft-9 in. (6.62 ft above the high water level)

TABLE 4.2-9

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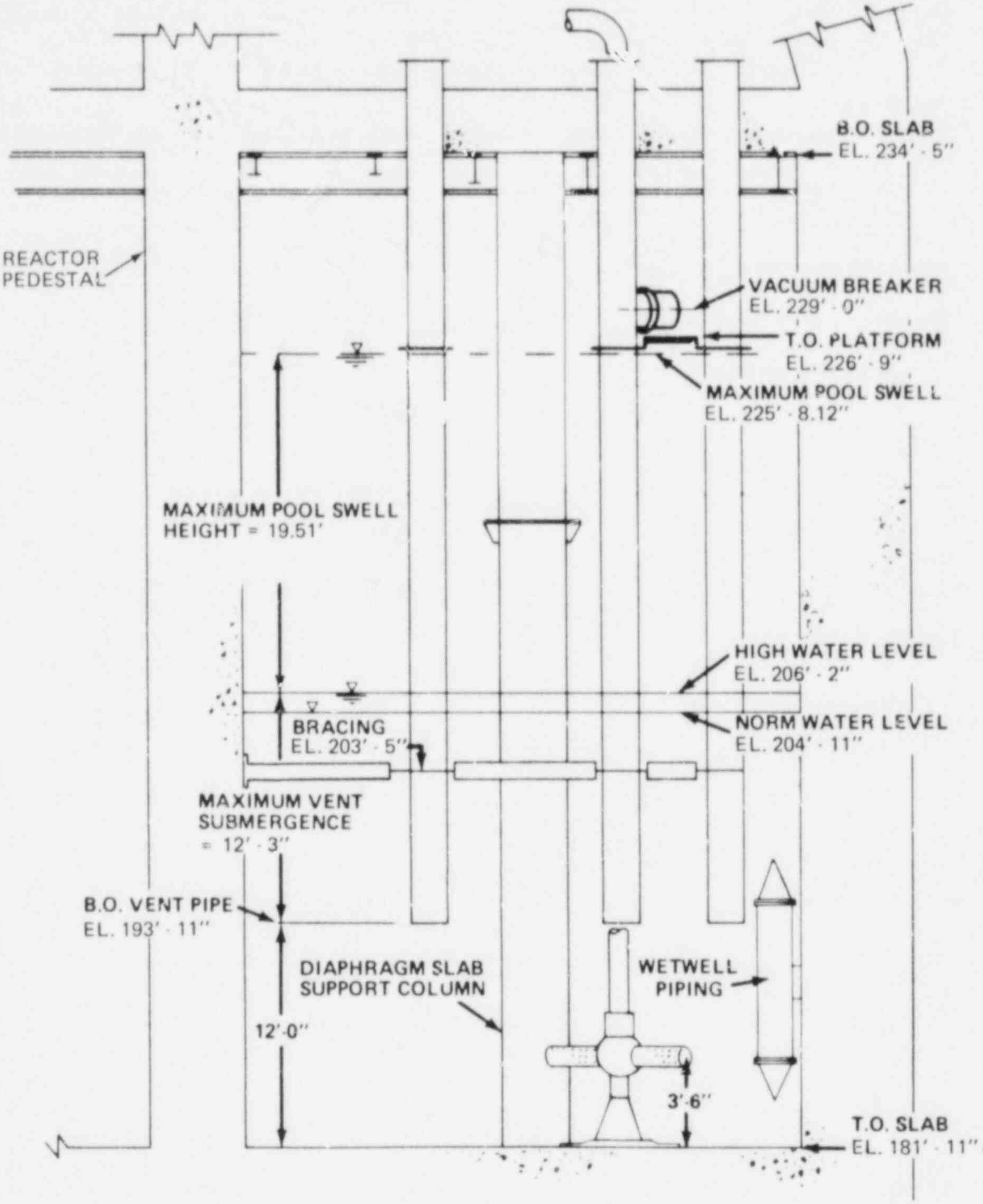

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COMPONENTS AFFECTED BY LOCA LOADS

FIGURE 4.2-16

REV 1, 09/82

CHAPTER 5

LOAD COMBINATIONS FOR STRUCTURES, PIPING, AND EQUIPMENT

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CHAPTER 5

TABLES

5.2 LOAD COMBINATIONS FOR CONCRETE DESIGN IN CONTAINMENT, REACTOR ENCLOSURE, AND CONTROL STRUCTURE

The loads on the containment, its concrete internals (i.e., RPV pedestal, diaphragm slab), reactor enclosure, and control structure are combined to assess the structural integrity in accordance with the design load combinations given in Table 5.2-1. The factored load approach is used in the assessment of the concrete structural components. The load factors adopted are based on the degree of certainty and probability of occurrence for the individual loads as discussed in Reference 1.3-1, section 5.1.2.

The loss-of-coolant accidents are characterized by several phenomena that result in non-concurrent loadings on the structures. Time sequences of occurrence of the various time dependent loads, as shown in Figures 5-5 through 5-20 of Reference 1.3-1, are taken into account to determine the most critical loading conditions.

LOAD COMBINATIONS FOR CONCRETE D

Equation	Load Condition	D	L	P_o	T_o	R_o	E_o
1	Normal w/o Temp.	1.4	1.7	1.0	-	-	-
2	Normal w/Temp.	1.0	1.3	1.0	1.0	1.0	-
3	Normal Sev. Env.	1.0	1.0	1.0	1.0	1.0	1.2
4	Abnormal	1.0	1.0	-	-	-	-
4a	Abnormal	1.0	1.0	-	-	-	-
5	Abnormal Sev. Env.	1.0	1.0	-	-	-	1.1
5a	Abnormal Sev. Env.	1.0	1.0	-	-	-	1.1
6	Normal Ext. Env.	1.0	1.0	1.0	1.0	1.0	-
7	Abnormal Ext. Env.	1.0	1.0	-	-	-	-
7a	Abnormal Ext. Env.	1.0	1.0	-	-	-	-

Load Description

D = Dead Loads

L = Live Loads

P_o = Operating Pressure Loads

T_o = Operating Temperature Loads

R_o = Operating Pipe Reactions

SRV = Safety Relieve Valve Loads

TABLE 5.2-1 (Page 1 of 2)

ESIGN IN CONTAINMENT, REACTOR ENCLOSURE, AND CONTROL STRUCTURE
CONSIDERING HYDRODYNAMIC LOADS)

	E_{ss}	P_B	P_A	T_A	B_A	R_V	SRV	AOT[1]	ADS	ASYM	Single Valve	LOCA[3]
	-	-	-	-	-	-	1.5	X[2]	X	X	-	
	-	-	-	-	-	-	1.3	X	-	X	-	
5	-	-	-	-	-	-	1.25	X	-	X	-	
	-	1.25	-	1.0	1.0	-	1.25	-	X	X	-	X
	-	-	1.25	1.0	1.0	-	1.0	-	-	-	X	X
	-	1.1	-	1.0	1.0	-	1.1	-	X	X	-	X
	-	-	1.1	1.0	1.0	-	1.0	-	-	-	X	X
	1.0	-	-	-	-	-	1.0	X	-	X	-	-
	1.0	1.0	-	1.0	1.0	1.0	1.0	-	X	X	-	X
	1.0	-	1.0	1.0	1.0	1.0	1.0	-	-	-	X	X

E_o = Operating-Basis Earthquake

E_{ss} = Safe Shutdown Earthquake

P_B = SRA or IBA (LOCA) Pressure Load

B_A = Pipe Break Temperatures Reaction Loads

P_A = DBA (LOCA) Pressure Load

T_A = Pipe Break Temperature Load

R_V = Reaction and jet forces associated with

AOT = Abnormal Operating Transient

ADS = Automatic Depressurization System

ASYM = Asymmetric

---

(1) For columns designated AOT, ADS, ASYM, a
columns may be included in the load comb
Equation 1, either AOT or ASYM may be co
ASYM simultaneously.

(2) X indicates applicability for the design

(3) LOCA includes chugging, condensation osc

TABLE 5.2-1 (Cont'd) (Page 2 of 2)

the pipe break

nd Single Valve, only one of the four possible
ination for any one equation. For example, in
nsidered with the other loads but not both AOT and

ated load combination.

illation, and large air bubble loads.

5.3 STRUCTURAL STEEL AND ASME CLASS MC STEEL COMPONENTS LOAD COMBINATIONS

The load combinations for structural steel in the containment, reactor enclosure, and control structure are given in Table 5.3-1. These combinations apply to the suppression chamber steel columns, the downcomer bracing, and miscellaneous structural steel within the containment, reactor enclosure, and control structure.

The loss-of-coolant accidents are characterized by several phenomena that result in non-concurrent loadings on the structures. Time sequences of occurrence of the various time dependent loads, as shown in figures 5-5 through 5-20 in Reference 1.3-1, are taken into account to determine the most critical loading conditions.

The load combinations for the ASME Class MC steel components in the concrete containment are given in Table 5.3-2. These combinations apply to the drywell head assembly, equipment hatches, personnel lock, suppression chamber access hatches, control rod drive removal hatch, and piping and electrical penetrations.

TABLE 5.3-1 (Page 1 of 2)

LOAD COMBINATIONS AND ALLOWABLE STRESSES FOR STRUCTURAL STEEL COMPONENTS (Suppression Chamber Columns, Downcomer Bracing, and Reactor Building Structural Steel)

Equation	Condition	Load Combination	Allowable Stress
1	Normal w/o Temp.	$D+L+P_o+SRV$	F_s
2	Normal w/Temp.	$D+L+P_o+T_o+SRV$	F_s
3	Normal/ Severe	$D+L+P_o+T_o+E+SRV$	$1.25\ F_s$
4	Normal/ Extreme	$D+L+P_o+T_o+E'+SRV$	(1)
5	Abnormal	$D+L+P+(T_o+T_a)+R$ $+SRV+LOCA$	(1)
6	Abnormal/ Severe	$D+L+P+(T_o+T_a)+R+E$ $+SRV+LOCA$	(1)
7	Abnormal/ Extreme	$D+L+P+(T_o+T_a)+R+E'$ $+SRV+LOCA$	(1)

---

(1) In no case shall the allowable stress exceed 0.90 Fy in bending, 0.85 Fy in axial tension or compression, and 0.50 Fy in shear. Where the design is governed by requirements of stability (local or lateral buckling), the actual stress shall not exceed 1.5F .

TABLE 5.3-1 (Cont'd) (Page 2 of 2)

Notations:

F_s = Allowable stress according to the AISC, "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings," dated 1969, Part 1

Fy = Minimum specified yield strength

D = Dead load

L = Live load

T_o = Thermal effects during normal operating conditions including temperature gradients and equipment and pipe reactions

T_a = Added thermal effects (over and above operating thermal effects) that occur during a design accident

P_o = Operating Pressure Load

P = Design basis accident pressure load

R = Local force or pressure on structure due to postulated pipe rupture including the effects of steam/water jet impingement, pipe whip, and pipe reaction

E = Load due to operating basis earthquake

E' = Load due to safe shutdown earthquake

SRV = Safety relief valve loads

LOCA = Loads due to loss-of-coolant accident conditions (chugging, condensation oscillation, or large air bubble loads)

TABLE 5.3-2 (Page 1 of 2)

LOAD COMBINATIONS AND ALLOWABLE STRESSES FOR ASME CLASS MC COMPONENTS

The drywell head assembly, equipment hatches, personnel lock suppression chamber access hatches, CRD removal hatch, and piping and electrical penetrations are designed for the following loading combinations and allowable stresses:

Equation	Condition	Load Combination	Stress Limits
1	Normal	$D+L+1.15P$	1.15 times ASME Section III, Class B
2	Normal	$D+L+T_A+P$	ASME Section III, Class B
3	Emergency	$D+L+T_A+P+H_A+R+E$	ASME Section III, Summer 1970 Addenda, Figure N-414
4	Faulted	$D+L+T_A+P+H_A+R+E'$	ASME Section III, Summer 1970 Addenda, Figure N-414
5	Normal w/Temp.	$D+L+T_o+SRV$	ASME Section III, Class MC Components
6	Abnormal/ Severe	$D+L+T_A+P+H_A+R+E$ $+SRV+LOCA$	ASME Section III, Fig. NB-3224-1 for "Emergency Conditions"
7	Abnormal/ Extreme	$D+L+T_A+P+H_A+R+E$ $+SRV+LOCA$	ASME Section III, Fig. NB-3225-1 for "Faulted Conditions"

Definitions

D = Dead load

L = Live Load

T_o = Thermal effects due to temperature gradient through the wall, under accident conditions

T_A = Thermal effects due to temperature gradient through the wall, under accident conditions

P = Design basis accident pressure load

TABLE 5.3-2 (Page 2 of 2)

R = Steam/water jet forces or reactions resulting from the rupture of process piping

E = Load due to the operating basis earthquake (OBE)

E' = Load due to the design basis earthquake (SSE)

B = Hydrostatic loading due to post-accident flooding of the primary containment to the level of the reactor core

H_A = Force on the structure due to thermal expansion of pipes, under accident conditions

SRV = Safety/relief valve loads

LOCA = Loads due to loss-of-coolant accident conditions (chugging, condensation oscillation, annulus pressurization or large air bubble loads)

5.5 DOWNCOMER LOAD COMBINATIONS

Load combinations and stress allowables for the downcomers are given in Table 5.5-1. These load combinations are based on the load combinations given in table 5-2 of Reference 1.3-1.

The loss-of-coolant accidents are characterized by several phenomena that result in non-concurrent loadings on the structures. Time sequences of occurrence of the various time dependent loads, as shown in figures 5-5 through 5-20 in Reference 1.3-1, are taken into account to determine the most critical loading conditions.

5.6 PIPING, QUENCHER, AND QUENCHER SUPPORT LOAD COMBINATIONS

LOCA loads considered on piping systems include poolswell impact loads, poolswell drag loads, downcomer water jet loads, poolswell air bubble loads, fallback drag loads, condensation oscillation loads, chugging loads, and inertial loading due to the acceleration of the containment structure produced by LOCA loads. Loads due to SRV discharge on piping systems include water clearing loads, air clearing loads, fluid transient loads on SRV discharge piping, reaction forces at the quencher, and inertial loading due to the acceleration of the containment structure produced by SRV discharge loads.

The load combinations and stress limits for piping systems are given in Table 5.6-1.

5.6.1 LOAD CONSIDERATIONS FOR PIPING INSIDE THE DRYWELL

Piping systems inside the drywell are subjected to inertial loading due to the acceleration of the containment produced by LOCA and SRV discharge loads in the wetwell. The SRV discharge piping in the drywell is also subjected to fluid transient forces due to SRV discharge.

5.6.2 LOAD CONSIDERATIONS FOR PIPING INSIDE THE WETWELL

All piping in the wetwell is subject to the inertial loading due to LOCA and SRV discharge.

Drag and impact loads due to LOCA and SRV discharge on individual pipes in the wetwell depend on the physical location of the piping. Other SRV discharge and LOCA loads applicable to piping in the wetwell are discussed in the paragraphs that follow.

Piping systems located below the suppression chamber water level are shown on Figures 5.6-1 and 5.6-2. In addition to the inertial loads, these piping systems are subjected to SRV air bubble and LOCA air bubble loads, condensation oscillation loads, and chugging loads. The SRV piping, quencher, and quencher support are also subject to fluid transient forces due to SRV discharge. Piping systems located within the jet impingement cone of the downcomer are also subjected to downcomer water jet loads.

Piping systems within the poolswell zone are shown on Figures 5.6-2, 5.6-3, and 5.6-4. All horizontal runs of these pipes are above the suppression chamber water level. The following loads, in addition to the inertial loads, act on these systems:

a. The horizontal runs of pipe below elevation 225'-8', experience poolswell impact, poolswell drag, and fallback drag loads.

b. The vertical portions of pipe in the water below elevation 225'-8" experience poolswell drag and fallback drag loads.

5.6.3 QUENCHER AND QUENCHER SUPPORT LOAD CONSIDERATIONS

The quencher and quencher supports are subjected to the following hydrodynamic loads in addition to the pressure, weight, thermal, and seismic loads:

a. Unbalanced loads on the quencher due to SRV water clearing and air clearing transients, irregular condensation, and steady-state blowdown.

b. Drag loads due to SRV discharge and LOCA.

c. SRV piping end loads.

d. Inertial loading due to the acceleration of the containment produced by SRV discharge and LOCA.

5.6.4 LOAD CONSIDERATIONS FOR PIPING IN THE REACTOR ENCLOSURE

The effects of the inertial loading due to acceleration of the containment produced by SRV discharge and LOCA loads are evaluated for this piping.

TABLE 5.6-1

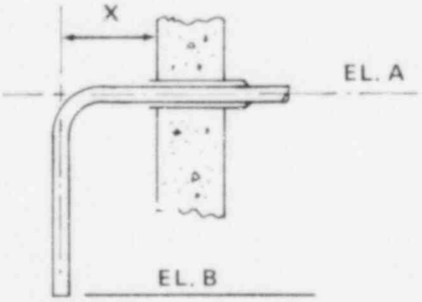
LOAD COMBINATIONS AND STRESS LIMITS FOR PIPING SYSTEMS

Equation	Condition	Load Combination	Stress Limit
1	Design	PD	NB-3652, NC-3600, ND-3600
2	Normal	$PD + DW$	NB-3654, NC-3600, ND-3600
3	Upset	(a) $PO+DW+(OBE^2+SRV^2)^{1/2}$ (b) $PO+DW+(RVC^2+OBE^2)^{1/2}$ (c) $PO+DW+FV$ (d) $PO+DW+OBE+RVO$	NB-3654, NC-3600, ND-3600
4	Emergency	(a) $PO+DW+(OBE^2+SRV^2_{ADS}+SBA^2)^{1/2}$ (b) $PO+DW+(FV^2+OBE^2)^{1/2}$	NB-3655, NC-3600, ND-3600
5	Faulted	(a) $PO+DW+(OBE^2+SRV^2_{ADS}+IBA^2)^{1/2}$ (b) $PO+DW+(SSE^2+SRV^2_{ADS}+IBA^2)^{1/2}$ (c) $PO+DW+(SSE^2+DBA^2)^{1/2}$	NB-3656, ASME Code Case 1606

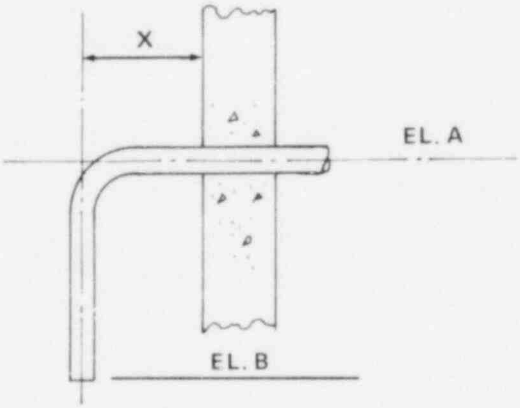
Notations:

PD = Design pressure
PO = Operating pressure
DW = Dead weight
OBE = Operating basis earthquake (inertia portion)
SSE = Safe shutdown earthquake (inertia portion)
SRV_x = Loads due to safety relief valve blow, axisymmetric or asymmetric
SRV_{ADS} = Load due to automatic depressurization SRV blow, axisymmetric
SBA = Small break accident
IBA = Intermediate break accident
DBA = Design basis accident
FV = Transient response of the piping system associated with fast valve closure (transients associated with valve closure times less than 5 seconds are considered)
RVC = Transient response of the piping system associated with relief valve opening in a closed system
RVO = Sustained load or response of the piping system associated with relief valve opening in an open system or last segment of the closed system with steady state load

DWG No.	LINE No.	QTY	SYSTEM	PENE-TRATION No.	TYPE OF PENE-TRATION	ELEVATION		
						A	B	
B	4"-HBD-187	1	HPCI	X-212	EMBEDDED	207'-6"	199'-11"	–
B	4"-HBD-188	1	HPCI	X-236	EMBEDDED	207'-6"	199'-11"	–
A	24"-HBD-189	1	HPCI	X-210	SLEEVE	207'-6"	192'-8"	–
B	4"-HBD-171	2	CORE SPRAY	X-208B X-235	EMBEDDED	207'-6"	199'-11"	–
B	10"-HBD-169	2	CORE SPRAY	X-207A X-207B	EMBEDDED	207'-6"	199'-11"	–
A	18"-GBD-143	2	RHR	X-204A,B	SLEEVE	219'-0"	199'-11"	–
A	4"-GBD-144	2	RHR	X-226A	SLEEVE	207'-6"	199'-11"	–
A	12"-HBD-173	1	RCIC	X-215	SLEEVE	207'-6"	199'-11"	–
B	6"-HBB-139	1	RHR	X-240	EMBEDDED	207'-3 1/4"	199'-11"	–
A	10"-HBB-140	1	RHR	X-238	SLEEVE	207'-9"	199'-11"	–
A	10"-HBB-140	1	RHR	X-239	SLEEVE	207'-1"	199'-11"	–
C	4"-HCB-106	1	LIQ. AND SOLID RADWASTE	X-231A	SLEEVE	207'-7"	205'-1"	2
C	4"-HCB-107	1	LIQ. AND SOLID RADWASTE	X-231B	SLEEVE	207'-9"	204'-6"	2
B	2"-HBD-357	1	REACTOR CORE ISOLATION COOLING	X-217	EMBEDDED	207'-6"	199'-11"	–
B	2"-HBD-356	1	REACTOR CORE ISOLATION COOLING	X-216	EMBEDDED	207'-6"	199'-11"	



DRAWING A



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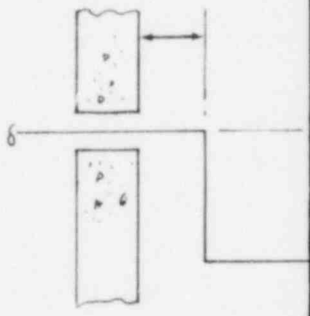

5.8 EQUIPMENT LOAD COMBINATIONS

Safety-related equipment located within the primary containment, reactor enclosure, and control structure are assessed for the governing load combinations shown in Table 5.8-1.

TABLE 5.8-1

LOAD COMBINATIONS AND DAMPING VALUES FOR NON-NSSS SAFETY-RELATED EQUIPMENT IN THE PRIMARY CONTAINMENT, REACTOR ENCLOSURE, AND CONTROL STRUCTURE

Equation	Condition	Load Combination	Damping(1)
1	Upset	a. $N+[OBE^2 + SRV^2]^{1/2}$	2%
		b. N+OBE	0.5%
2	Emergency	a. $N+[OBE^2 + SRV^2 + SBA^2]^{1/2}$	2%
3	Faulted	a. $N+[OBE^2 + SRV^2 + IBA^2]^{1/2}$	2%
		b. $N+[SSE^2 + SRV^2 + IBA^2]^{1/2}$	2%
		c. $N+[SSE^2 + DBA^2]^{1/2}$	2%
		d. Envelope of a, b & c	2%
		e. N+SSE	0.5%
4	Worst	a. Envelope of 1a, 2 and 3d	2%

Notations:

N = Normal loads (dead weight + operating temp + operating press.)
OBE = Operating basis earthquake loads
SSE = Safe shutdown earthquake loads
SRV = Safety relief valve discharge loads
SBA = Small break accident loads
IBA = Intermediate break accident loads
DBA = Design basis accident loads

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(1) Where justified, a higher damping value may be used.

TABLE 5.10-1 (Page 1 of 2)

LOAD COMBINATIONS AND ALLOWABLE STRESSES FOR HVAC DUCT SYSTEMS

DUCTS

Equation	Condition	Load Combination	Allowable Stress
1	Normal	D+L+SRV	Fs
2	Normal	$D+P_M+SRV$	Fs
3	Abnormal	$D+P_T$	$1.25F_s$
4	Normal/Severe	$D+P_M+E$	$1.25F_s$ (1)
5	Normal/Severe	$D+P_M+E+SRV$	$1.25F_s$
6	Normal	D+Po	Fs
7	Normal/Severe	D+Po+E	$1.25F_s$
8	Normal/Extreme	D+Po+E'	(2)
9	Normal/Extreme	$D+P_M+E'+SRV$	(2)
10	Extreme/Abnormal	$D+P_O+P_A+E'+SRV+LOCA$	(2)
11	Extreme/Abnormal	When protection against tornado depressurization is required:	
12	Extreme/Abnormal	$D+P_O+W_D+SRV+LOCA$	(2)
		For ducts inside drywell of containment, the following additional load combination is also applicable:	
		$D+H_A+P_O+P_A+E'+SRV+LOCA$	(2)

DUCT SUPPORTS

Equation	Condition	Load Combination	Allowable Stress
1	Normal	D+L+SRV	Fs
2	Normal/Severe	D+E	$1.25F_s$ (1)
3	Normal/Severe	D+E+SRV	(2)
4	Extreme/Abnormal	D+E'+SRV+LOCA	(2)

CHAPTER 6

DESIGN CAPABILITY ASSESSMENT CRITERIA

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6.2 CONTAINMENT, REACTOR ENCLOSURE, AND CONTROL STRUCTURE CAPABILITY ASSESSMENT CRITERIA

6.2.1 CONTAINMENT STRUCTURE CAPABILITY ASSESSMENT CRITERIA

The acceptance criteria detailed in the LGS FSAR Section 3.8.1.5 have been used to assess the structural integrity of the containment and internal structures. No changes are made in these acceptance criteria when the effects of the dynamic SRV discharge and LOCA loads are included.

6.2.2 REACTOR ENCLOSURE AND CONTROL STRUCTURE CAPABILITY ASSESSMENT CRITERIA

The acceptance criteria for seismic Category I structures presented in the LGS FSAR Section 3.8.4.5 have been used to assess the structural integrity of the reactor enclosure, control structure, and their components. No changes are made in these acceptance criteria when the effects of the dynamic SRV discharge and LOCA loads are included.

6.3 STRUCTURAL STEEL AND ASME CLASS MC STEEL COMPONENT CAPABILITY ASSESSMENT CRITERIA

The allowable stresses for structural steel in the containment, reactor enclosure, and control structure are given in Table 5.3-1. These criteria apply to the suppression chamber steel columns, the downcomer bracing, and miscellaneous structural steel within the containment, reactor enclosure, and control structure.

The allowable stresses for ASME Class MC steel components in the concrete containment are given in Table 5.3-2. These allowable stresses apply to the drywell head assembly, equipment hatches, personnel lock, suppression chamber access hatches, and piping and electrical penetrations.

6.4 LINER PLATE CAPABILITY ASSESSMENT CRITERIA

The strains in the liner plate and anchorage system (welds and anchors) from self-limiting loads such as dead load, creep, shrinkage, and thermal effects are limited to the allowable values specified in Table CC-3720-1 of Reference 6.4-1. The displacements of the liner anchorage are limited to the displacement values of Table CC-3730-1 of Reference 6.4-1.

Stresses in the liner plate and anchorage system (welds and anchors) from mechanical loads such as SRV discharge and chugging are checked according to Reference 6.4-2. Specifically, primary plus secondary membrane plus bending stresses are checked according to subsection NE-3222.2. Fatigue strength evaluation is based on subsection NE-3222.4. Allowable design stress intensity values, design fatigue curves, and material properties that are used conform to subsection NA, Appendix I.

The capacity of the liner plate anchorage is limited by the concrete pull-out to the service load allowable for concrete as specified in Reference 6.4-3.

6.4.1 REFERENCES

6.4-1 ASME Boiler and Pressure Vessel Code, Section III, Division 2, 1975 Edition

6.4-2 ASME Boiler and Pressure Vessel Code, Section III, Division 1, 1974.

6.4-3 ACI 318, "Building Code Requirements for Reinforced Concrete", 1971 Edition.

6.6 PIPING, QUENCHER, AND QUENCHER SUPPORT CAPABILITY SUPPORT ASSESSMENT CRITERIA

Piping systems in the containment and reactor enclosure are analyzed in accordance with ASME Section III, Division 1 (1971 Edition with Addenda through Winter 1972), subsections NB-3600, NC-3600, and ND-3600, and ANSI B31.1 (Power Piping Code) for the loading described in Table 5.6-1. In addition to these code requirements, when piping is required to deliver rated flow during or following an emergency or faulted event, the functional capability requirement shall be met for the load combinations with the event.

The quencher and quencher support are designed in accordance with ASME Section III, Division 1 (1977 Edition with Addenda through Summer 1979), subsections NC-3200 and NF-3000, respectively, for the loading discussed in Section 5.6.3.

6.8 EQUIPMENT CAPABILITY ASSESSMENT CRITERIA

6.8.1 ANALYSIS

Safety-related equipment located in the primary containment, reactor enclosure, and control structure are analyzed to satisfy load combinations 1a, 1b, 2, 3d, and 3e of Table 5.8-1. The maximum load effects result from simultaneous exitation in all three principal directions for all combinations involving dynamic loads as detailed in Section 7.1.7.4.1.3. The operability of active components required to operate during a dynamic event is also considered.

6.8.2 TESTING

When safety-related equipment is qualified by testing, a test response spectrum (TRS) is derived to envelope the required response spectrum (RRS) for load combinations 1b, 3e, and 4 of Table 5.8-1. The minimum test sequence is to perform five runs of the TRS for load combination 1b, followed by one run of load combination 3e, then one run of load combination 4. Qualification is achieved if the equipment does not fail or malfunction during the test. Operability is verified before and after the test sequence. Active components required to function during a dynamic event are also operated during the test.

An example of a combined RRS and an enveloping TRS are presented in Appendix H.

6.8.3 COMBINED ANALYSIS TEST

Some equipment is qualified by a combination of analysis and testing procedures. Details of this method, as well as further documentation of the equipment qualification program, are presented in Appendix H.

CHAPTER 7

DESIGN ASSESSMENT

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DESIGN ASSESSMENT

7.1 ASSESSMENT METHODOLOGY

Loads on LGS structures, piping, and equipment are defined in Chapter 4. The methods by which these loads are combined are discussed in Chapter 5. The criteria for establishing design capability are stated in Chapter 6.

This section describes the assessment methodology used in the final evaluation of structures, piping, and equipment.

7.1.1 CONTAINMENT, REACTOR ENCLOSURE, AND CONTROL STRUCTURE ASSESSMENT METHODOLOGY

7.1.1.1 Containment Structure

7.1.1.1.1 Hydrodynamic Loads

7.1.1.1.1.1 Structural Models

The dynamic analysis for the structural response of the containment and internal structures due to the SRV discharge loads and LOCA loads is performed using the finite element method. The ANSYS (FSAR Section 3.8.7) finite element computer program was chosen for the transient dynamic analysis. Figure 7.1-1 shows the ANSYS finite element model. The concrete containment walls, slabs, RPV, RPV pedestal, and shield wall are modeled with shell elements. The refueling bellows and stabilizer truss are modeled with spar elements. The RPV internals are modeled with beam elements. The suppression pool fluid mass is modeled with lumped mass elements. The ANSYS model includes a total of 797 elements and 206 dynamic degrees of freedom.

The soil structure interaction is taken into consideration by modelling the soil using a series of discrete springs and dampers in three directions as shown in Figure 7.1-1. The properties of the discrete springs and dampers are calculated based on the formulae for lumped parameter foundations found in Reference 7.1-1.

7.1.1.1.1.2 Damping

a. Structural Damping

The equations of motion for a discretized structure must include a term to account for viscous damping that is linearly proportional to the velocity. The equations of motion for a damped system are:

$$[M]\{\ddot{r}\} + [C]\{\dot{r}\} + [K]\{r\} = \{R(t)\} \qquad (7.1\text{-}1)$$

where [C] is the viscous damping matrix.

A viscous damping matrix of the form

$$[C] = \alpha [M] + \beta [K] \qquad (7.1\text{-}2)$$

was used (Reference 7.1-2) where α and β are proportionality constants that relate damping to the velocity of the nodes and the strain rates, respectively. This damping matrix leads to the following relation between α and β and the damping ratio of the ith mode C_i:

$$C_i = \alpha/2w_i + \beta w_i/2 \qquad (7.1\text{-}3)$$

where w is the natural circular frequency of the ith mode. For the usual case of only structural damping, $\alpha = 0$ and therefore $\beta = 2C_i/w_i$.

Because only a single value of β is permitted in the ANSYS input, the most dominant natural frequency of the structure is selected for the computation of β (Reference 7.1-3).

A value of β equal to 0.00063 is used in the ANSYS model which corresponds to structural modal damping of approximately 4 percent of critical at 20 Hz which is the most dominant natural frequency of the structure.

Figure 7.1-2 shows modal damping ratio versus modal frequency for structural stiffness-proportional-damping.

b. <u>Soil Springs and Radiation Damping</u>

The elastic half-space theory as described by Reference 7.1-1 was used to compute the values of the spring constants and dampers in the horizontal, vertical, and rocking directions (K_H, K_V, K_ψ, C_H, C_V, C_ψ). The following parameters are used to represent the rock foundation:

G = Shear modulus of foundation medium
= 1.154×10^3 KSI

ν = Poisson's ratio of foundation medium
= 0.3

ρ_S = Material density of foundation medium
= 0.00481 K-sec^2/ft^4

V_S = Shear wave velocity
= 6180 ft/sec

From which we get the following:

K_H = 3.37×10^6 K/in

C_H = 1.57×10^4 K-sec/in

$K_V = 3.96 \times 10^6$ K/in

$C_V = 2.72 \times 10^4$ K-sec/in

$K_\psi = 9.5 \times 10^{11}$ K-in/Rad

$C_\psi = 2.29 \times 10^9$ K-in-sec/Rad

The above lumped foundation springs and dampers were then distributed to every node on the basemat according to the tributary area.

7.1.1.1.1.3 Fluid-Structure Interaction

The ANSYS finite element model with appropriate fluid - structure coupling was developed for the analysis of the containment structure. The water mass constitutes only 1/7 of the total mass of the reinforced concrete structure. The model used considers fluid - structure coupling by lumping the water mass in the suppression pool at each node of the wetted surface. The weighted area approach was considered to determine the fluid mass at each node of the suppression pool.

7.1.1.1.1.4 Supplementary Computer Programs

Supplementary computer programs were used for preprocessing and postprocessing of data generated for or by the ANSYS computer program.

Preprocessing programs called PREPRC1, PREPRC2, and PREPRC3 were developed to convert the SRV, condensation oscillation, and chugging pressure time histories into force time histories, respectively, acting at the associated nodes of the ANSYS model. The programs write the nodal force time histories onto a file for processing by ANSYS.

A postprocessor program was developed to calculate the nodal acceleration time history. This program is called DISQGE. It reads the structural response displacement time histories generated from ANSYS (displacement pass option), scans for the maximum displacements, and generates the acceleration time histories using the Fast Fourier Transformation method.

The enveloped response spectra are furnished in two sets of damping values, the low and the high damping. The low damping values are 0.5, 1, 2, and 5 percent of critical. The high damping values are 7, 10, 15, and 20 percent of critical. The spectra are broadened by ±15 percent to account for the uncertainties in the structural modeling techniques and material properties.

7.1.1.1.1.6.2 Stress Analysis

The ANSYS computer program (stress pass option) is used to compute the force and moment resultants due to SRV and LOCA - related loads. A postprocessor program called SCALE is used to scan for the maximum absolute values of forces and moments in the circumferential and meridional directions.

The forces and moments due to chugging and condensation oscillation loads are considered for the load combinations including the LOCA loads. The governing forces and moments from the six different frequencies are used in the stress analysis.

7.1.1.1.2 Seismic Loads

Seismic loads constitute a significant loading in the structural assessment. The same seismic loads as those used in the initial building design are used. In that design, a dynamic analysis was made using discrete mathematical idealization of the entire structure using lumped masses. The resulting axial forces, moments, and shear forces at various levels due to the operating basis earthquake and the safe shutdown earthquake are used (FSAR Section 3.7). The effects of the seismic overturning moment and vertical accelerations are converted into forces at the elements.

7.1.1.1.3 Static and Thermal Loads

The loads under consideration are the static loads (dead load and accident pressure) and temperature loads (operating and accident temperature) which are all axisymmetrical.

a. To analyze the above static loads, an in-house computer program, FINEL (FSAR Section 3.8.7), is used. Moments, axial forces, and shear forces are computed by FINEL in an uncracked axisymmetric finite element containment model.

b. The operating and accident temperature gradients are computed using ME 620 (FSAR Section 3.8.7) computer program (Bechtel program).

c. The results from a, b, and the hydrodynamic/seismic analysis are combined and applied to a containment element. The element contains data relative to rebar location, direction, and quantity and concrete properties. Within that wall element, force equilibrium and strain compatibility between the rebar and concrete is established by allowing the concrete to crack in tension. In this way, the stresses in the rebar and concrete are determined. The program used for this analysis is called CECAP (FSAR Section 3.8.7).

7.1.1.1.4 Load Combinations

All load combinations from equations 1 through 7a as presented in Table 5.2-1 have been analyzed.

The reversible nature of the structural responses due to the pool dynamic loads and seismic loads is taken into account by considering the peak positive and negative magnitudes of the response forces and maximizing the total positive and negative forces and moments governing the design.

Seismic and pool dynamic load effects are combined by conservatively summing the peak responses of each load by the absolute sum (ABS) method. Even though the square root sum of squares (SRSS) method is more appropriate because the peak effects of all loads may not occur simultaneously (Reference 7.1-4), the conservative ABS method is used in the design assessment of the containment and internal concrete structures to expedite licensing.

7.1.1.1.5 Design Assessment

Material stresses at the critical sections in the primary containment and internal concrete structure are analyzed using the CECAP computer program. Critical sections for bending moment, axial force and shear in three directions are located throughout the containment structure. Liner plate is not considered as a structural element. The CECAP program considers concrete cracking in the analysis of reinforced concrete sections. CECAP uses an iterative technique to obtain stresses considering redistribution of forces due to cracking and, in the process, it reduces the thermal stresses due to the relieving effect of concrete cracking. The program is also capable of describing the spiral and transverse reinforcement stresses directly. The input data for the program consists of the uncracked forces, moments and shears calculated by FINEL, ANSYS, and seismic analysis. The loads are then combined in accordance with Table 5.1-1 with appropriate load factors. The stress margins are calculated in Section 7.2.

7.1.1.2 Reactor Enclosure and Control Structure

7.1.1.2.1 Hydrodynamic Loads

7.1.1.2.1.1 Load Definitions

The reactor enclosure and control structure were analyzed for both the SRV discharge load and the LOCA condensation oscillation and chugging loads. Description of the different load cases are presented in Section 7.1.1.1.1.5.

7.1.1.2.1.2 Hydrodynamic Analysis Models

For the hydrodynamic loads described in Section 7.1.1.2.1.1, different mathematical models are constructed for the determination of the reactor enclosure and control structure hydrodynamic responses. The mathematical models are presented in detail in the following sections and are summarized in Table 7.1-1.

7.1.1.2.1.2.1 SRV Analysis Models

The reactor enclosure and control structure were modeled to simultate global structural response during SRV actuation. Included in the analyses were an axisymmetric model for axisymmetric SRV loads and flexible base vertical, N-S, and E-W stick models for the asymmetric SRV loads. The latter uses the ANSYS containment finite element model response as input. The mathematical models and analysis procedures are described below.

7.1.1.2.1.2.1.1 Axisymmetric SRV Analysis Model

An axisymmetric model, based on Bechtel proprietary code CE971-FESS, was created to generate vertical response data for the NSSS new loads' structure and equipment adequacy assessment. The axisymmetric model has been closely correlated with in-plant test data (Reference 7.1-5).

The model represents a containment system, adjacent structure (including reactor enclosure and control structure), and the soil medium as shown in Figure 7.1-3. Figure 7.1-8 shows a mass-proportional and stiffness-proportional damping simulation. The containment system and soil medium were modeled as FESS axisymmetric finite elements, whereas the adjacent structure was simulated by a coupled stick model. Altogether, the model has a combination of 673 dynamic degrees of freedom.

The model was modified to simulate as-built conditions (i.e., concrete aging effect, etc) and normal plant operating conditions (i.e., RPV mass, etc) for generation of response data used for associated equipment adequacy evaluation. The analytical elements have the material properties as shown below:

Element Material Type	Young's Modulus, E Kip/ft^2	Material Density, ρ Kip.s^2/ft^4	Poisson's Ratio	Shear Wave, Vs (Ft/s)
Concrete	0.0936E+6*	0.00446	0.22	-
Steel	0.4176E+7	0.01524	0.33	-
Soil Medium	0.432E+6	0.00481	0.30	5950**

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*The modulus represents a dynamic modulus of elasticity.

**The shear wave velocity, Vs, is used to simulate a soil shear modulus ($G=Vs^2\rho$), equal to 0.166 E+6 Kip/ft^2.

7.1.1.2.1.2.1.2 Asymmetric SRV Analysis Models

Analysis models for the asymmetric load include the combined use of the ANSYS finite element containment model response as input to the flexible base vertical, N-S horizontal and E-W horizontal stick models of the reactor enclosure and control structure. The ANSYS containment model is shown in Figure 7.1-1, and the stick models are shown in Figures 7.1-4 and 7.1-5. The stick model damping uses the composite damping method (Reference 7.1-1).

The vertical stick model was taken from the verified axisymmetric (FESS) coupled model. This model has 46 dynamic degrees of freedom. The flexible base was similated by a soil spring and a damper as recommended in the Bechtel design guide (Ref. 7.1-1).

The N-S and E-W analytical stick models were similar to those used in the seismic analyses. Each stick model has 12 dynamic degrees of freedom.

Input load data were taken from associated ANSYS containment analysis output data. This includes use of a vertical input time-history at the adjacent structure base equal to an average vertical response acceleration time history (from ANSYS) at the containment wall base, multiplied by an attenuation factor and use of horizontal input acceleration time history at the adjacent structure base equal to the gross motion generated from the associated containment ANSYS output data.

7.1.1.2.1.2.2 CO Analysis Model

The reactor enclosure and control structure were modeled to simulate global structural response due to CO loads. Included in the analyses were an axisymmetric model for basic CO load case and CO-ADS load case, as was used in the axisymmetric SRV analysis described in Section 7.1.1.2.1.2.1.1.

7.1.1.2.1.2.3 CHUG Analysis Models

The reactor enclosure and control structure were modeled to simulate global structural response during various CHUG events. Included in the time-history analyses were flexible base stick models presented in Section 7.1.1.2.1.2.1.2, which use the ANSYS containment model response as input for the CHUG asymmetric loads, and an axisymmetric model for the CHUG equivalent axisymmetric loads. The mathematical models and analytical procedures are described below.

7.1.1.2.1.2.3.1 CHUG Asymmetric Analysis Models

Analysis models for the CHUG asymmetric loads, as were used for SRV asymmetric loads, include the combined use of the ANSYS finite element containment model response as input to the flexible base vertical, N-S horizontal and E-W horizontal stick models of the reactor enclosure and control structure. The ANSYS containment model is shown in Figure 7.1-1, and the stick models are shown in Figures 7.1-4 and 7.1-5. The stick model damping used the composite damping method (Reference 7.1-1).

The vertical stick model used was taken from the verified axisymmetric (FESS) coupled model. This model has 46 dynamic degrees of freedom. The flexible base was simulated by a soil spring and damper as recommended in the Bechtel design guide (Ref. 7.1-1).

The N-S and E-W analytical stick models were the same as were used in the seismic analyses. Each stick model has 12 dynamic degrees of freedom.

Input load data were taken from associated ANSYS containment analysis output data. This includes the use of a vertical input time history at the reactor enclosure and control structure base equal to an average vertical response acceleration time history (from ANSYS) at the containment wall base, multiplied by an attenuation factor, and the use of horizontal input acceleration time history at the reactor enclosure and control structure base equal to the gross motion generated from the associated containment ANSYS output data (no attenuation factor being used).

7.1.1.2.1.2.3.2 CHUG Axisymmetric Analysis Model

An axisymmetric model, based on Bechtel proprietary code CE971-FESS, was created to generate vertical response data for the NSSS new loads' structure and equipment adequacy assessment.

Similar to the axisymmetric SRV analysis model (Section 7.1.1.2.1.2.1.1) and the axisymmetric CO analysis model (Section 7.1.1.2.1.2.2), CHUG axisymmetric analysis model represents a containment system, an adjacent structure (including reactor enclosure and control structure), and the soil medium as shown in Figure 7.1-3. The containment system and soil medium were modeled as FESS axisymmetric finite elements, whereas the adjacent structure was simulated by a coupled stick model. The model has a combination of 673 dynamic degrees of freedom. The model was modified to simulate as-built conditions (i.e., concrete aging effect, etc) and normal plant operating conditions (i.e., RPV mass, etc), for generation of response data used for associated equipment adequacy evaluation.

The analytical elements have the material properties as shown in the table of Section 7.1.1.2.1.2.1.1.

7.1.1.2.1.2.4 Control Structure Floor/Local Models

Based on the excitation source at floor-wall junctions, analytical models for the selected floors were constructed to generate floor vertical response. Each floor considered was as a finite element model, with boundaries at walls simulated by clamped edges. Along the line of symmetry (N-S direction), symmetric boundary conditions were imposed in the construction of a "half model" for the transient analyses, i.e., SRV and CHUG loads.

To deal with dynamic problems of larger load duration, i.e., CO, CO-ADS, and seismic loads, a "quarter model" was formed by taking a symmetric line in the E-W direction of the "half model". Symmetric boundary were imposed similarly.

The half model (Figure 7.1-6) consists of 42 model nodes and 30 quadrilateral elements. By choosing five dynamic degrees of freedom (DDOF) to each interior node and three DDOF to each symmetric node, the model has 115 DDOF. Similarly, the quarter model has 9 model nodes and 4 quadrilateral elements (Figure 7.1-7), with 12 DDOF selected for analysis.

All floor models considered have identical nodal coordinates and similar model material properties (i.e., equivalent floor element thickness and mass density to take into account the beam slab system action).

Floor-supporting steel girders have contributed a substantial portion of equivalent floor element thickness calculated for the slab-beam system. The contribution of the girders are different in magnitude, depending upon girder size and junction with or without shear connectors. The floors, except that of El. 269 feet (control room), were built with shear connectors. The floor model at El 269 feet (control room) was verified by data correlation/comparison with an in-plant test.

In addition, the models were modified to simulate as-built conditions (e.g., concrete aging effect, etc). To deal with seismic events, the models were further modified to consider cracking effects.

Floor model material properties are shown in Table 7.1-2.

7.1.1.2.1.3 Hydrodynamic Analysis

7.1.1.2.1.3.1 Analysis Procedures

7.1.1.2.1.3.1.1 Axisymmetric Analysis Procedure

The axisymmetric analysis general procedure is to perform a time history analysis using equivalent axisymmetric input forcing vectors described in Sections 7.1.1.1.1.5.1 and 7.1.1.1.1.5.2, using Bechtel proprietary code CE971-FESS. Acceleration response spectra (ARS) data are generated using the acceleration response time histories obtained from the time history analysis using Bechtel proprietary code CE789-MSPEC. All associated ARS data are enveloped, widened ±15 percent, and plotted, using Bechtel proprietary codes ENVLPS and MSPEC.

7.1.1.2.1.3.1.2 Asymmetric Analysis Procedure

The general analytical procedure for asymmetric analysis consists of generating input load vectors to ANSYS model from appropriate use of the load definition and applying ANSYS transient response for asymmetric loadings to adjacent structure decoupled stick models (N-S, E-W, and vertical). A transient analysis is performed using decoupled BSAP stick models for each load case. The acceleration response spectra (ARS) data are generated using the response acceleration time histories and Bechtel proprietary code CE789-MSPEC. All associated ARS data are enveloped, widened ±15 percent, and plotted.

7.1.1.2.1.3.1.3 Floor/Local Model Analysis Procedure

The floor model analysis general procedure is to perform a time history analysis using input forcing vectors taken from the output of stick model analyses described in Sections 7.1.1.2.1.3.1.1 and 7.1.1.2.1.3.1.2 and using the model according to Bechtel proprietary code CE800-BSAP. ARS data are developed using the acceleration response time histories and Bechtel proprietary codes CE789-MSPEC and ENVLPS.

7.1.1.2.1.3.2 Generation of Response Data

7.1.1.2.1.3.2.1 Acceleration Response Spectra Data

7.1.1.2.1.3.2.1.1 SRV ARS Data

Two sets of ARS data were generated. One set is for SRV axisymmetric analysis and the other set is for SRV asymmetric analysis. The ARS data, enveloped from associated data and broadened ±15 percent at peak frequencies, represent global response, applicable to structural assessment and NSSS equipment (or other safety-related equipment) adequacy evaluations located at or near the adjacent structure walls and/or columns. The ARS at selected typical locations on the reactor enclosure and control structure are presented in Appendix B.

7.1.1.2.1.3.2.1.2 CO ARS Data

Two sets of ARS data are generated. One set is for basic CO load case analysis and the other set is for the CO-ADS load case. Again, the ARS data, enveloped from associated data and broadened ±15 percent at all peak frequencies, represent global response. The data are applicable to structure and/or equipment adequancy assessment located at or near the adjacent structure walls and/or columns. The ARS at selected locations are presented in Appendix B.

7.1.1.2.1.3.2.1.3 CHUG ARS Data

Two sets of broadened ARS data are presented in Appendix B for appropriate use in structure and equipment adequacy assessment. Set one is for CHUG asymmetric analysis case, and set two is for the CHUG equivalent axisymmetric analysis case.

The ARS data for the CHUG asymmetric case were developed and plotted similar to the SRV asymmetric analysis case. The data plots include the broadened ARS data in the three global directions (vertical, N-S, and E-W axes).

The CHUG asymmetric vertical ARS data provide responses for the applicable areas for the NSSS equipment adequacy assessment. The N-S and E-W ARS data apply to all NSSS equipment situated in any location of the reactor enclosure and control structure.

The ARS data for CHUG equivalent axisymmetric analysis cases were developed and plotted similar to SRV axisymmetric analysis cases.

Again, the data represent only global response, applicable to the NSSS equipment adequacy evaluations located at or near the adjacent structure walls and/or columns. Local/floor models are required for generating vertical ARS data for some floor-mounted equipment.

7.1.1.2.1.3.2.1.4 Hydrodynamic Local ARS Data

The local ARS data in the control structure were generated based on the floor/local model analytical procedure described in Sections 7.1.1.2.1.2.4 and 7.1.1.2.1.3.1.3. The data was broadened ±15 percent at all peaks of the data enveloped from associated dynamic events.

The hydrodynamic events considered in the enveloping were SRV, CHUG, CO (basic), and CO-ADS.

The hydrodynamic local ARS data are used for the structures, components, and floor-mounted equipment where the global ARS data are not applicable.

7.1.1.2.2 Seismic Loads

The seismic analysis methodology is discussed in FSAR Section 3.7.2.1. A seismic local model (Section 7.1.1.2.1.2.4) was developed to generate local ARS data for the floors of the control structure.

7.1.1.2.3 Static Loads

The static loads are discussed in FSAR Section 3.8.4.3.

7.1.1.2.4 Load Combinations

All individual loads for concrete structures are combined with the appropriate load factors, as shown in Table 5.2-1, for analysis of all loading combinations.

Steel structures are checked for the load combinations listed in Table 5.3-1.

7.1.1.2.5 Design Assessment

Critical sections for bending moment, axial force, and shear in all three directions are located throughout the reactor enclosure and control structure. Design capability at the critical sections is determined, and then the design capability is compared with the actual forces and moments acting on the sections under all the load combinations. This comparison yields design margins. The design margins are discussed in Section 7.2.

7.1.2 STRUCTURAL STEEL AND ASME CLASS MC STEEL COMPONENTS ASSESSMENT METHODOLOGY

7.1.2.1 Suppression Chamber Columns

There are 12 suppression chamber columns, which are 42-inch diameter pipe with 1-1/4 inch wall thickness. The columns are attached at the underside of the diaphragm slab at El. 234 ft-2 in. and at the basemat at El. 181 ft-11 in.

7.1.2.1.1 Structural Models

The columns were independently analyzed for static and dynamic loads. The analytical methods used for nonhydrodynamic loads such as dead, live, pressure, temperature, seismic, and pipe rupture loads are described in FSAR Section 3.8.3.4.5.

To deal with dynamic effects from seismic and hydrodynamic events, two analytical approaches were used. The ANSYS containment model (Section 7.1.1.1), in which the columns were also modeled, was used for LOCA load cases. For seismic and SRV loads, the BSAP beam model (Figure 7.1-17) was used. The beam model has 13 beam elements and 14 nodes, with effective water mass in the submerged portion. The column ends were modeled as clamped edges.

7.1.2.1.2 Loads

The columns, partially submerged in the suppression pool, are subjected to direct pressure loads from air bubble oscillation, etc, and inertia loads due to building response (or movement) from dynamic loads (seismic and hydrodynamic). Thermal loads are induced due to the rise of temperature during hydrodynamic LOCA events.

7.1.2.1.2.1 SRV Discharge Loads

The SRV discharge pressure-time histories are considered as acting on the submerged portions of the columns.

The inertia forces from building response due to SRV discharge load are included by using the response spectra shown in Appendix A.

7.1.2.1.2.2 LOCA Related Loads

The manner in which the LOCA related loads are applied to the column is the same as described for SRV loads in Section 7.1.2.1.2.1.

7.1.2.1.2.3 Seismic Loads

The seismic loads on the column were obtained by response spectrum method. The response spectra used are developed for OBE and SSE as described in FSAR Section 3.7.

7.1.2.1.2.4 Static Load

Static loads, including dead load and thermal load, were considered in the column analysis.

7.1.2.1.2.5 Load Combinations

The load combinations and allowable stresses are in accordance with Section 5.3. Member forces and moments obtained from dynamic loads are combined by the SRSS method. The resulting combined dynamic loads are combined with the static loads by the absolute sum technique.

7.1.2.1.2.6 Design Assessment

The combined stresses due to axial force and bending moment were calculated and compared with allowable stresses.

7.1.2.2 Downcomer Bracing

The following covers the methodology used in the assessment of the bracing system at EL. 203' - 5" in the primary containment suppression pool.

7.1.2.2.1 Bracing System Description

The downcomer bracing system is designed as a two-dimensional truss system to provide horizontal support for 87 downcomers, 14 MSRV discharge lines, and other miscellaneous piping in the suppression pool. The bracing system is supported vertically by the 87 downcomers and at 12 anchor points around the RPV pedestal wall. The bracing system is made of stainless steel members connected to carbon steel collars at the downcomers and embeddment plates at the pedestal wall by high-strength stainless steel bolts. The bracing members consist of 10-inch and 12-inch diameter schedule 160 pipe sections, and 3-1/4 inch end connection plates. The bracing system is designed in accordance with Reference 7.1-10.

The bracing system layout and typical connection details are shown in Figures 7.1-9 and 7.1-10. The mathematical model used in the bracing system is presented in Figure D.2-10 of Appendix D.

7.1.2.2.2 Loads

The bracing system is assessed for all plant operation induced loads described below. The basis for all hydrodynamic loads considered in the analysis is presented in Chapter 4.

7.1.2.2.2.1 SRV Discharge Loads

Discharge through the SRV discharge pipe creates horizontal as well as vertical loading on the bracing system due to unbalanced pressures. The horizontal (lateral) load is considered as acting on the downcomers and the SRV discharge pipes. The vertical load is considered acting on the bracing members alone. These loads are applied to the bracing system by considering them as equivalent static loads using a dynamic magnification factor which is obtained from the dynamic analysis of the downcomer, as described in Section 7.1.4.

The SRV discharge also induces hydrodynamic forces in the containment structure. Inertial forces of the bracing system, due to the response of the containment structure, are considered using hydrodynamic reponse spectra of the containment structure shown in Appendix A.

The lateral loads and the containment structure response form the complete SRV discharge load set on the bracing system.

7.1.2.2.2.2 LOCA Related Loads

Loss-of-coolant accidents are characterized by several phenomena that result with non-concurrent loadings on the bracing system as described in Section 4.2. These hydrodynamic loads induce accelerations of the containment structure, which in turn induce additional loads on the bracing system. These loads are obtained from the hydrodynamic acceleration response spectra shown in Appendix A.

In addition, the LOCA event induces lateral forces on the submerged portion and tip of downcomers. The loads include drag loads, pressure loads, and chugging tip load. The hydrodynamic analysis of a single downcomer for the lateral loads is presented in Section 7.1.4. The resulting reaction forces at the bracing support are applied as equivalent static load in accordance with section 3.1 of Reference 7.1-6.

7.1.2.2.2.3 Seismic Loads

The forces due to the seismic accelerations of the downcomers, the SRV lines, and the bracing members are obtained by analysis of these structures using the response spectra developed for OBE and SSE as described in FSAR Section 3.7.2.

7.1.2.2.2.4 Static Loads

The dead load of the bracing members is considered with allowance for buoyancy.

7.1.2.2.2.5 Thermal Load

The operating and accident temperature considered is 90 and 210°F, respectively. The reference temperature of the system is assumed to be 60°F.

7.1.2.2.2.6 Load Combinations

The load combinations and allowable stresses are described in Table 5.3-1. Although the loads on the bracing system under consideration act in random horizontal directions, each individual load is applied on the system in the worst possible direction to find the maximum resultant forces.

7.1.2.2.3 Design Assessment

The two-dimensional truss model of the bracing system is analyzed for the static, thermal, and equivalent static hydrodynamic loads using the computer program STRUDL. The containment structure inertial load is analyzed for seismic and hydrodynamic responses using the computer program ANSYS. The bracing member forces due to the various loading conditions are combined by the absolute sum method and assessed for the conditions specified in Table 5.3-1.

7.1.2.3 ASME Class MC Steel Components

The assessment methodology used for hydrodynamic loads on MC components will be provided later.

7.1.3 LINER PLATE ASSESSMENT METHODOLOGY

FSAR Section 3.8.1.1.2 provides a description of the containment liner plate and its anchorage system.

The analysis and design of the liner plate anchorages for nonhydrodynamic loads is in accordance with Reference 7.1-7.

For the analysis of the liner plate and anchorages for hydrodynamic suction pressure loads, the contributing load on the liner is that due to the net negative pressure load. The net negative pressure load is determined from the dynamic negative pressure due to SRV actuation and/or LOCA chugging minus the static positive pressure due to the wetwell hydrostatic pressure and/or LOCA wetwell pressure. Figures 7.1-12 through 7.1-15 describe the loads on the suppression chamber liner plate for the normal and abnormal load conditions.

For the normal condition, the hydrostatic pressure on the base mat liner is 10.4 psi (positive) and the maximum negative pressure due to the actuation of all SRVs is 11.67 psi (negative). The distribution of these pressures on the suppression chamber wall is shown in Figure 7.1-12. The maximum net negative pressure is 1.27 psi (negative).

For the abnormal condition, the total positive pressure on the basemat liner is 35.4 psi which consists of 10.4 psi (positive) from hydrostatic pressure plus 25.0 (positive) from a small or intermediate break LOCA (Figure 7.1-13). The total maximum negative pressure on the basemat liner is 16.9 psi (negative) due to the axisymmetric chugging and SRV loads (Figure 7.1-14). The maximum negative pressures from SRV actuation and chugging are combined for conservatism. It is recognized that the probability of these two phenomena producing peak negative pressures at the same time is very low. The combined pressure distribution due to hydrostatic, LOCA, SRV, and chugging is shown in Figure 7.1-15.

7.1.4 DOWNCOMER ASSESSMENT METHODOLOGY

7.1.4.1 Structural Model

There are 87, 24-inch OD, steel pipe downcomers running vertically down from the diaphragm slab. The downcomers are embedded in the diaphragm slab and extend downward to El. 193'-11", which is approximately 12 feet below high water level, as shown in Figure 1.4-2. All downcomers are supported laterally at El 203'-5" by the downcomer bracing system. Any vertical loads are transmitted by the bracing system to the downcomers and therefore to the diaphragm slab.

The structural model considers the downcomer as a vertical pipe fixed at the underside of the diaphragm slab with a spring in the horizontal direction at bracing level. This model is shown in Figure 7.1-16. The inertial effect of the water in the submerged portion of the downcomer (12 feet) was approximated by the addition of a equivalent mass of water lumped at the appropriate nodal points. The model is evaluated for three spring values for a representative support stiffness provided by the bracing system to the downcomers. The bracing spring is set to 50 k/in, 50 k/in, and 15000 k/in to represent the tangential mode, the radial mode, and rigid response of the bracing system.

7.1.4.2 Loads

The downcomer is subjected to static and dynamic loads due to normal, upset, emergency, and faulted conditions. Loading cases and combinations are described in Table 5.5-1. The basis for all hydrodynamic loads considered in the analysis is presented in Chapter 4.

7.1.4.3 Analysis

Downcomers are analyzed for the specified loading conditions using the Bechtel computer program BSAP. The downcomers are analyzed for both the hydrodynamic loads acting directly on the submerged portions and the inertial forces due to containment responses to the hydrodynamic and seismic loads.

The hydrodynamic load analyses, due to SRV discharge and LOCA related loads acting on the submerged portion of the downcomers, are performed using the mode-superposition time history technique. The seismic and hydrodynamic load analyses, due to containment responses, are performed using the response-spectrum analysis procedure. Damping values used are equal to 2 percent of critical for OBE and SRV loads, and 7 percent of critical for SSE and LOCA loads.

7.1.4.4 Design Assessment

The resultant stresses in the downcomers due to the load combinations described in Table 5.5-1 are compared with the allowable stresses in accordance with the criteria given in Reference 6.4-2.

7.1.4.5 Fatigue Evaluation Of Downcomers In Wetwell Air Space

A fatigue analysis of the downcomers was conducted in accordance with ASME Section III, Division 1 (1979 Summer Addendum), subsection NB-3650. Only that portion of the downcomer in the air space of the suppression chamber need be evaluated for fatigue. Figures D.2-8 and D.2-9 of Appendix D show the number of cycles considered and the load histogram, respectively.

7.1.5 PIPING AND SRV SYSTEMS ASSESSMENT METHODOLOGY

The piping and SRV systems will be analyzed for the load combinations described in Table 5.6-1 using Bechtel computer programs ME101 and ME632. These programs are described in FSAR Section 3.9. Static and dynamic analysis of the piping and SRV systems are performed as described in the paragraphs below.

Static analysis techniques are used to determine the stresses due to steady state loads and/or dynamic loads having equivalent static loads.

Response spectra at the piping anchors are obtained from the dynamic analysis of the containment subjected to LOCA and SRV loading. Piping systems are then analyzed for these response spectra following the method described in Reference 7.1-8.

Time history dynamic analysis of the SRV discharge piping subjected to fluid transient forces in the pipe due to relief valve opening is performed using Bechtel computer code ME632.

7.1.6 NSSS ASSESSMENT METHODOLOGY

To be provided later.

7.1.7 EQUIPMENT ASSESSMENT METHODOLOGY

Safety-related equipment located within the containment and the reactor enclosure and control structure are subjected to hydrodynamic loads due to SRV and LOCA discharge effects principally originating in the suppression pool of the containment structure. The equipment and equipment supports are assessed to verify their adequacy to withstand these hydrodynamic loads in combination with seismic and all other applicable loads in accordance with the load combinations given in Table 5.8-1.

7.1.7.1 Hydrodynamic loads

7.1.7.1.1 SRV Discharge Loads

Loadings associated with the axisymmetric and asymmetric SRV discharges are described in Chapters 3 and 4. Acceleration response spectra at the various elevations where the equipment are located have been generated for all appropriate pressure history traces (Figures 4.1-25 through 4.1-27) for damping values of 1/2, 1, 2 and 5 percent. These have been enveloped into a single curve for each of the above damping values. Such enveloped curves are generated for each of the N-S, E-W and vertical directions. These curves form the basis for the SRV loads for equipment assessment.

7.1.7.1.2 LOCA Related Loads

Loadings associated with loss-of-coolant accident (LOCA) are described in Chapters 3 and 4. The various LOCA loadings considered include condensation oscillation and chugging (Section 4.2.2). Acceleration response spectra at various elevations where the equipment are located have been generated for the above LOCA loads for damping values of 1/2, 1, 2 and 5 percent. These have been enveloped into a single curve for each of the above damping values. Such enveloped curves are generated for each of the N-S, E-W and vertical directions. These curves form the basis for the LOCA loads for equipment assessment.

7.1.7.2 Seismic Loads

The details of seismic input and seismic loads are discussed in FSAR Section 3.7. The effects of both operating basis earthquake (OBE) and safe shutdown earthquake (SSE) are considered. These loads are provided in the form of acceleration response spectra at each floor for damping values of 1/2, 1, 2, and 5 percent for each of N-S, E-W and vertical directions.

7.1.7.3 Other Loads

In addition to hydrodynamic and seismic loads, other loads such as dead loads, live loads, operating loads, pressure loads, thermal loads, nozzle loads and equipment piping interaction loads, as applicable, are also considered.

7.1.7.4 Qualification Methods

The adequacy of the design of the equipment is assessed by one of the following:

a. Dynamic analysis

b. Testing under simulated conditions

c. Combination of testing and analysis.

The choice is based on the practicality of the method depending upon function, type, size, shape, and complexity of the equipment and the reliability of the qualification method.

In general, the requirements outlined in Reference 7.1-9 are followed for the qualification of equipment.

7.1.7.4.1 Dynamic Analysis

7.1.7.4.1.1 Methods and Procedures

The dynamic analysis of various equipment is classified into three groups according to the relative rigidity of the equipment based on the magnitude of the fundamental natural frequency described below.

a. Structurally simple equipment - comprised of that equipment which can be adequately represented by one degree of freedom system.

b. Structurally rigid equipment - Comprised of that equipment whose fundamental frequency is:

    1) greater than 33 Hz for the consideration of seismic loads, and,

    2) greater than 100 Hz for the consideration of hydrodynamic loads.

c. Structurally complex equipment - Comprised of that equipment which cannot be classified as structurally simple or structurally rigid.

When the equipment is structurally simple or rigid in one direction but complex in the other, each direction may be classified separately to determine the dynamic loads.

The appropriate response spectra for specific equipment are obtained from the response spectra for the elevation at which the equipment is located in a building for OBE, SSE, and hydrodynamic loads. This includes the vertical as well as both the N-S and E-W horizontal directions.

For equipment that is structurally simple, the dynamic loading (either seismic or hydrodynamic) consists of a static load corresponding to the equipment weight times the acceleration selected from the appropriate response spectrum. The acceleration selected corresponds to the equipment's natural frequency, if the equipment's natural frequency is known. If the equipment's natural frequency is not known, the acceleration selected corresponds to the maximum value of the response spectra.

For equipment that is structurally rigid, the seismic load consists of a static load corresponding to the equipment weight times the acceleration at 33 Hz, selected from the appropriate response spectrum and the hydrodynamic loading consists of a static load corresponding to the equipment weight times the acceleration at 100 Hz, selected from the appropriate response spectrum.

For the analysis of structurally complex equipment, the equipment is idealized by a mathematical model that adequately predicts the dynamic properties of the equipment, and a dynamic analysis is performed using any standard analysis procedure. An acceptable alternative method of analysis is by static coefficient analysis for verifying structural integrity of frame type structures such as members physically similar to beams and columns that can be represented by a simple model. No determination of natural frequencies is made, and the response of the equipment is assumed to be the peak of the response spectrum at damping values in accordance with Section 7.1.7.4.1.2. This response is then multiplied by a static coefficient of 1.5 to take into account the effects of both multifrequency excitation and multimode response.

7.1.7.4.1.2 Appropriate Damping Values

The following damping values are used for the design assessment:

a.	Load combinations involving OBE but not hydrodynamic loads	-1/2%
b.	Load combinations involving SSE but not hydrodynamic loads	-1/2%
c.	Load combinations involving hydrodynamic loads, or seismic and hydrodynamic loads	- 2%

Higher damping values may be used where justified.

7.1.7.4.1.3 Three Components of Dynamic Motions

The responses such as internal forces, stresses, and deformations at any point from the three principal orthogonal directions of the dynamic loads are combined as follows.

The response value used shall be the maximum value obtained by adding the response due to vertical earthquake with the larger value of the responses due to one of the horizontal earthquakes by the absolute sum method.

For the other dynamic loads, the response value shall be obatained by combining the response due to three orthogonal directions of an individual load by the square root of the sum of the squares (SRSS) method.

7.1.7.4.2 Testing

In lieu of performing dynamic analysis, dynamic adequacy is established by providing dynamic test data. Such data must conform to one of the following:

a. Performance data of equipment that has been subjected to equal or greater dynamic loads (considering appropriate frequency range) than those to be experienced under the specified dynamic loading conditions.

b. Test data from comparable equipment previously tested under similar conditions that has been subjected to equal or greater dynamic loads than those specified.

c. Actual testing of equipment in operating conditions simulating, as closely as possible, the actual installation, the required loadings and load combinations.

A continuous sinusoidal test, sine beat test, or decaying sinusoidal test is used when the applicable floor acceleration spectrum is a narrow band response spectrum. Otherwise, random motion test (or equivalent) with broad frequency content is used.

The equipment to be tested is mounted in a manner that simulates the actual service mounting. Sufficient monitoring devices are used to evaluate the performance of the equipment. With the appropriate test method selected, the equipment is considered to be qualified when the test response spectra (TRS) envelopes the required response spectra (RRS) and the equipment does not malfunction or fail. A new test does not need to be conducted if equipment requires only minor modifications such as additional bracings or change in switch model, etc, and if proper justification is given to show that the modifications would not jeopardize the strength and function of the equipment.

7.1.7.4.3 Combined Analysis and Testing

There are several instances where the qualification of equipment by analysis alone or testing alone is not practical or adequate because of its size, or its complexity, or large number of similar configurations. In these instances, a combination of analysis and testing is the most practical. The following are general approaches:

a. An analysis is conducted on the overall assembly to determine its stress level and the transmissibility of motion from the base of the equipment to the critical components. The critical components are removed from the assembly and subjected to a simulation of the environment on a test table.

b. Experimental methods are used to aid in the formulation of the mathematical model for any piece of equipment. Mode shapes and frequencies are determined experimentally and incorporated into a mathematical model of the equipemnt.

7.1.8 ELECTRICAL RACEWAY SYSTEM ASSESSMENT METHODOLOGY

To be provided later.

7.1.9 HVAC DUCT SYSTEM ASSESSMENT METHODOLOGY

To be provided later.

7.1.10 REFERENCES

7.1-1 "Seismic Analyses of Structures and Equipment for Nuclear Power Plants," <u>BC-TOP-4A</u>, Bechtel Power Corporation, November 1974.

7.1-2 Wilson, E. L, "A Computer Program for the Dynamic Stress Analysis of Underground Structures," USAEWES, Control Report 1-175, January 1968.

7.1-3 Desai and Abel, "Introduction to the Finite Element Method," Van Nostroid Reinold Co., 1972

7.1-4 "Technical Bases for the Use of SRSS Method for Combining Dynamic Loads for Mark II Plants," NEDE-24010-P, General Electric Co, July 1977.

7.1-5 SRV In-Plant Test Report

7.1-6 Davis, W. M., "MK II Main Vent Lateral Loads Summary Report," NEDE-23806-P, General Electric Co., October 1978.

7.1-7 T. E. Johnson, et al., "Containment Building Liner Plate Design Report," BC-TOP-1, Bechtel Corporation, San Francisco, December 1972.

7.1-8 "Seismic Analysis of Piping Systems," BP-TOP-1, Revision 2, Bechtel Power Corporation, San Francisco, January 1975.

7.1-9 IEEE Standard 344-1975, "Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations."

7.1-10 American Institute of Steel Construction, Manual of Steel Construction, 7th Edition, 1970.

SUMMA

LOAD CASE MODEL (FIGURE NO.)
Axisymmetric "FESS" Vertical Coupled Model (Fig. 7.1-3)
Vertical Flexible Base Stick Model (Fig. 7.1-4)
Horizontal Flexible Base Stick Model (Fig. 7.1-5)
Control Structure Floor Half Model (Fig. 7.1-6)
Control Structure Floor Quarter Model (Fig. 7.1-7)

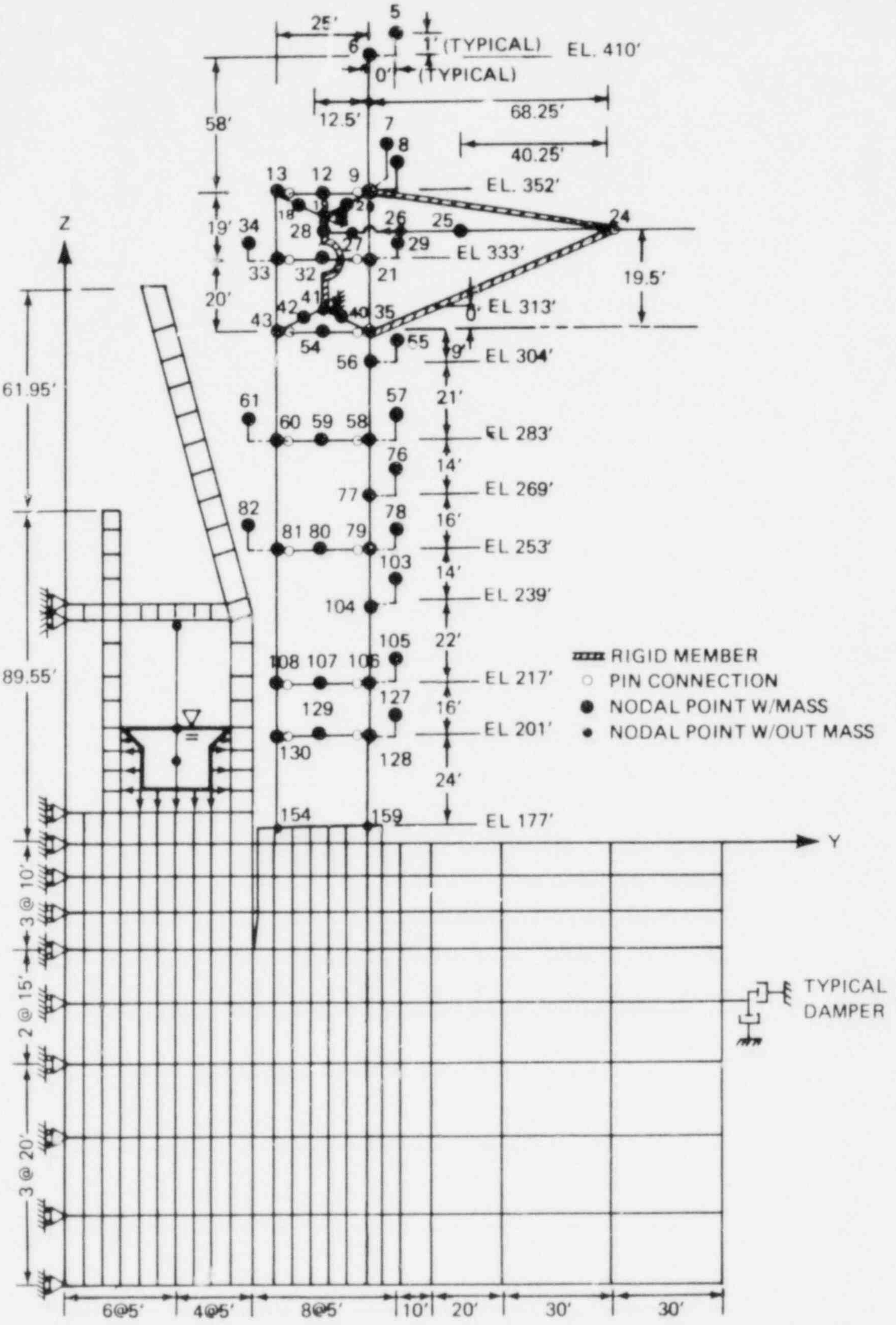
TABLE 7.1-2

CONTROL STRUCTURE FLOOR MODEL MATERIAL PROPERTIES

Control Structure Floor Elevation (ft)	Slab Thickness t_c (ft)	Equiv. Floor Element[1] Thickness, t_{eff} (ft)	Floor Element Mass Density ρ' $Kip.S^2/ft^4$
El. 217	1.25 2.125, 2.5	2.66 3.26	.002554 .003334
El. 239	1.0	2.93	.003241
El. 253	1.0	2.61	.002538
El. 269	1.5	2.63	.003219
El. 289	1.5	2.96	.002610
El. 304	1.0	2.50	.002145
El. 331	2, 1.5	3.595 2.965	.0040821 .0044573

---

[1] Equivalent floor element thickness and mass density ρ' to take into account the beam-slab system action.



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REACTOR ENCLOSURE AND
CONTROL STRUCTURE
VERTICAL AXISYMMETRIC
COUPLED MODEL (FESS)

FIGURE 7.1-3

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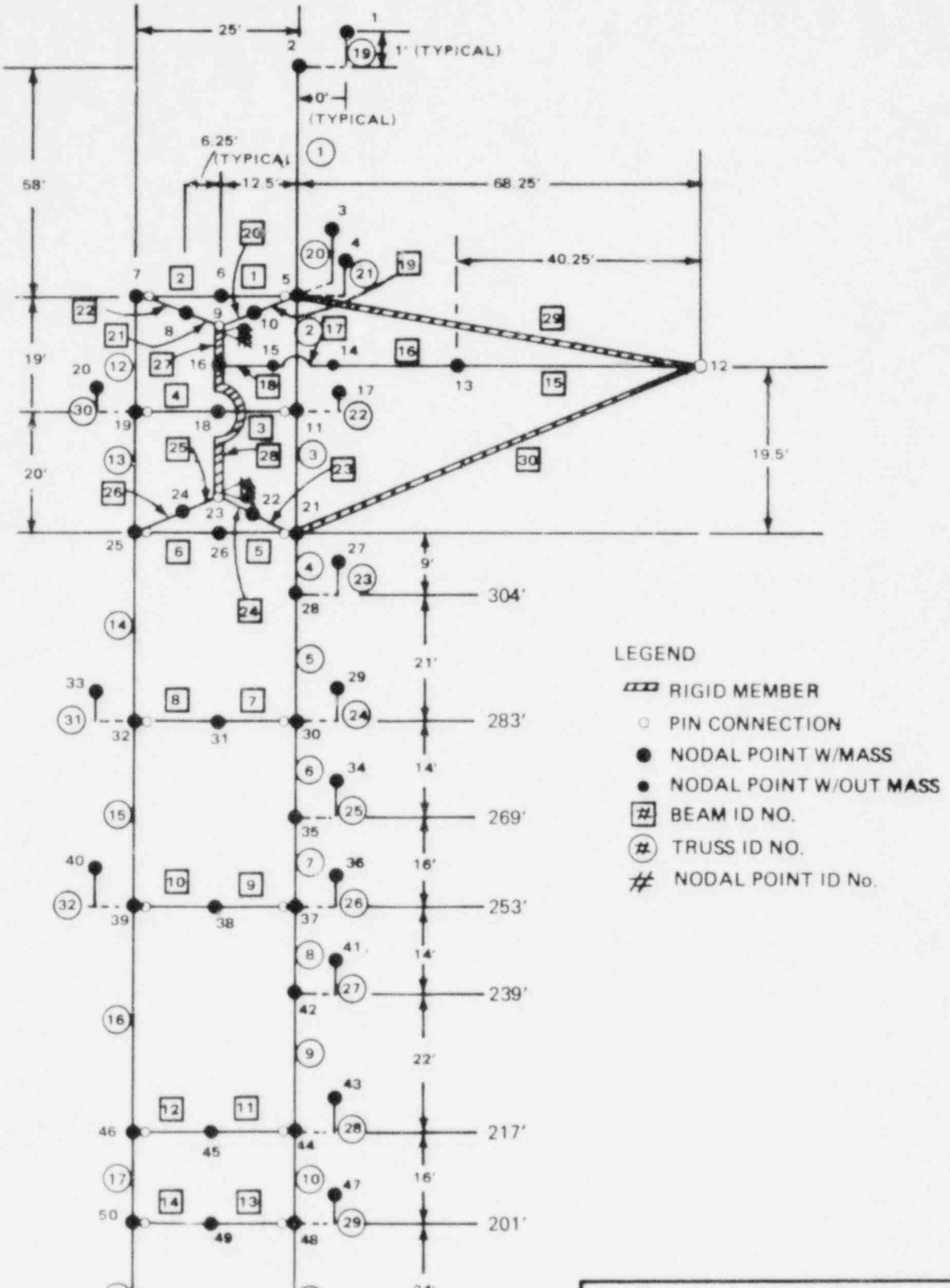

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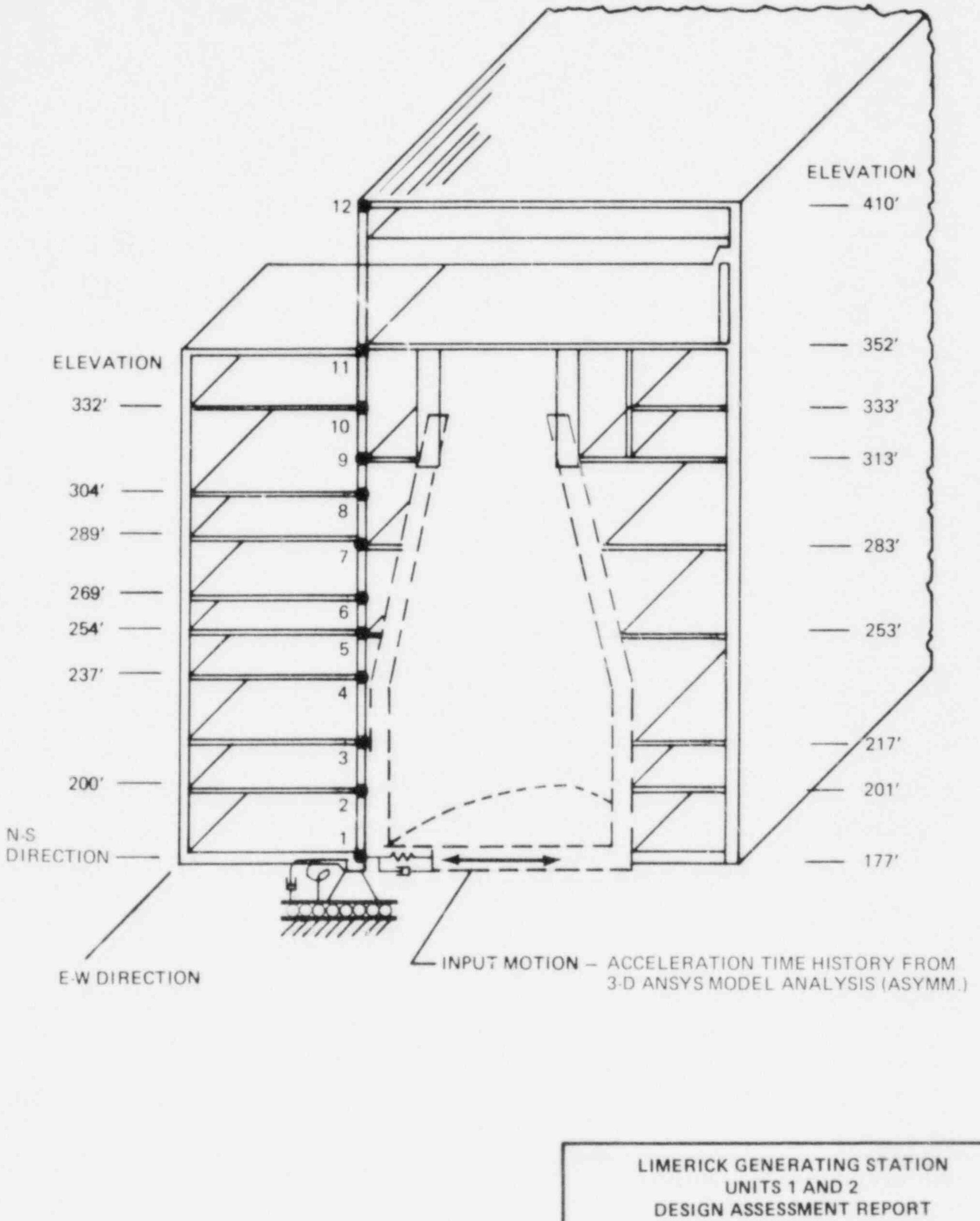
REACTOR ENCLOSURE AND
CONTROL STRUCTURE
VERTICAL STICK MODEL

FIGURE 7.1-4

REV 1, 09/82



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REACTOR ENCLOSURE AND
CONTROL STRUCTURE
HORIZONTAL STICK MODEL

FIGURE 7.1-5

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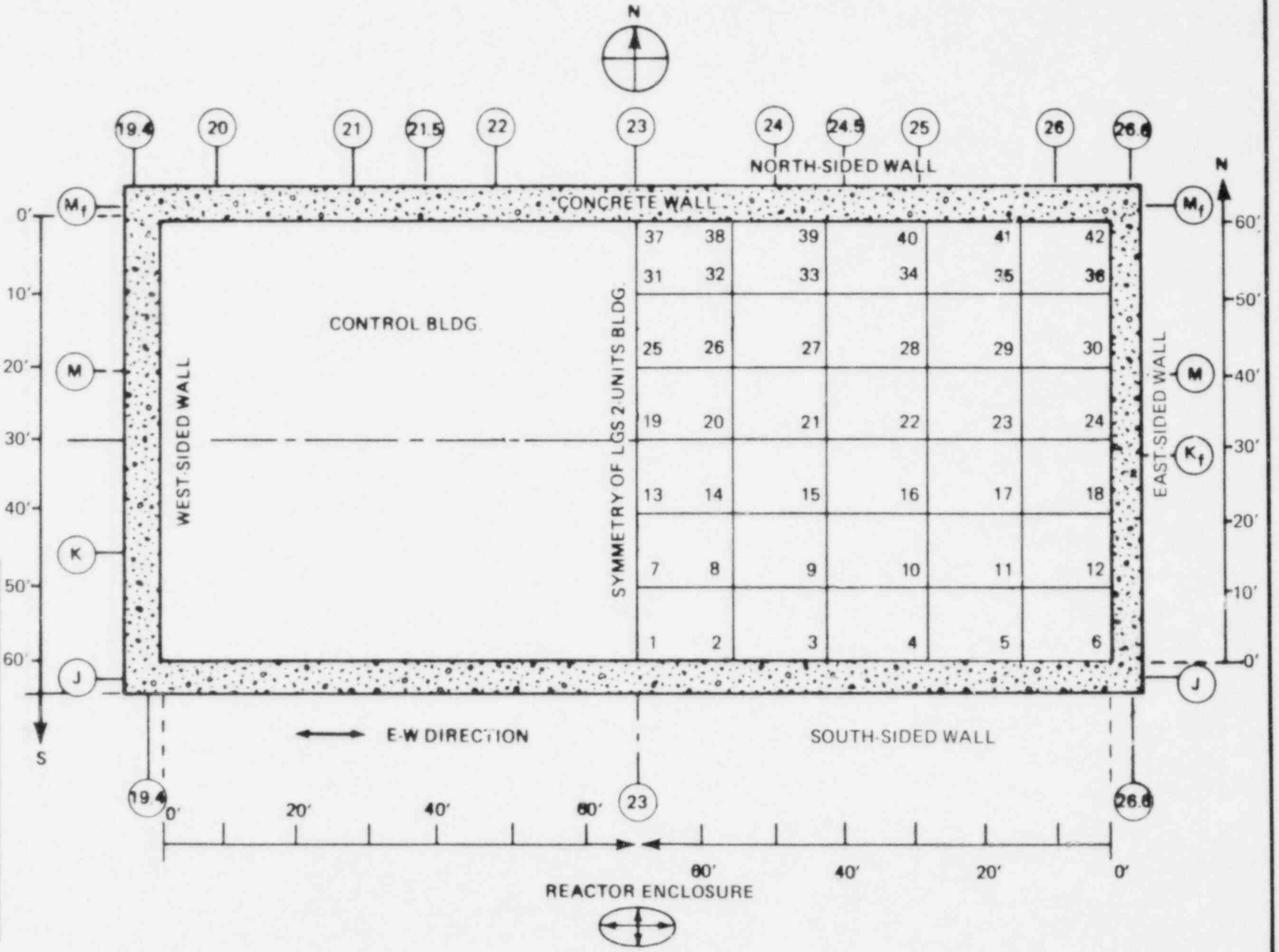

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CONTROL STRUCTURE FLOOR
"HALF MODEL"

FIGURE 7.1-6

REV 1, 09/82

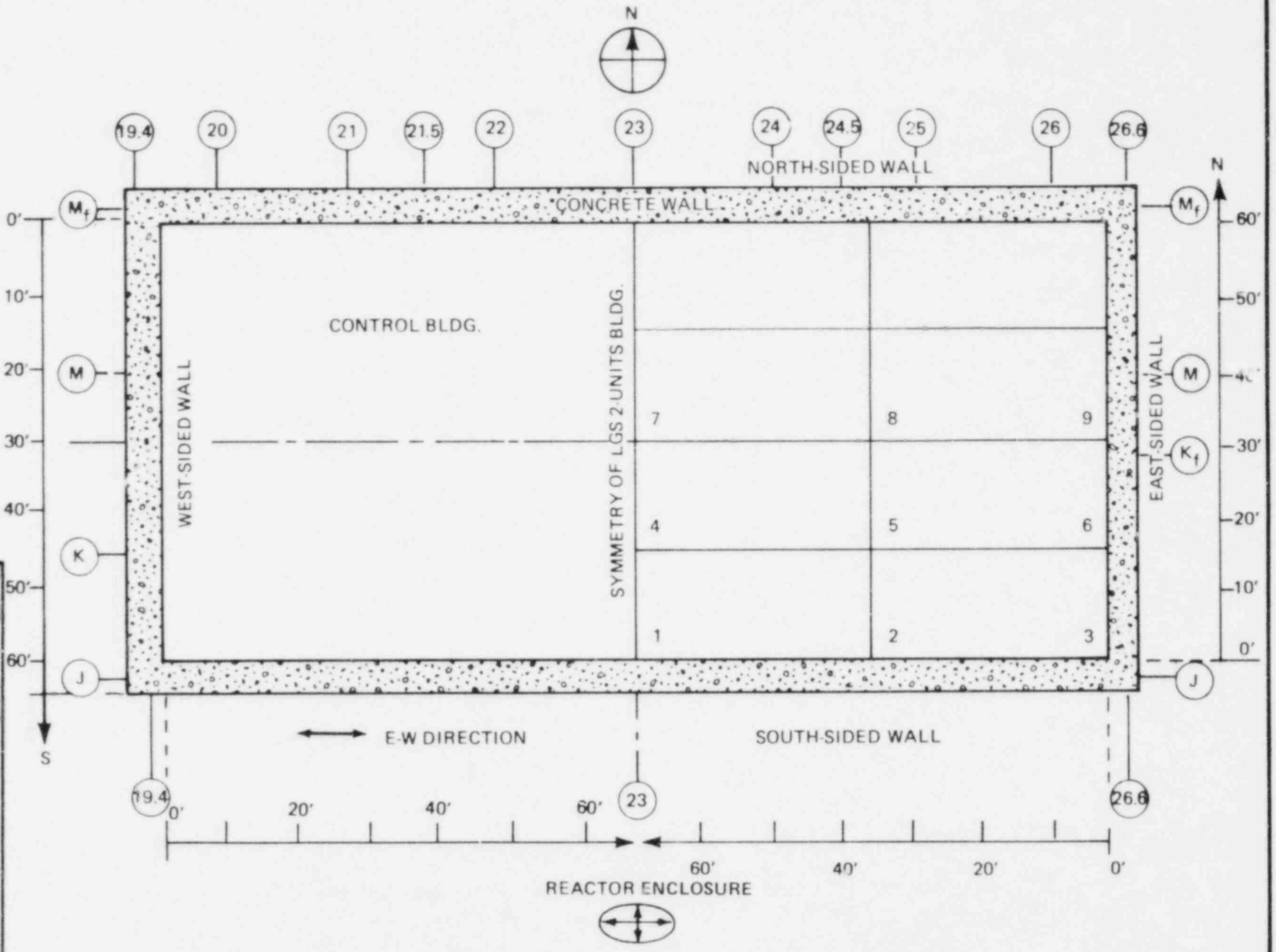

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FIGURE 7.1-7

CONTROL STRUCTURE FLOOR
"QUARTER MODEL"

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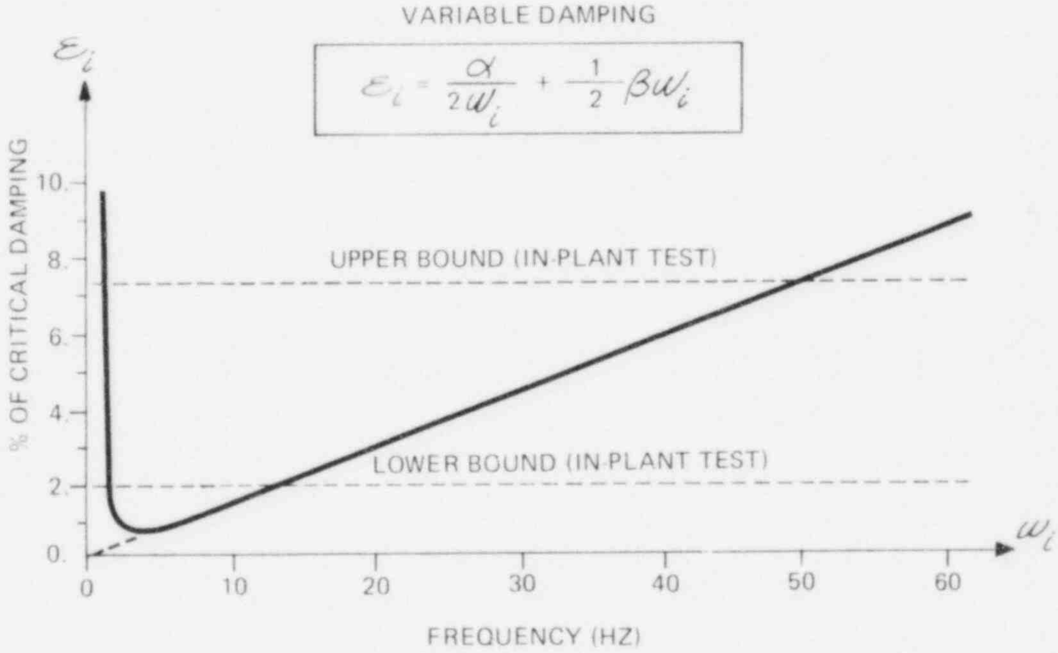
MASS–PROPORTIONAL AND STIFFNESS–PROPORTIONAL

$$[C] = \alpha[M] + \beta[K]$$



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EQUIVALENT MODAL DAMPING RATIO VS. MODAL FREQ. FOR STRUCTURAL DAMPING (REACTOR ENCLOSURE AND CONTROL STRUCTURE)

FIGURE 7.1-8 REV 1, 09/82

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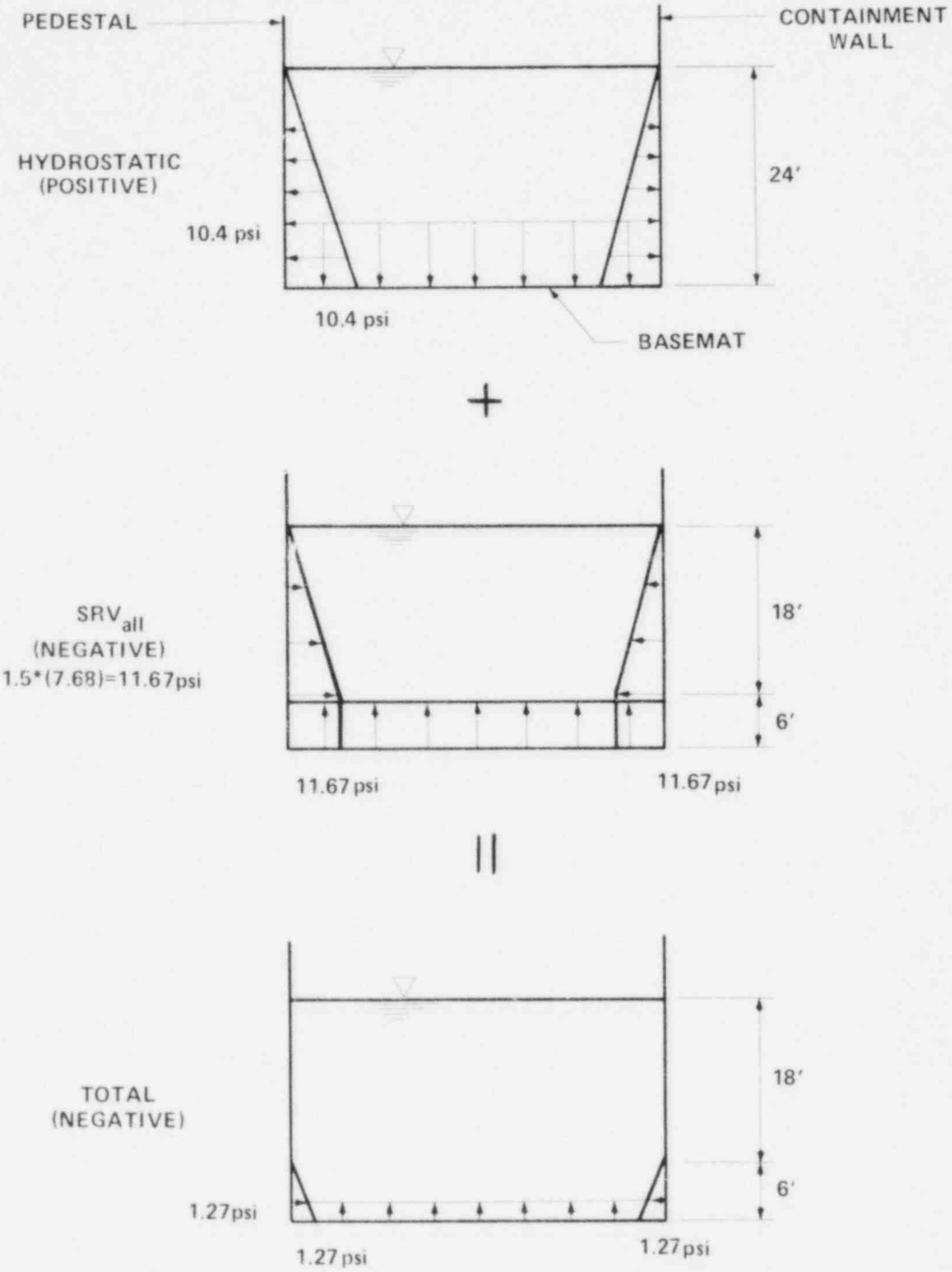
FIGURE 7.1-11 REV. 1, 09/82



*PRESSURE MULTIPLIER

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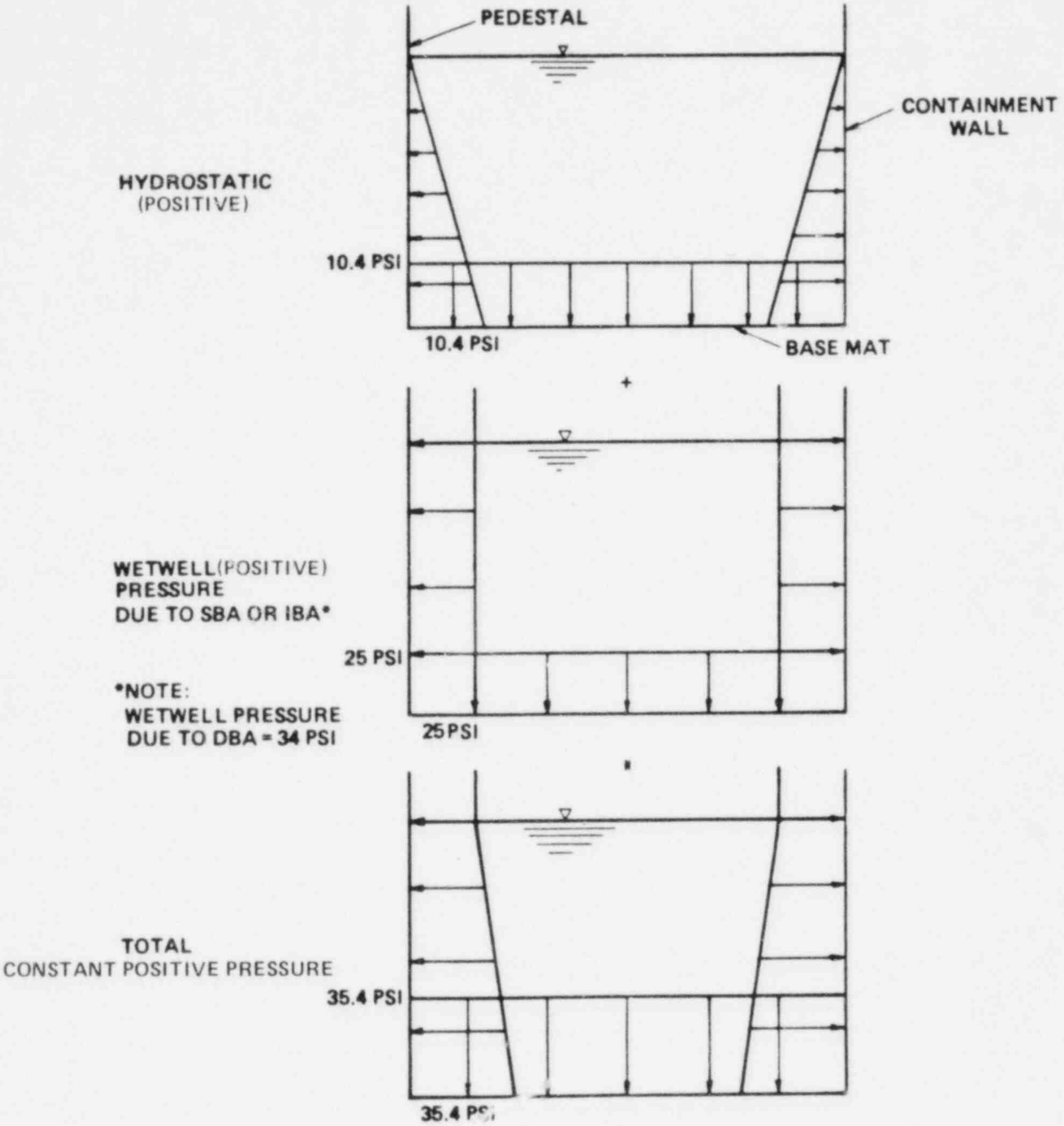
LINER PLATE PRESSURES
NORMAL CONDITION

FIGURE 7.1-12 REV.1, 09/82



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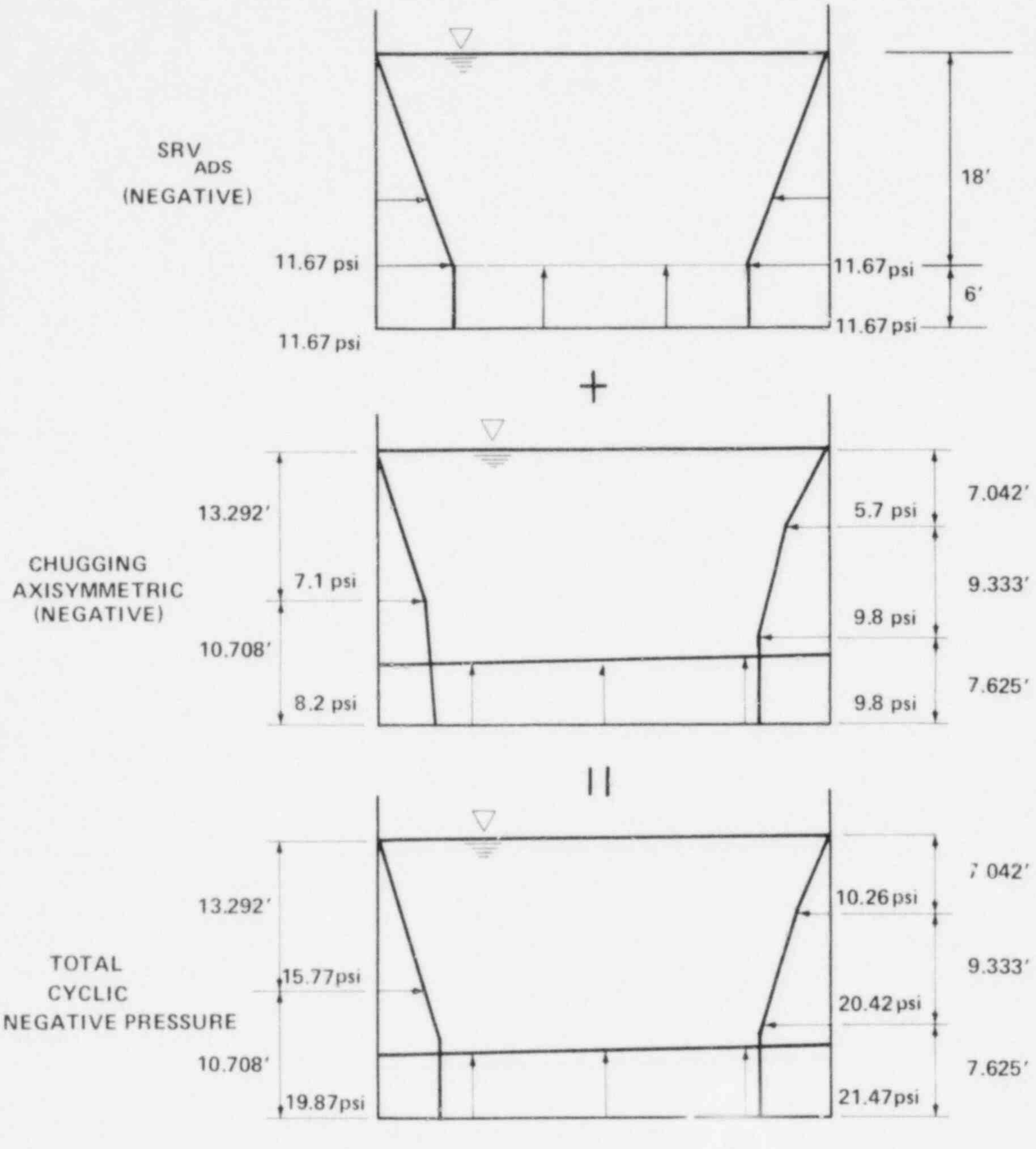
LINER PLATE PRESSURES
ABNORMAL CONDITION

FIGURE 7.1-13

REV 1, 09/82



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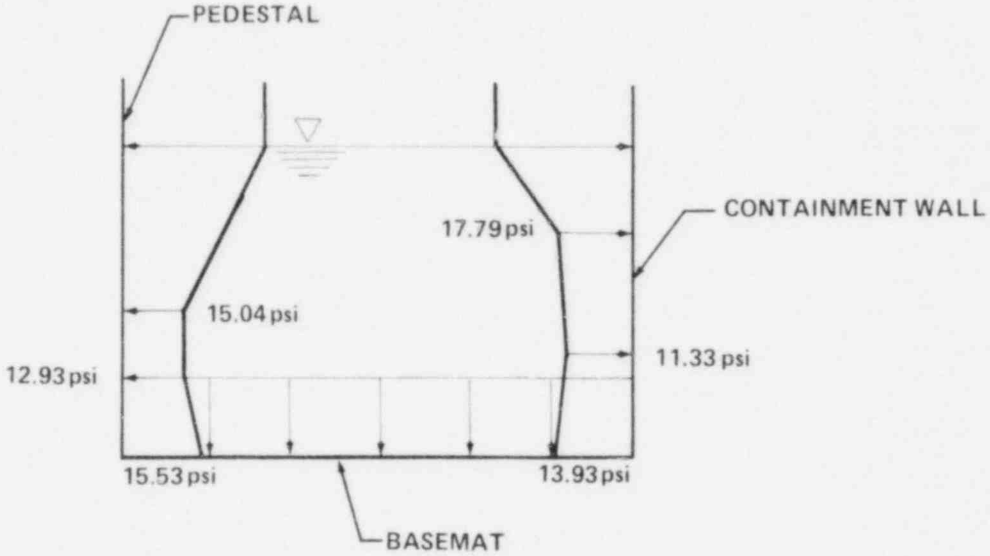
LINER PLATE PRESSURES
ABNORMAL CONDITION

FIGURE 7.1-14

REV 1, 09/82



NET PRESSURE = TOTAL POSITIVE PRESSURE + TOTAL NEGATIVE PRESSURE

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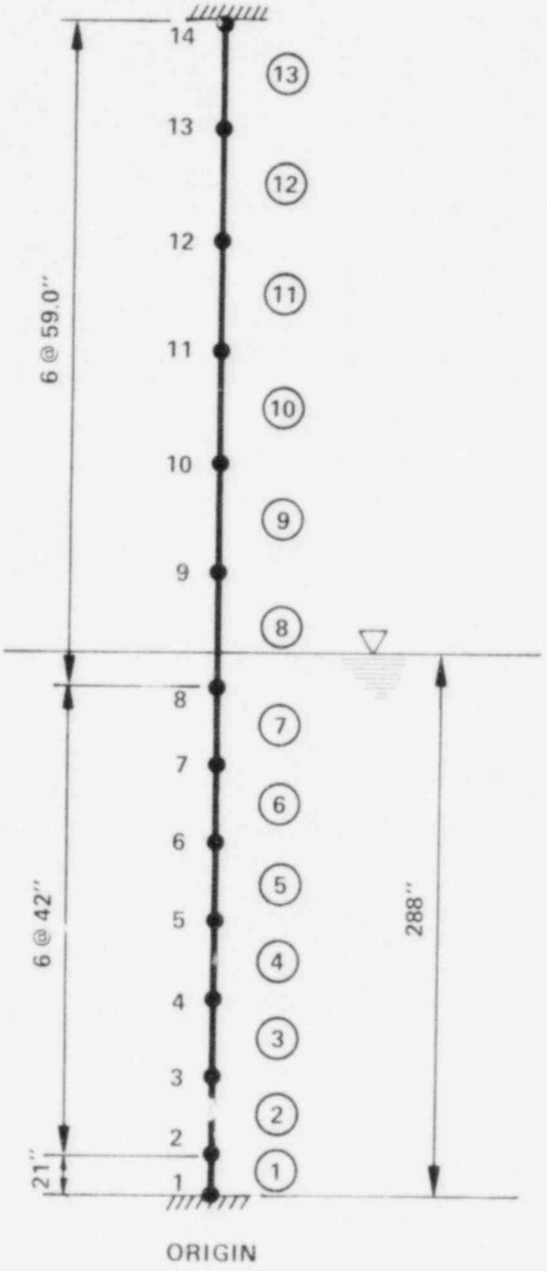
LINER PLATE PRESSURES
ABNORMAL CONDITION

FIGURE 7.1-15 REV 1, 09/82



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SUPPRESSION CHAMBER COLUMN
ANALYTICAL MODEL

FIGURE 7.1-17 REV.1, 09/82

7.2 DESIGN CAPABILITY MARGINS

This section describes the design margins for structures, piping, and equipment resulting from the LGS design assessment which uses the methods of Section 7.1

7.2.1 STRESS MARGINS

Stresses at the critical sections for all of the structures, piping, and equipment described in Section 7.1 are evaluated for the loading combinations presented in Chapter 5.

The stress margin (SM) in percent is defined as follows:

$$SM = (1 - SR) \times 100$$

where SR represents the stress ration. SR is calculated by dividing the factored stress ($C_n f_n$) by the associated stress allowable (F_n) or, mathematically,

$$SR = \Sigma \; (C_n f_n / F_n)$$

7.2.1.1 Containment Structure

The detailed results from the structural assessment of the containment structure are summarized in Appendix D.1. Figure D.1-1 shows the design sections in the basemat, shield walls, containment walls, reactor pedestal, and the diaphragm slab that were considered in the structural assessment. Figures D.1-2 through D.1-25 give the calculated maximum design stresses for the load combinations listed in Table 5.2-1.

Both rebar stresses and concrete stresses are calculated based on the applicable load combination equations. The stresses in the drywell wall are calculated at design sections 1 to 5 and are tabulated in Figures D.1-2 through D.1-5. The stresses in the wetwell wall are calculated at design sections 6 to 11 and are tabulated in Figures D.1-6 through D.1-9. The stresses in the shield wall are calculated at design sections 12 and 13 and are tabulated in Figures D.1-10 and D.1-11, respectively. The RPV pedestal stresses are calculated at design sections 14 to 20 and are tabulated in Figures D.1-12 through D.1-16. The stresses in the diaphgram slab are calculated at design sections 21 to 25 and are tabulated in Figures D.1-17 through D.1-20. The stresses in the basemat are calculated at design sections 26 to 30 and are tabulated in Figures D.1-21 through D.1-25.

The containment assessment is summarized as follows:

a. The calculated stress level is very low for load combination equation 1 (an operating condition), i.e., rebar stresses are far less than 20 ksi.

b. The maximum rebar stress is predicted as 53.9 ksi at design sections 6 and 11, located in the wetwell vertical direction. The magnitude is within the rebar stress allowable (0.9 Fy = 54 ksi).

c. In general, rebar stresses and concrete compressive stresses are within stress allowables.

7.2.1.2 Reactor Enclosure and Control Structure

Results of the structural assessment of the reactor enclosure and control structure are summarized in Appendix E. Figures E.1-1 through E.1-21 show the selected structural elements and sections where stresses were calculated.

Appendix E contains tabulations of predicted stresses, stress allowables, and design margins for critical loading combinations considered. The sections selected for assessment were considered to be the most critical based on previous seismic calculations.

The critical load combinations are tabulated considering critical locations/sections related to reactor enclosure and control structure shear walls, foundations, floor slabs and supporting steel, steel platforms, and floor support columns.

Emphasis is placed on margins of principal resisting structural elements, with reinforcing bar stresses for reinforced concrete structures and axial and/or bending stresses for steel structures.

Also included in Appendix E are diagrams of axial forces, N-S shear forces, N-S overturning moments, E-W shear forces, E-W overturning moments for reactor enclosure and control structure as shown in Figures E.1-22 through E.1-31.

The reactor enclosure floor system stress margins were calculated for both slabs and floor support steel beams, including floors at El. 201, 217, 253, 283, 313, 333, and 352 ft. Calculated slab stress levels were generally governed by either Equation 1 or 7a of Table 5.2-1. The highest reinforcing bar stress was found at the floor of El. 253 ft, having a stress intensity of 51.26 ksi and an associated stress margin of approximately 5 percent. Figure E.1-32 shows rebar stresses and related stress margins of the aforementioned floors. In addition, the stresses and related stress margins of floor support steel beams are presented in Figure E.1-33. The governing equations were Equations 1 and 7 of Table 5.3-1. Stress levels were generally low.

In the case of reactor enclosure support columns, load combination 7 of Table 5.3-1 governs the column stress interaction. Stress interaction calculations were performed and show that columns were generally understressed (Figure E.1-34). The column at column lines 30.5 and E of El. 217 to 253 ft has a fully stressed situation.

The reactor enclosure shear wall sections close to the base (El. 177 ft) were assessed as shown in Figure E.1-35. The highest stress conditions occurred in the walls of column lines 14.1 (west wall) and 31.9 (east wall) due to shearing effect at the base. The corresponding stress margin was approximately 1 percent.

The floor system of the control structure, including the concrete slabs and their supporting steel beams, are shown in Figure E.1-9 through E.1-17, while the stress margins are listed in Figures E.1-36 and E.1-37.

In general, none of those selected critical sections were found overstressed in the control structure. All concrete floors were assessed. The concrete slabs are governed by the normal load conditions, Equation 1 of Table 5.2-1. The steel floor beams supporting the concrete slabs are governed by the abnormal extreme environmental load conditions, Equation 7 of Table 5.2-1. Generally, the concrete slabs have a higher stress margin than the supporting steel beams.

For the control structure shear walls, the stress levels are critical in the walls close to the base due to seismic loads. The stress margins for the shear walls at column lines 19.4 and 26.6, as shown in Figure E.1-38, were found most critical under the abnormal extreme environmental load condition including DBE and seismic torsional effects.

The steel platforms at El. 313, 322, 340, and 350 ft were also assessed. The dynamic loads applied on the steel frames which support the platforms were found less significant than the normal loads. All the steel frames are governed by the normal load condition, Equation 2 of Table 5.3-1, with its associated allowable stresses. Those assessed steel members are shown in Figures E.1-18 through E.1-21. As demonstrated in Figure E.1-39, steel frames are generally understressed.

7.2.1.3 Suppression Chamber Columns

The column vibration mode shapes are calculated using computer program BSAP. The mode shapes are shown in Appendix D, Figure D.2-1. The equivalent water mass is equal to the column volume.

The stresses at the top and bottom of the suppression chamber columns were calculated and combined in accordance with the load combinations shown in Table 5.3-1. The maximum stresses in the column are governed by load combination Equation 7. The maximum stresses in the column (42-inch diameter pipe), top anchorage, and bottom anchorage are shown in Figure D.2-2. The lowest stress margin in the column structure is 10 percent.

7.2.1.4 Downcomer Bracing

The bracing member forces and the corresponding design margins due to the governing load combinations are given in Figure D.2-11 for the critical bracing members.

7.2.1.5 Liner Plate

For the normal load condition, maximum negative pressure (suction) on the pressure boundary portion of the liner plate occurs on the basemat and lower portions of the containment wall and RPV pedestal. The magnitude is 1.27 psi (negative). There is a large stress margin because the liner plates were designed for resisting a large suction, i.e., 5 psi (negative).

For the abnormal load condition, the liner plate does not experience net negative pressure, as can be observed from Figure 7.1-15.

7.2.1.6 Downcomers

The downcomer vibration mode shapes are calculated for the modal analyses using computer program BSAP. The mode shapes are shown in Appendix D, Figures D.2-3 through D.2-5, for the three representative bracing system spring stiffnesses. The equivalent water mass included in the model is equal to the downcomer volume.

The downcomers were assessed in accordance with ASME Section III, Division 1, subsection NB-3652, using load combinations in Table 5.5-1. Stresses and design margins are given in Appendix D, Figure D.2-6.

Downcomer fatigue at three critical locations were also checked. Loads are combined by the absolute sum method. Figure D.2-7 shows the fatigue usage factors at these critical locations, computed in accordance with ASME Section III, Division 1, subsection NB-3650 (1979 Summer Addenda). Downcomers are adequate for fatigue considerations.

7.2.1.7 Electrical Raceway System

To be provided later.

7.2.1.8 HVAC Duct System

To be provided later.

7.2.2 ACCELERATION RESPONSE SPECTRA

7.2.2.1 Containment Structure

The method of analysis and load description for the acceleration response spectrum generation are outlined in Section 7.1.1.1.1.6.1. From a review of the acceleration response spectra curves for the containment structure, the

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FIGURE 7.2-1 REV. 1, 09/82

QUESTION 220.16 (DAR Section 5.3)

In Table 5.3-1 load combinations 1, 2 and 3 do not contain the term Po, the operating pressure loads. Since the load combinations listed in this table also applies to reactor building structural steel, not only to containment internal structures, provide your justification for not including Po in these load combinations. Indicate if the containment will be inerted for hydrogen control. In load combination 6, the sign before LOCA is minus (-). Is this a typographical error?

RESPONSE

During power operation of the reactor, the containment atmosphere is inerted with nitrogen gas to preclude the possibility of a combustible mixture of hydrogen and oxygen accumulation in the primary containment. The method provided for inerting the containment is described in FSAR Section 9.4.5.1.

The effect of the operating pressure load, where applicable, has been considered in the assessment of structural steel within the containment and reactor enclosure. DAR Table 5.3-1 has been changed to include operating pressure loads in load combinations 1, 2, 3, and 4. In addition, the allowable stress in load combination 4 and the typographical errors in load combinations 5 and 6 have been corrected.

QUESTION 220.17 (DAR Section 7.2)

In Section 7.2, Design Capacity Margins, it is stated that you are going to provide the pertinent information on margins of various structures at a later date. Indicate when you will be able to provide the necessary information.

RESPONSE

DAR Sections 7.2.1.1, 7.2.1.2, 7.2.1.3, and 7.2.1.6 have been added to provide pertinent information on the design capacity margins of the containment structure, reactor enclosure and control structure, suppression chamber columns, and downcomers, respectively.

Information concerning the design capacity margins of the raceway system (Section 7.2.1.7) and HVAC duct system (Section 7.2.1.8) will be provided in the first quarter of 1983.

QUESTION 480.62

Although FSAR Section 6.2.2.2 states that the RHR intake strainers are designed to withstand all hydrodynamic loads postulated to occur in the suppression pool, concerns arise due to the close proximity of the downcomer discharges to the intake strainers. Provide a list of all loads used in the design of the strainers and also provide additional information on your analyses that demonstrate the capability of the strainers to accommodate the hydrodynamic loads from downcomer discharges.

RESPONSE

The requested information will be provided in the fourth quarter of 1982.

QUESTION 480.67

Chapter 8 of the Design Assessment Report (DAR) that addresses the T-quencher verification test (proprietary) has not been submitted. We request that a copy of this chapter be submitted for our review.

RESPONSE

Volume 3 (proprietary) of the Design Assessment Report containing Chapter 8 was submitted to the NRC with Amendment 35 to the Limerick License Application by letter from E. J. Bradley to H. R. Denton, dated June 30, 1982.

QUESTION 480.68

Provide the pool temperature analysis for the transient involving the actuation of one or more SRV's. For additional guidance, your attention is directed to NUREG-0873, "Pool Temperature Transients for BWR."

RESPONSE

The requested information will be provided in the first quarter of 1983.

QUESTION 480.69

Table 1.3-2 of the DAR indicates that the quencher arm loads, the total quencher loads during SRV opening, and loads during irregular condensation are under evaluation. Provide these load specifications.

RESPONSE

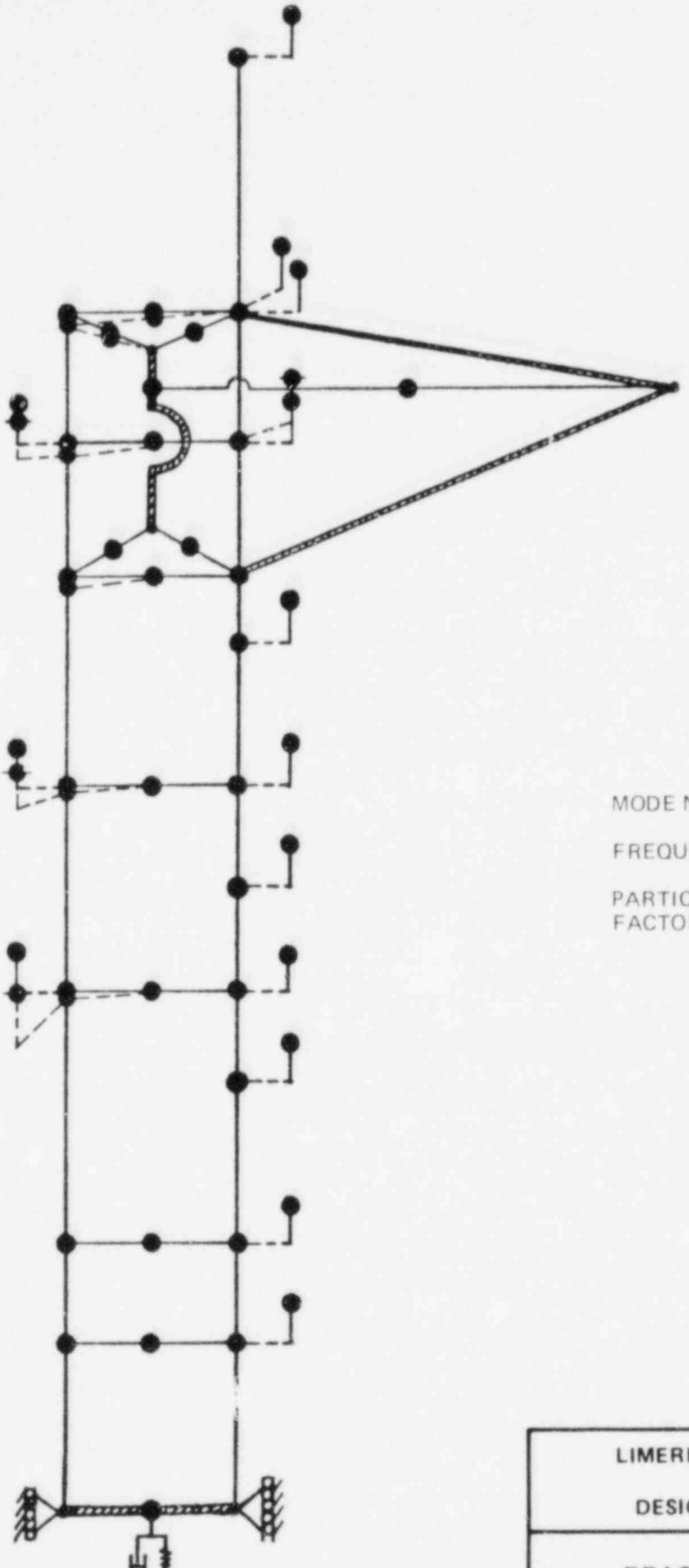
The quencher load specifications are provided in DAR Volume 3 (Proprietary), Section 4.1. DAR Volume 3 was submitted to the NRC with Amendment 35 to the Limerick License Application by letter from E.J. Bradley to H.R. Denton, dated June 30, 1982.

QUESTION 480.70

Concerns regarding the capability of the vacuum breaker to perform its function during the pool swell and chugging phases of LOCA have been raised. Provide the design changes, if any, that have been implemented to resolve this concern.

RESPONSE

A redesign and requalification program that considers the effects of the poolswell and chugging events has been initiated. The design changes will be implemented on Limerick during the second and third quarter of 1983 and will be provided in the DAR at that time.



MODE No. 6

FREQUENCY = 4.28 Hz

PARTICIPATION
FACTOR = −24.40

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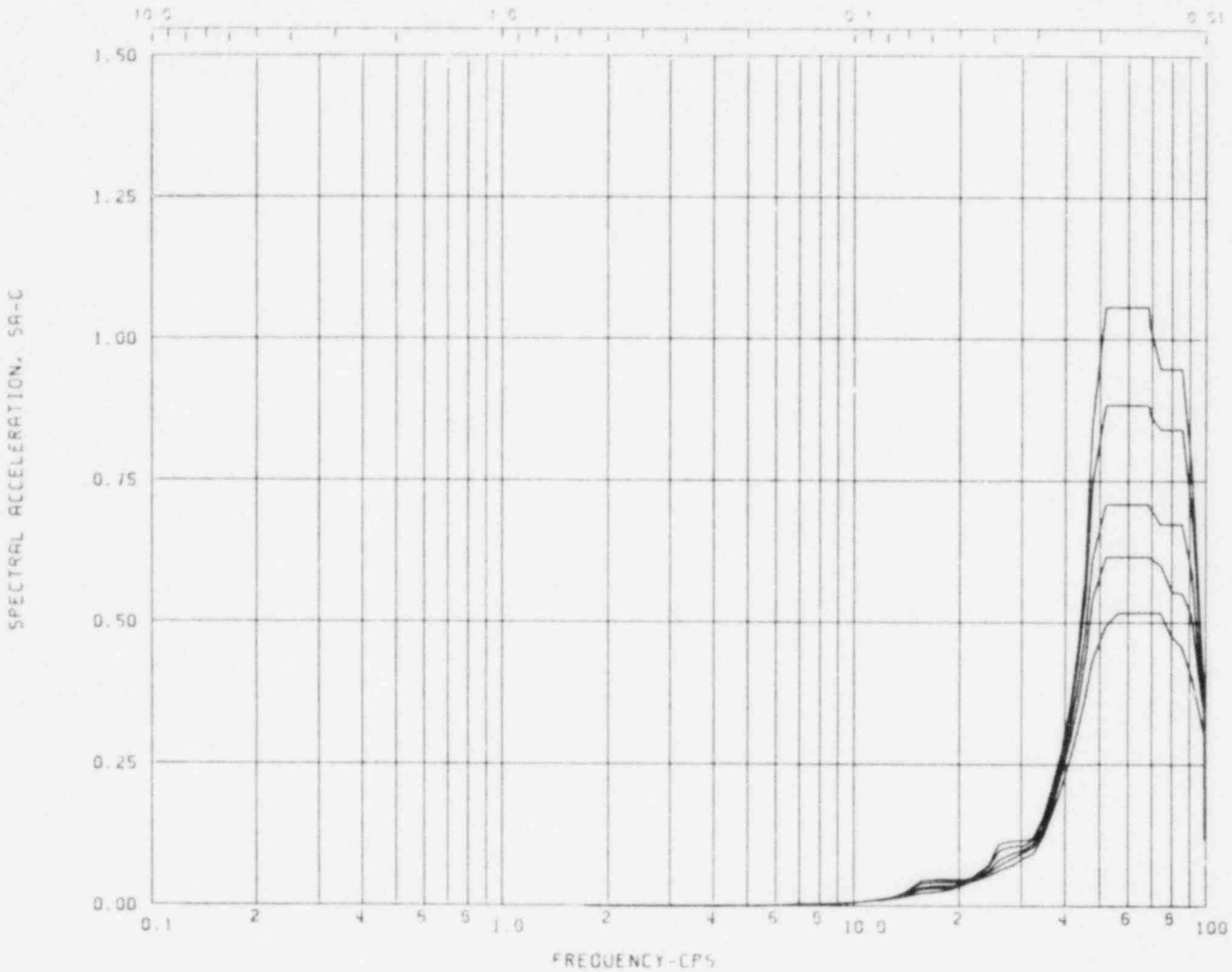
REACTOR ENCLOSURE AND
CONTROL STRUCTURE
VERTICAL MODE SHAPES

FIGURE B.1-5 REV 1, 09/82



Acceleration Spectra for REACTOR ENCL., CONTROL STRUCTURE

Load Case: ASYMMETRIC CHUGGING GE 700 SERIES ENVELOPE (WIDENED - 15%)

Node: 1 Direction: HORIZ E-W Elev: 177'-0

Damping: 0.005,0.01,0.02,0.03,0.05

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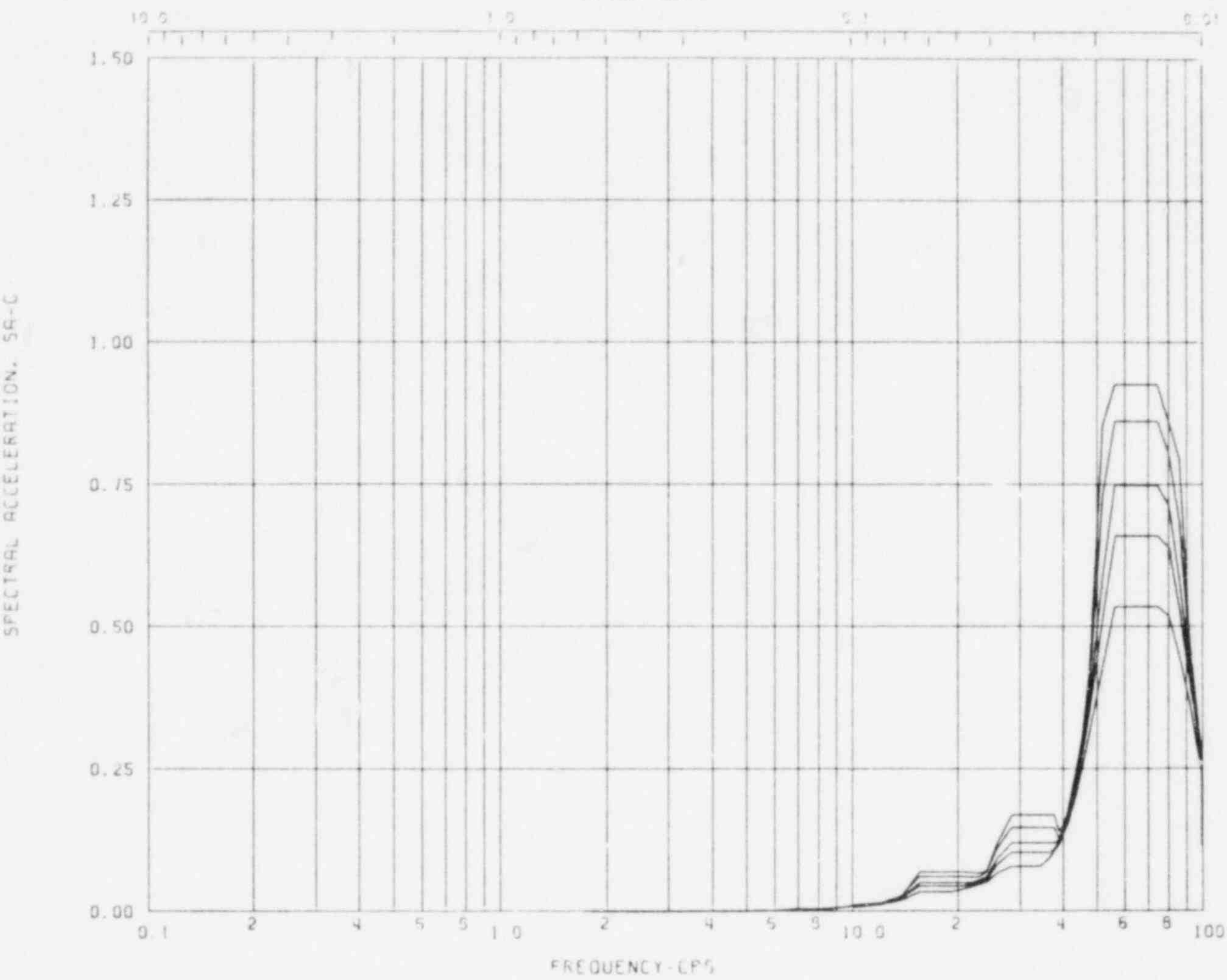
REACTOR ENCLOSURE AND CONTROL STRUCTURE GLOBAL RESPONSE SPECTRA, E-W HORIZONTAL, CHUG ASYMMETRIC

FIGURE B.2-71 REV 1, 09/82



Acceleration Spectra for REACTOR ENCL., CONTROL STRUCTURE

Load Case: ASYMMETRIC CHUGGING GE 700 SERIES ENVELOPE (WIDENED - 15%)

Node: 2 Direction: HORIZ E-W Elev: 201'-0

Damping: 0.005,0.01,0.02,0.03,0.05

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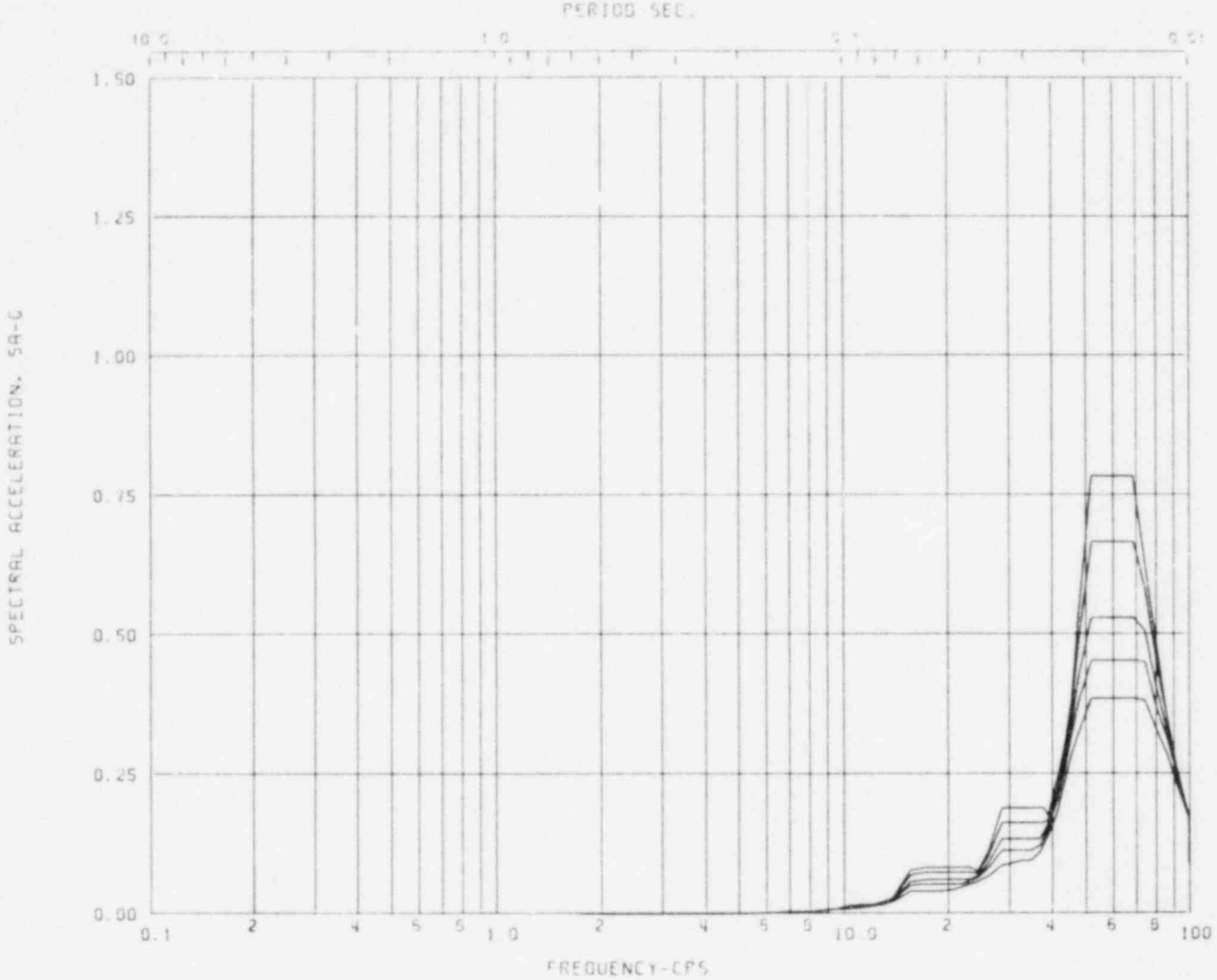
REACTOR ENCLOSURE AND CONTROL STRUCTURE GLOBAL RESPONSE SPECTRA, E-W HORIZONTAL, CHUG ASYMMETRIC

FIGURE B.2-72 REV 1, 09/82



Acceleration Spectra for REACTOR ENCL., CONTROL STRUCTURE

Load Case: ASYMMETRIC CHUGGING GE 700 SERIES ENVELOPE (WIDENED - 15%)

Node: 3 Direction: HORIZ E-W Elev: 217'-0

Damping: 0.005,0.01,0.02,0.03,0.05

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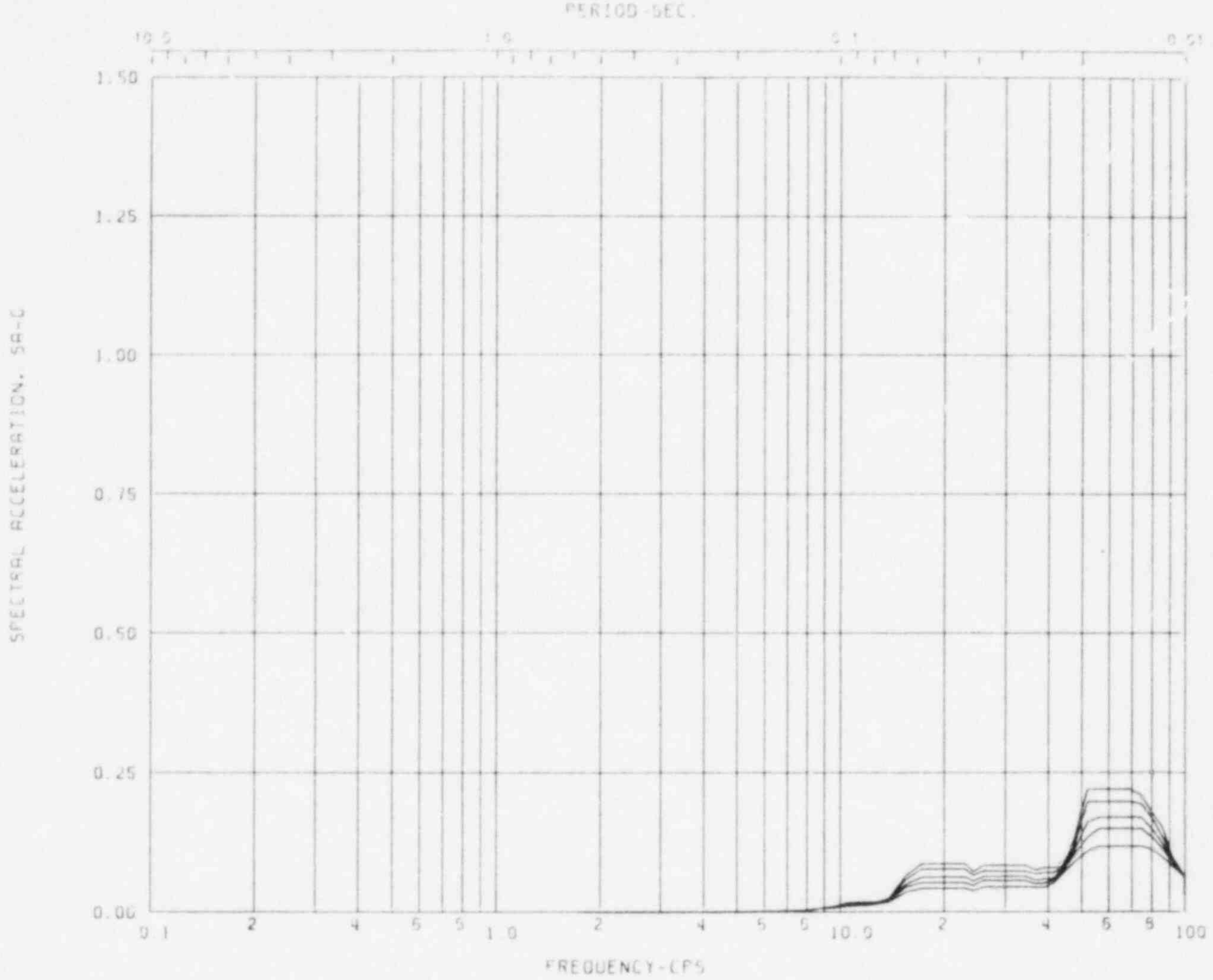
REACTOR ENCLOSURE AND CONTROL STRUCTURE GLOBAL RESPONSE SPECTRA, E-W HORIZONTAL, CHUG ASYMMETRIC

FIGURE B.2-73

REV 1, 09/82



Acceleration Spectra for REACTOR ENCL., CONTROL STRUCTURE

Load Case: ASYMMETRIC CHUGGING GE 700 SERIES ENVELOPE (WIDENED - 15%)

Node: 4 Direction: HORIZ E-W Elev: 239'-0

Damping: 0.005,0.01,0.02,0.03,0.05

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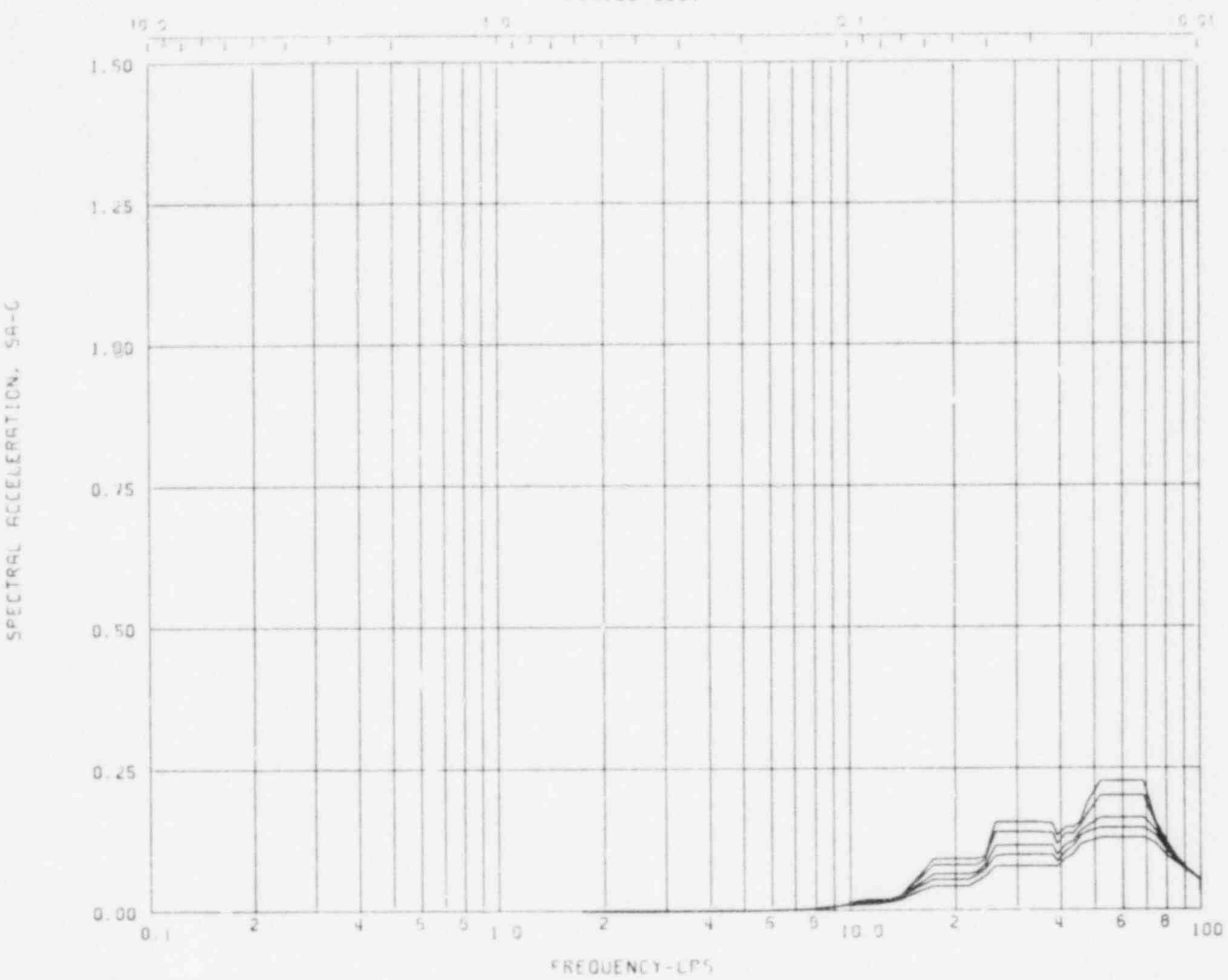
REACTOR ENCLOSURE AND CONTROL STRUCTURE GLOBAL RESPONSE SPECTRA, E-W HORIZONTAL, CHUG ASYMMETRIC

FIGURE B.2-74 REV 1, 09/82



Acceleration Spectra for REACTOR ENCL., CONTROL STRUCTURE

Load Case: ASYMMETRIC CHUGGING GE 700 SERIES ENVELOPE (WIDENED - 15%)

Node: 5 Direction: HORIZ E-W Elev: 253'-0

Damping: 0.005,0.01,0.02,0.03,0.05

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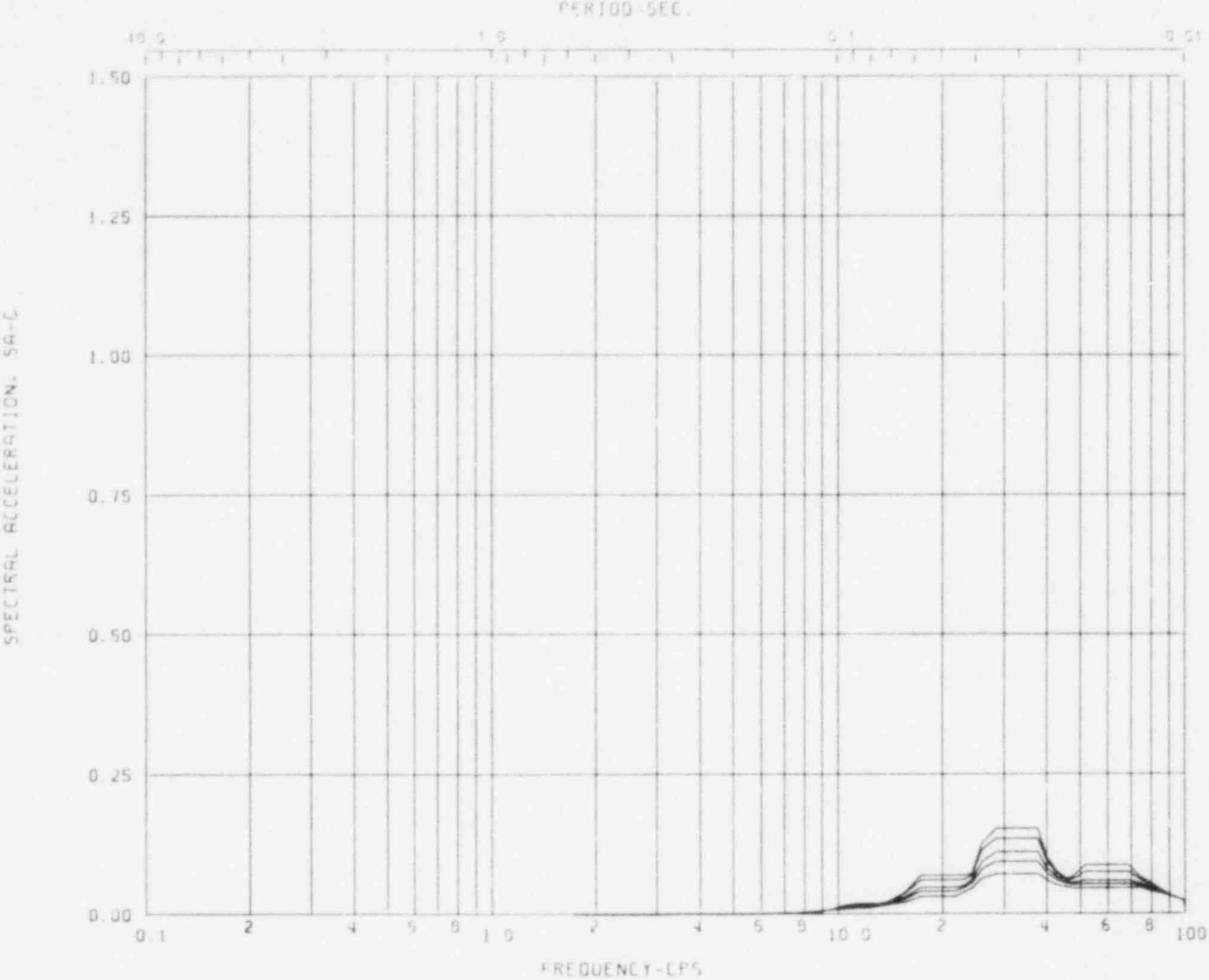
REACTOR ENCLOSURE AND CONTROL STRUCTURE GLOBAL RESPONSE SPECTRA, E-W HORIZONTAL, CHUG ASYMMETRIC

FIGURE B.2-75

REV 1, 09/82



Acceleration Spectra for REACTOR ENCL., CONTROL STRUCTURE

Load Case: ASYMMETRIC CHUGGING GE 700 SERIES ENVELOPE (WIDENED - 15%)

Node: 6 Direction: HORIZ E-W Elev: 269'-0

Damping: 0.005,0.01,0.02,0.03,0.05

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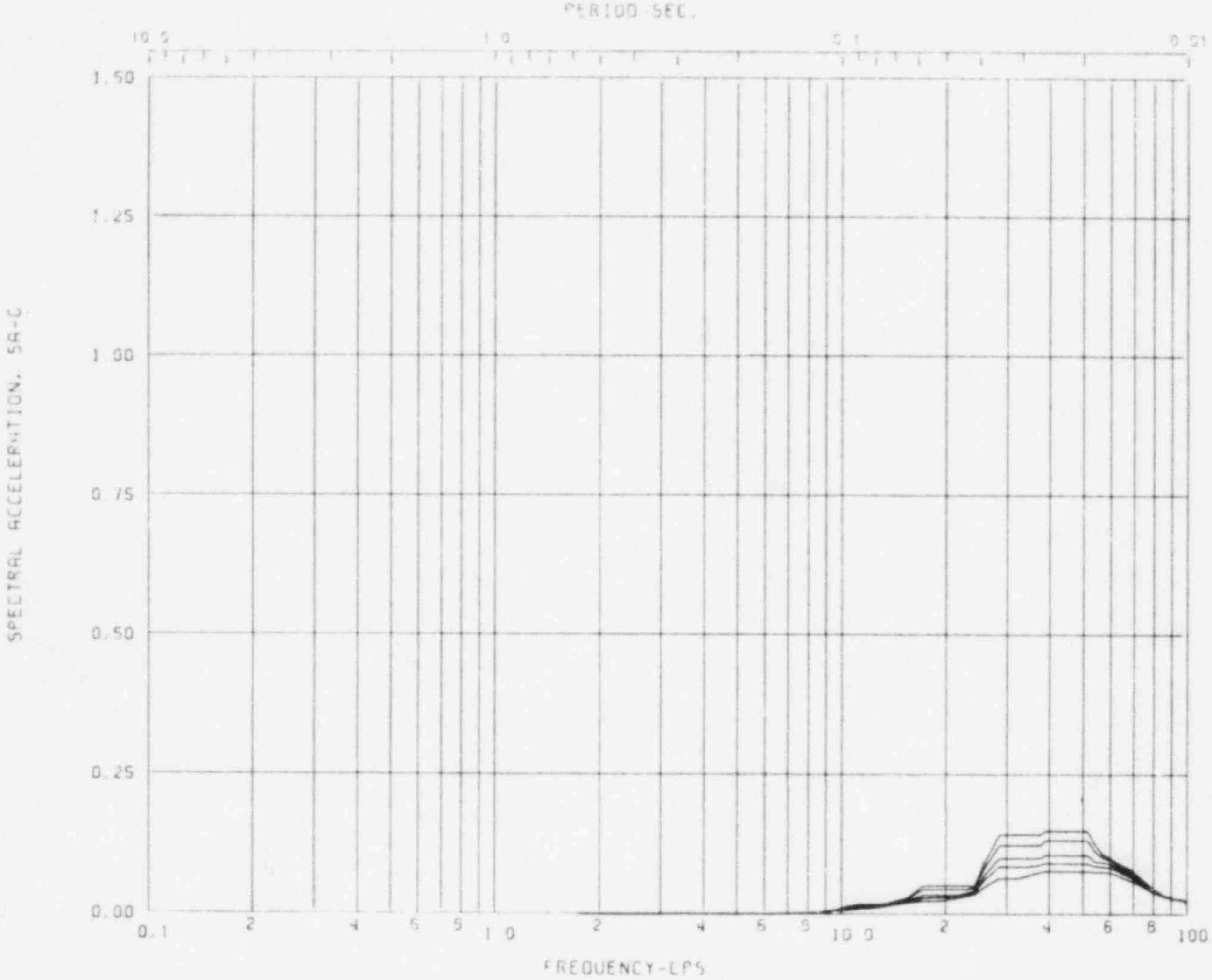
REACTOR ENCLOSURE AND CONTROL STRUCTURE GLOBAL RESPONSE SPECTRA, E-W HORIZONTAL, CHUG ASYMMETRIC

FIGURE B.2-76

REV.1, 09/82



Acceleration Spectra for REACTOR ENCL., CONTROL STRUCTURE

Load Case: ASYMMETRIC CHUGGING GE 700 SERIES ENVELOPE (WIDENED - 15%)

Node: 7 Direction: HORIZ E-W Elev: 283'-0

Damping: 0.005,0.01,0.02,0.03,0.05

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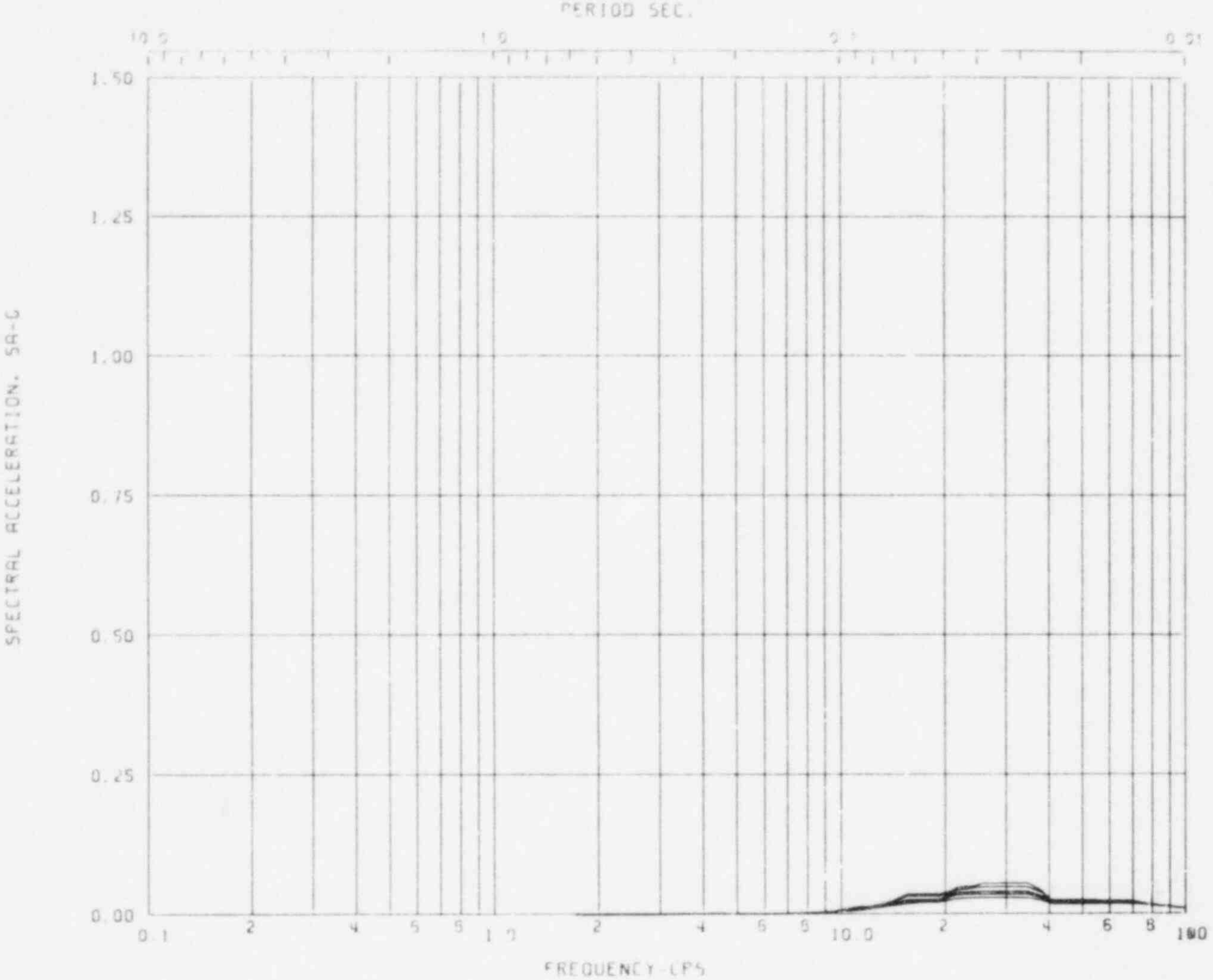
REACTOR ENCLOSURE AND CONTROL STRUCTURE GLOBAL RESPONSE SPECTRA, E-W HORIZONTAL, CHUG ASYMMETRIC

FIGURE B.2-77

REV 1, 09/82



Acceleration Spectra for REACTOR ENCL., CONTROL STRUCTURE

Load Case: ASYMMETRIC CHUGGING GE 700 SERIES ENVELOPE (WIDENED - 15%)

Node: 8 Direction: HORIZ E-W Elev: 304'-0

Damping: 0.005,0.01,0.02,0.03,0.05

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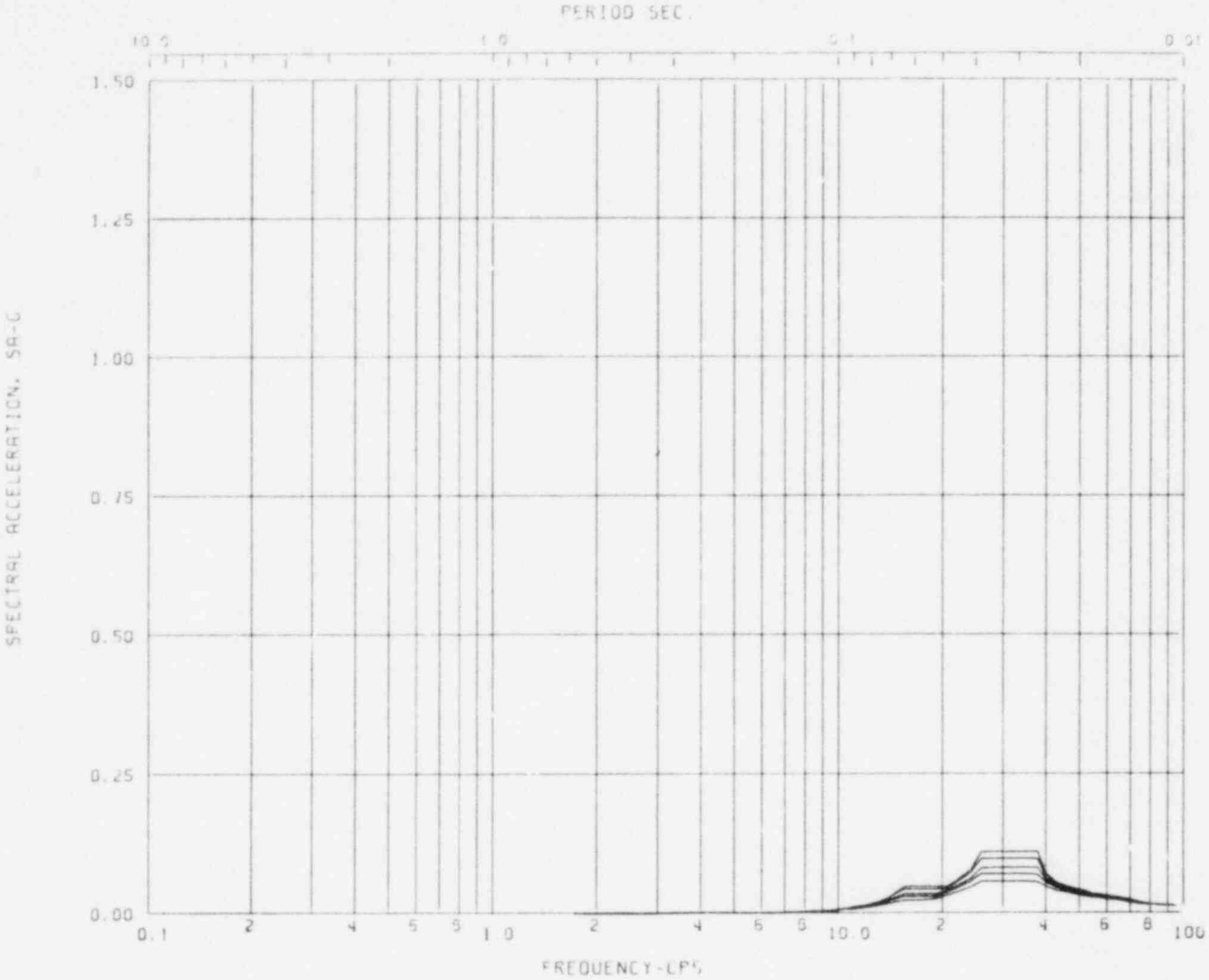
REACTOR ENCLOSURE AND CONTROL STRUCTURE GLOBAL RESPONSE SPECTRA, E-W HORIZONTAL, CHUG ASYMMETRIC

FIGURE B.2-78

REV 1, 09/82



Acceleration Spectra for REACTOR ENCL., CONTROL STRUCTURE

Load Case: ASYMMETRIC CHUGGING GE 700 SERIES ENVELOPE (WIDENED - 15%)

Node: 9 Direction: HORIZ E-W Elev: 313'-0

Damping: 0.005,0.01,0.02,0.03,0.05

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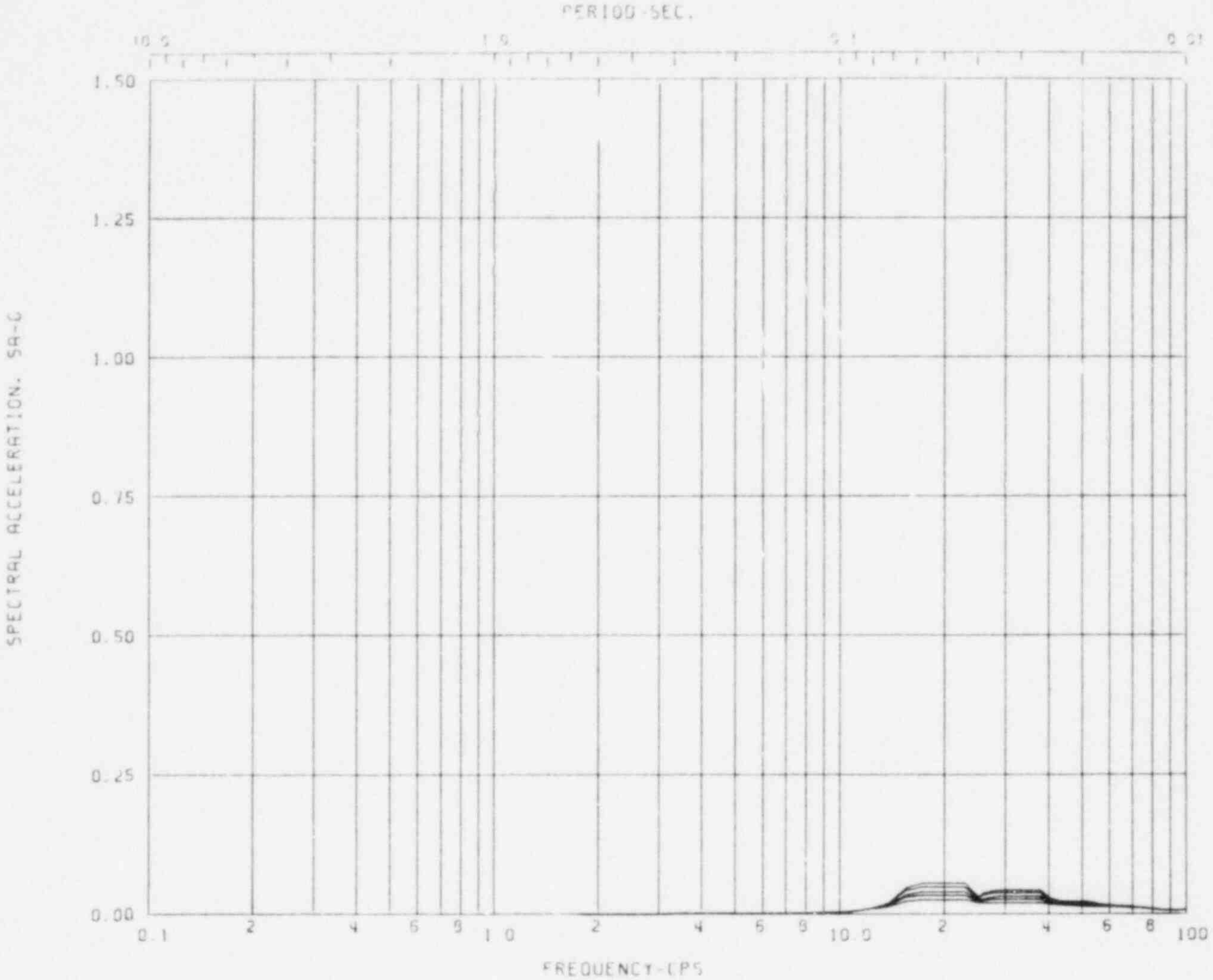
REACTOR ENCLOSURE AND CONTROL STRUCTURE GLOBAL RESPONSE SPECTRA, E-W HORIZONTAL, CHUG ASYMMETRIC

FIGURE B.2-79 REV 1, 09/82



Acceleration Spectra for REACTOR ENCL., CONTROL STRUCTURE

Load Case: ASYMMETRIC CHUGGING GE 700 SERIES ENVELOPE (WIDENED - 15%)

Node: 10 Direction: HORIZ E-W Elev: 332'-0

Damping: 0.005,0.01,0.02,0.03,0.05

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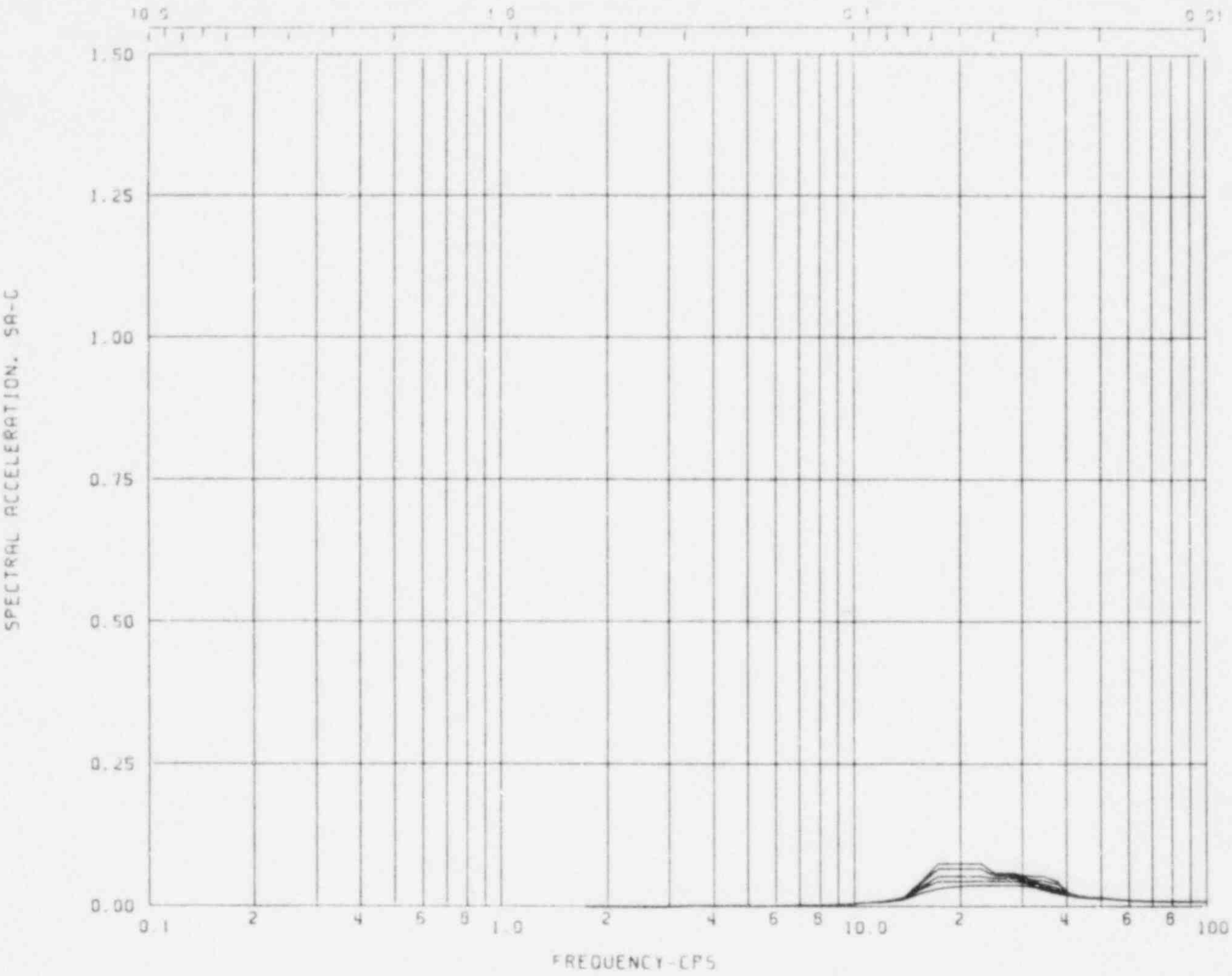
REACTOR ENCLOSURE AND CONTROL STRUCTURE GLOBAL RESPONSE SPECTRA, E-W HORIZONTAL, CHUG ASYMMETRIC

FIGURE B.2-80 REV 1, 09/82



Acceleration Spectra for REACTOR ENCL., CONTROL STRUCTURE

Load Case: ASYMMETRIC CHUGGING GE 700 SERIES ENVELOPE (WIDENED - 15%)

Node: 11 Direction: HORIZ E-W Elev: 352'-0

Damping: 0.005,0.01,0.02,0.03,0.05

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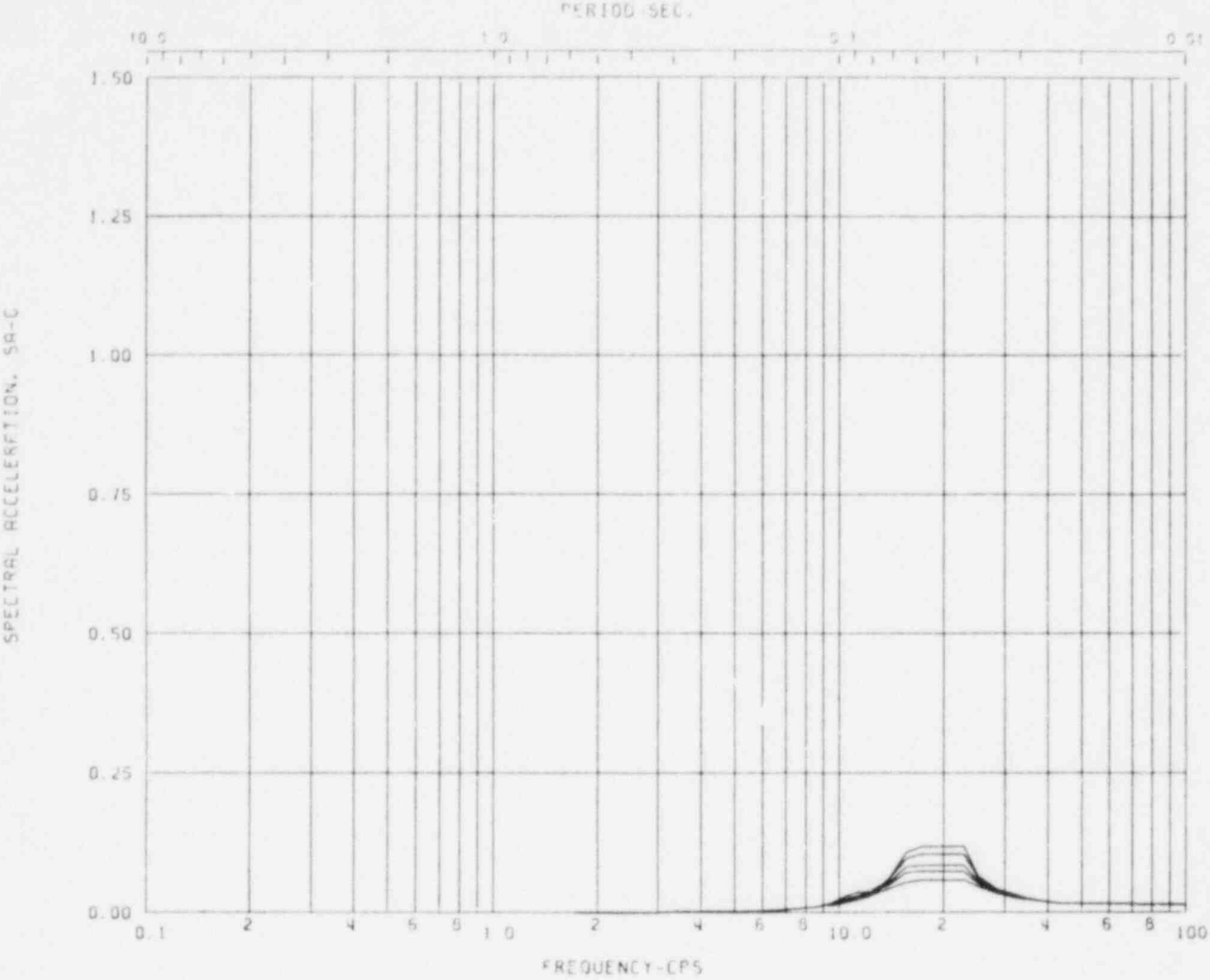
REACTOR ENCLOSURE AND CONTROL STRUCTURE GLOBAL RESPONSE SPECTRA, E-W HORIZONTAL, CHUG ASYMMETRIC

FIGURE B.2-81 REV 1, 09/82



Acceleration Spectra for REACTOR ENCL., CONTROL STRUCTURE

Load Case: ASYMMETRIC CHUGGING GE 700 SERIES ENVELOPE (WIDENED - 15%)

Node: 12 Direction: HORIZ E-W Elev: 410'-0

Damping: 0.005,0.01,0.02,0.03,0.05

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REACTOR ENCLOSURE AND CONTROL STRUCTURE GLOBAL RESPONSE SPECTRA, E-W HORIZONTAL, CHUG ASYMMETRIC

FIGURE B.2-82 REV 1, 09/82

APPENDIX D

FIGURES

APPENDIX D

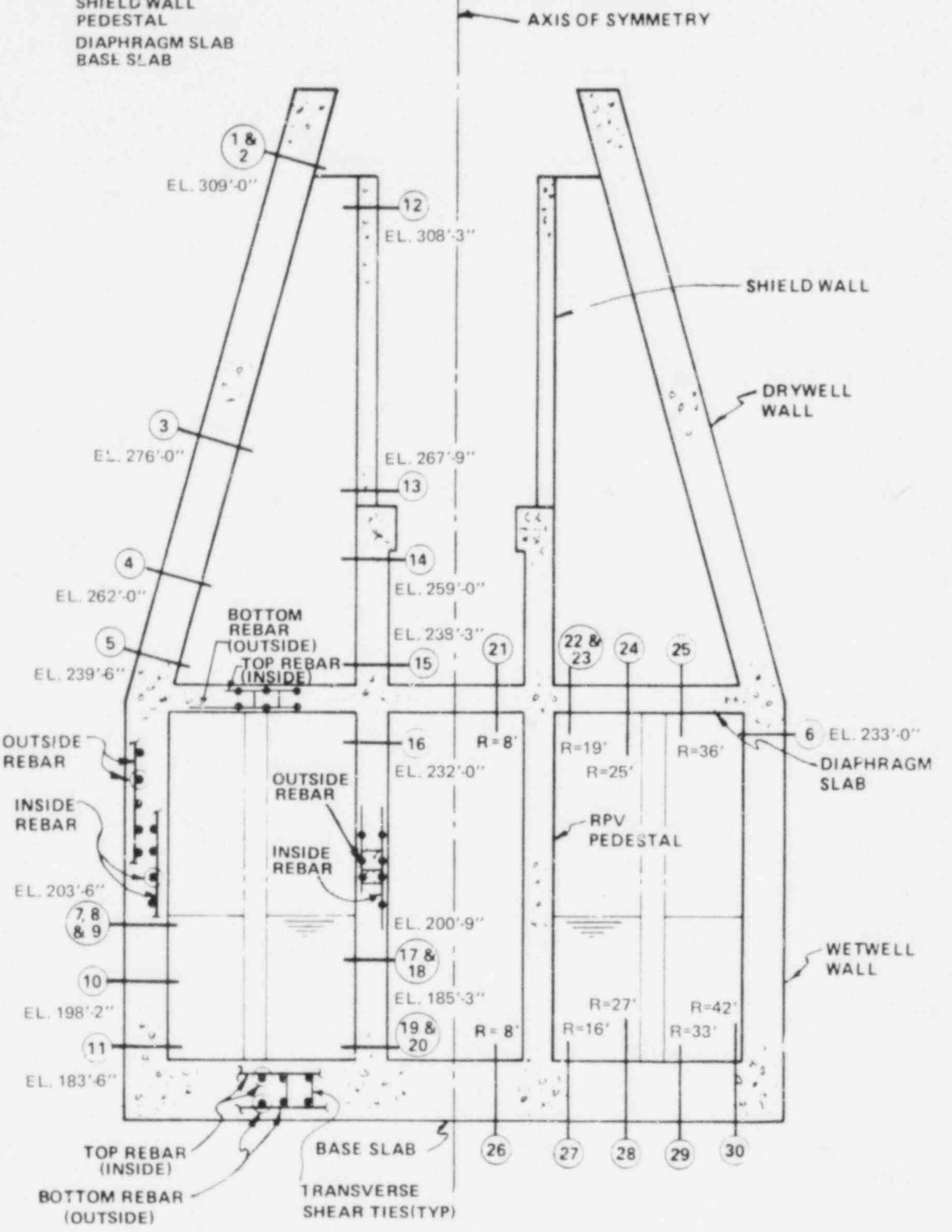
FIGURES

D.1 CONTAINMENT STRUCTURAL DESIGN ASSESSMENT

Figure D.1-1 indicates the containment structural elements and cross sections where stresses are determined, and Figures D.1-2 through D.1-25 contain a tabulation of the predicted stresses and allowable stresses for each loading combination considered.

Load combinations, taken from Table 5.2-1, are tabulated to cover all of the critical sections in the containment concrete structures. Load combination Equation 2 for all sections and Equations 1 and/or 3 and 6 for some sections are not executed because they do not represent the governing cases.

SECTIONS	LOCATIONS
1–5	DRYWELL WALL
6–11	WETWELL WALL
12–13	SHIELD WALL
14–20	PEDESTAL
21–25	DIAPHRAGM SLAB
26–30	BASE SLAB



○ SECTION WHERE STRESSES ARE ASSESSED

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CONTAINMENT
ASSESSMENT
SECTION LOCATION

FIGURE D.1-1

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DRYWELL WALL
SECTIONS: 1, 2

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)						Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER			Transverse Ties	
	Vert	Hoop	Vert	Hoop	Diag.		
1	-	-	-	-	-	-	-
3, 6	-	-	-	-	-	-	-
4, 4a	18.57	31.36	5.82	13.90	11.17	6.50	-0.233
4T, 4aT	7.14	6.83	13.4	19.75	16.83	10.99	-0.967
5, 5a, 7, 7a	25.66	30.04	9.95	13.45	20.82	4.60	-0.257
5T, 5aT, 7T, 7aT	11.36	-4.66	16.34	24.41	32.46	11.67	-1.542

NOTES:
(1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
DRYWELL WALL

FIGURE D.1-2

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DRYWELL WALL
SECTION: 3

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)						Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER			Transverse Ties	
	Vert	Hoop	Vert	Hoop	Diag.		
1	-0.46	-0.07	-0.55	-0.04	-0.28	0.12	-0.432
3, 6	11.4	6.26	11.3	4.2	15.7	15.1	-0.200
4, 4a	9.97	43.0	14.8	19.5	17.4	11.4	-0.218
4T, 4aT	3.45	18.7	23.8	28.0	24.5	12.2	-0.926
5, 5a, 7, 7a	24.1	40.2	21.3	17.4	36.9	20.1	-0.460
5T, 5aT, 7T, 7aT	14.9	15.9	34.5	27.4	52.0	17.6	-1.38

NOTES:
(1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
DRYWELL WALL

FIGURE D.1-3

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DRYWELL WALL
SECTION: 4

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)						Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER			Transverse Ties	
	Vert	Hoop	Vert	Hoop	Diag.		
1	-0.55	-0.02	-0.69	0.06	-0.35	0.15	-0.097
3, 6	13.0	6.44	13.0	4.2	17.1	20.3	-0.230
4, 4a	8.49	41.7	21.8	20.9	23.2	10.8	-0.202
4T, 4aT	4.43	20.3	29.2	30.2	32.4	11.4	-0.822
5, 5a, 7, 7a	26.3	39.3	28.7	17.5	39.7	24.9	-0.522
5T, 5aT, 7T, 7aT	16.8	16.3	40.6	28.6	48.0	21.8	-1.431

NOTES: (1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
DRYWELL WALL

FIGURE D.1-4

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DRYWELL WALL
SECTION: 5

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)						Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER			Transverse Ties	
	Vert	Hoop	Vert	Hoop	Diag.		
1	-0.73	1.04	-0.80	1.0	-0.35	0.16	-0.106
3, 6	15.5	10.3	14.6	5.5	20.0	18.6	-0.294
4, 4a	31.2	33.7	21.6	6.9	14.6	39.8	-0.671
4T, 4aT	22.6	13.2	24.1	24.4	22.7	36.5	-0.671
5, 5a, 7, 7a	43.6	33.2	32.8	9.5	37.6	54.0	-0.931
5T, 5aT, 7T, 7aT	30.4	9.9	45.5	22.1	47.7	46.2	-1.71

NOTES:
(1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
DRYWELL WALL

FIGURE D.1-5

REV. 1, 09/82

WETWELL WALL

SECTION: 6

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)						Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER			Transverse Ties	
	Vert	Hoop	Vert	Hoop	Diag.		
1	-1.2	1.8	-0.76	1.7	0.63	0.161	-0.99
3, 6	16.9	17.7	16.5	4.8	20.6	0.52	-0.361
4, 4a	31.1	39.6	26.8	9.2	18.6	43.7	-0.582
4T, 4aT	26.0	48.7	26.7	28.1	28.2	35.0	-0.718
5, 5a, 7, 7a	50.1	43.1	36.0	12.9	45.7	44.8	-1.009
5T, 5aT, 7T, 7aT	24.9	48.8	53.9	26.7	47.6	27.5	-1.592

NOTES:

(1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
WETWELL WALL

FIGURE D.1-6

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WETWELL WALL
SECTIONS: 7, 8, 9

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)						Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER			Transverse Ties	
	Vert	Hoop	Vert	Hoop	Diag.		
1	-1.36	9.7	-1.4	4.8	2.09	0.89	-0.210
3, 6	25.5	20.3	23.3	6.8	28.4	5.3	-0.427
4, 4a	14.8	38.4	26.8	25.5	26.2	13.6	-0.616
4T, 4aT	12.8	46.2	34.6	33.0	33.8	14.0	-1.31
5, 5a, 7, 7a	37.7	37.0	47.9	21.8	48.6	15.2	-0.819
5T, 5aT, 7T, 7aT	33.2	41.0	50.0	46.3	53.9	17.3	-2.12

NOTES:
(1) Allowable Reinforcing Steel Stress = 54 KSI
(2) Allowable Concrete Compressive Stress = 3.4 KSI
(3) "+" for Tensile Stress; "-" for Compressive Stress
(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
WETWELL WALL

FIGURE D.1-7 REV. 1, 09/82

WETWELL WALL
SECTION: 10

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)						Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER			Transverse Ties	
	Vert	Hoop	Vert	Hoop	Diag.		
1	-1.68	15.8	-1.5	7.4	3.35	1.1	-0.254
3, 6	27.5	30.7	25.5	7.58	31.1	0.70	-0.503
4, 4a	16.6	42.4	29.1	35.3	31.4	5.3	-0.744
4T, 4aT	12.2	35.6	38.0	39.7	37.9	8.13	-1.50
5, 5a, 7, 7a	37.5	40.1	43.6	27.5	50	6.7	-1.13
5T, 5aT, 7T, 7aT	29.4	46.7	53.8	35.6	52.4	7.4	-2.25

NOTES:
(1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
WETWELL WALL

FIGURE D.1-8

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WETWELL WALL
SECTION: 11

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)						Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER			Transverse Ties	
	Vert	Hoop	Vert	Hoop	Diag.		
1	-1.57	4.95	-1.5	2.96	1.16	2.81	-0.233
3, 6	29.8	21.2	27.1	8.48	34.3	15.3	-0.527
4, 4a	38.1	35.5	33.2	6.48	20.3	42.9	-0.702
4T, 4aT	36.1	18.5	38.2	11.2	25.1	44.5	-0.990
5, 5a, 7, 7a	53.9	32.9	46.0	9.0	45.0	45.0	-1.04
5T, 5aT, 7T, 7aT	47.2	40.6	51.2	17.0	47.4	45.4	-1.69

NOTES:
(1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
WETWELL WALL

FIGURE D.1-9 REV. 1, 09/82

SHIELD WALL
SECTION: 12

Load Combination Equations (4)	MAXIMUM STEEL STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER PLATE		OUTER PLATE		Transverse Ties	
	Vert	Hoop	Vert	Hoop		
1	0.39	3.6	-0.11	1.2	1.0	-0.071
3, 6	7.1	8.7	2.1	2.9	1.4	-0.293
4, 4a	2.2	9.2	-0.64	3.7	7.5	-0.265
4T, 4aT	2.0	8.8	0.81	3.3	7.5	-0.265
5, 5a, 7, 7a	8.5	12.8	2.7	5.1	9.5	-0.407
5T, 5aT, 7T, 7aT	8.3	12.4	2.5	4.7	9.5	-0.407

NOTES:

(1) Allowable Reinforcing Steel Stress = 30.6 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
SHIELD WALL

FIGURE D.1-10

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SHIELD WALL
SECTION: 13

Load Combination Equations (4)	MAXIMUM STEEL STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER PLATE		OUTER PLATE		Transverse Ties	
	Vert	Hoop	Vert	Hoop		
1	-0.28	0.08	-0.57	-0.10	0.128	-0.077
3, 6	9.7	3.5	2.9	1.1	0.63	-0.404
4, 4a	-0.65	0.29	-0.94	-0.15	0.26	-0.128
4T, 4aT	-1.45	-1.73	-0.53	1.03	0.26	-0.128
5, 5a, 7, 7a	10.7	3.6	2.9	1.1	2.4	-0.444
5T, 5aT, 7T, 7aT	9.9	1.9	3.3	2.1	2.4	-0.444

NOTES:
(1) Allowable Reinforcing Steel Stress =30.6 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
SHIELD WALL

FIGURE D.1-11

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RPV PEDESTAL
SECTION: 14

	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
Load Combination Equations (4)	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-1.0	1.0	-1.2	1.2	0.34	-0.157
3, 6	17.2	13.4	29.2	17.4	3.9	-0.352
4, 4a	-1.3	2.4	-1.7	2.0	0.31	-0.230
4T, 4aT	7.98	7.0	-2.31	4.97	0.31	-0.230
5, 5a, 7, 7a	17.2	14.7	25.6	17.2	3.3	-0.432
5T, 5aT, 7T, 7aT	25.7	19.3	25.0	20.2	3.3	-0.432

NOTES: (1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
RPV PEDESTAL

FIGURE D.1-12

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RPV PEDESTAL
SECTION: 15

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-1.5	0.94	-2.2	0.32	0.35	-0.290
3, 6	43.9	27.2	52.5	33.6	4.7	0.649
4, 4a	4.5	32.2	6.1	47.0	21.1	-0.474
4T, 4aT	14.5	-4.8	4.9	-5.9	48.3	-0.910
5, 5a, 7, 7a	52.9	50.1	52.9	51.8	39.4	-0.856
5T, 5aT, 7T, 7aT	49.9	8.2	51.9	-4.0	27.4	-1.017

NOTES: (1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
RPV PEDESTAL

FIGURE D.1-13

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RPV PEDESTAL
SECTION: 16

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-1.5	1.1	-2.0	2.1	0.34	-0.266
3, 6	30.3	13.0	39.4	29.1	0.86	-0.526
4, 4a	6.9	12.6	-4.8	30.4	7.9	-0.678
4T, 4aT	13.3	13.3	-5.7	28.0	15.0	-1.051
5, 5a, 7, 7a	45.0	26.1	42.7	36.8	19.6	-0.931
5T, 5aT, 7T, 7aT	37.3	16.0	22.7	15.5	27.9	-1.249

NOTES: (1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

CONTAINMENT STRESSES
RPV PEDESTAL

FIGURE D.1-14

REV. 1, 09/82

RPV PEDESTAL
SECTIONS: 17, 18

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-2.1	5.0	-2.7	12.9	9.0	-0.382
3, 6	9.9	8.5	10.5	17.0	12.9	-0.690
4, 4a	-4.1	11.9	-4.8	28.3	17.0	-0.681
4T, 4aT	4.13	13.8	-4.3	28.9	26.8	-0.635
5, 5a, 7, 7a	18.6	15.7	20.5	29.8	22.5	-1.017
5T, 5aT, 7T, 7aT	23.0	22.1	22.0	32.6	38.9	-0.968

NOTES: (1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTAINMENT STRESSES
RPV PEDESTAL

FIGURE D.1-15 REV. 1, 09/82

RPV PEDESTAL
SECTIONS: 19, 20

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-2.01	-0.176	-2.95	0.27	0.59	-0.424
3, 6	17.9	5.26	11.8	5.4	4.7	-0.483
4, 4a	4.86	3.69	-5.2	7.1	5.68	-0.744
4T, 4aT	5.2	-6.1	-5.39	-4.8	5.68	-0.744
5, 5a, 7, 7a	25.9	7.2	32.5	12.8	15.9	-0.851
5T, 5aT, 7T, 7aT	26.2	-5.8	32.3	8.2	15.9	-0.851

NOTES:
(1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
RPV PEDESTAL

FIGURE D.1-16

REV. 1, 09/82

DIAPHRAGM SLAB
SECTION: 21

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-	-	-	-	-	-
3, 6	8.5	8.6	6.9	7.7	1.01	-0.073
4, 4a	38.8	30.2	28.9	22.7	8.8	-0.374
4T, 4aT	32.8	21.6	35.9	27.6	9.5	-1.82
5, 5a, 7, 7a	35.6	30.1	29.3	23.3	8.8	-0.365
5T, 5aT, 7T, 7aT	31.7	21.5	34.6	28.0	8.9	-1.83

NOTES:
(1) Allowable Reinforcing Steel Stress = 54 KSI
(2) Allowable Concrete Compressive Stress = 3.4 KSI
(3) "+" for Tensile Stress; "-" for Compressive Stress
(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTAINMENT STRESSES
DIAPHRAGM SLAB

FIGURE D.1-17 REV. 1, 09/82

DIAPHRAGM SLAB
SECTIONS: 22, 23

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-	-	-	-	-	-
3, 6	7.9	9.5	10.2	13.0	4.46	-0.370
4, 4a	14.1	21.5	18.4	24.2	16.1	-0.383
4T, 4aT	-11.1	12.3	26.2	29.8	7.0	-1.367
5, 5a, 7, 7a	16.4	23.1	23.7	27.9	18.0	-0.623
5T, 5aT, 7T, 7aT	-13.1	16.0	25.5	35.9	7.2	-1.727

NOTES: (1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTAINMENT STRESSES
DIAPHRAGM SLAB

FIGURE D.1-18 REV. 1, 09/82

DIAPHRAGM SLAB
SECTION: 24

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-	-	-	-	-	-
3, 6	10.2	9.6	9.1	8.0	3.0	-0.272
4, 4a	22.8	22.6	30.5	21.1	5.9	-0.842
4T, 4aT	-8.61	-8.29	33.2	29.4	4.2	-1.59
5, 5a, 7, 7a	27.9	25.4	33.4	24.4	6.2	-0.931
5T, 5aT, 7T, 7aT	-10.3	12.3	35.5	30.8	4.9	-1.738

NOTES:
(1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

LIMERICK GENERATING STATION
UNITS 1 AND 2
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CONTAINMENT STRESSES
DIAPHRAGM SLAB

FIGURE D.1-19 REV. 1, 09/82

DIAPHRAGM SLAB
SECTION: 25

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-	-	-	-	-	-
3, 6	13.0	15.5	12.1	14.5	0.66	-.157
4, 4a	26.7	28.0	23.5	30.6	9.9	-.336
4T, 4aT	12.9	24.0	26.1	35.4	6.5	-2.04
5, 5a, 7, 7a	33.6	38.5	28.6	35.9	10.4	-.423
5T, 5aT, 7T, 7aT	19.3	31.8	41.1	42.4	9.5	-2.40

NOTES:
(1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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CONTAINMENT STRESSES
DIAPHRAGM SLAB

FIGURE D.1-20 REV. 1, 09/82

BASE SLAB
SECTION: 26

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stabs, KSI (2)(3)
	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-	-	-	-	-	-
3, 6	1.7	16.6	5.93	6.22	5.29	-0.318
4, 4a	2.72	1.61	7.10	3.29	0.43	-0.213
4T, 4aT	-5.21	-5.63	15.2	14.9	3.4	-1.21
5, 5a, 7, 7a	10.9	20.7	10.4	9.51	4.03	-0.443
5T, 5aT, 7T, 7aT	-6.36	-4.95	18.4	17.3	3.12	-1.34

NOTES:
(1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTAINMENT STRESSES
BASE SLAB

FIGURE D.1-21

REV. 1, 09/82

BASE SLAB
SECTION: 27

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-	-	-	-	-	-
3, 6	25.4	26.8	15.5	6.43	24.7	-0.479
4, 4a	10.3	-0.43	11.1	0.65	23.9	-0.309
4T, 4aT	22.4	-7.3	29.8	13.3	33.1	-1.70
5, 5a, 7, 7a	39.8	34.4	29.3	13.9	41.0	-0.540
5T, 5aT, 7T, 7aT	30.0	20.2	29.0	17.1	39.8	-1.79

NOTES:
(1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

LIMERICK GENERATING STATION
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CONTAINMENT STRESSES
BASE SLAB

FIGURE D.1-22 REV. 1, 09/82

BASE SLAB
SECTION: 28

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-	-	-	-	-	-
3, 6	34.0	17.8	11.1	10.6	17.5	-0.910
4, 4a	21.7	9.15	16.9	8.7	12.5	-0.304
4T, 4aT	-8.25	-8.07	17.7	13.4	6.7	-1.59
5, 5a, 7, 7a	42.1	21.2	18.2	16.1	25.2	-0.985
5T, 5aT, 7T, 7aT	25.4	-8.4	23.7	19.8	18.7	-1.72

NOTES: (1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

LIMERICK GENERATING STATION
UNITS 1 AND 2
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CONTAINMENT STRESSES
BASE SLAB

FIGURE D.1-23 REV. 1, 09/82

BASE SLAB
SECTION: 29

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-	-	-	-	-	-
3, 6	12.7	15.6	9.01	8.52	11.1	-0.524
4, 4a	11.8	9.51	17.3	7.95	11.0	-0.243
4T, 4aT	9.32	-6.40	20.6	12.6	12.0	-1.23
5, 5a, 7, 7a	17.7	18.9	19.0	13.3	18.5	-0.508
5T, 5aT, 7T, 7aT	14.4	-6.22	21.5	16.1	18.9	-1.18

NOTES: (1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include thermal components.

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DESIGN ASSESSMENT REPORT

CONTAINMENT STRESSES
BASE SLAB

FIGURE D.1-24

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BASE SLAB
SECTION: 30

Load Combination Equations (4)	MAXIMUM REBAR STRESSES, KSI (1)(3)					Max. Concrete Stress, KSI (2)(3)
	INNER		OUTER		Transverse Ties	
	Radial	Hoop	Radial	Hoop		
1	-	-	-	-	-	-
3, 6	9.32	16.9	9.14	8.54	7.0	-0.414
4, 4a	29.9	33.5	34.1	10.2	25.6	-0.430
4T, 4aT	29.2	5.5	38.5	12.9	27.4	-0.902
5, 5a, 7, 7a	23.9	36.5	32.9	16.6	28.4	-0.688
5T, 5a%, 7T, 7aT	22.5	-6.36	36.5	19.6	28.9	-0.915

NOTES: (1) Allowable Reinforcing Steel Stress = 54 KSI

(2) Allowable Concrete Compressive Stress = 3.4 KSI

(3) "+" for Tensile Stress; "-" for Compressive Stress

(4) Load Combination Equations are taken from Table 5.2-1, 4T, 4aT, 5T, 5aT, 7T, 7aT include Thermal Components.

LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTAINMENT STRESSES
BASE SLAB

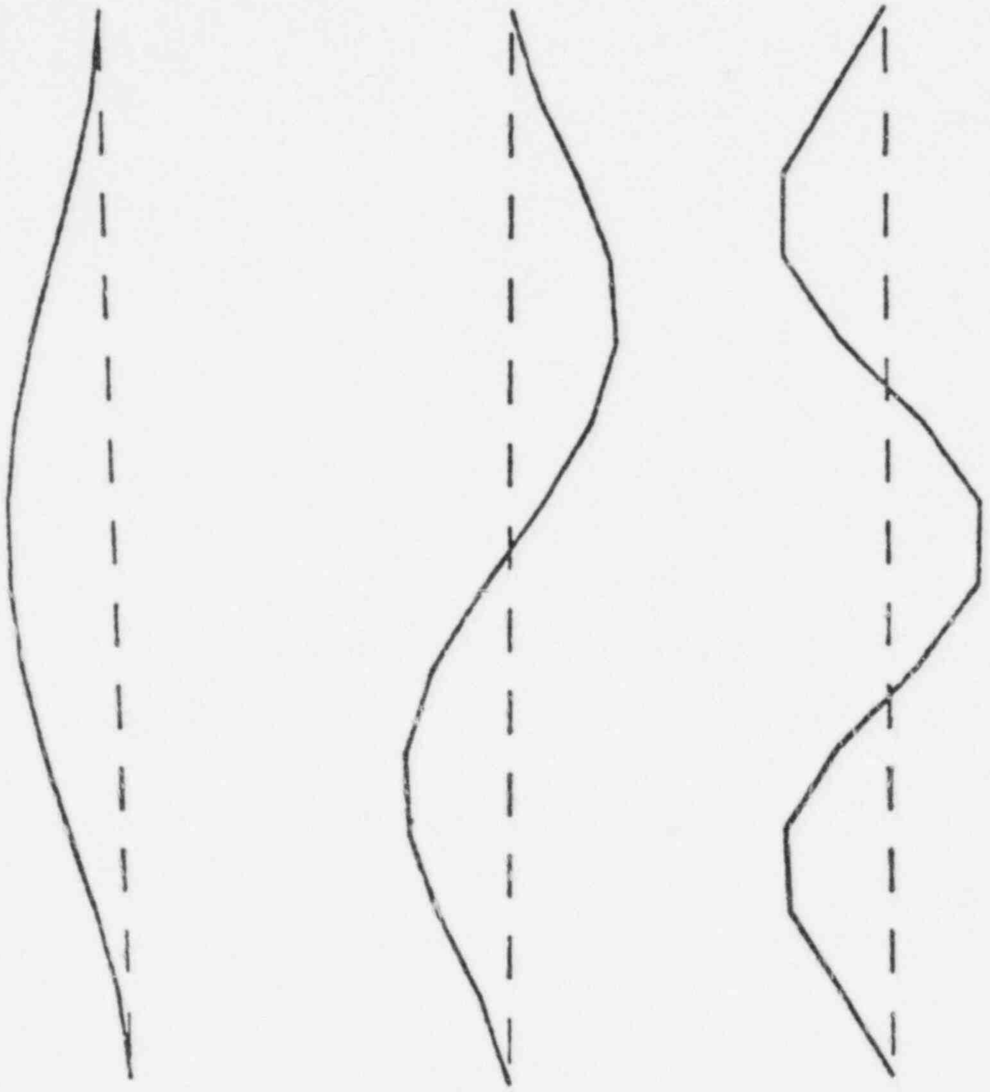
FIGURE D.1-25 REV. 1, 09/82

D.2 SUBMERGED STRUCTURE DESIGN ASSESSMENT

The submerged structures in the suppression chamber include the diaphgragm slab support columns, the downcomer bracing system, and the downcomers. The bracing system and the columns are assessed in accordance with Table 5.3-1. In the column assessment, the dynamic loads are combined by the SRSS method and then combined with the static loads using the absolute sum procedure. In the assessment of the downcomer bracing system, all loads are combined using the absolute sum method. For both the downcomer bracing system and the columns, Equation 7 of Table 5.3-1 is the most critical combination.

The natural vibration frequencies and shapes of the suppression chamber columns are presented in Figure D.2-1, and the assessment results are summarized in Figure D.2-2. Bolt stresses are not shown in the bottom anchorage because the design is more critical at the connecting flange, which yields a design margin of 10 percent.

The downcomer bracing system mathematical model is shown in Figure D.2-10, and the design margins for the most critical member in each quadrant are summarized in Figure D.2-11.



MODE 1
f=20 HZ

MODE 2
f=53 HZ

MODE 3
f=93 HZ

(WITH WATER MASS)

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UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

SUPPRESSION CHAMBER COLUMNS
MODE SHAPES

FIGURE D.2-1

REV. 1, 09/82

SUPPRESSION CHAMBER COLUMNS

COLUMN	MAXIMUM AXIAL STRESS (KSI)	ALLOWABLE AXIAL STRESS (KSI)	MAXIMUM FLEXURAL STRESS (KSI)	ALLOWABLE FLEXURAL STRESS (KSI)	COMBINED STRESS RATIO	STRESS MARGIN %
42" dia pipe (shell element)	11.7	27.3	8.7	28.0	0.74	26
Top Anchorage	22.6	29.9	-	-	0.76	24
Bottom Anchorage	-	-	-	-	-	10

NOTE: These stress margins are based on load combination 7 of Table 5.3.1 which is the critical load combination.

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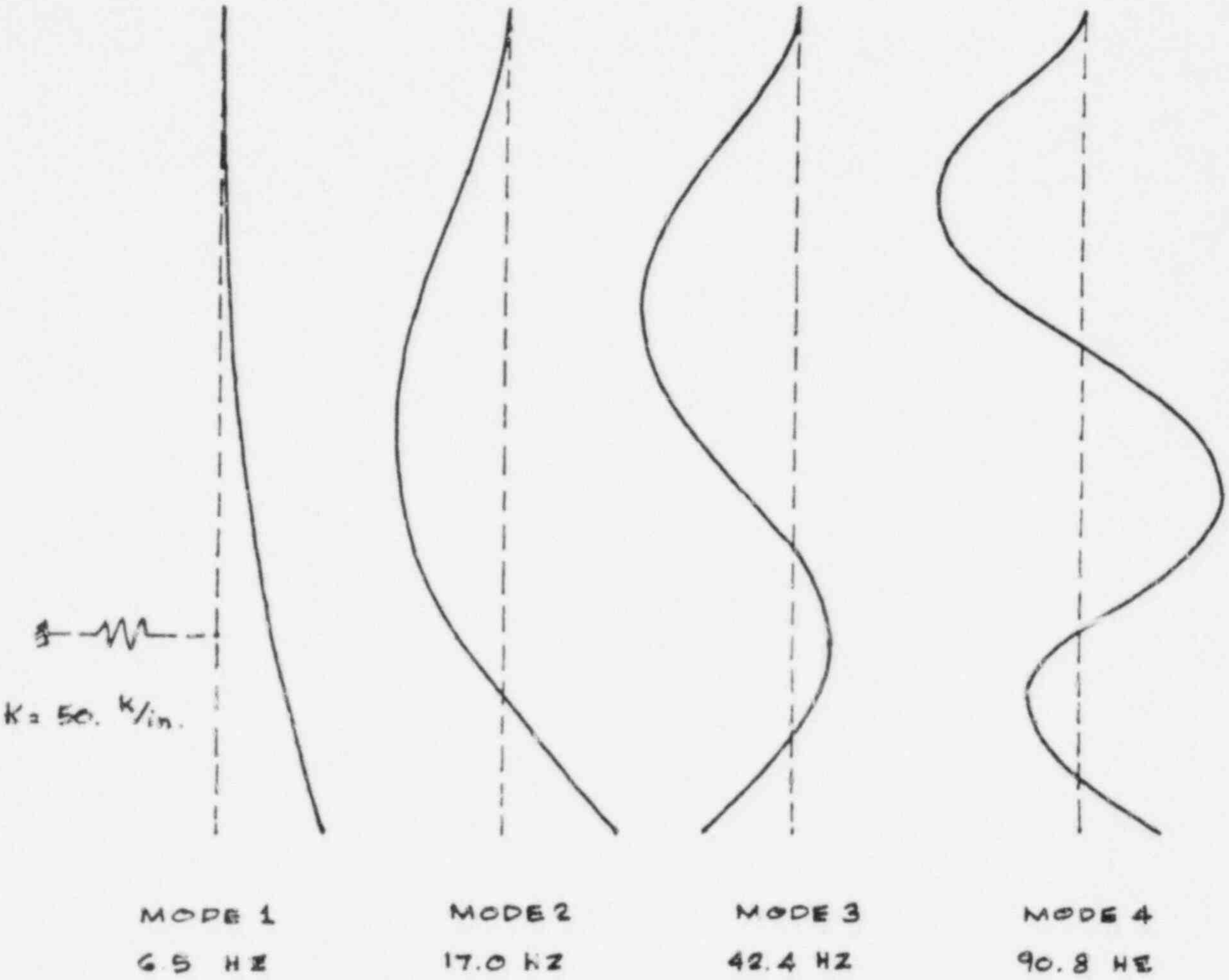
DESIGN ASSESSMENT REPORT

SUPPRESSION CHAMBER COLUMNS
DESIGN MARGIN

FIGURE D.2-2

REV. 1, 09/82

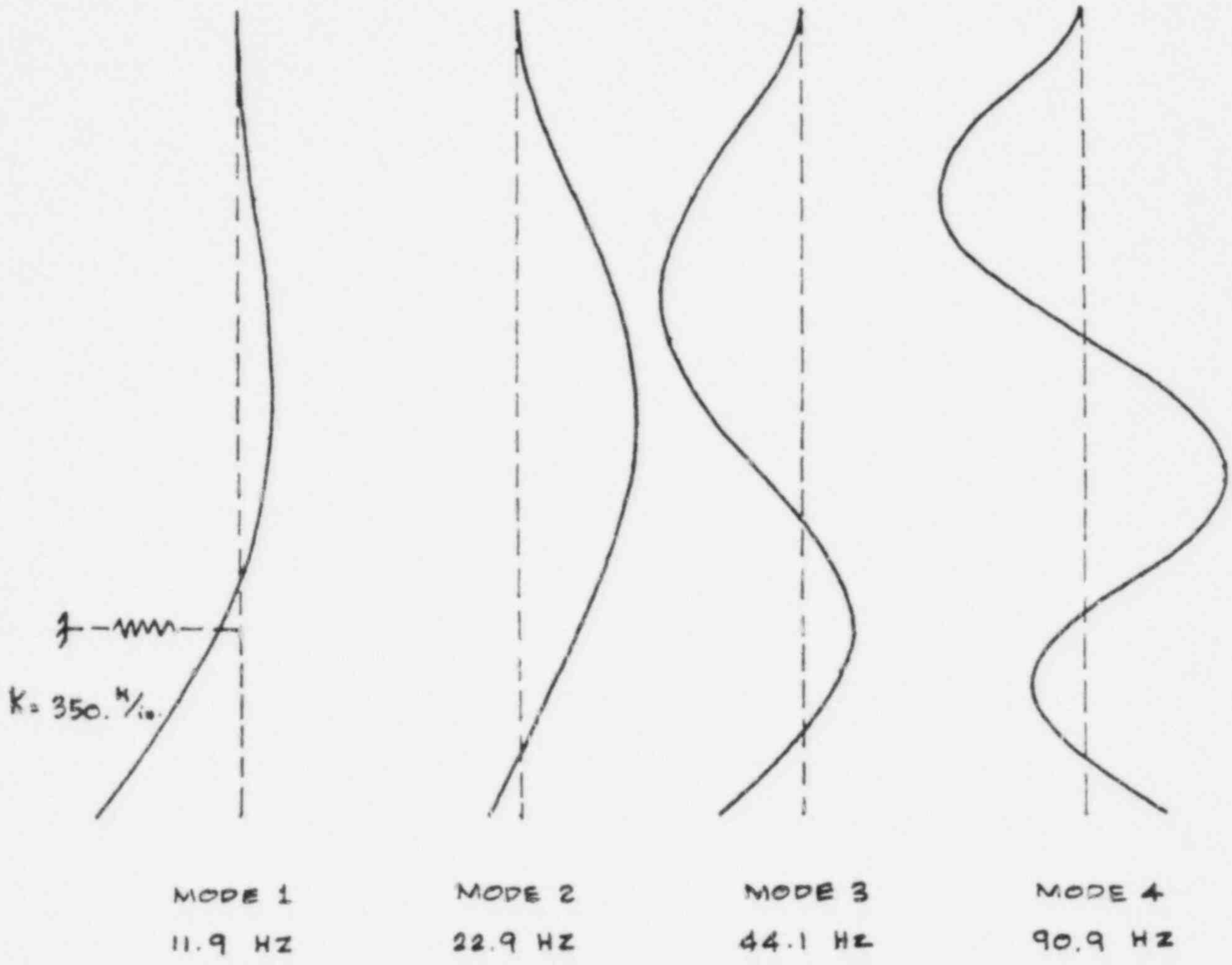


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

DOWNCOMER
MODE SHAPES, K=50 $^{k}/_{in}$

FIGURE D.2-3

REV 1, 09/82

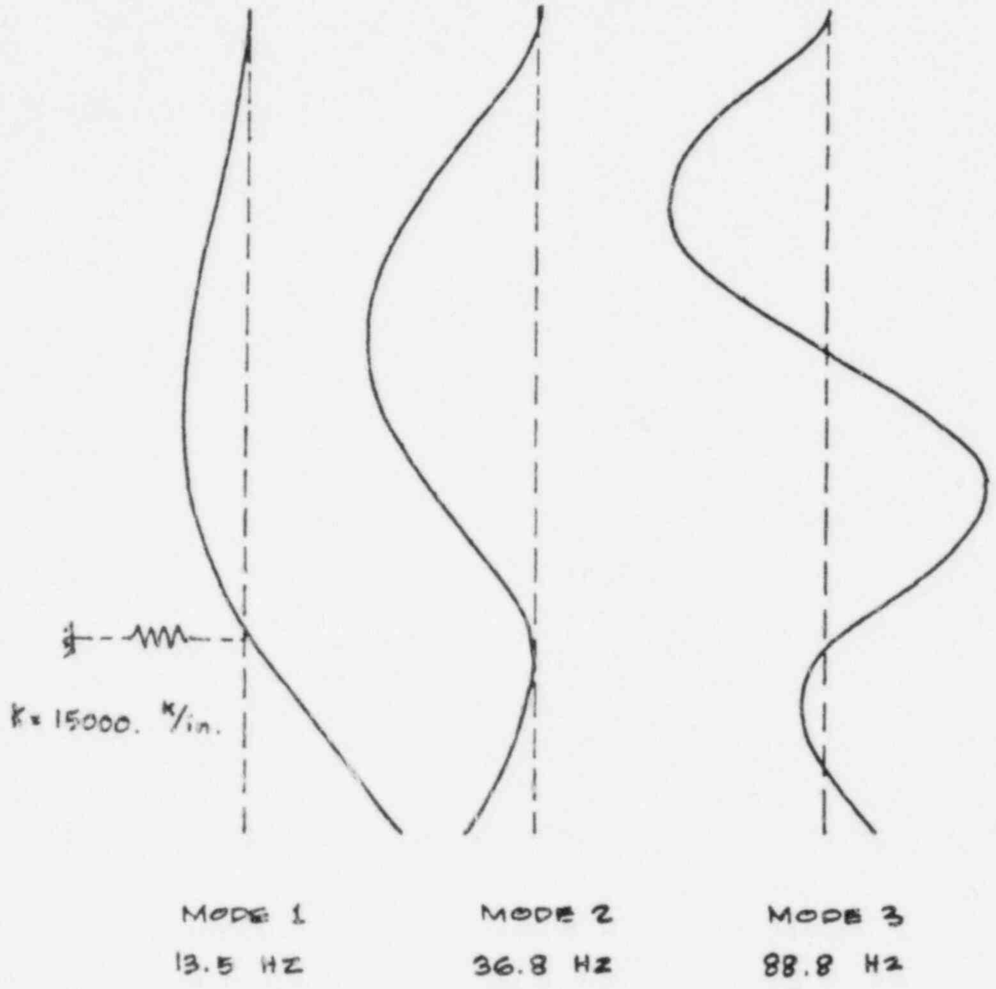


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

DOWNCOMER
MODE SHAPES, K= 350 $^{k}/_{in}$

FIGURE D.2-4

REV.1, 09/82



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DOWNCOMER
MODE SHAPES, K=15000 $^{k}/_{in}$

FIGURE D.2-5

REV. 1, 09/82

DOWNCOMER - STRESS SUMMARY AND DESIGN MARGINS

LOAD COMBINATION	CONDITION	ALLOWABLE STRESS (KSI)	STRESS (KSI)	DESIGN MARGIN (%)
Equation 1	Upset	28.4	17.5	38.4
Equation 2	Emergency	42.5	19.9	53.2
Equation 3	Emergency	42.5	37.4	12.0
Equation 4	Faulted	56.7	20.0	64.7
Equation 5	Faulted	56.7	37.4	34.0
Equation 6	Faulted	56.7	37.5	33.9
Equation 7	Faulted	56.7	24.5	56.8

NOTE: Equation numbers are based on Table 5.5-1.

LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

DOWNCOMER
DESIGN MARGIN

FIGURE D.2-6

REV. 1, 09/82

USAGE FACTOR SUMMARY OF DOWNCOMERS

	NORMAL/UPSET CONDITION				EMERGENCY/FAULTED CONDITIONS		
					SBA	IBA or SBA	DBA
LOADS	± OBE ± SRV_1 ± SRV_2	± SRV_1 ± SRV_2 ± CHUG	± SRV_1 ± SRV_2	± SRV_1	° Pressure ° Thermal Transient ° Steam Flow ± CHUG ± SRV_1 ± SRV_2	° Pressure ° Thermal Transient ° Steam Flow ± CHUG ± SRV_1 ± SRV_2 ± SSE	° Pressure ° Thermal Transient ° Steam Flow ± CHUG ± SSE
At Platform Ring Elev. 223'-0"	0.0020	0.5475	0.6638	0.7552	0.7612		
At Vacuum Breaker Weld Elev. 231'-0"	0	0.0429	0.0429	0.0429	0.0432		
At Pipe Attachment Elev. 221'-0"	0.0014	0.5467	0.6242	0.6953	0.6984		

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DESIGN ASSESSMENT REPORT

DOWNCOMER
FATIGUE USAGE FACTOR

FIGURE D.2-7

REV. 1, 09/82

STRESS CYCLES FOR FATIGUE EVALUATION OF DOWNCOMERS

LOAD TYPE	No. OF CYCLES
N_{SRV1}	14100
N_{SRV2}	7700
N_{OBE}	50
N_{CHUG}	3000
N_{SSE}	10

N_{OBE} = Cycles associated with OBE
N_{SRV1} = Cycles associated with SRV_1 (Submerged Structure Load)
N_{SRV2} = Cycles associated with SRV_2 (Inertia)
N_{CHUG} = Cycles associated with Chugging
N_{SSE} = Cycles associated with SSE

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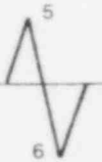
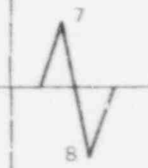
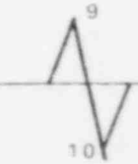
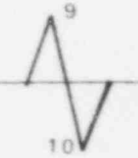
DESIGN ASSESSMENT REPORT

DOWNCOMER
FATIGUE CYCLES

FIGURE D.2-8

REV. 1, 09/82

FATIGUE LOAD HISTOGRAM FOR DOWNCOMERS

NORMAL/UPSET CONDITION				EMERGENCY	FAULTED	
				SBA	IBA or SBA	DBA
± OBE ± SRV_1 ± SRV_2	± SRV_1 ± SRV_2 ± CHUG	± SRV_1 ± SRV_2	± SRV_1	° Pressure ° Thermal Transient ° Steam Flow ± CHUG ± SRV_1 ± SRV_2	° Pressure ° Thermal Transient ° Steam Flow ± CHUG ± SRV_1 ± SRV_2 ± SSE	° Pressure ° Thermal Transient ° Steam Flow ± CHUG ± SSE
						
50 cycles	3000 cycles	4650 cycles	6400 cycles	Load set pair 9-10 is for one of the three above events which produce the largest combined stress. The cycles associated with oscillatory loads combined with SSE are assumed conservatively to be 10.		

LIMERICK GENERATING STATION
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DOWNCOMER
FATIGUE HISTOGRAM

FIGURE D.2.9

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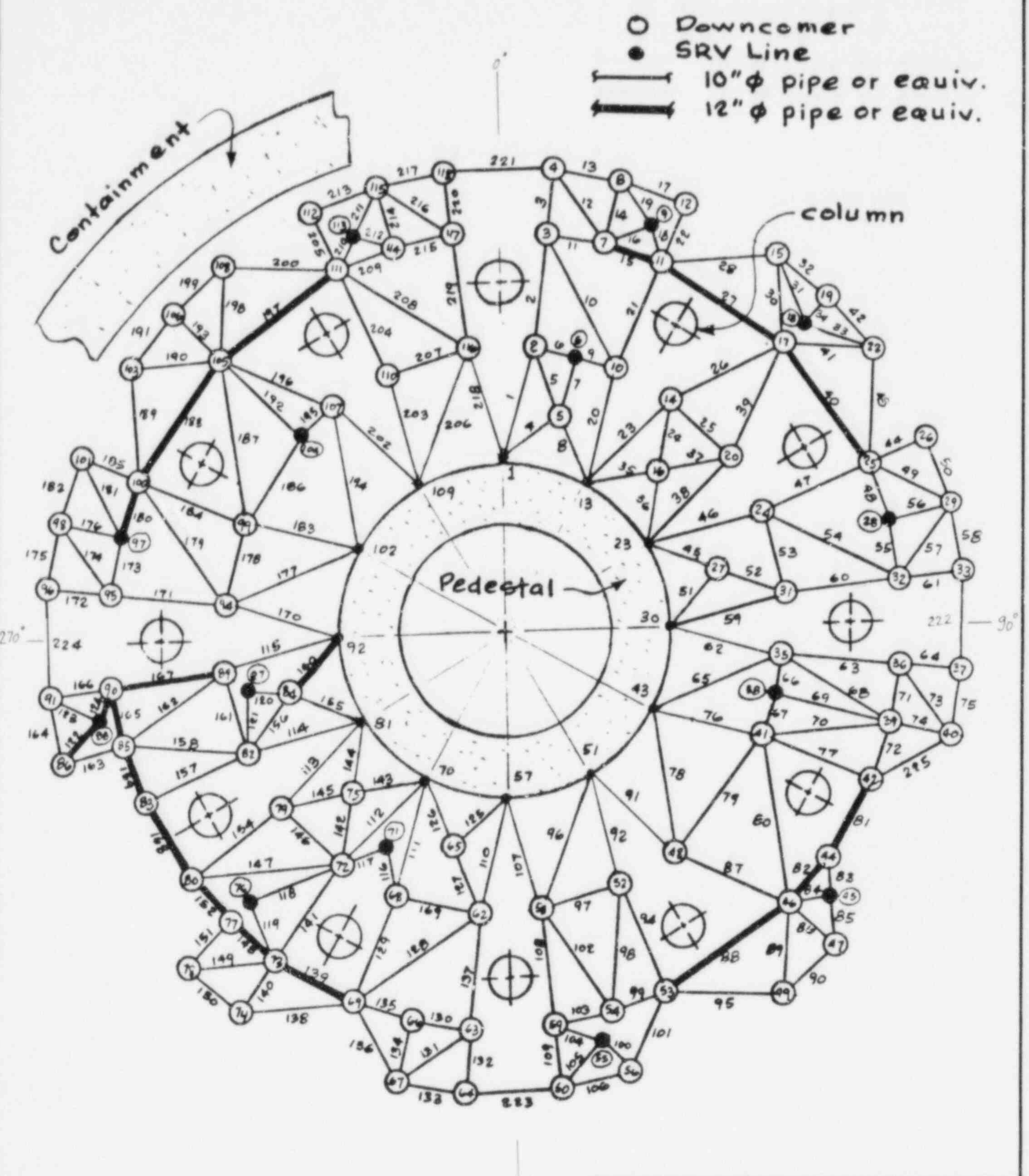

LIMERICK GENERATING STATION
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DESIGN ASSESSMENT REPORT

DOWNCOMER BRACING
MATHEMATICAL MODEL

FIGURE D.2-10 REV 1, 09/82

DOWNCOMER BRACING SYSTEM - STRESS SUMMARY

BRACING MEMBER DESIGN MARGINS FOR CRITICAL MEMBERS AND GOVERNING LOAD COMBINATION

QUADRANT(2)	MEMBER(2)	EQUATION(1)	MARGIN - %
1	58	7	5%
2	75	7	6%
3	126	7	5%
4	217	7	4%
Link between Quadrants	221	7	3%

NOTES: (1) Equation number is based on Table 5.3-1

(2) Figure D.2-10 gives location reference

LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

DOWNCOMER BRACING SYSTEM
DESIGN MARGIN

FIGURE D.2-11

REV. 1, 09/82

APPENDIX E

REACTOR ENCLOSURE AND CONTROL STRUCTURE STRUCTURAL DESIGN ASSESSMENT

TABLE OF CONTENTS

APPENDIX E

FIGURES

APPENDIX E

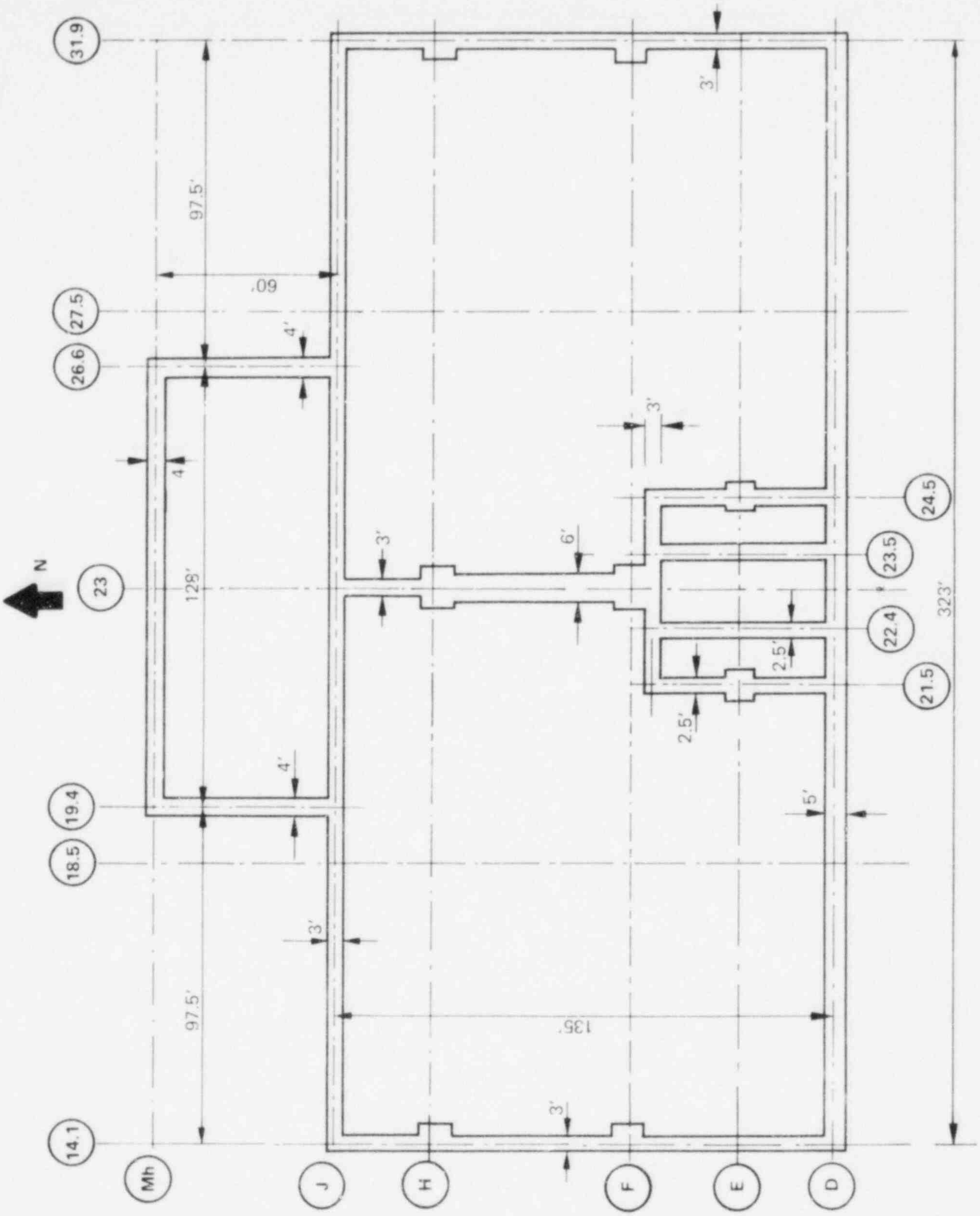
E.1 REACTOR ENCLOSURE AND CONTROL STRUCTURE STRUCTURAL DESIGN ASSESSMENT

Figure E.1-1 presents the reactor enclosure and control structure general floor plan at El. 177 ft to aid in the location of wall marks.

Figures E.1-2 through E.1-21 identify and locate the selected critical structural elements where stresses are assessed in the reactor enclosure and control structure.

Figures E.1-22 through E.1-31 present diagrams of combined vertical (axial) forces, N-S and E-W shear forces, and N-S and E-W overturning moments, based on the dynamic portion of the load combinations specified in Tables 5.2-1 and 5.3-1.

Figures E.1-32 through E.1-39 contain tabulations of predicted stresses, stress allowables, and/or stress margins for the reactor enclosure and control structure floor slabs, floor support steel, and shear walls.



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UNITS 1 AND 2
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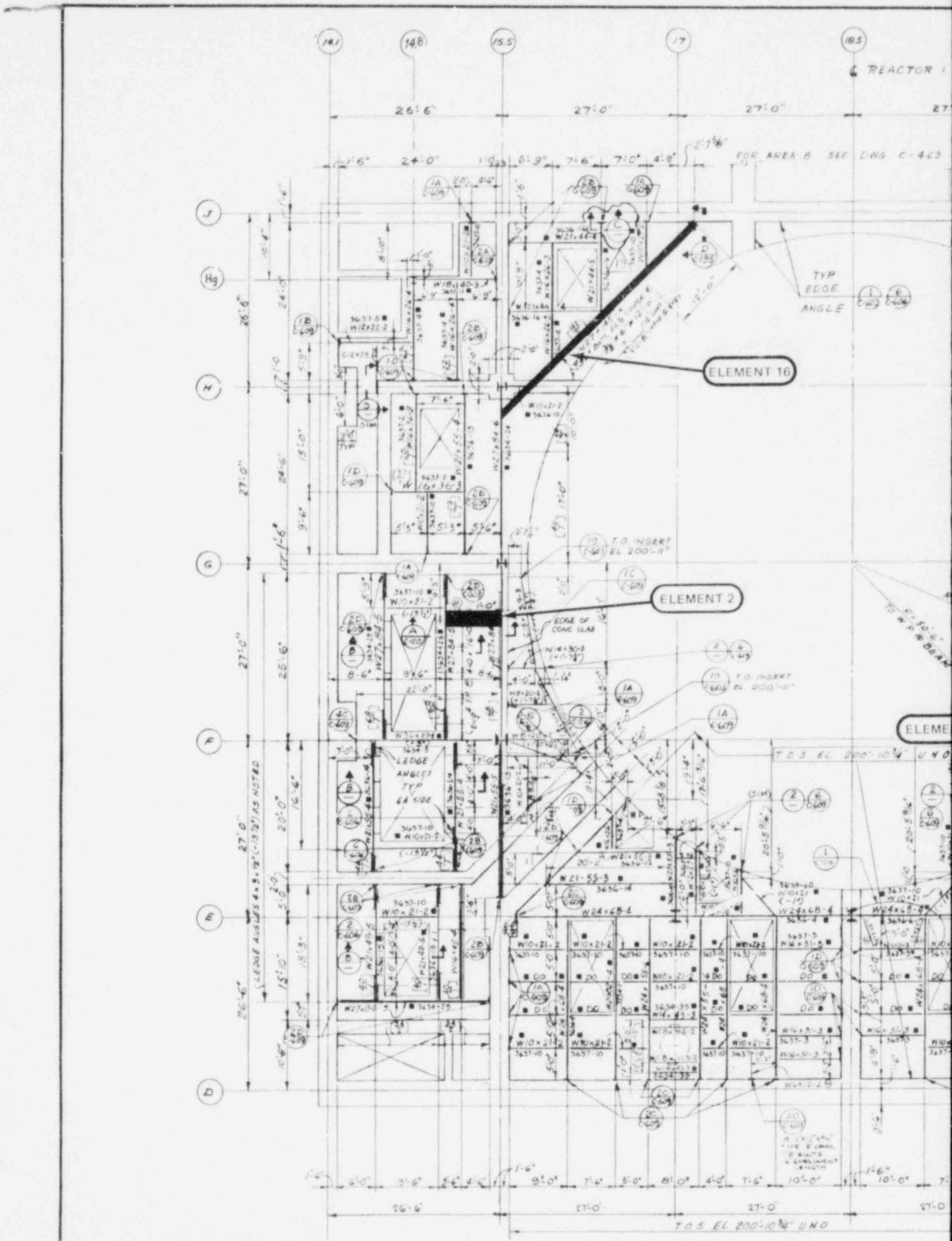
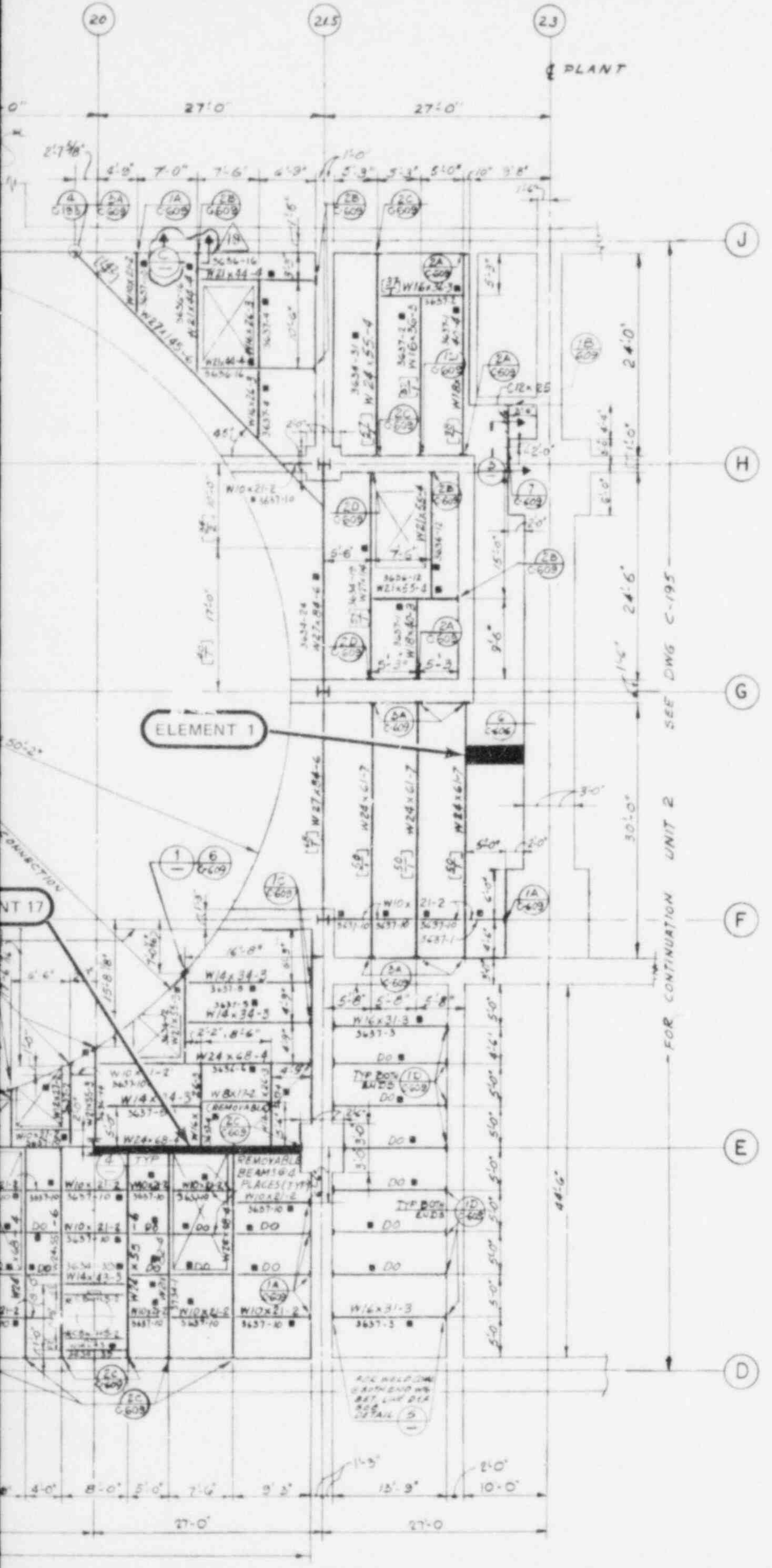
REACTOR ENCLOSURE & CONTROL STRUCTURE FLOOR PLAN AT ELEVATION 177 FT.

FIGURE E.1-1

REV. 10, 09/82


14.1
14.8
15.5
17
18.5
℄ REACTOR
26'-6"
27'-0"
27'-0"
FOR AREA B SEE DWG C-463
J
Hg
H
G
F
E
D
TYP EDGE ANGLE
ELEMENT 16
ELEMENT 2
ELEME
EDGE OF CONC SLAB
T.O. INSERT EL 200'-11"
T.O. INSERT EL 200'-8"
LEDGE ANGLES TYP EA SIDE
LEDGE ANGLES 4×3×½" (-13½") AS NOTED
TOS EL 200'-10¾" UNO
W24×68-4
W21×55-3
W10×21-2
W16×36-3
W27×94-6
26'-6"
27'-0"
27'-0"
TOS EL 200'-10¾" UNO

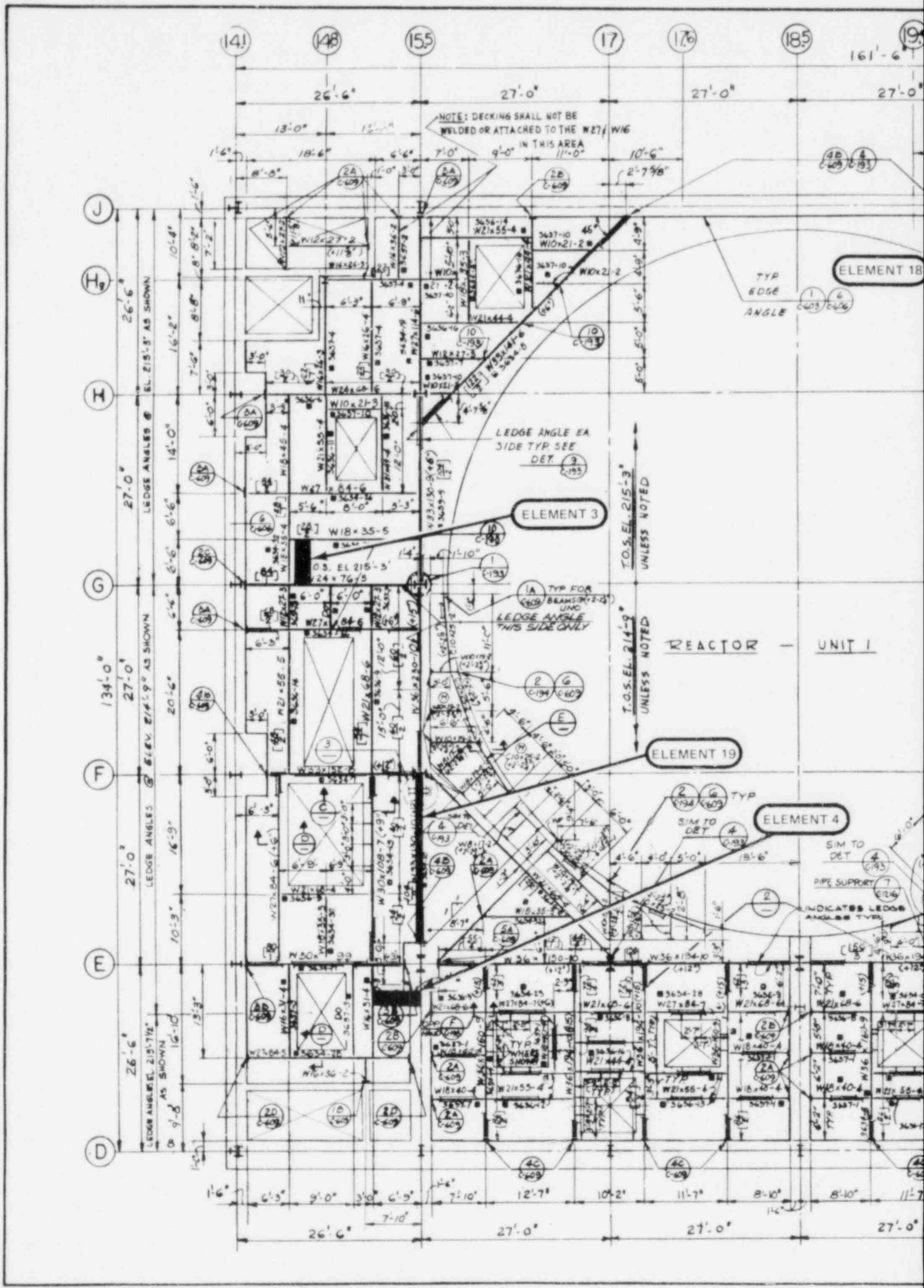


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

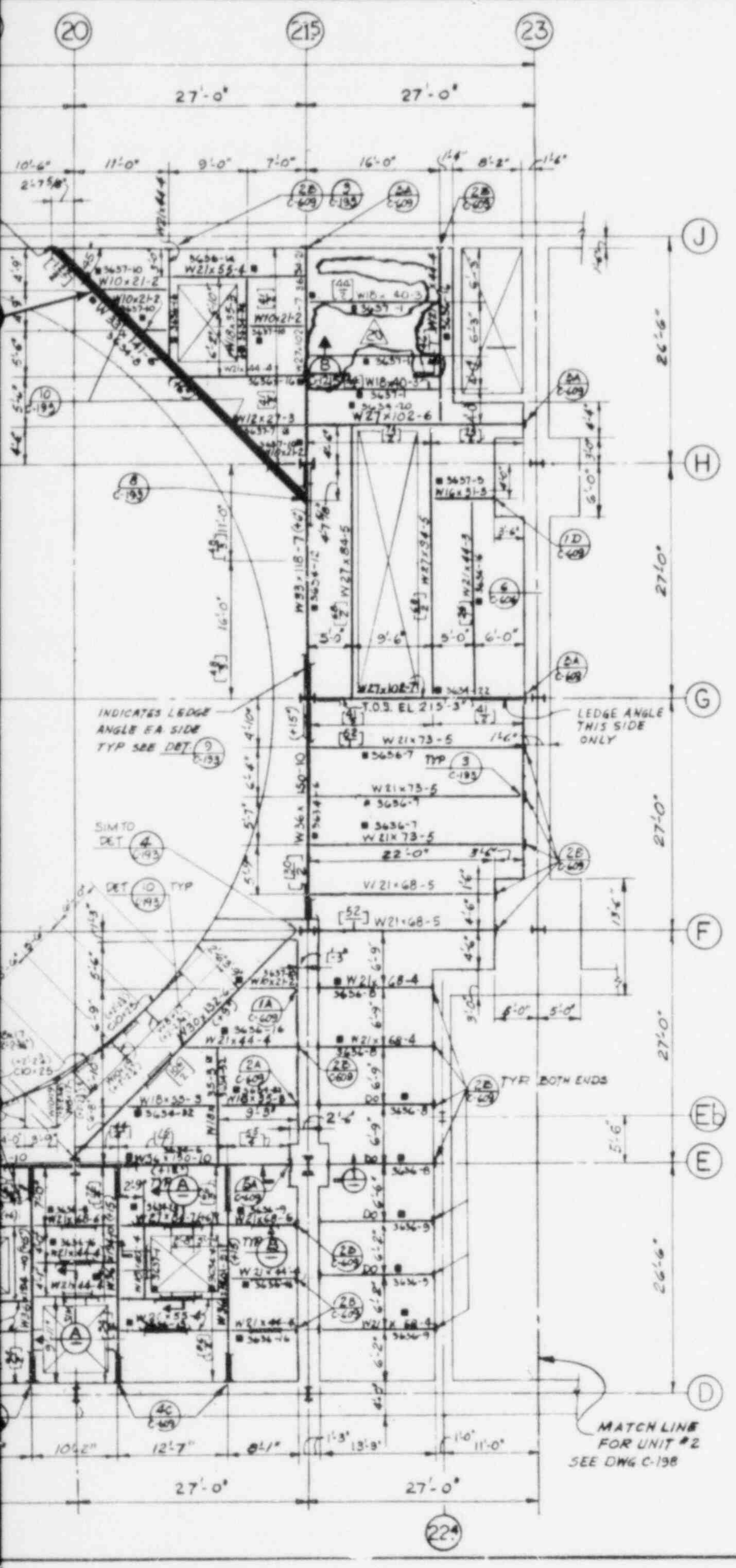
REACTOR ENCLOSURE
STEEL FRAMING PLAN
EL. 201'

FIGURE E.1-2

REV. 1, 09/82



(14.1)
(14.8)
(15.5)
(17)
(17.6)
(18.5)
161'-6"
26'-6"
27'-0"
27'-0"
27'-0"
13'-0"
12'-0"
NOTE: DECKING SHALL NOT BE WELDED OR ATTACHED TO THE W27/W16 IN THIS AREA
1'-6"
18'-6"
6'-6"
7'-0"
9'-0"
11'-0"
10'-6"
8'-8"
11'-0"
3'-0"
2'-7 5/8"
J
Hg
H
G
F
E
D
26'-6"
27'-0"
134'-0"
27'-0"
27'-0"
26'-6"
LEDGE ANGLES @ EL. 215'-3" AS SHOWN
LEDGE ANGLES @ ELEV. 214'-9" AS SHOWN
LEDGE ANGLES @ EL. 215'-7 1/2" AS SHOWN
W12x27-2
W10x21-2
W21x55-4
W10x21-2
W21x44-4
W33x141-6
W18x27-3
W24x68-6
W10x21-3
W21x55-4
W18x45-4
W27x84-6
W18x35-5
W24x76-5
W27x84-6
W21x55-5
W21x68-6
W36x230-10A
W33x130-9
W30x108-7
W27x84-6
W30x99
W16x31-4
W16x36-2
W23x84-5
W36x150-10
W36x134-10
W21x65-6
W27x84-7
W21x68-6
W18x40-4
W21x55-4
W18x40-4
W18x35-5
ELEMENT 18
TYP EDGE ANGLE
ELEMENT 3
T.O.S. EL 215'-3"
LEDGE ANGLE EA SIDE TYP. SEE DET.
T.O.S. EL 215'-3" UNLESS NOTED
TYP FOR BEAMS @ (+2'-2") UNO
LEDGE ANGLE THIS SIDE ONLY
REACTOR — UNIT 1
T.O.S. EL 214'-9" UNLESS NOTED
ELEMENT 19
ELEMENT 4
SIM TO DET
SIM TO DET
TYP
PIPE SUPPORT
INDICATES LEDGE ANGLES TYP.
TYP WHERE SHOWN
1'-6"
6'-3"
9'-0"
3'-0"
6'-9"
7'-10"
12'-7"
10'-2"
11'-7"
8'-10"
8'-10"
26'-6"
7'-10"
27'-0"
27'-0"
27'-0"

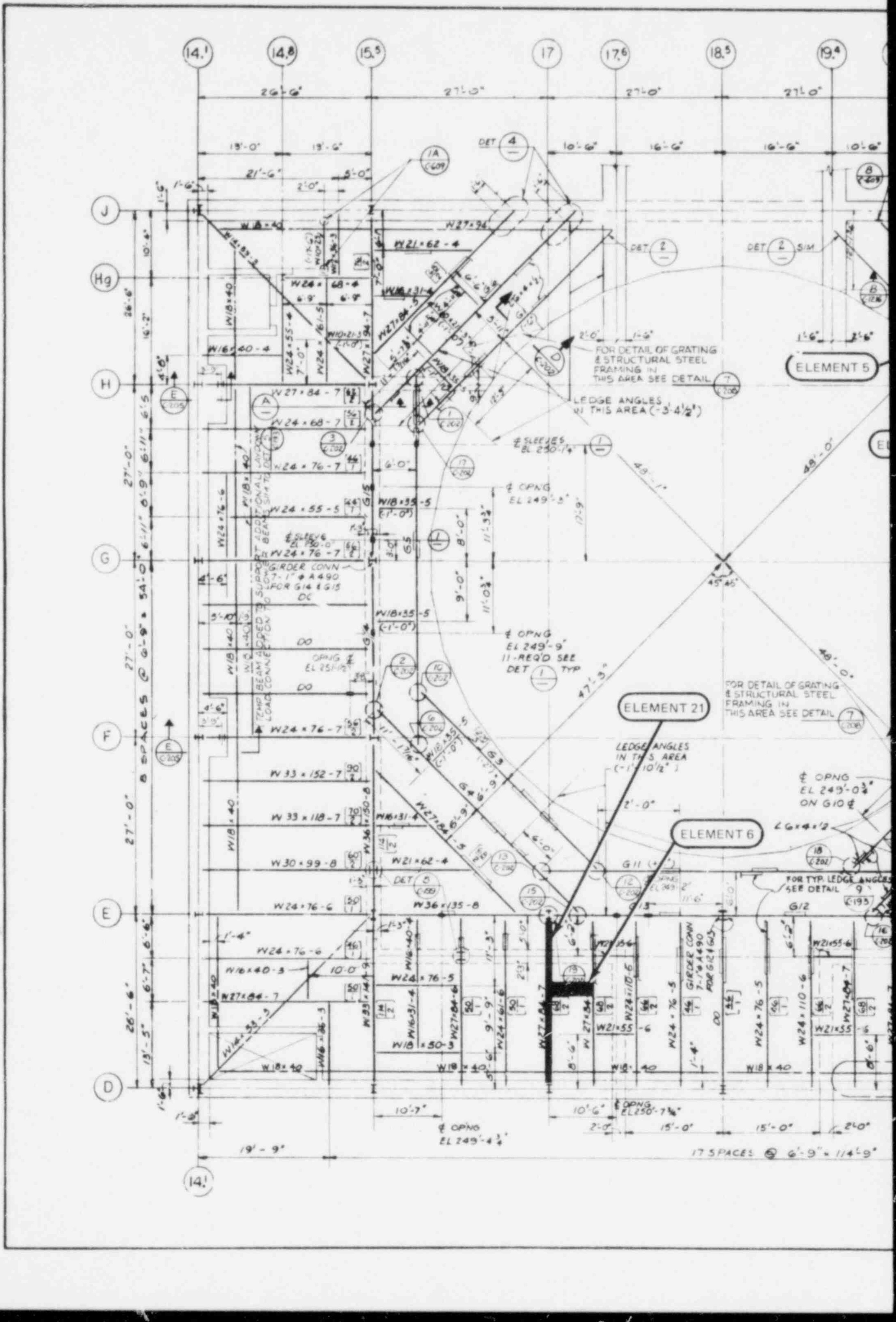


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

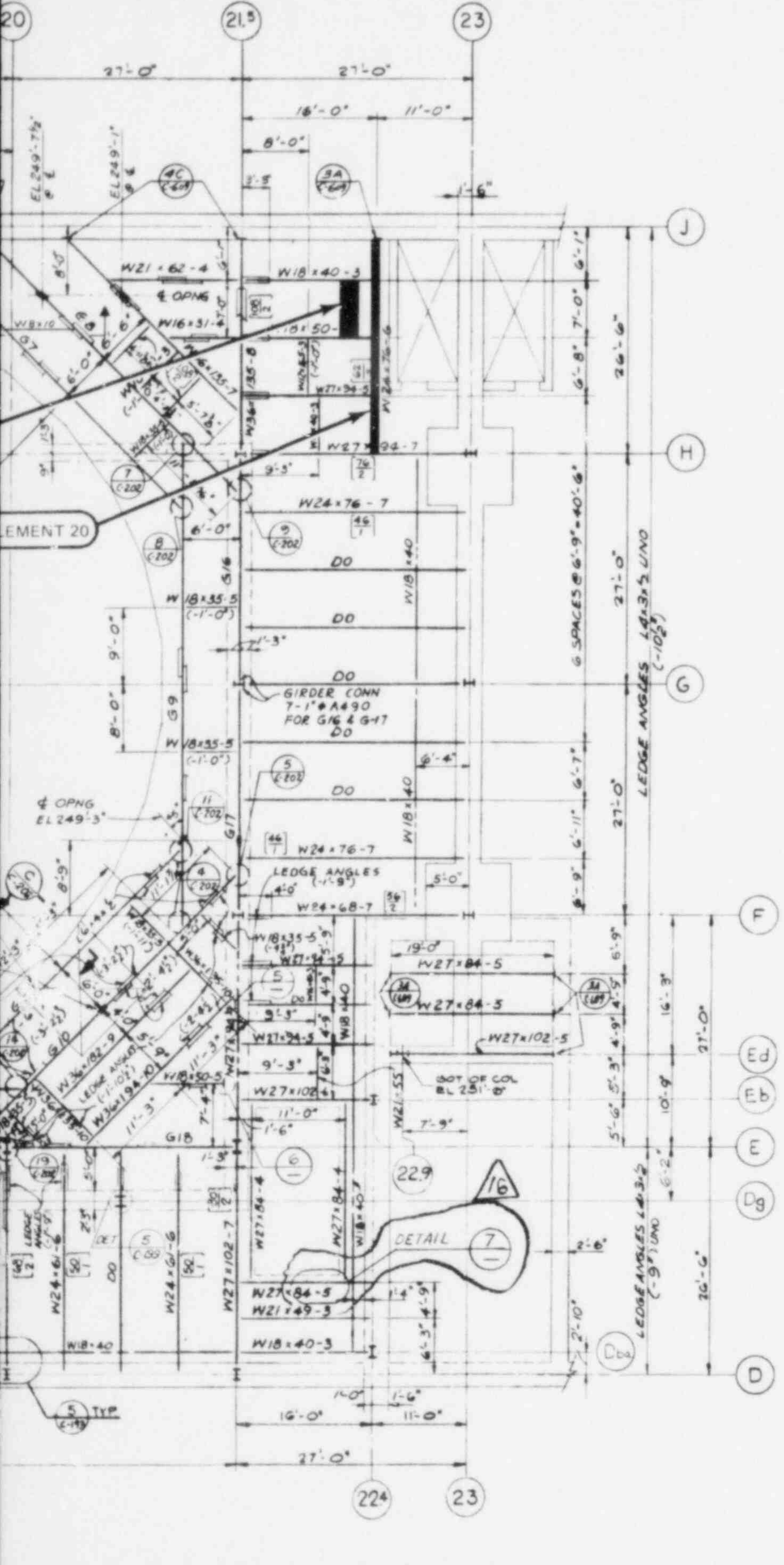
REACTOR ENCLOSURE
STEEL FRAMING PLAN
EL. 217'

FIGURE E.1-3

REV. 1, 09/82



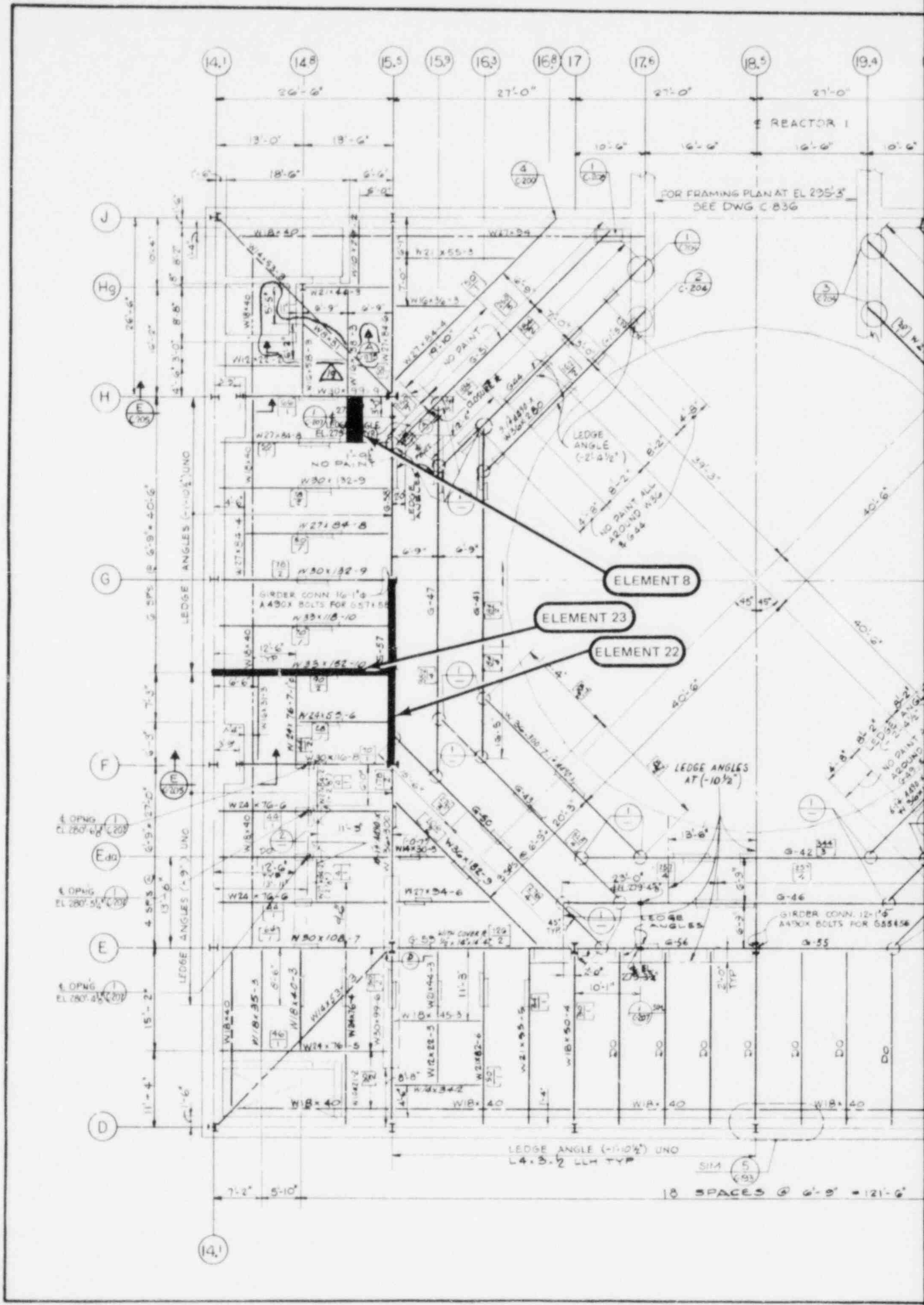
14.1
14.8
15.5
17
17.6
18.5
19.4
J
Hg
H
G
F
E
D
ELEMENT 5
ELEMENT 21
ELEMENT 6
8 SPACES @ 6'-9" = 54'-0"
17 SPACES @ 6'-9" = 114'-9"
FOR DETAIL OF GRATING & STRUCTURAL STEEL FRAMING IN THIS AREA SEE DETAIL 7 C-208
LEDGE ANGLES IN THIS AREA (-3'-4½")
LEDGE ANGLES IN THIS AREA (-1'-10½")
℄ SLEEVES EL 250'-1¼"
℄ OPNG EL 249'-3"
℄ OPNG EL 249'-9" 11-REQ'D SEE DET 1 TYP
℄ OPNG EL 249'-0¾" ON G10 ℄
℄ OPNG EL 249'-4¾"
℄ OPNG EL 250'-7¾"
GIRDER CONN 7-1" ⌀ A490 FOR G14 & G15
GIRDER CONN 7-1" ⌀ A490 FOR G12 & G13
TEMP BEAM ADDED TO SUPPORT ADDITIONAL LOAD CONNECTION TO ... SIM TO DET
FOR TYP. LEDGE ANGLES SEE DETAIL 9 C-193
W24×76-7
W33×152-7
W33×118-7
W30×99-8
W24×76-6
W36×135-8
W27×84-7
W24×68-7
W24×55-5
W18×35-5
W21×62-4
W18×40
W16×40-4
W16×40-3
W27×94
W21×55-6
W24×110-6
W18×50-3
49'-0"
47'-3"
49'-1"
45° 45°

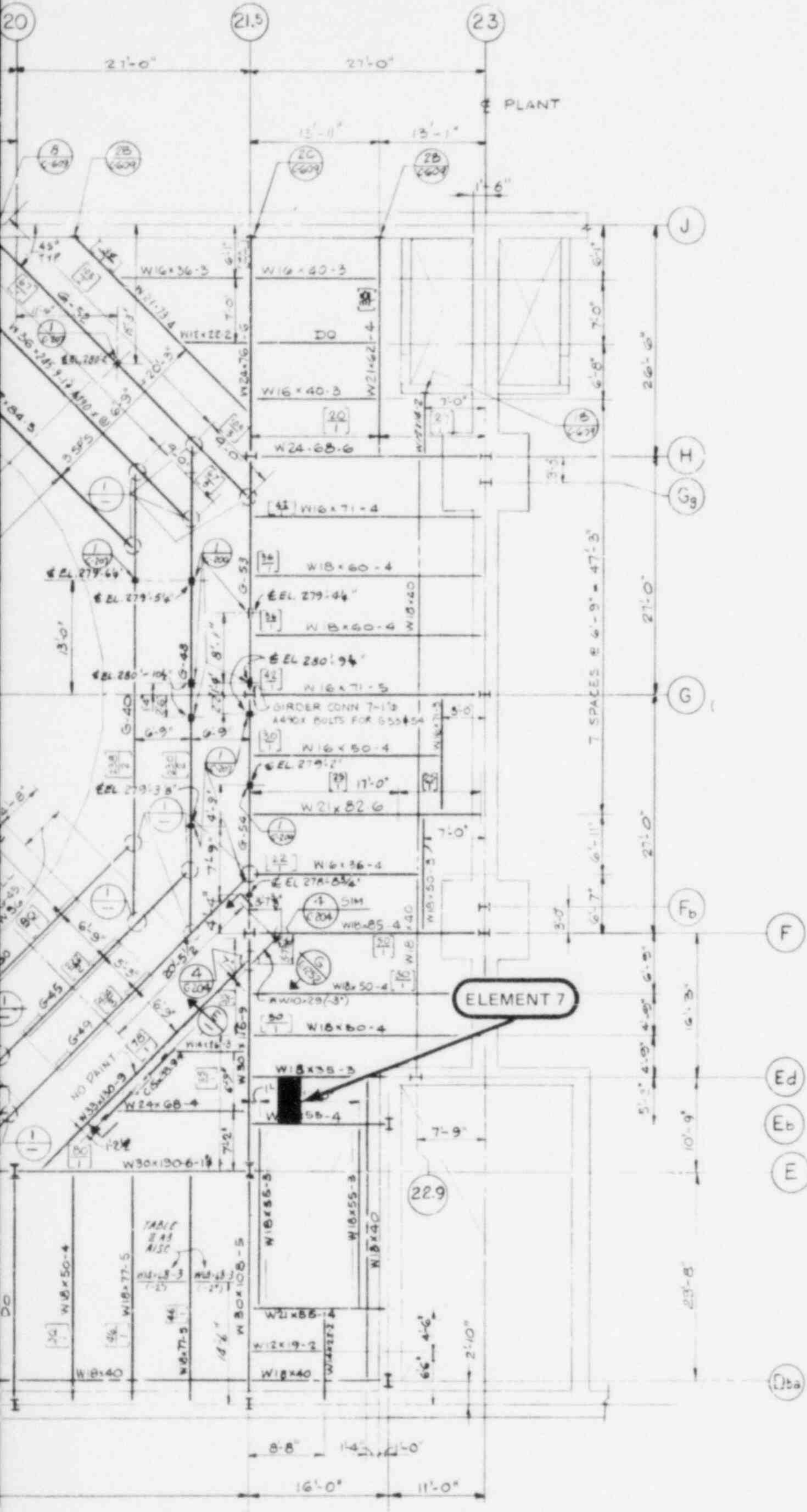


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE
STEEL FRAMING PLAN
EL. 253'

FIGURE E.1-4 REV. 1, 09/82

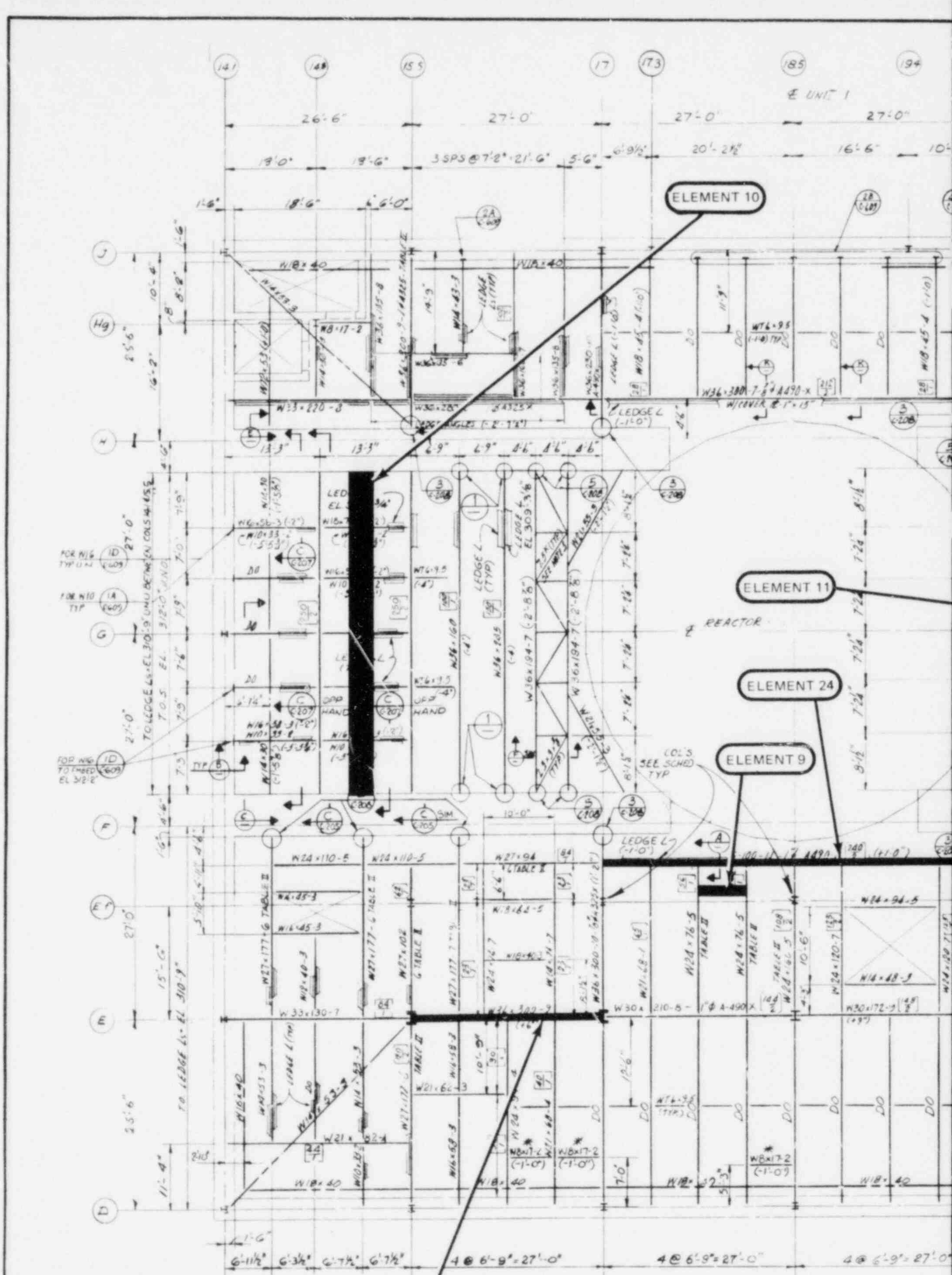

ELEMENT 8
ELEMENT 23
ELEMENT 22
14.1
14.8
15.5
15.9
16.3
16.8
17
17.6
18.5
19.4
J
Hg
H
G
F
Eda
E
D
℄ REACTOR 1
FOR FRAMING PLAN AT EL 235'-3"
SEE DWG C 836
26'-6"
27'-0"
13'-0"
18'-6"
10'-6"
16'-6"
LEDGE ANGLE (-2'-4½")
NO PAINT
NO PAINT ALL AROUND W36 & G44
LEDGE ANGLES (-1'-10½") UNO
GIRDER CONN. 16-1"Ø A490X BOLTS FOR G57 & 58
W33×118-10
W33×152-10
W24×55-6
W30×132-9
W27×84-8
W30×116-8
W24×76-6
W30×108-7
LEDGE ANGLES AT (-10½")
LEDGE ANGLES (+9") UNO
GIRDER CONN. 12-1⅛" A490X BOLTS FOR G55 & 56
G-42
G-46
G-55
G-56
G-57
G-47
G-41
G-43
G-50
40'-6"
W18×40
LEDGE ANGLE (-1'-10½") UNO
L4×3×½ LLH TYP
18 SPACES @ 6'-9" = 121'-6"
℄ OPNG EL 280'-6⅛"
℄ OPNG EL 280'-5¾"
℄ OPNG EL 280'-4⅞"
7'-2"
5'-10"



LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE
STEEL FRAMING PLAN
EL. 283'

FIGURE E.1-5 REV. 1, 09/82

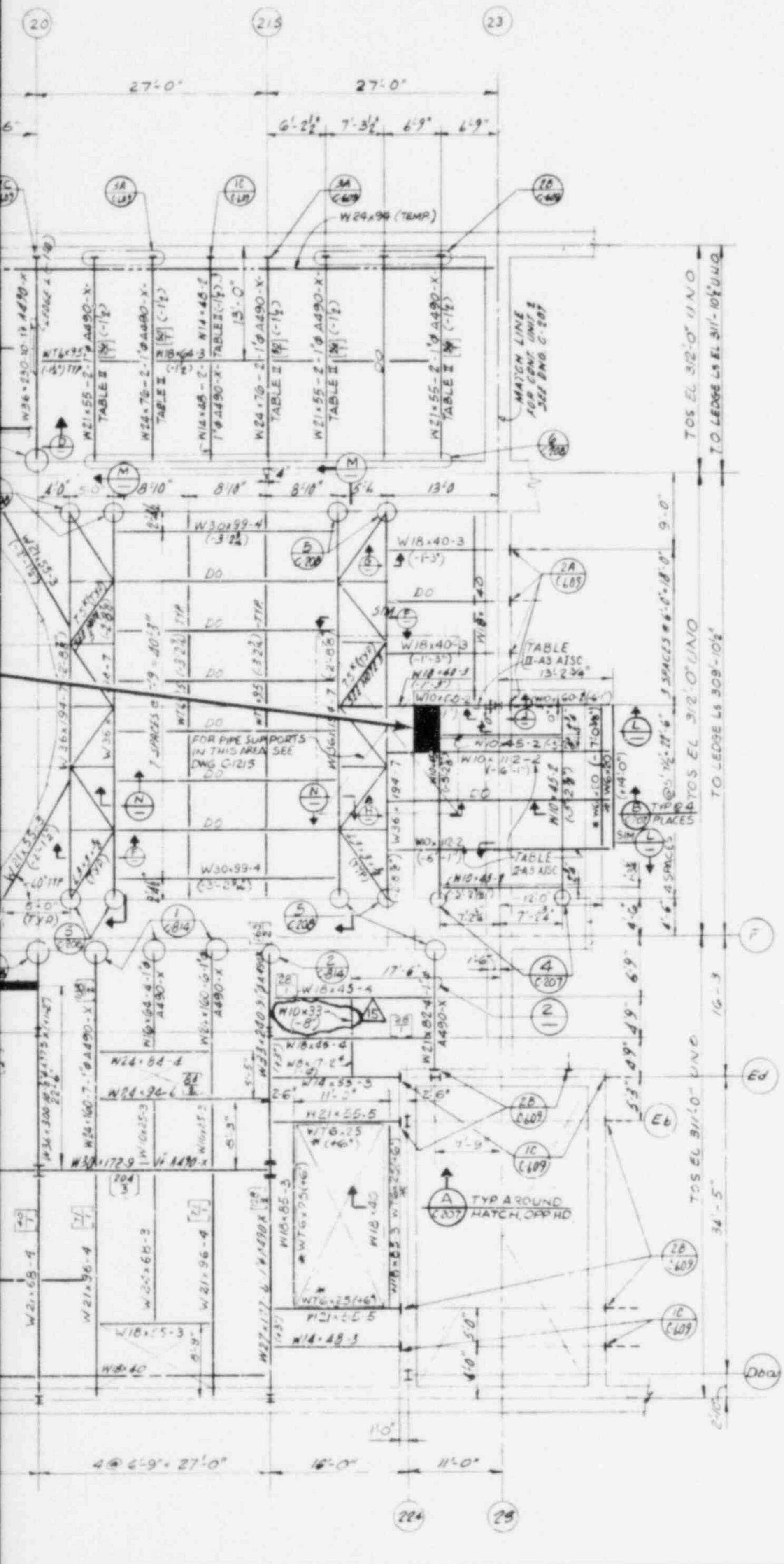

ELEMENT 10

ELEMENT 11

ELEMENT 24

ELEMENT 9

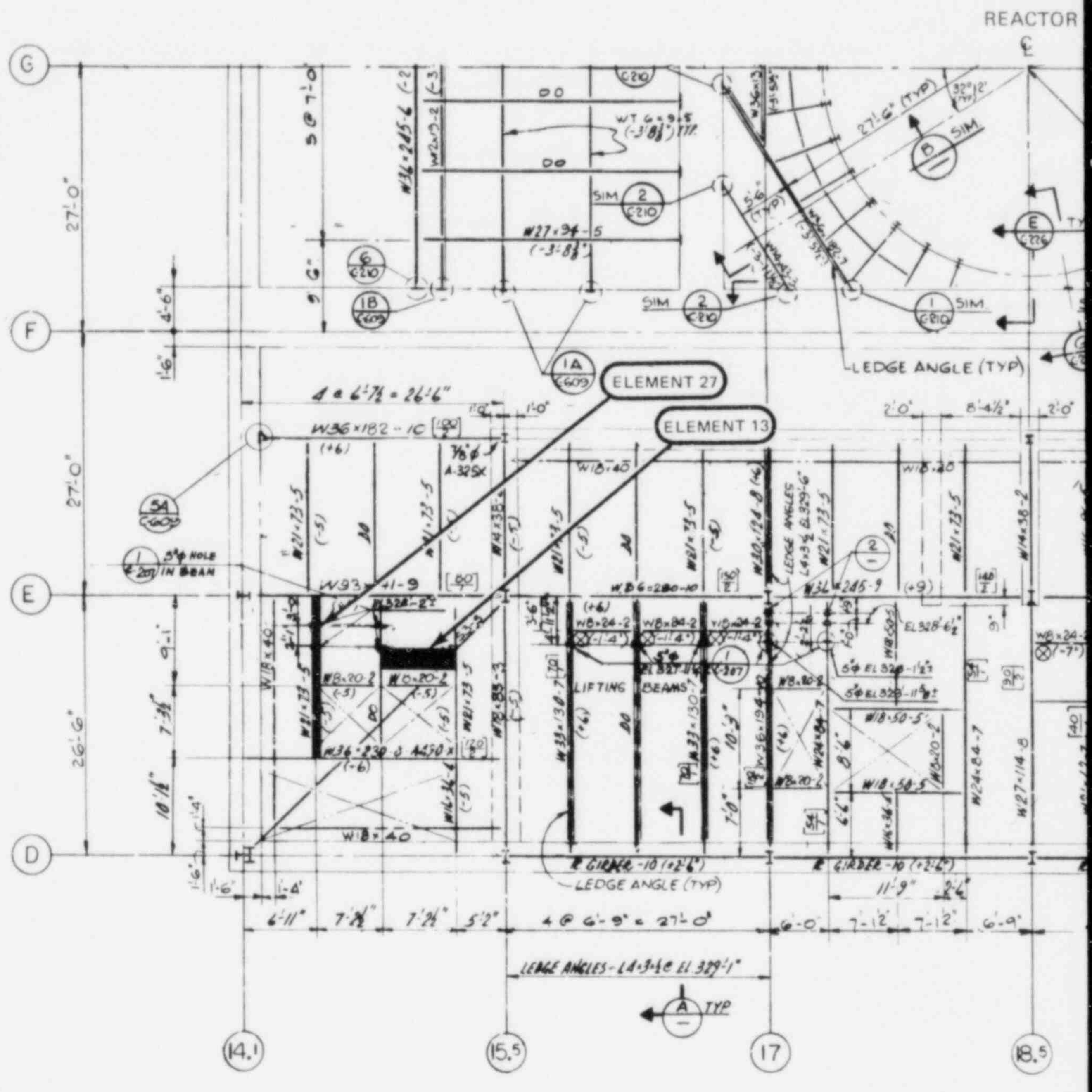
ELEMENT 25

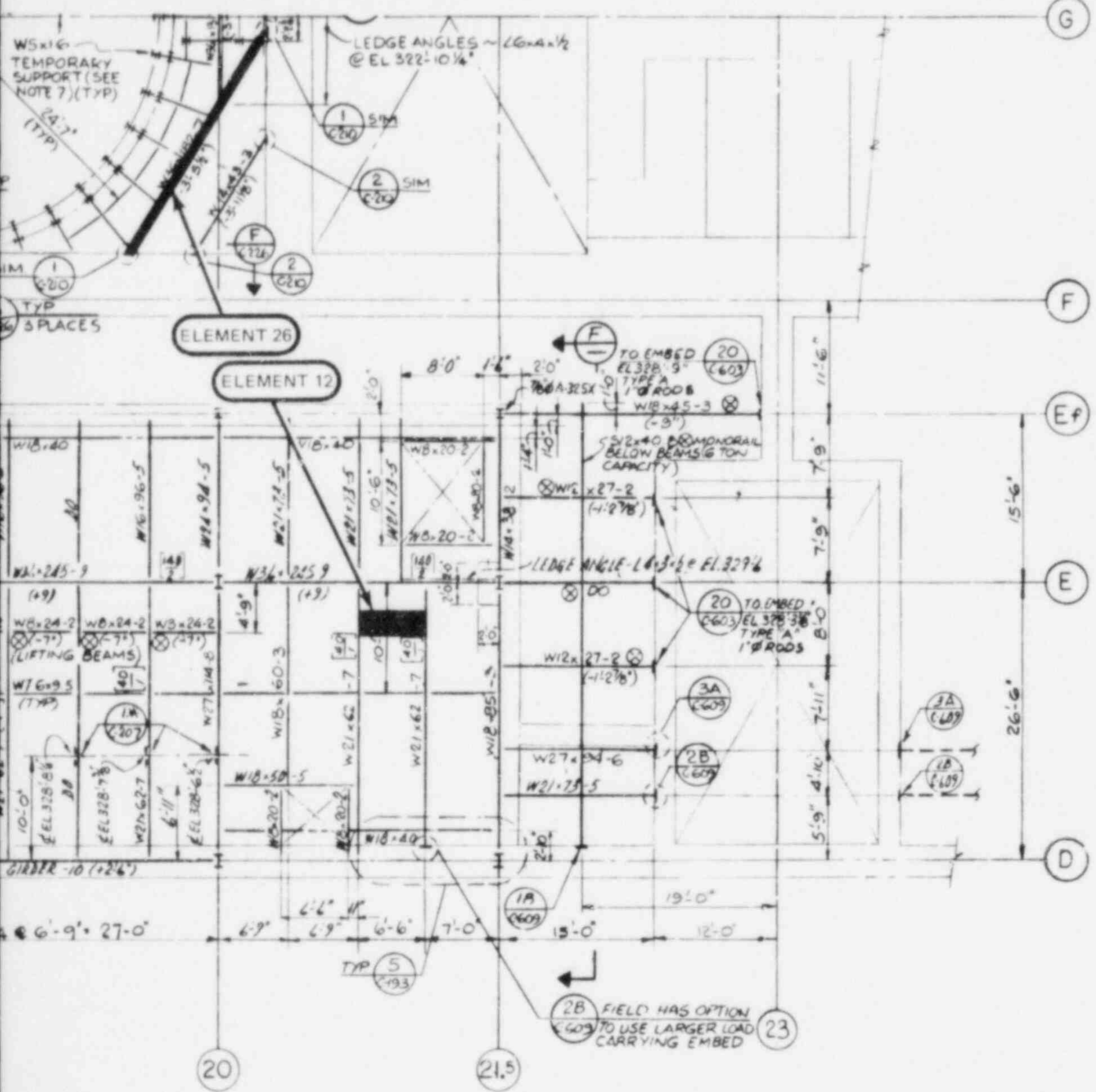


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE
STEEL FRAMING PLAN
EL. 313'

FIGURE E.1-6 REV. 1, 09/82

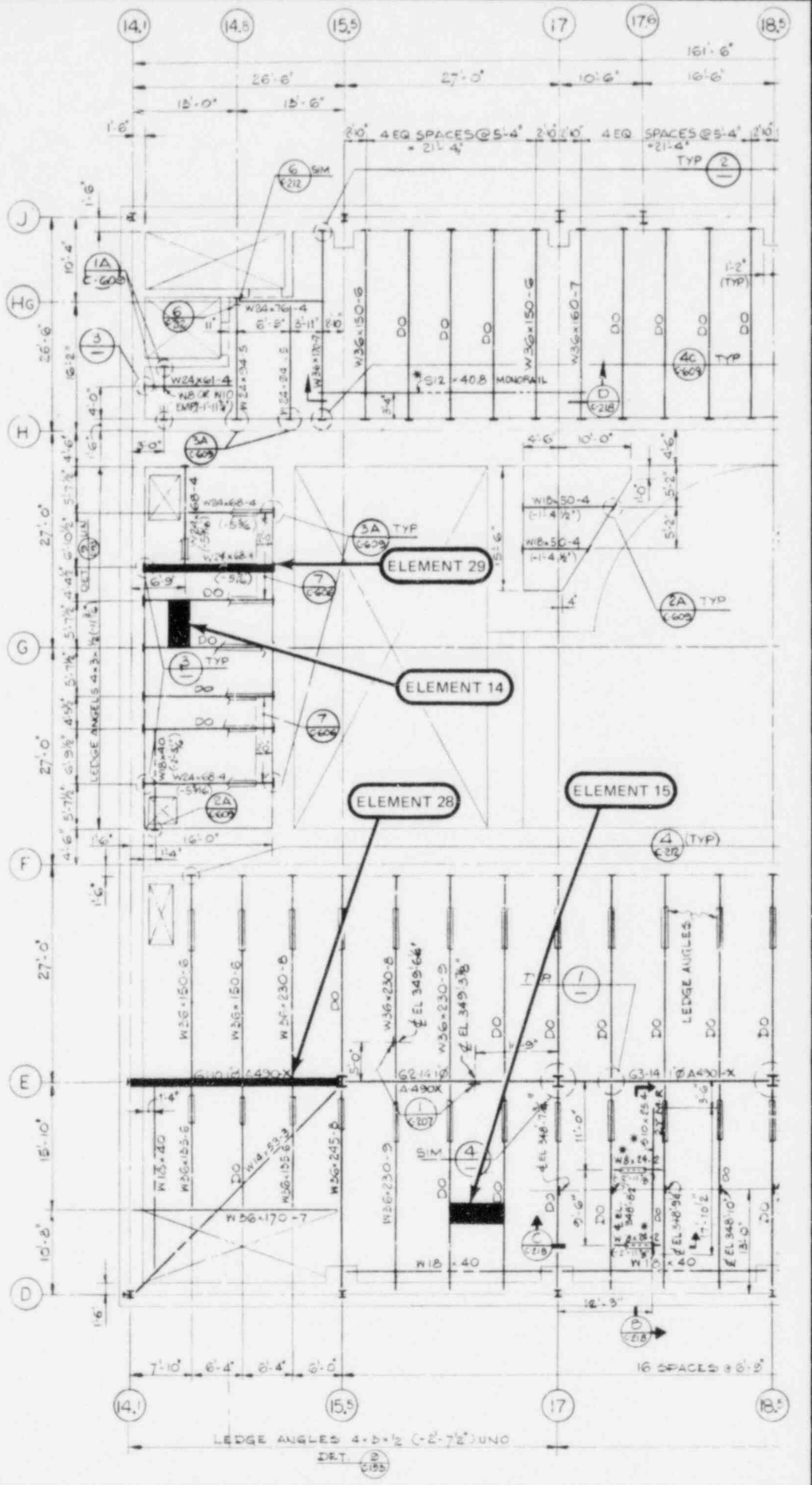

REACTOR
℄
G
F
E
D
14.1
15.5
17
18.5
27'-0"
27'-0"
26'-6"
4'-6"
1'-6"
9'-1"
7'-3½"
10'-1½"
3 @ 7'-0"
9'-6"
ELEMENT 27
ELEMENT 13
LEDGE ANGLE (TYP)
LEDGE ANGLE (TYP)
27'-6" (TYP)
SIM
W36×182 - 1C
W36×245-6
W27×94-5
W36×280-10
W36×230-3
W18×40
LIFTING BEAMS
℄ GIRDER -10 (+2'-6")
℄ GIRDER -10 (+2'-6")
4 @ 6'-7½" = 26'-6"
4 @ 6'-9" = 27'-0"
6'-11"
7'-2½"
7'-2½"
5'-2"
6'-0"
7'-1½"
7'-1½"
6'-9"
11'-9"
1'-6"
1'-4"
2'-0"
8'-4½"
2'-0"
LEDGE ANGLES - L4×3×½ @ EL 329'-1"
A TYP
ELEMENT 27
ELEMENT 13



LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE
STEEL FRAMING PLAN
EL. 331'

FIGURE E.1-7 REV. 1, 09/82

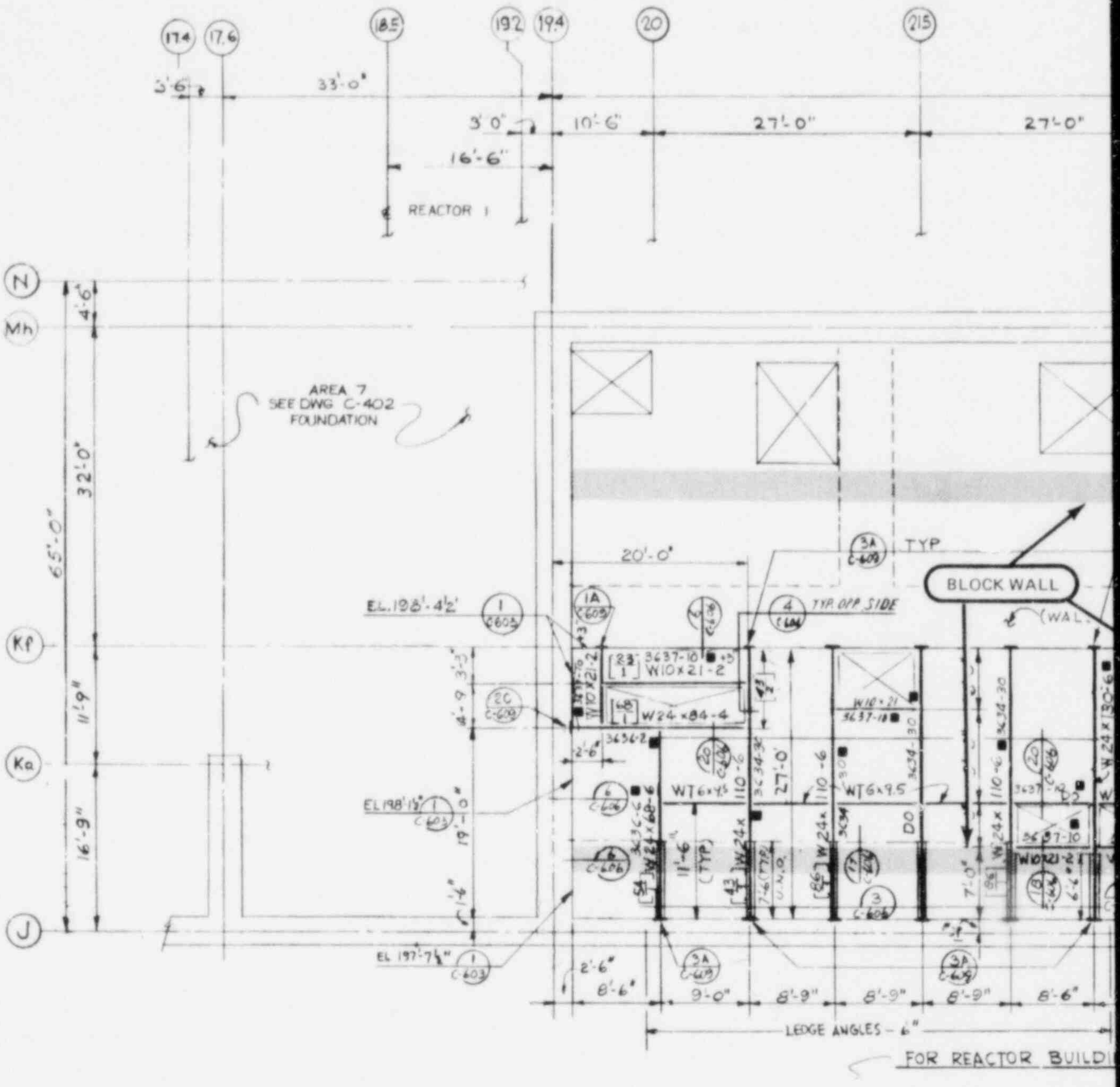

ELEMENT 29
ELEMENT 14
ELEMENT 28
ELEMENT 15
14.1
14.8
15.5
17
17.6
18.5
J
HG
H
G
F
E
D
161'-6"
26'-6"
27'-0"
10'-6"
16'-6"
13'-0"
13'-6"
1'-6"
4 EQ SPACES @ 5'-4" = 21'-4"
TYP
W36×150-6
W36×60-7
DO
S12×40.8 MONORAIL
W24×61-4
W8 OR W10
W24×68-4
W18×50-4
(-1'-4 1/2")
LEDGE ANGLES 4×3×1/2 (-1'-8 1/4")
LEDGE ANGLES
W18×40
W36×230-8
W36×230-9
℄ EL 349'-6 1/4"
℄ EL 349'-3 3/8"
G3-14 1"Ø A490-X
A-490X
W36×135-6
W14×53
W36×155-6
W36×245-6
W36-170-7
W18×40
12'-3"
7'-10"
6'-4"
6'-0"
16 SPACES @ 8'-9"
LEDGE ANGLES 4×3×1/2 (-2'-7 1/2") UNO
DET 2 C155

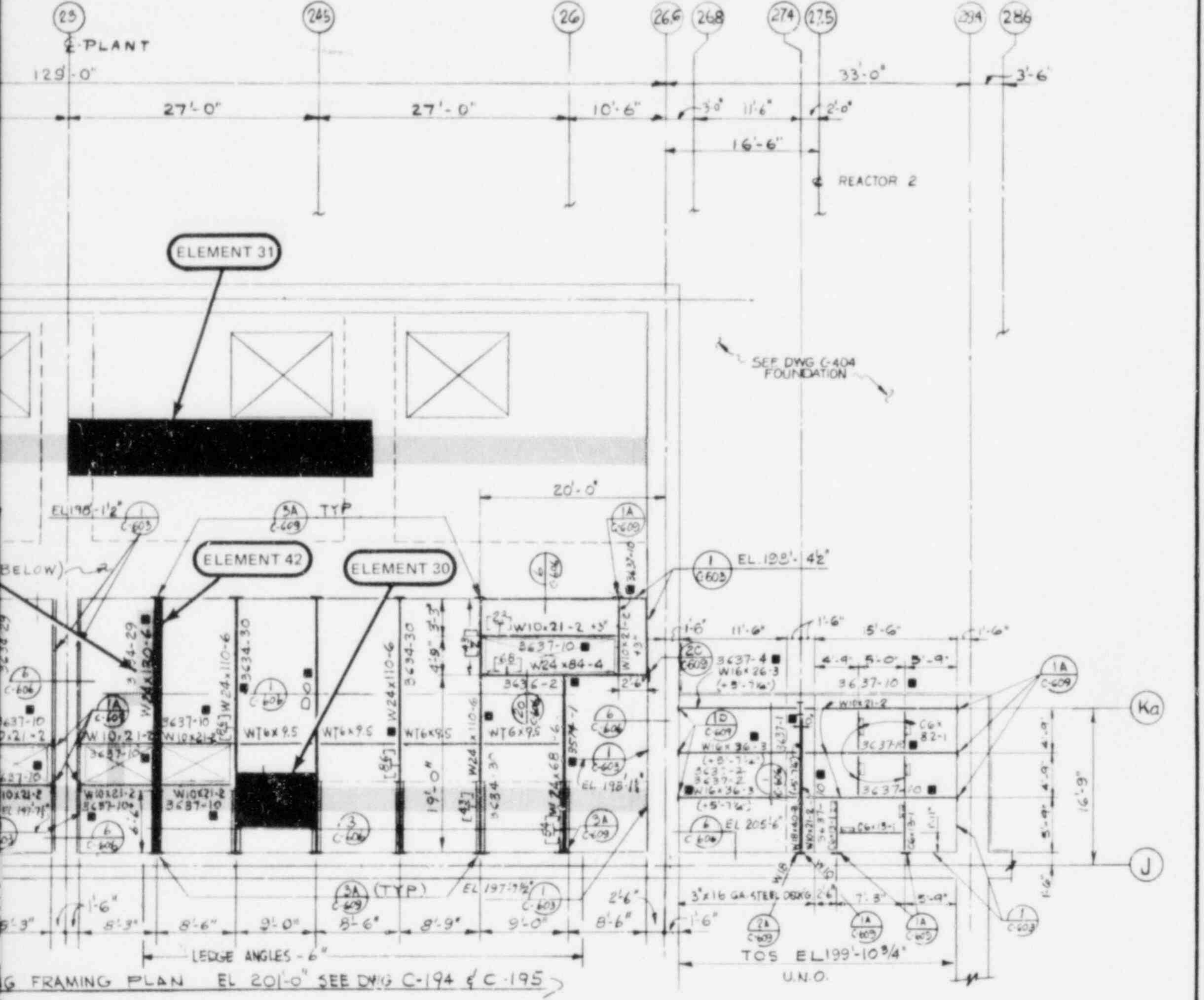
LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE
STEEL FRAMING PLAN
EL. 352'

FIGURE E.1-8

REV. 1, 09/82


17.4
17.6
18.5
19.2
19.4
20
21.5
3'-6"
33'-0"
3'-0"
10'-6"
27'-0"
27'-0"
16'-6"
℄ REACTOR 1
N
Mh
Kf
Ka
J
4'-6"
32'-0"
65'-0"
11'-9"
16'-9"
AREA 7
SEE DWG C-402
FOUNDATION
20'-0"
3A C-609 TYP
BLOCK WALL
(WAL
EL. 198'-4½"
1 C-603
1A C-605
4 C-606 TYP. OPP. SIDE
3637-10
W10x21-2
W24x84-4
W10x21
3637-10
2C C-609
3636-2
WT6x4.5
WT6x9.5
27'-0"
110-6
3634-30
DO
W24x
EL 198'-1½"
1 C-603
6 C-606
11'-6" (TYP)
7'-6" (TYP) U.N.O.
3 C-606
7'-0"
W10x21-2
EL 197'-7½"
1 C-603
3A C-609
3A C-609
2'-6"
8'-6"
9'-0"
8'-9"
8'-9"
8'-9"
8'-6"
LEDGE ANGLES - 6"
FOR REACTOR BUILDI

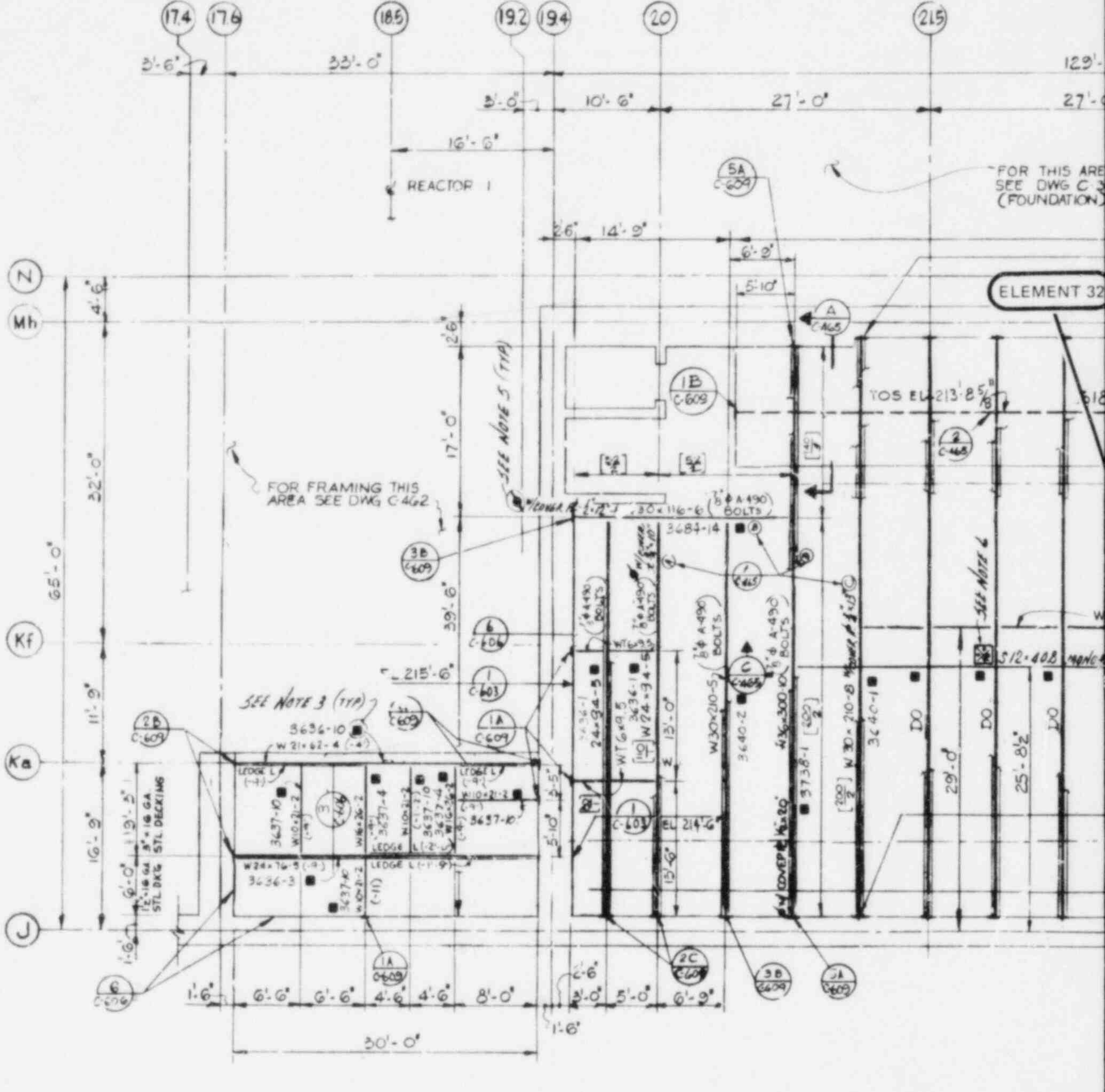


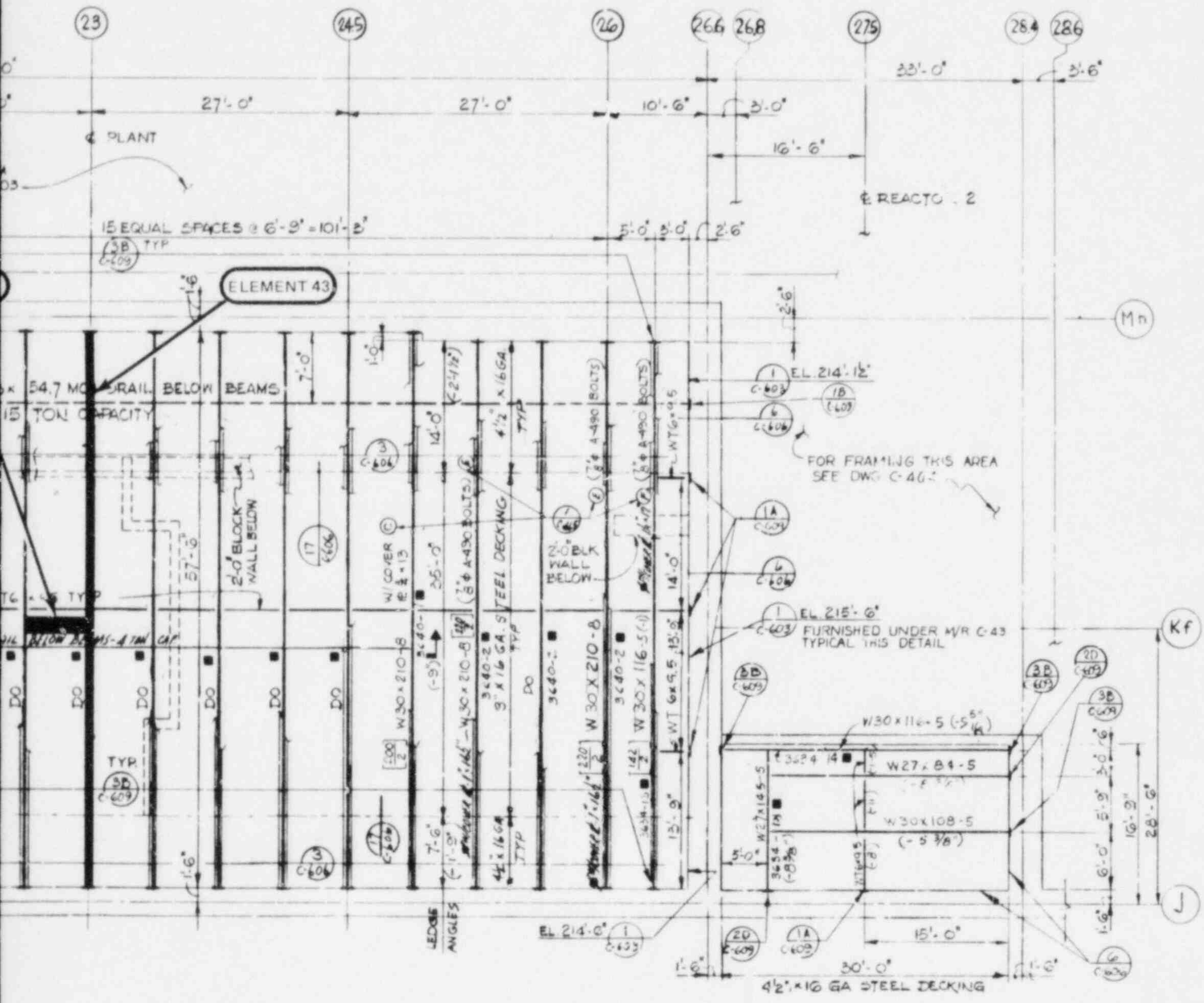
LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTROL STRUCTURE
STEEL FRAMING PLAN
EL. 200'

FIGURE E.1-9

REV. 1, 09/82

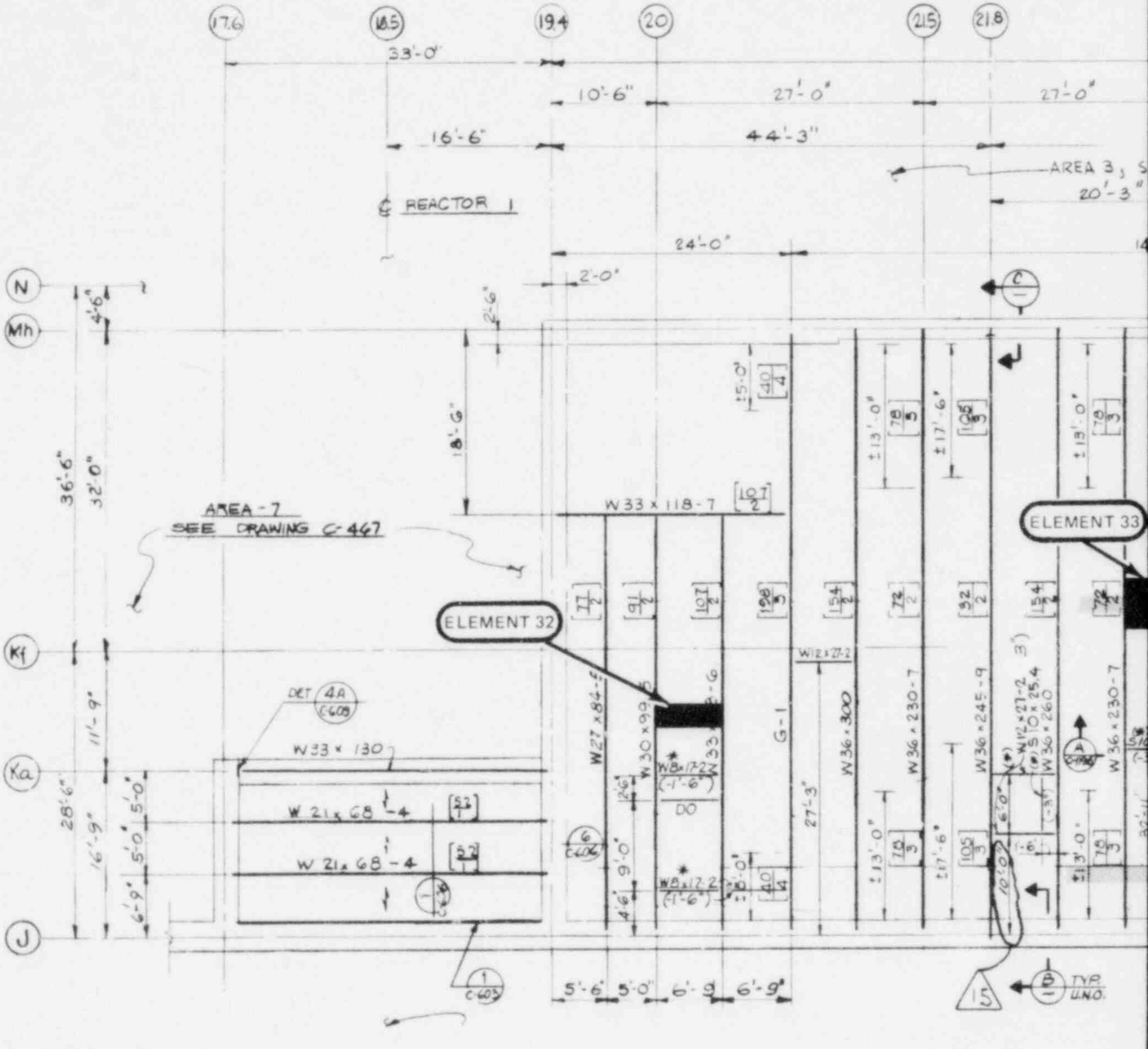

17.4
17.6
18.5
19.2
19.4
20
21.5
3'-6"
33'-0"
3'-0"
10'-6"
27'-0"
27'-
129'-
16'-6"
REACTOR 1
FOR THIS ARE
SEE DWG C-3
(FOUNDATION)
2'-6"
14'-9"
6'-9"
5'-10"
ELEMENT 32
N
Mh
Kf
Ka
J
4'-6"
32'-0"
65'-0"
11'-9"
16'-9"
13'-5"
6'-0"
1'-9"
2'-6"
17'-0"
39'-6"
SEE NOTE 5 (TYP)
FOR FRAMING THIS AREA SEE DWG C-462
TOS EL 213'-8 5/8"
SEE NOTE 6
215'-6"
SEE NOTE 3 (TYP)
3636-10
W 21×62-4
3/4" A-490 BOLTS
3684-14
W30×116-6
3637-10
3636-3
3637-4
W24×76-5
W24×94-5
WT 6×9.5
3636-1
W30×210-5
3640-2
3738-1
W 30×210-8
3640-1
DO
29'-0"
25'-8 1/2"
S12×40.8
EL 214'-6"
13'-0"
13'-6"
5'-10"
3'-5"
LEDGE L
3" × 16 GA STL DECKING
1 1/2" × 16 GA STL DKG
5A C-609
A C-465
1B C-609
3B C-609
6 C-606
1 C-603
1A C-609
2B C-609
2C C-609
3A C-609
C C-465
2 C-465
1'-6"
6'-6"
6'-6"
4'-6"
4'-6"
8'-0"
2'-6"
3'-0"
5'-0"
6'-9"
1'-6"
30'-0"

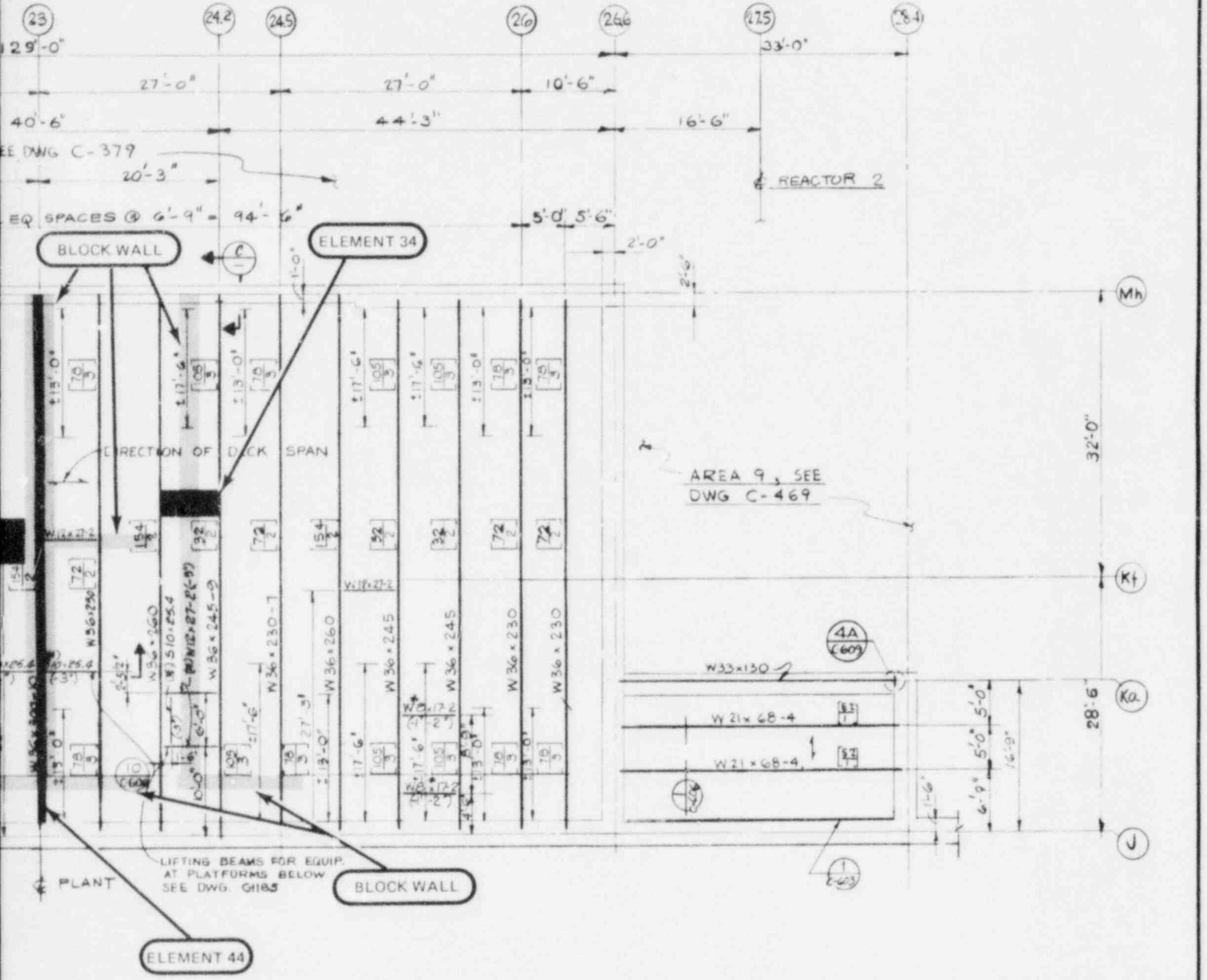


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTROL STRUCTURE
STEEL FRAMING PLAN
EL. 217'

FIGURE E.1-10 REV. 1, 09/82


17.6
18.5
19.4
20
21.5
21.8
33'-0"
10'-6"
27'-0"
27'-0"
16'-6"
44'-3"
AREA 3, S
20'-3"
℄ REACTOR 1
24'-0"
2'-0"
N
Mh
Kf
Ka
J
4'-6"
2'-6"
36'-6"
32'-0"
18'-6"
15'-0"
±13'-0"
±17'-6"
W33 x 118-7
AREA - 7
SEE DRAWING C-467
ELEMENT 32
ELEMENT 33
W12 x 27-2
W27 x 84-4
W30 x 99
W33
G-1
W36 x 300
W36 x 230-7
W36 x 245-9
W36 x 230-7
W12 x 27-2
S10 x 25.4
W36 x 260
DET 4A C-609
W33 x 130
W 21 x 68-4
W 21 x 68-4
11'-9"
28'-6"
16'-9"
5'-0"
5'-0"
6'-9"
W8 x 17-2
(-1'-6")
DO
W8 x 17-2
(-1'-6")
9'-0"
4'-6"
27'-3"
6'-0"
10'-0"
1'-6"
6 C-606
1 C-603
5'-6"
5'-0"
6'-9"
6'-9"
15
B TYP U.N.O.
A
C

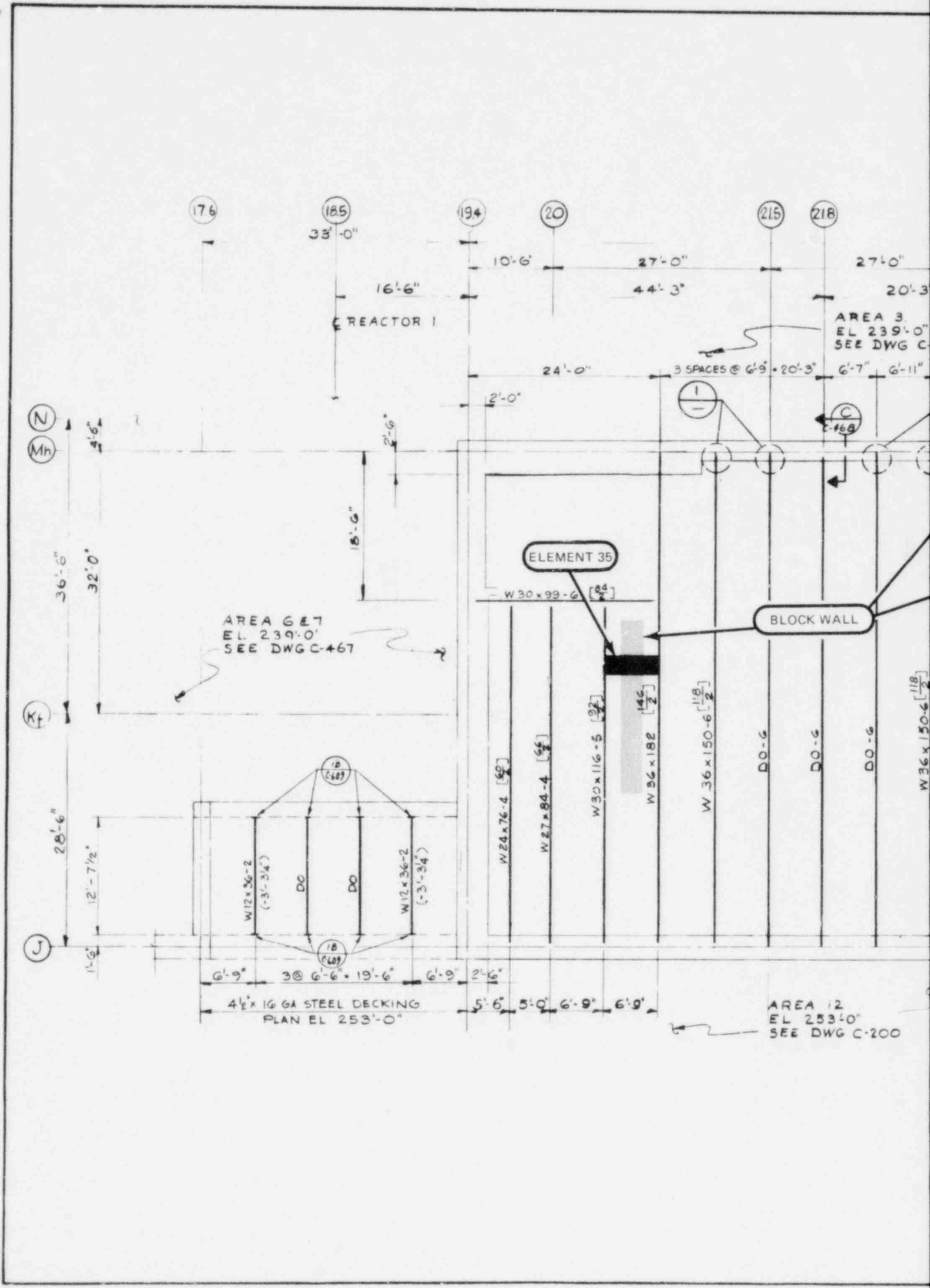


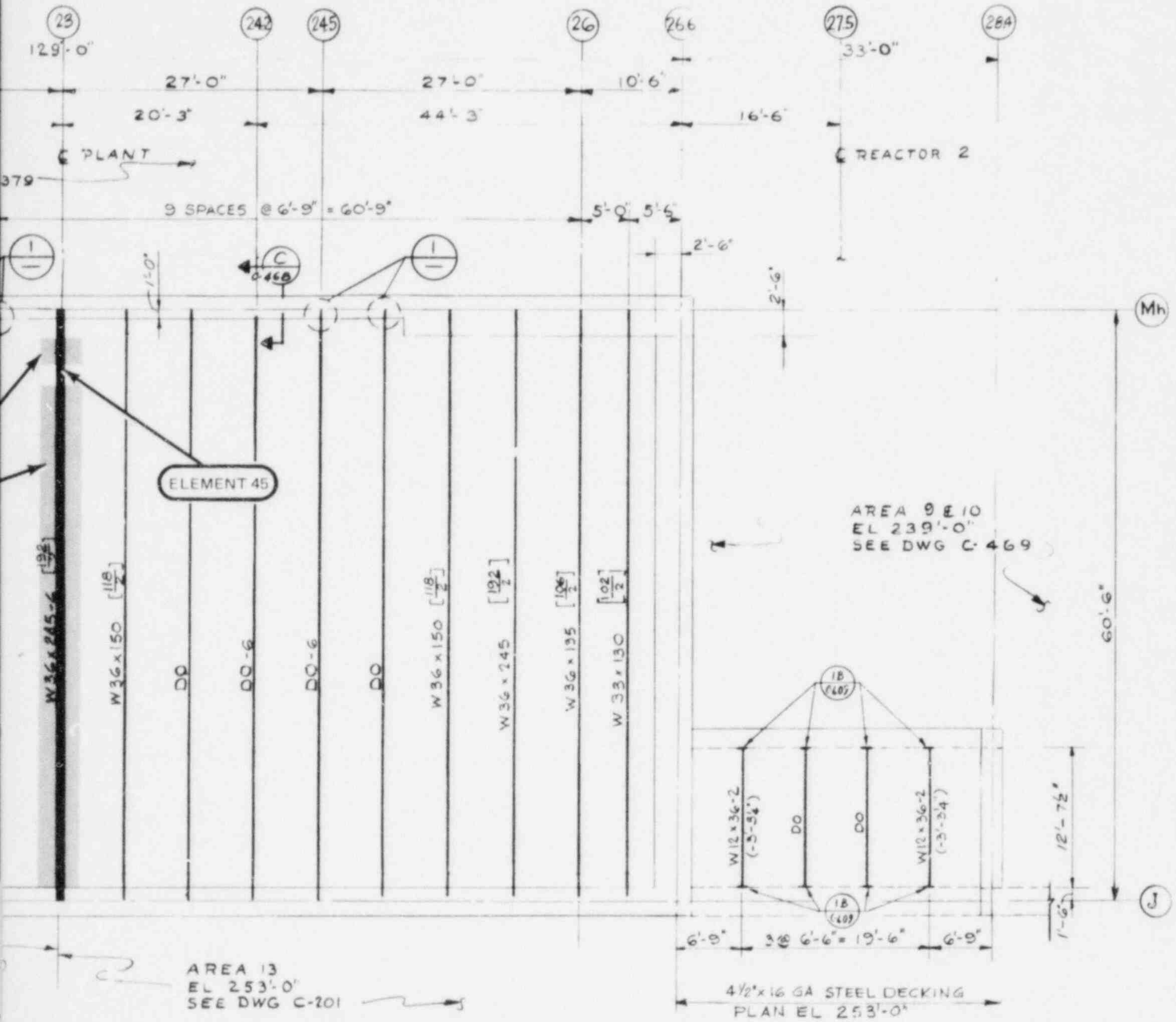
LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTROL STRUCTURE
STEEL FRAMING PLAN
EL. 239'

FIGURE E.1-11

REV. 1, 09/82

17.6
18.5
19.4
20
21.5
21.8
33'-0"
10'-6"
27'-0"
27'-0"
16'-6"
44'-3"
20'-3
℄ REACTOR 1
AREA 3
EL 239'-0"
SEE DWG C-
24'-0"
3 SPACES @ 6'-9" = 20'-3"
6'-7"
6'-11"
2'-0"
1
C
C-468
N
Mn
Kt
J
4'-6"
2'-6"
36'-6"
32'-0"
18'-6"
ELEMENT 35
W 30 x 99 - 6 [84/2]
BLOCK WALL
AREA 6 & 7
EL. 239'-0'
SEE DWG C-467
W24x76-4 [60/2]
W27x84-4 [66/2]
W30x116-5 [92/2]
W 36 x 182 [146/2]
W 36 x 150-6 [118/2]
DO-6
DO-6
DO-6
W 36 x 150-6 [118/2]
18
C-609
28'-6"
12'-7½"
W12 x 36-2 (-3'-3¼")
DO
DO
W12 x 36-2 (-3'-3¼")
18
C-609
1'-9"
6'-9"
3@ 6'-6" = 19'-6"
6'-9"
2'-6"
4½" x 16 GA STEEL DECKING
PLAN EL 253'-0"
5'-6"
5'-0"
6'-9"
6'-9"
AREA 12
EL 253'-0"
SEE DWG C-200

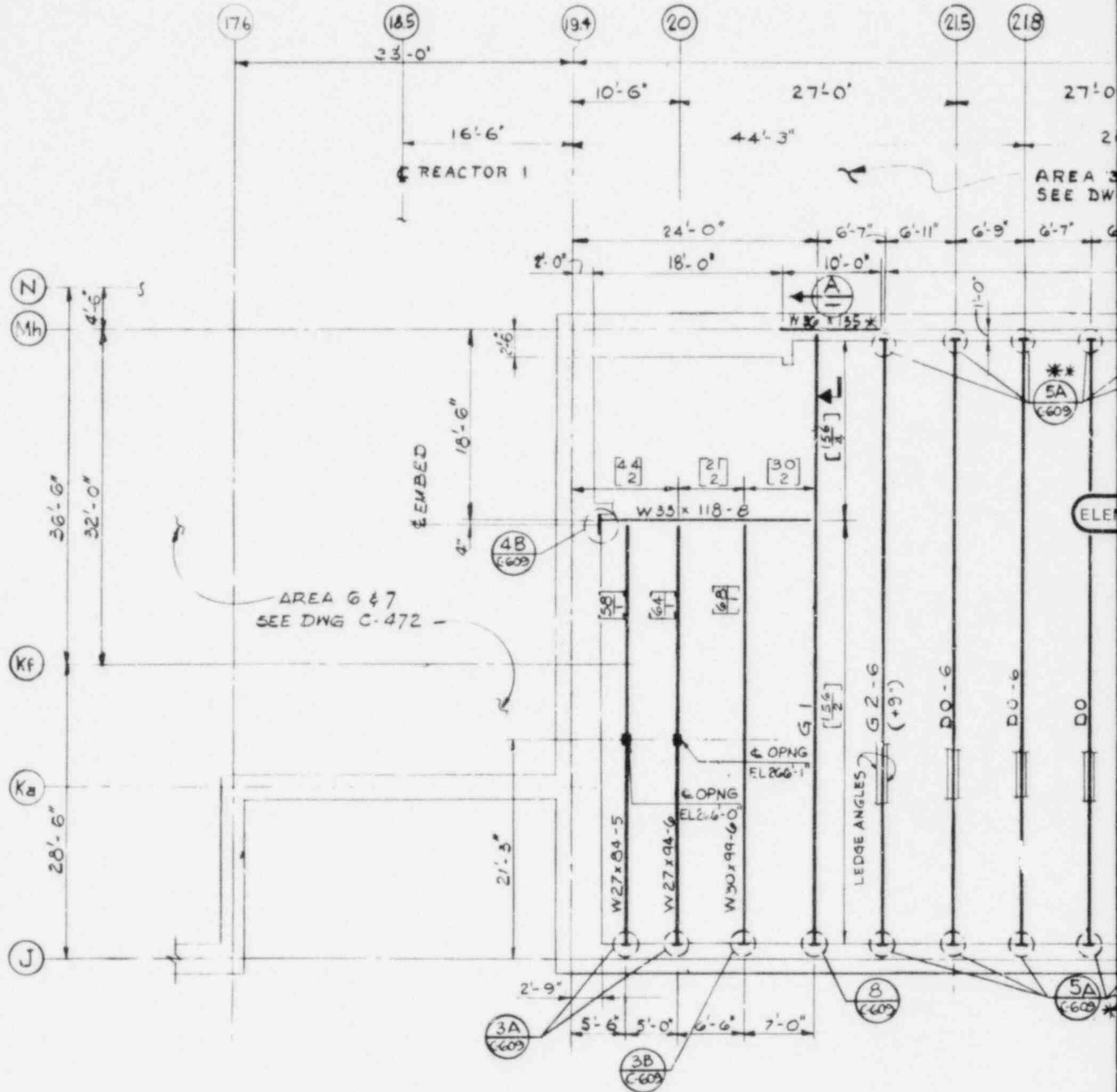


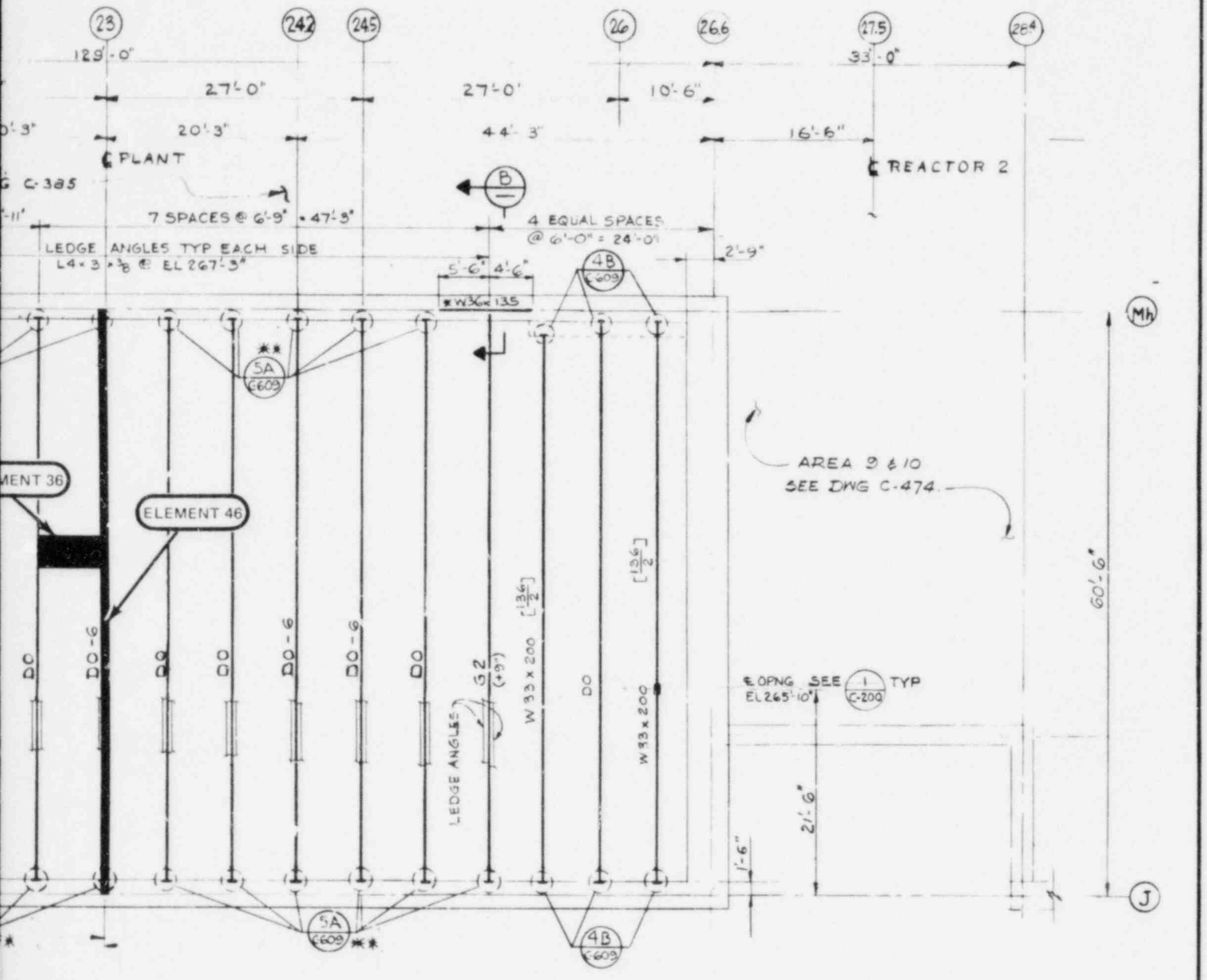
LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTROL STRUCTURE
STEEL FRAMING PLAN
EL. 254'

FIGURE E.1-12

REV. 1, 09/82


176
18.5
19.4
20
21.5
21.8
23'-0"
10'-6"
27'-0"
27'-0
16'-6"
44'-3"
2
℄ REACTOR 1
AREA 3
SEE DW
24'-0"
6'-7"
6'-11"
6'-9"
6'-7"
2'-0"
18'-0"
10'-0"
A
1'-0"
N
Mh
Kf
Ka
J
4'-6"
3'-6"
18'-6"
36'-6"
32'-0"
28'-6"
21'-3"
4"
℄ EMBED
W36 x 135 *
**
5A
C-609
[1.56/4]
[44/2]
[2/2]
[30/2]
W33 x 118-8
ELE
4B
C-609
AREA 6 & 7
SEE DWG C-472
[58/1]
[64/1]
[68/1]
G 1
[1.56/2]
G 2-6
(+9")
DO-6
DO-6
DO
LEDGE ANGLES
℄ OPNG
EL266'-1"
℄ OPNG
EL266'-0"
W27x84-5
W27x94-6
W30x99-6
2'-9"
5'-6"
5'-0"
6'-6"
7'-0"
3A
C-609
3B
C-609
8
C-609
5A
C-609

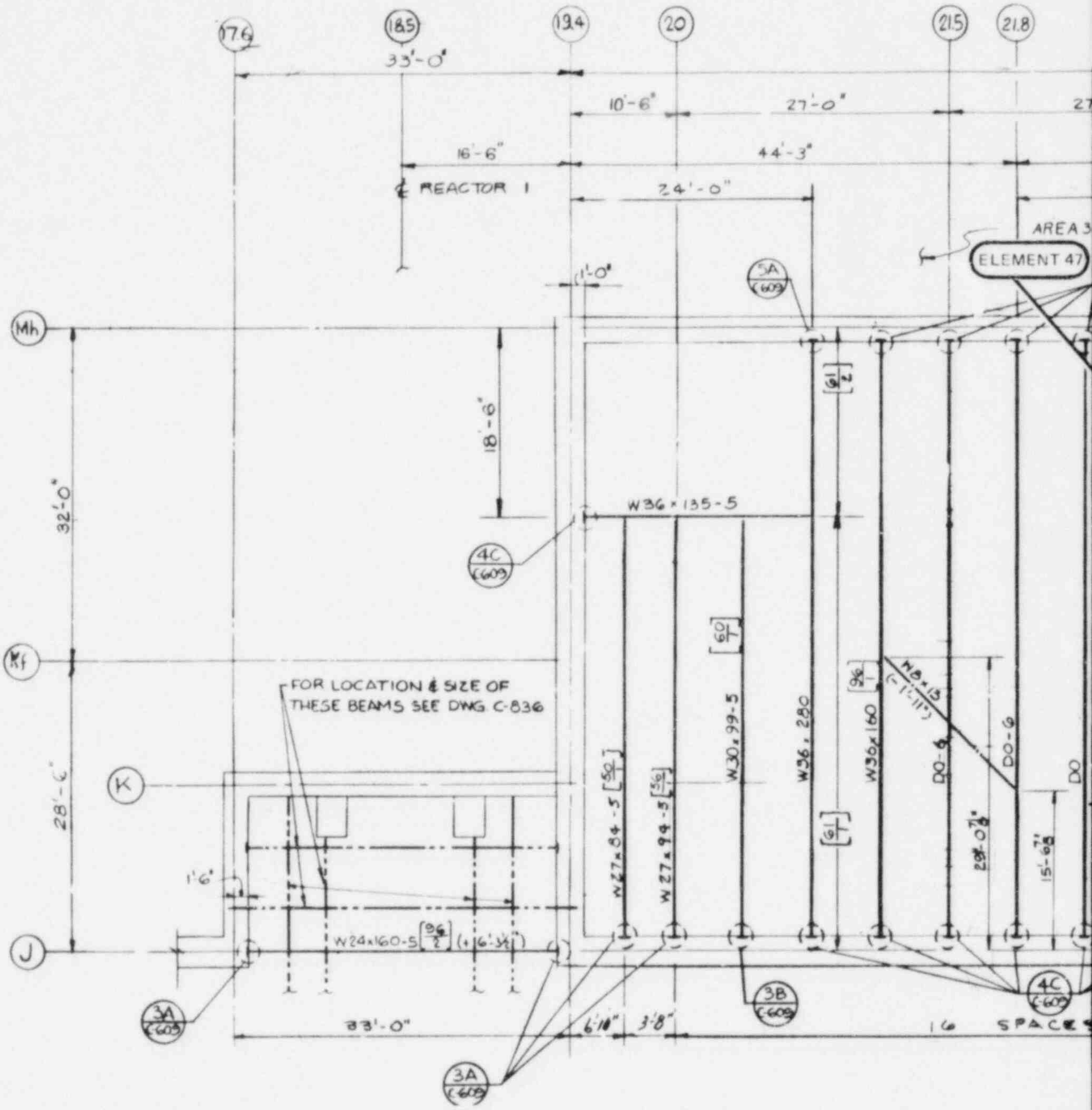


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

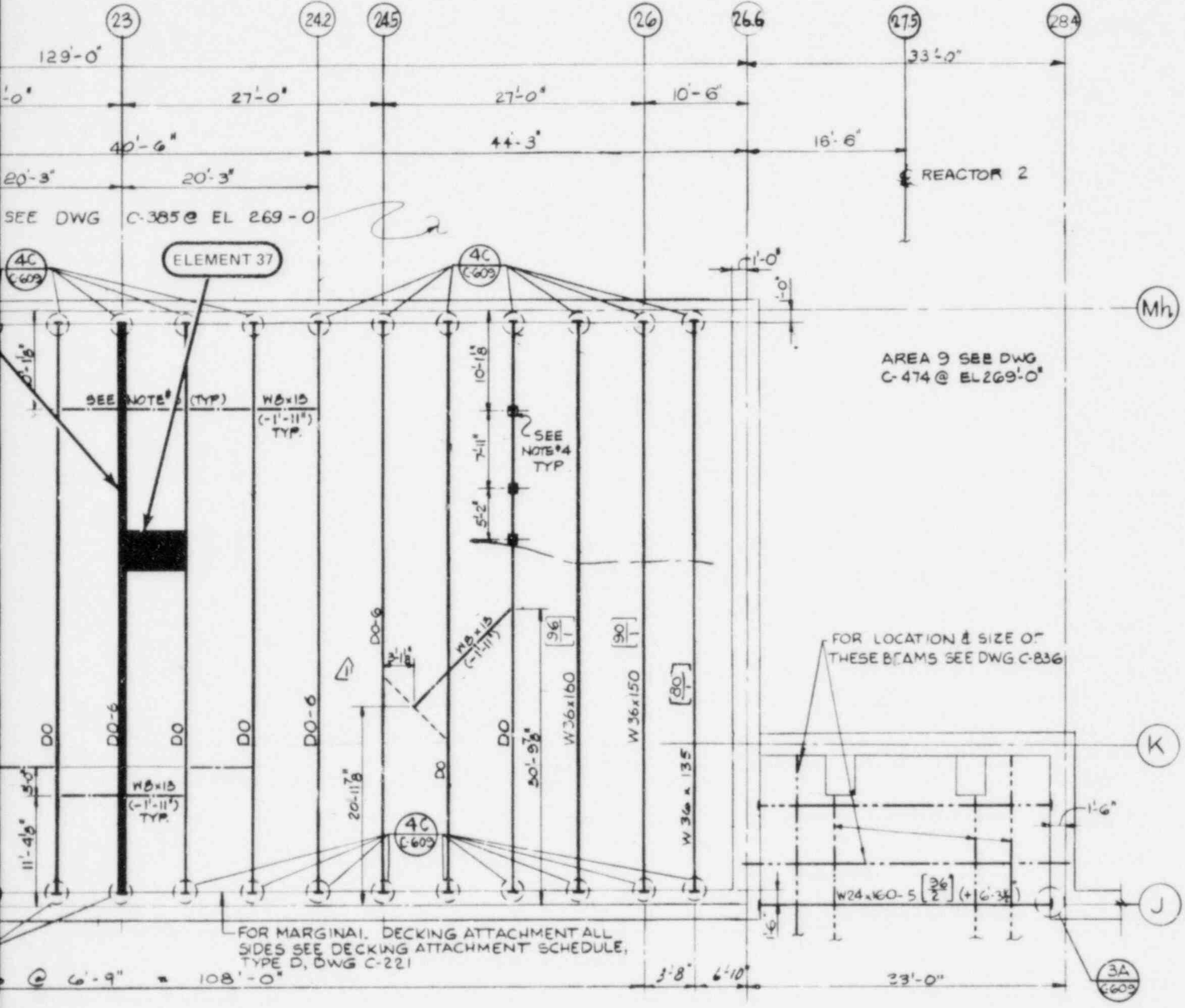
CONTROL STRUCTURE
STEEL FRAMING PLAN
EL. 269'

FIGURE E.1-13

REV. 1, 09/82



17.6
18.5
19.4
20
21.5
21.8
33'-0"
10'-6"
27'-0"
27
16'-6"
44'-3"
℄ REACTOR 1
24'-0"
AREA 3
ELEMENT 47
1'-0"
5A
C609
Mh
Kf
K
J
32'-0"
28'-6"
18'-6"
W36×135-5
4C
C609
61
2
60
T
96
1
W8×13
(-1'-11")
W27×84-5
50
T
W27×94-5
56
1
W30×99-5
W36×280
W36×160
61
T
DO-6
DO-6
DO
28'-0 7/8"
15'-6 7/8"
FOR LOCATION & SIZE OF THESE BEAMS SEE DWG. C-836
1'6"
W24×160-5
96
2
(+16'-3 1/4")
3A
C609
3B
C609
33'-0"
6'10"
3'-8"
16 SPACES

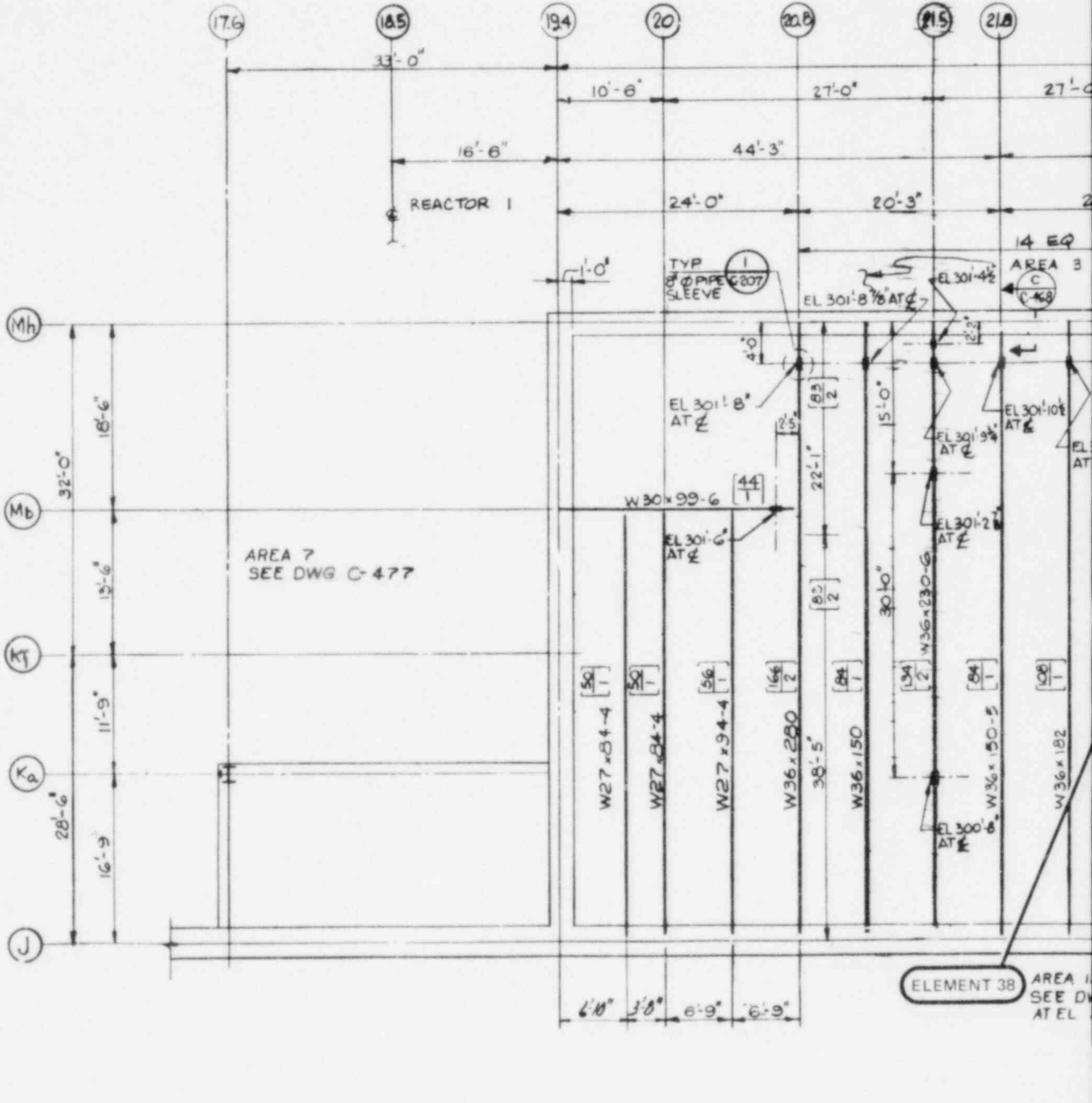


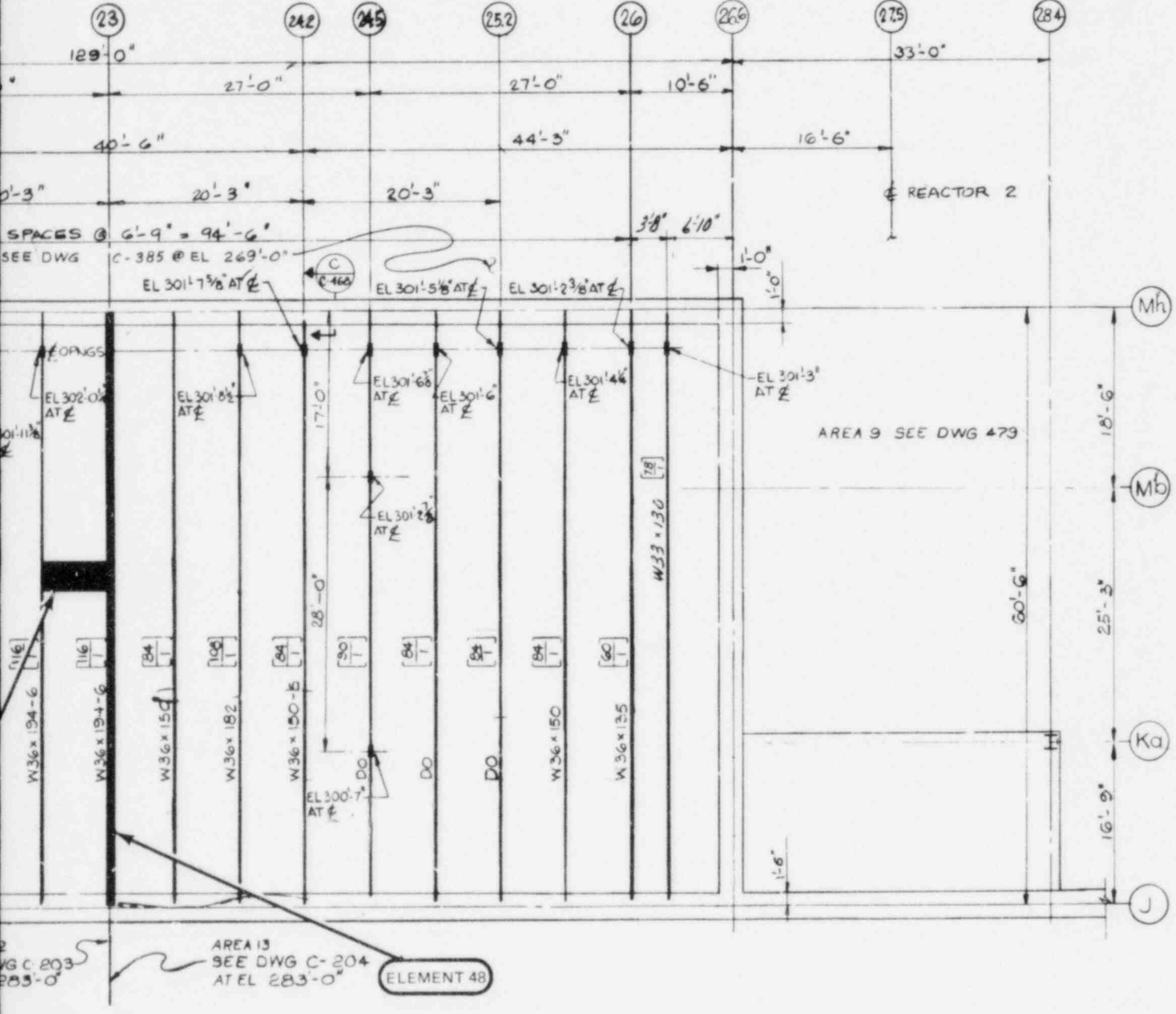
LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTROL STRUCTURE
STEEL FRAMING PLAN
EL. 289'

FIGURE E.1-14

REV. 1, 09/82


17.6
18.5
19.4
20
20.8
21.5
21.8
33'-0"
10'-6"
27'-0"
27'-
16'-6"
44'-3"
REACTOR 1
24'-0"
20'-3"
14 EQ
AREA 3
C
C-468
1'-0"
TYP
8" Ø PIPE SLEEVE
1
C-207
EL 301'-8 7/8" AT ℄
EL 301'-4½"
Mh
Mb
Kj
Ka
J
32'-0"
18'-6"
15'-6"
11'-9"
28'-6"
16'-9"
4'-0"
2'-2"
EL 301'-8" AT ℄
15'-0"
83/2
22'-1"
EL 301'-10½ AT ℄
EL 301'-9¾" AT ℄
W30×99-6
44/1
EL 301'-6" AT ℄
EL 301'-2¾" AT ℄
AREA 7
SEE DWG C-477
30'-0"
W36×230-6
83/2
50/1
50/1
56/1
166/2
84/1
134/2
84/1
108/1
W27×84-4
W27×84-4
W27×94-4
W36×280
38'-5"
W36×150
W36×150-5
W36×182
EL 300'-8" AT ℄
ELEMENT 38
AREA 1
SEE DW
AT EL
6'-10"
3'-8"
6'-9"
6'-9"

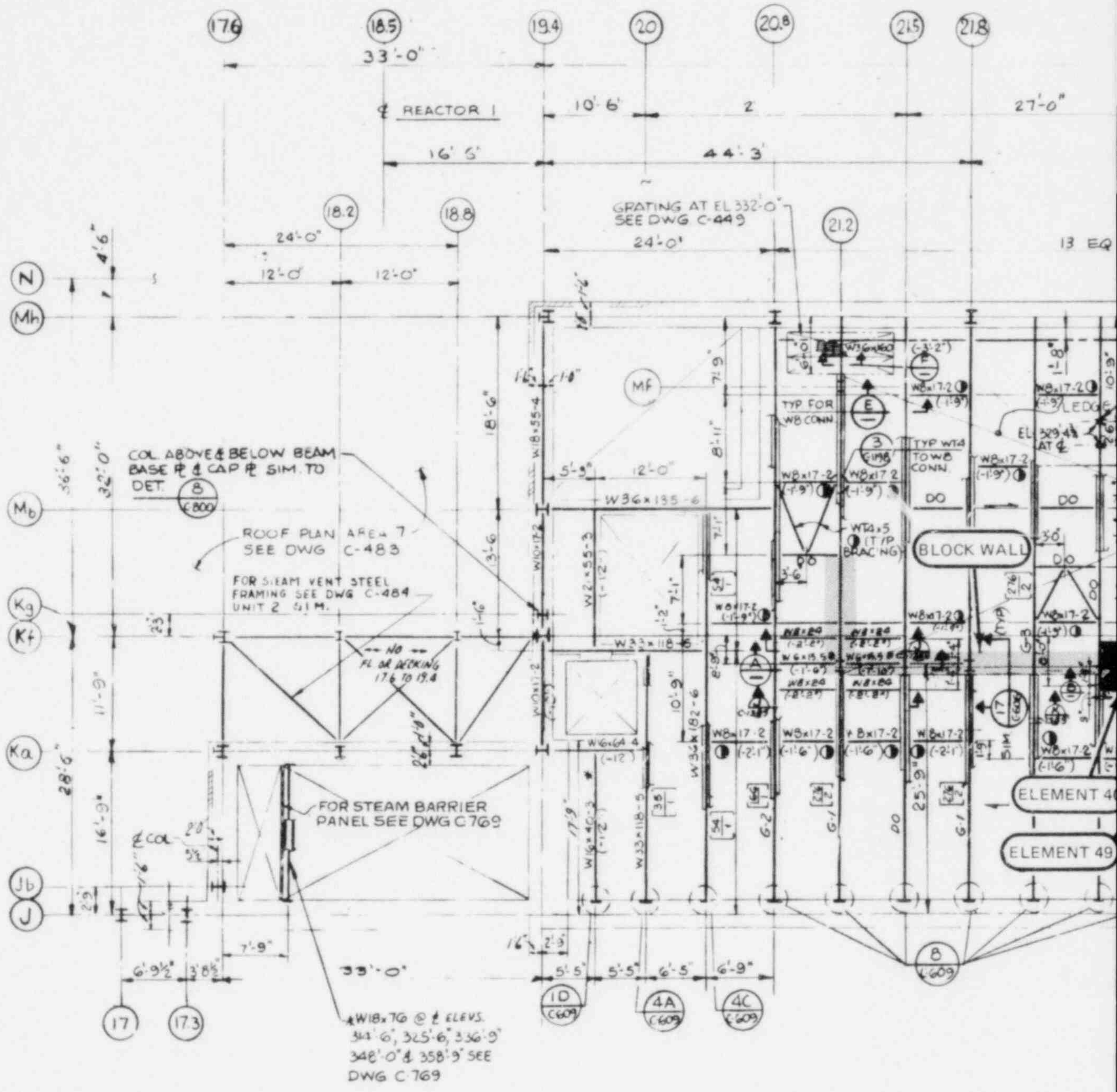


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

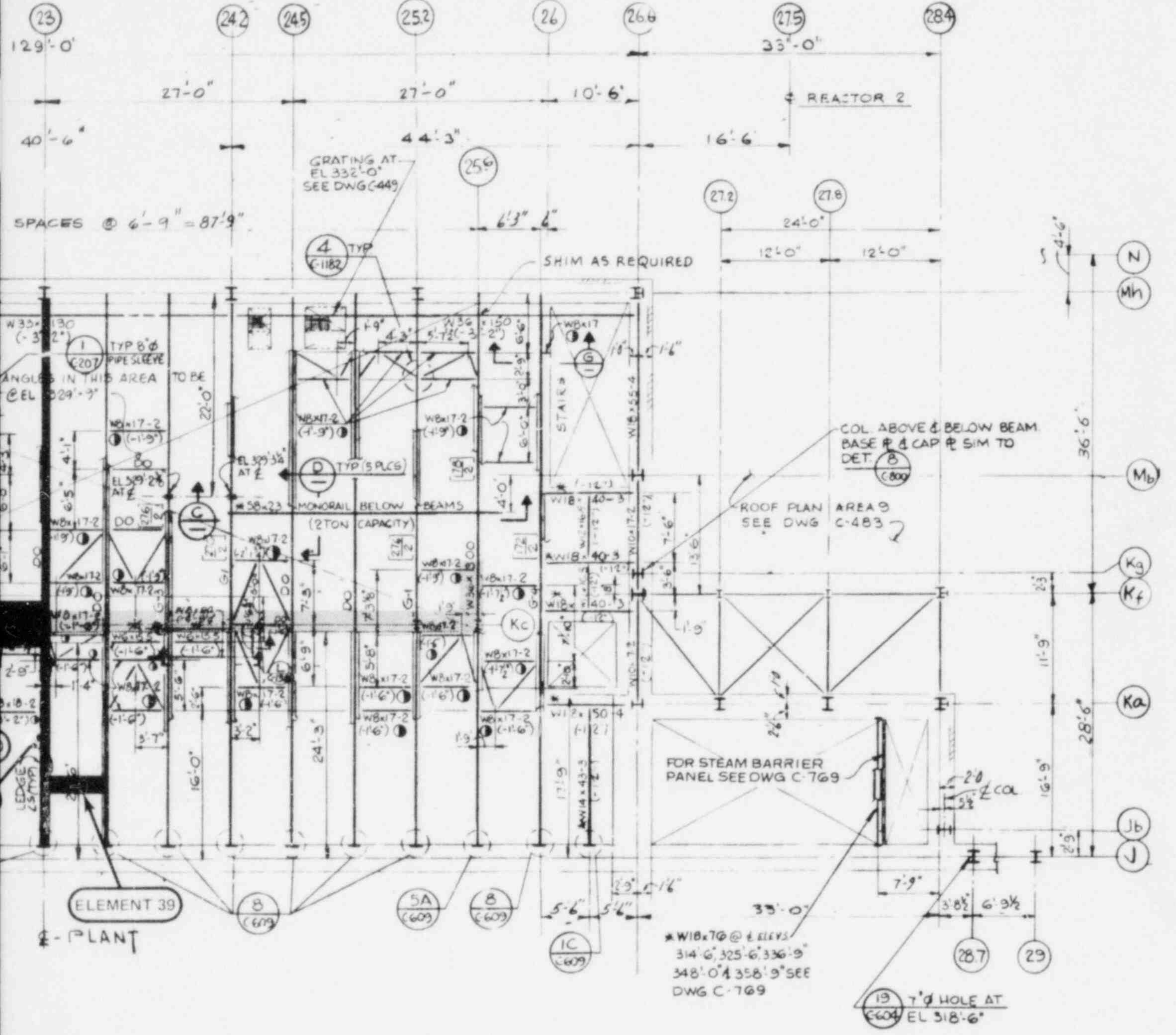
CONTROL STRUCTURE
STEEL FRAMING PLAN
EL. 304'

FIGURE E.1-15

REV. 1, 09/82



17.6
18.5
19.4
20
20.8
21.5
21.8
33'-0"
℄ REACTOR 1
10'-6"
2'
27'-0"
16'-6"
44'-3"
18.2
18.8
21.2
GRATING AT EL 332'-0"
SEE DWG C-449
24'-0"
24'-0"
12'-0"
12'-0"
13 EQ
N
Mh
Mf
Mb
Kg
Kf
Ka
Jb
J
4'-6"
36'-6"
32'-0"
28'-6"
11'-9"
16'-9"
18'-6"
COL. ABOVE & BELOW BEAM
BASE ℄ & CAP ℄ SIM. TO
DET. 8 C-800
ROOF PLAN AREA 7
SEE DWG C-483
FOR STEAM VENT STEEL
FRAMING SEE DWG C-484
UNIT 2 SIM.
NO
FL OR DECKING
17.6 TO 19.4
W36x135-6
W33x118-6
W18x55-4
W21x55-3
W36x182-6
W33x118-5
W16x64-4
W8x17-2
W8x24
W6x15.5
WT4x5 (T/P BRACING)
TYP FOR W8 CONN.
TYP WT4 TO W8 CONN.
BLOCK WALL
LEDGE
EL 329'-4" AT ℄
DO
ELEMENT 40
ELEMENT 49
FOR STEAM BARRIER
PANEL SEE DWG C769
℄ COL.
G-1
G-2
G-3
SIM
7'-9"
39'-0"
6'-9½"
3'-8½"
5'-5"
5'-5"
6'-5"
6'-9"
1D C609
4A C609
4C C609
8 C609
17
17.3
W18x76 @ ℄ ELEVS.
314'-6", 325'-6", 336'-9"
348'-0" & 358'-9" SEE
DWG C-769

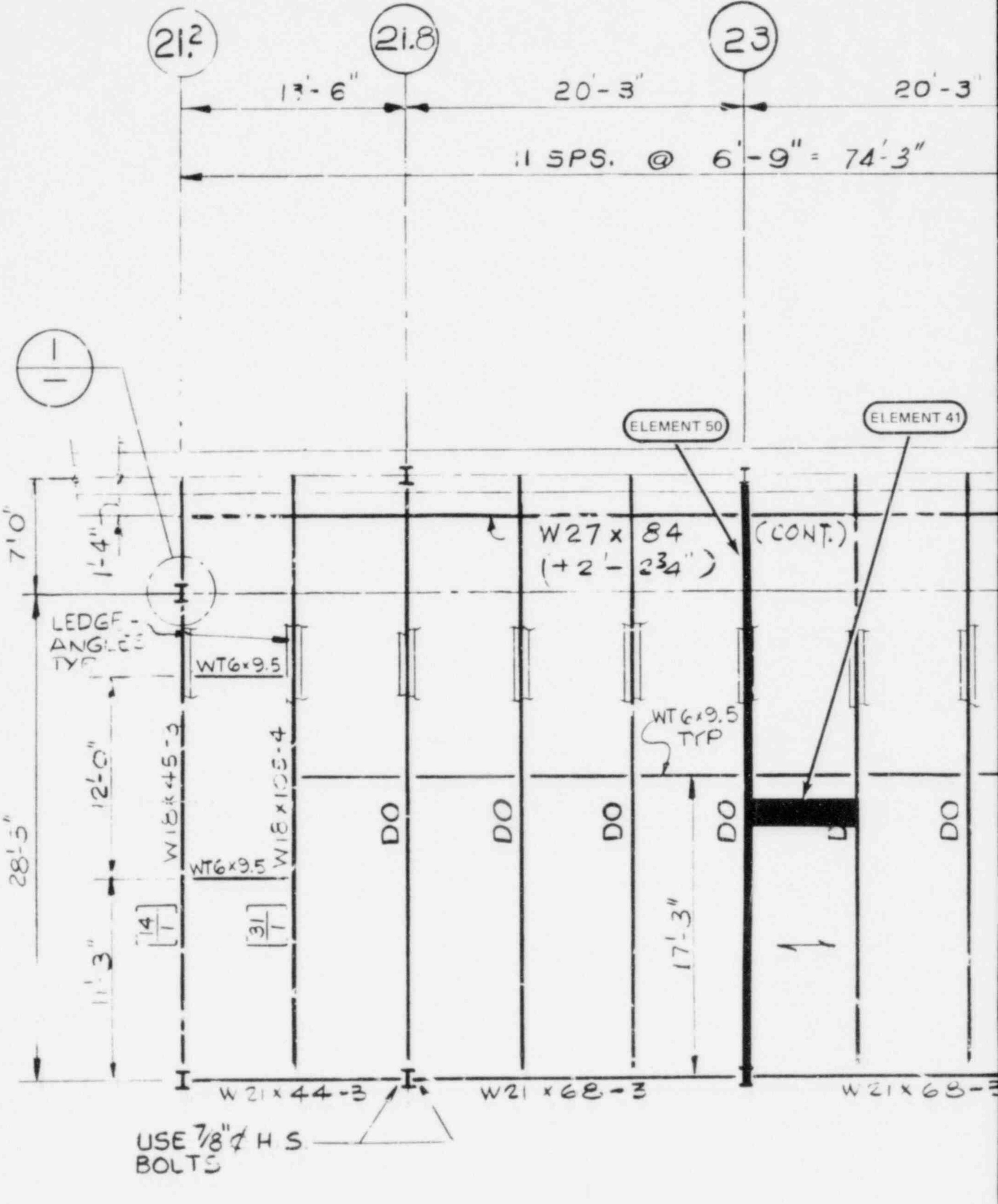


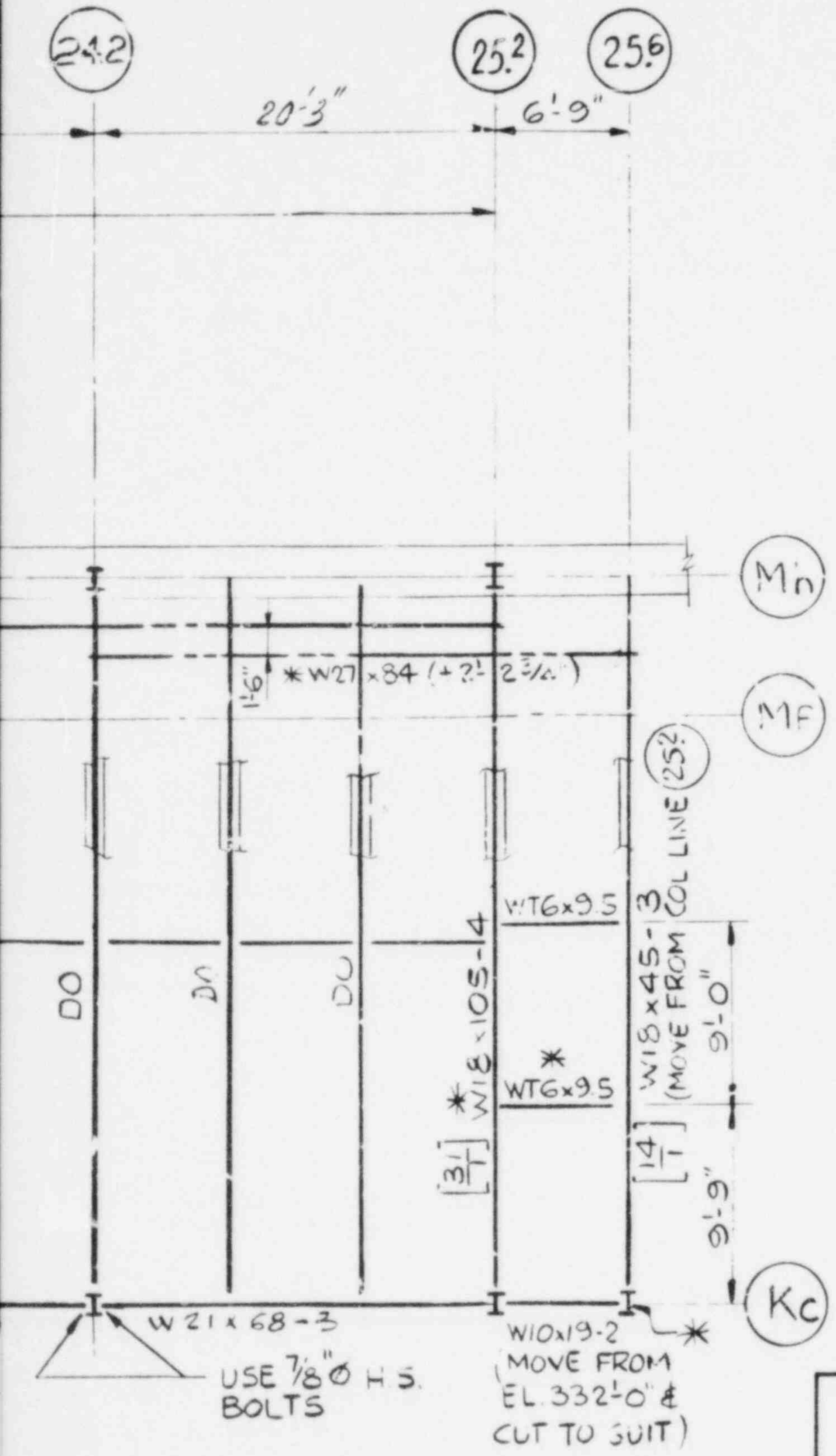
LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTROL STRUCTURE
STEEL FRAMING PLAN
EL. 332'

FIGURE E.1-16

REV. 1, 09/82

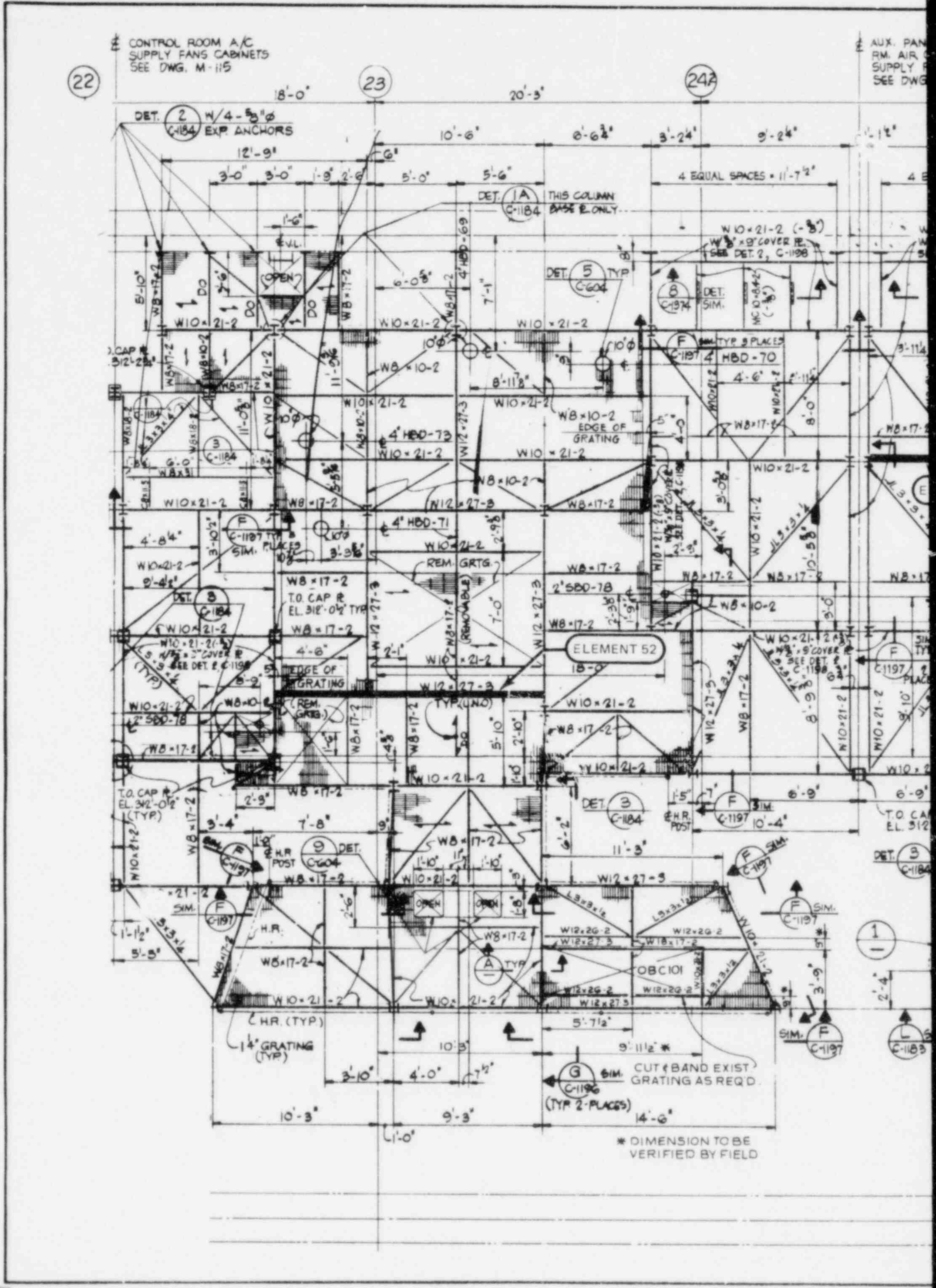

21.2
21.8
23
13'-6"
20'-3"
20'-3"
11 SPS. @ 6'-9" = 74'-3"
1
ELEMENT 50
ELEMENT 41
7'0"
1'-4"
W27 x 84
(+2'-2 3/4")
(CONT.)
LEDGE-ANGLES TYP
WT6x9.5
WT6x9.5 TYP
28'-5"
12'-0"
W18x45-3
W18x105-4
WT6x9.5
14/1
31/1
11'-3"
DO
DO
DO
DO
DO
17'-3"
W21x44-3
W21x68-3
W21x68-3
USE 7/8"⌀ H.S. BOLTS

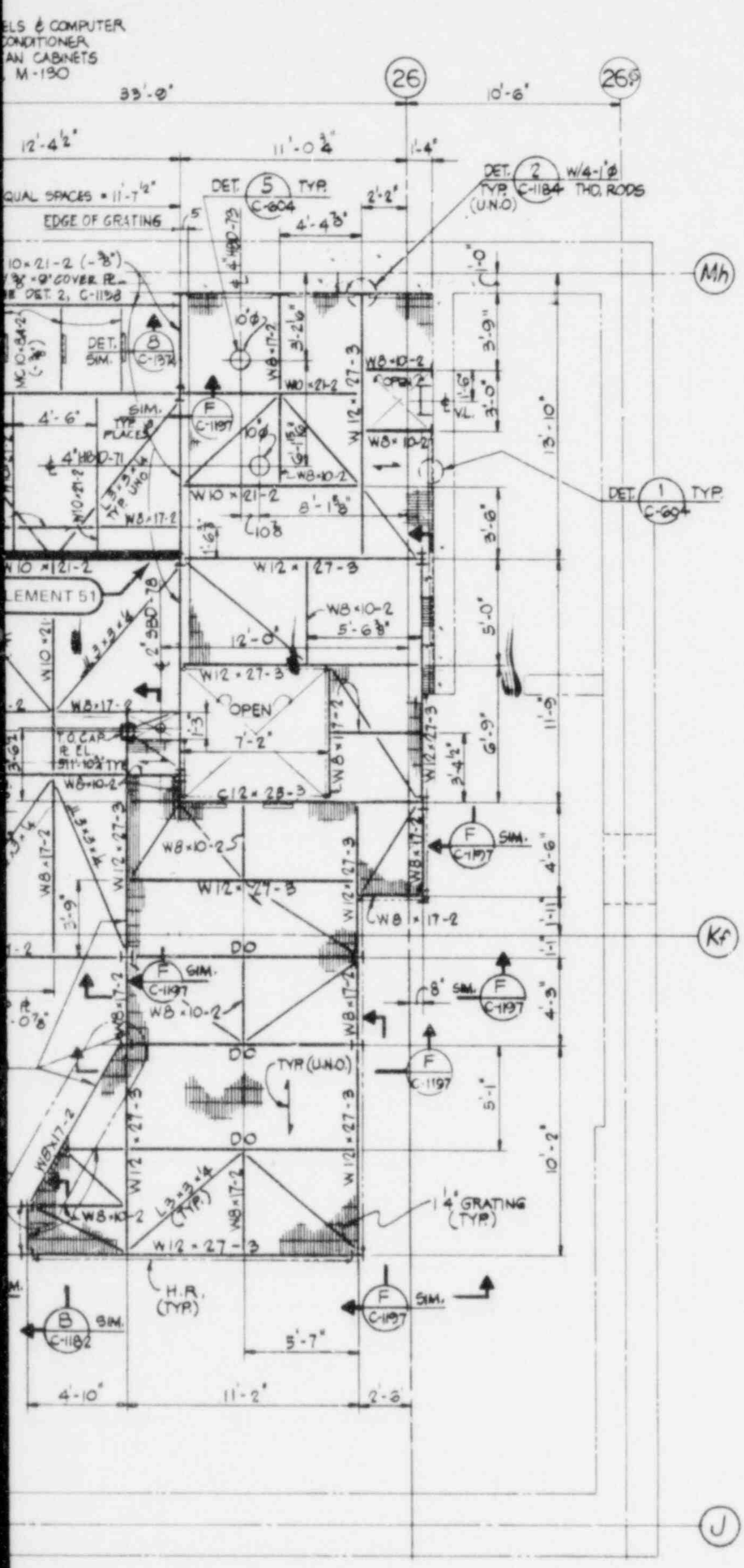


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTROL STRUCTURE
STEEL FRAMING PLAN
EL. 350'

FIGURE E.1-17 REV. 1, 09/82

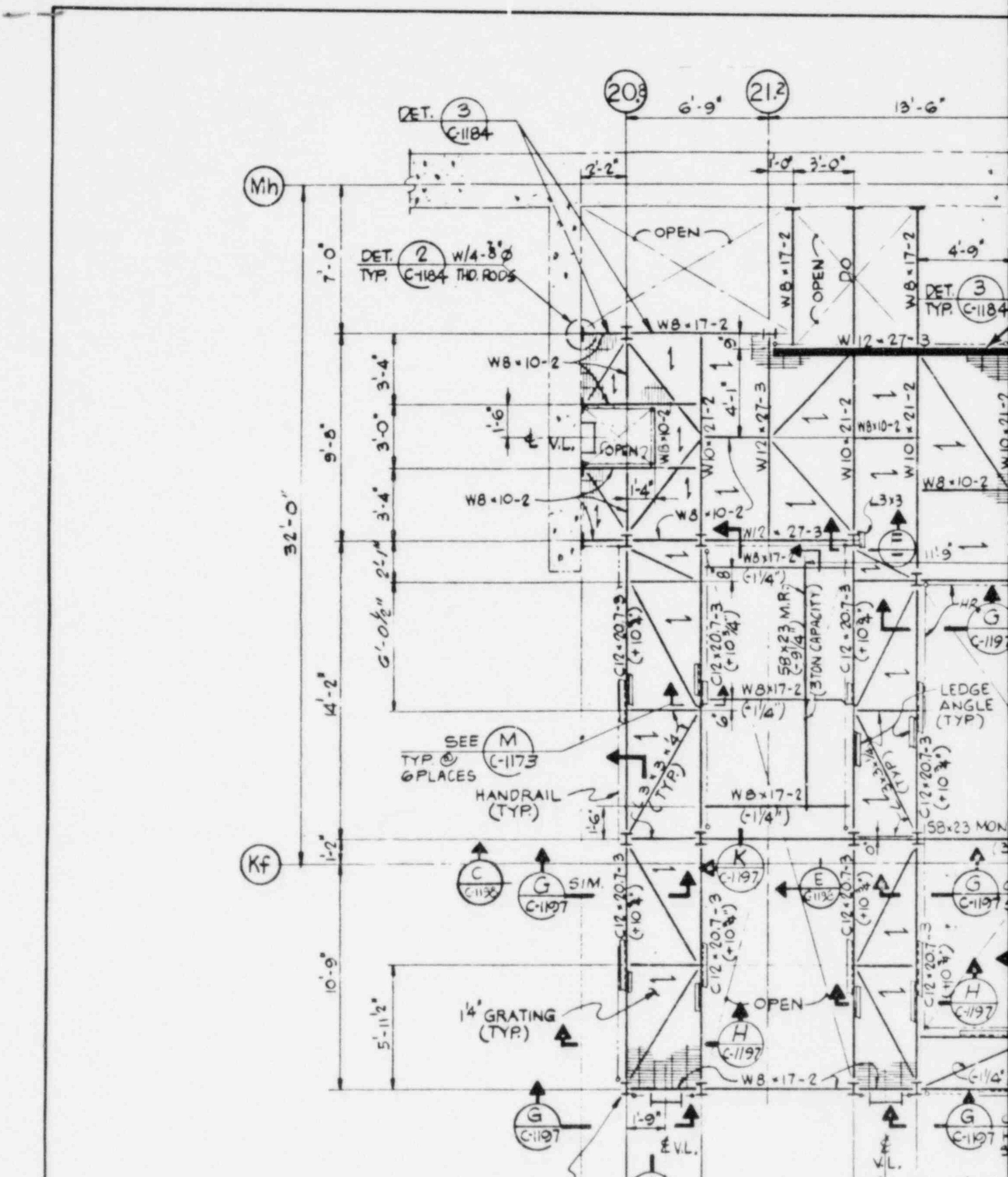

℄ CONTROL ROOM A/C SUPPLY FANS CABINETS SEE DWG. M-115
℄ AUX. PAN RM. AIR SUPPLY SEE DWG
22
23
24A
18'-0"
20'-3"
DET. 2 C-1184 W/4-⅝"φ EXP. ANCHORS
10'-6"
6'-6¾"
3'-2¼"
9'-2¼"
12'-9"
3'-0"
3'-0"
1'-9"
2'-6"
5'-0"
5'-6"
4 EQUAL SPACES = 11'-7½"
DET. 1A C-1184 THIS COLUMN BASE ℞ ONLY
W10×21-2 (-⅜")
W⅜"×9" COVER ℞ SEE DET. 2, C-1198
DET. 5 C-604 TYP
8 C-1374
DET. SIM.
OPEN
DO
W8×17-2
W10×21-2
W8×10-2
4" HBD-69
4" HBD-70
4" HBD-71
4" HBD-73
10"φ
F C-1197 TYP 3 PLACES
W8×17-2
W10×21-2
W12×27-3
EDGE OF GRATING
DET. 3 C-1184
W8×31
6'-0"
T.O. CAP ℞ EL. 312'-0½" TYP
REM. GRTG.
(REMOVABLE)
2" SBD-78
ELEMENT 52
W⅜"×9" COVER ℞ SEE DET. ℞ C-1198
L3×3×¼
TYP (U.N.O.)
(REM. GRTG.)
T.O. CAP ℞ EL. 312'-0½" (TYP)
H.R. POST
9 C-604 DET.
F C-1197 SIM.
W12×27-3
W12×26-2
W18×17-2
OBC 101
A TYP
H.R.
H.R. (TYP.)
1¼" GRATING (TYP)
10'-3"
3'-10"
4'-0"
7½"
5'-7½"
9'-11½" *
G C-1196 SIM. (TYP 2-PLACES)
CUT & BAND EXIST GRATING AS REQ'D.
10'-3"
9'-3"
14'-6"
1'-0"
1'-1½"
5'-3"
11'-3"
6'-9"
10'-4"
L C-1183
1
* DIMENSION TO BE VERIFIED BY FIELD



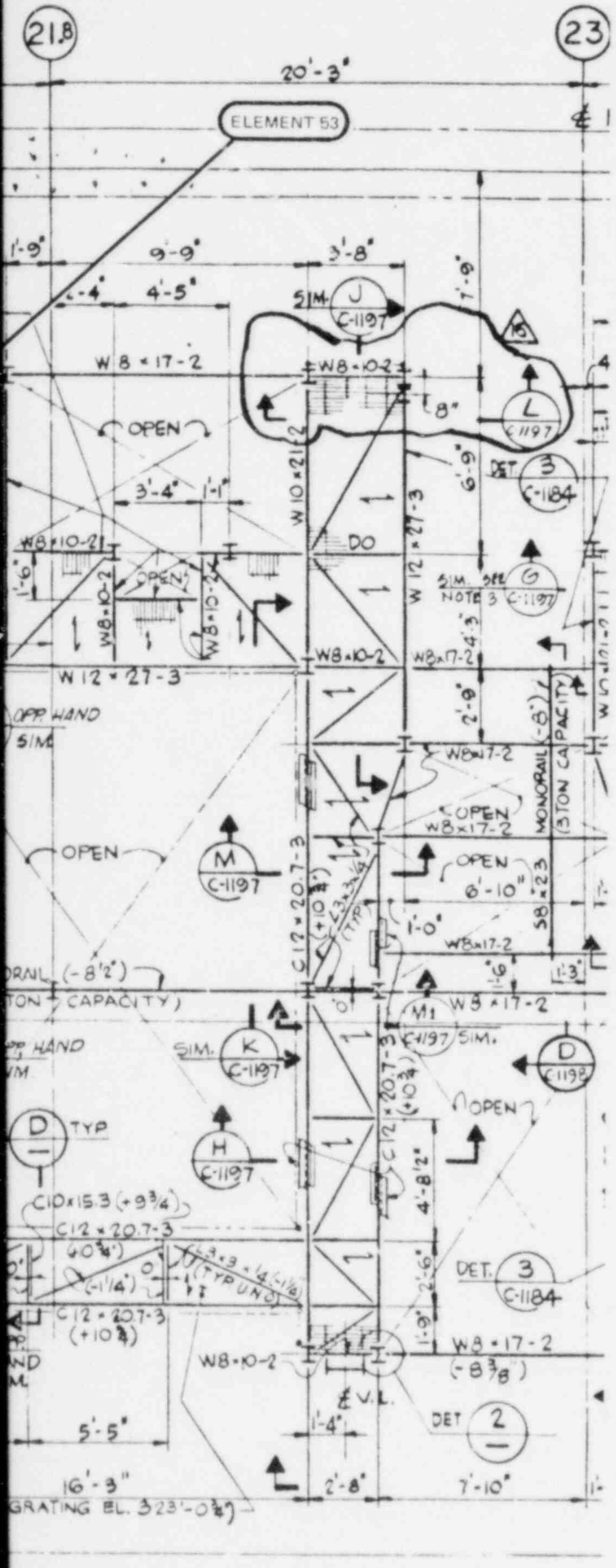
LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTROL STRUCTURE
PLATFORMS
EL. 313'

FIGURE E.1-18 REV. 1, 09/82



20.8
21.2
6'-9"
13'-6"
DET. 3 C-1184
Mh
Kf
2'-2"
1'-0"
3'-0"
OPEN
DO
4'-9"
DET. TYP. 2 C-1184 W/4-3/4"Ø THD. RODS
DET. TYP. 3 C-1184
W8×17-2
W12×27-3
W8×10-2
W10×21-2
W12×27-3
W8×10-2
W10×21-2
4'-1"
1'-6"
℄ V.L.
OPEN
1'-4"
W8×10-2
W8×10-2
W12×27-3
L3×3
11'-9"
32'-0"
7'-0"
9'-8"
3'-4"
3'-0"
3'-4"
2'-1"
6'-0 1/2"
14'-2"
1'-2"
10'-9"
5'-11 1/2"
W8×17-2
(-1 1/4")
C12×20.7-3 (+10 3/4")
S8×23 M.R. (-9 1/4") (3 TON CAPACITY)
HR
G C-1197
LEDGE ANGLE (TYP)
SEE M C-1173 TYP. @ 6 PLACES
HANDRAIL (TYP.)
L3×3×1/4 (TYP.)
1'-6"
W8×17-2 (-1 1/4")
S8×23 MON
C C-1136
G C-1197 SIM.
K C-1197
E C-1136
H C-1197
1 1/4" GRATING (TYP.)
OPEN
W8×17-2
(-1 1/4")
G C-1197
1'-9"
℄ V.L.
J C-1197
W8×17 HANGERS (TYP.)
3'-6"
7'-3"
3'-0"
1'-6"
5'-5"
T.O.S. EL. 322'-0 3/4" (U.N.O.)

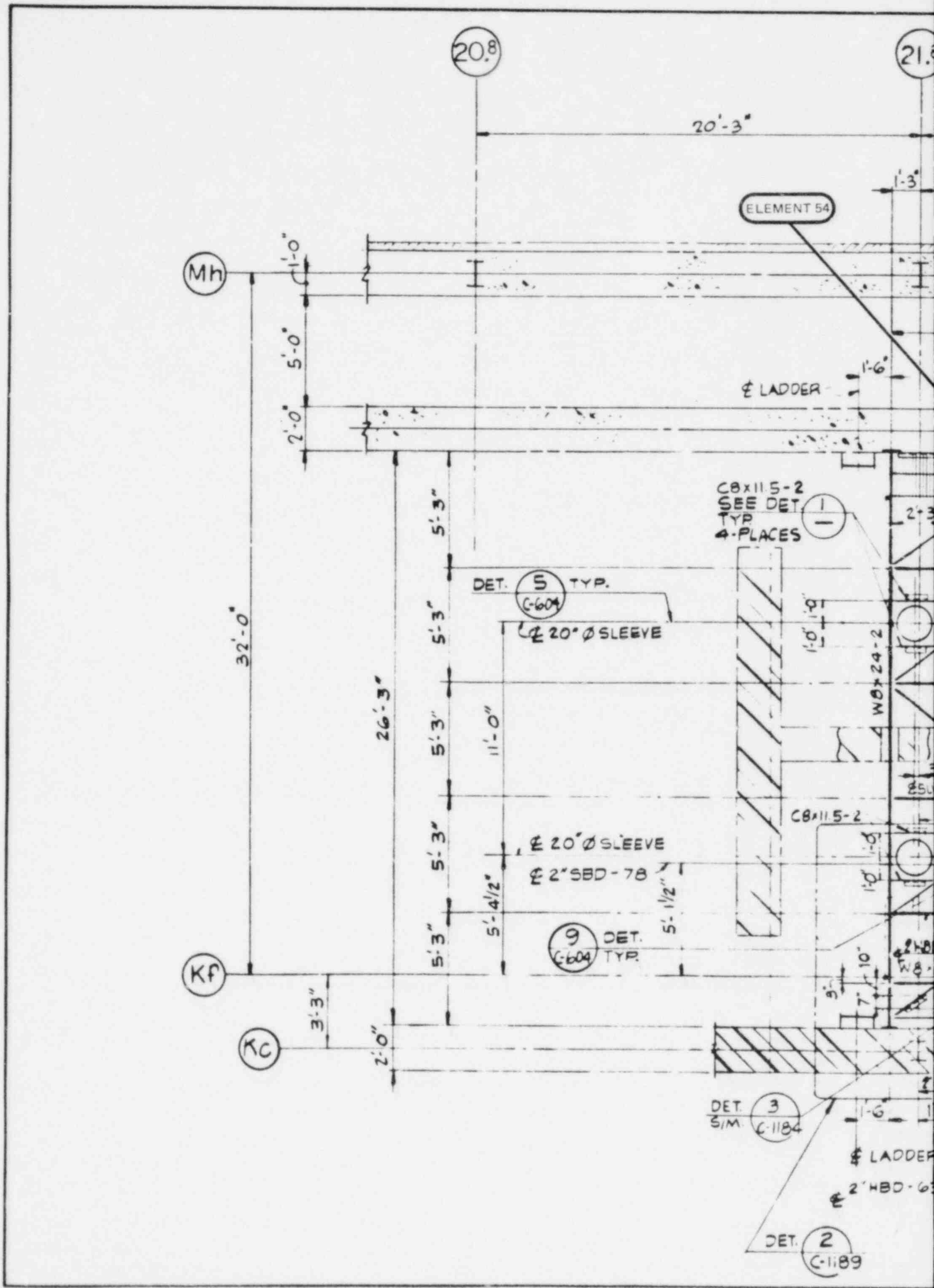


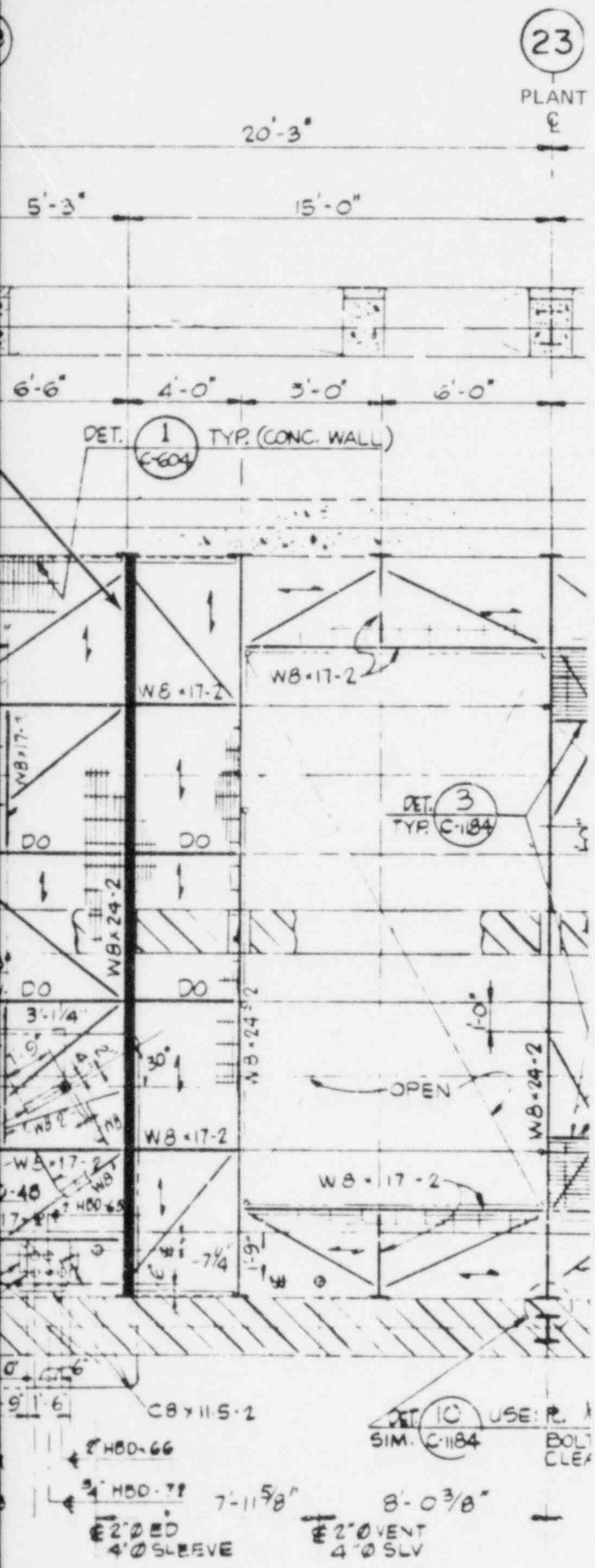
LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTROL STRUCTURE
PLATFORMS
EL. 322'

FIGURE E.1-19

REV. 1, 09/82

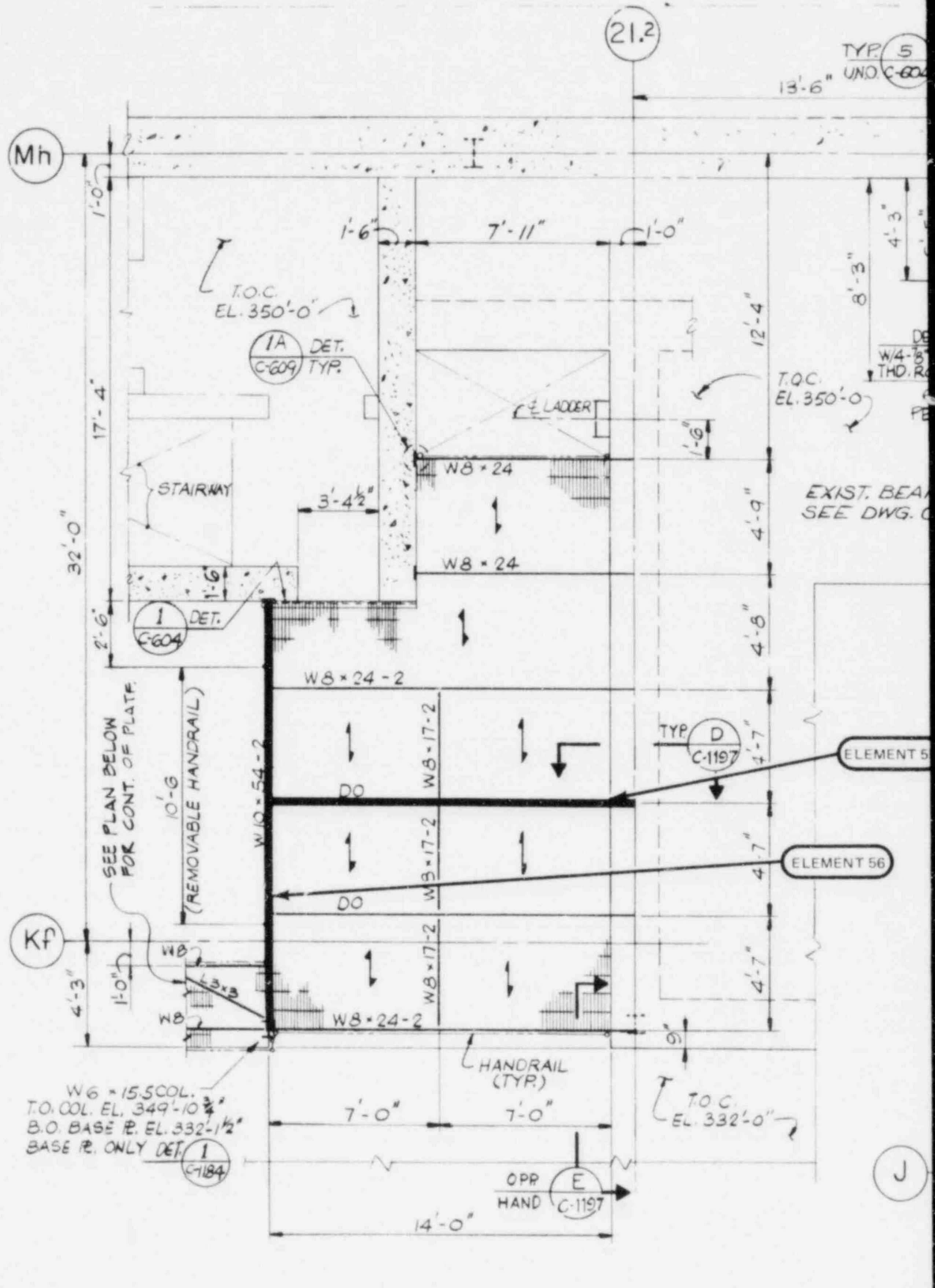

20.8
21.8
20'-3"
1'-3"
ELEMENT 54
Mh
1'-0"
5'-0"
2'-0"
1'-6"
℄ LADDER
C8x11.5-2
SEE DET. 1
TYP.
4-PLACES
2'-3
5'3"
5'3"
5'3"
5'3"
5'3"
5'3"
DET. 5 C-604 TYP.
℄ 20"Ø SLEEVE
1'-0" 1'-0"
W8x24-2
32'-0"
26'-3"
11'-0"
C8x11.5-2
℄ 20"Ø SLEEVE
℄ 2"SBD-78
5'-4 1/2"
5'-1 1/2"
1'-0" 1'-0"
9 C-604 DET. TYP.
Kf
3'-3"
Kc
2'-0"
10"
9"
7"
DET. SIM. 3 C-1184
1'-6"
℄ LADDER
℄ 2"HBD-6
DET. 2 C-1189



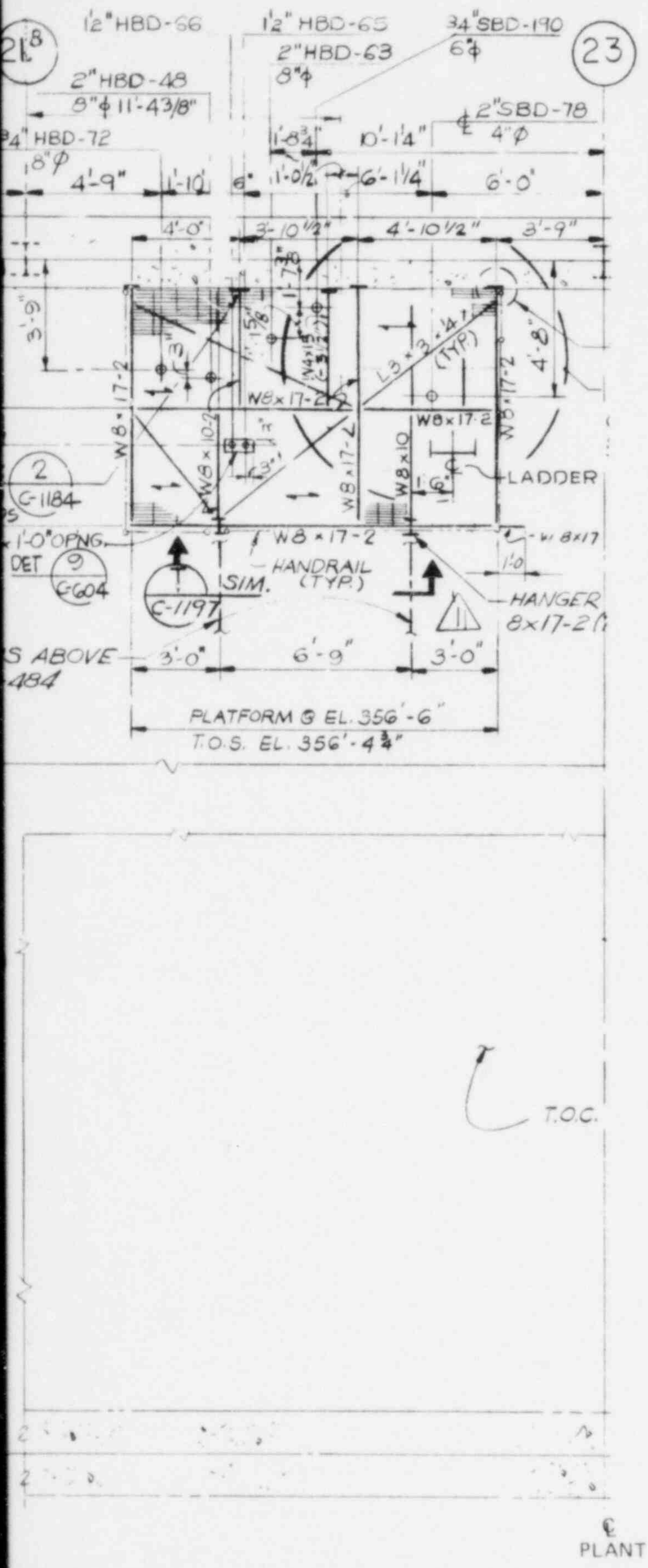
LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTROL STRUCTURE
PLATFORMS
EL. 340'

FIGURE E.1-20 REV. 1, 09/82



21.2
TYP. 5 UNO. C-604
13'-6"
Mh
1'-0"
1'-6"
7'-11"
1'-0"
4'-3"
8'-3"
T.O.C. EL. 350'-0"
12'-4"
1A C-609 DET. TYP.
W/4-5/8" THD. R
℄ LADDER
T.O.C. EL. 350'-0"
1'-6"
17'-4"
32'-0"
W8 × 24
STAIRWAY
3'-4½"
EXIST. BEA
SEE DWG. C
4'-9"
W8 × 24
1'-6"
2'-6"
1 C-604 DET.
4'-8"
W8 × 24-2
SEE PLAN BELOW FOR CONT. OF PLATF.
10'-6" (REMOVABLE HANDRAIL)
W10 × 54-2
W8 × 17-2
TYP. D C-1197
4'-7"
ELEMENT 5
DO
W8 × 17-2
4'-7"
ELEMENT 56
DO
Kf
W8
L3×3
W8 × 17-2
4'-7"
4'-3"
1'-0"
W8
W8 × 24-2
9"
HANDRAIL (TYP.)
W6 × 15.5 COL.
T.O. COL. EL. 349'-10¾"
B.O. BASE ℞. EL. 332'-1½"
BASE ℞. ONLY DET. 1 C-1184
7'-0"
7'-0"
T.O.C. EL. 332'-0"
OPP. HAND E C-1197
J
14'-0"

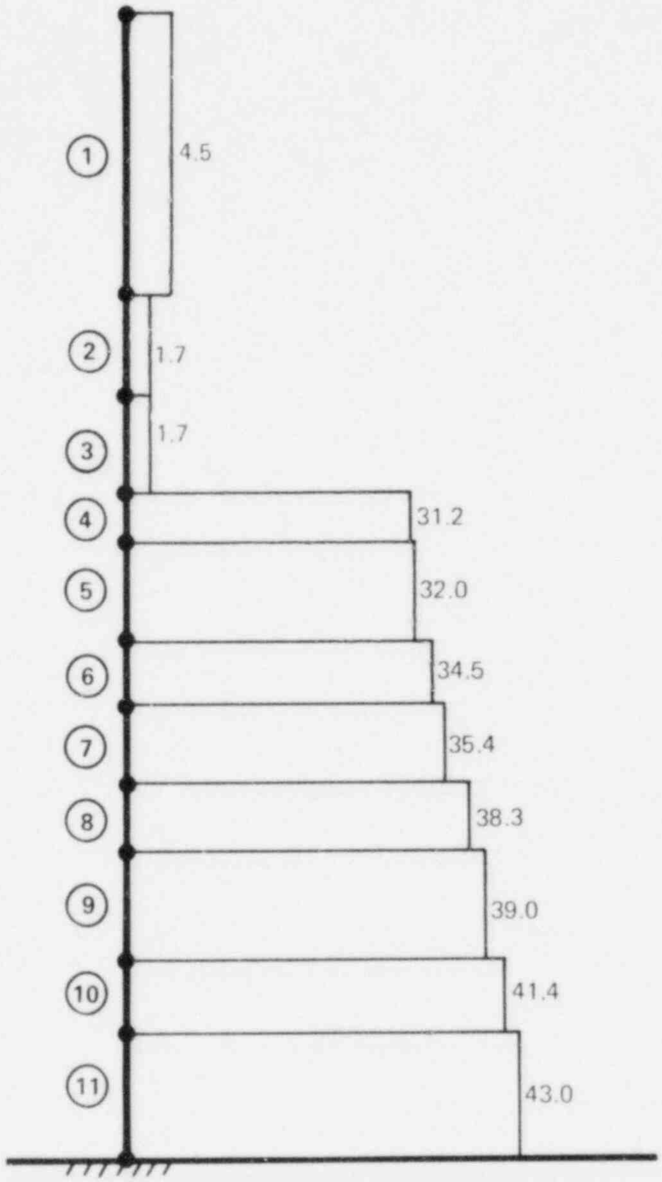


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

CONTROL STRUCTURE
PLATFORMS
EL. 350'

FIGURE E.1-21

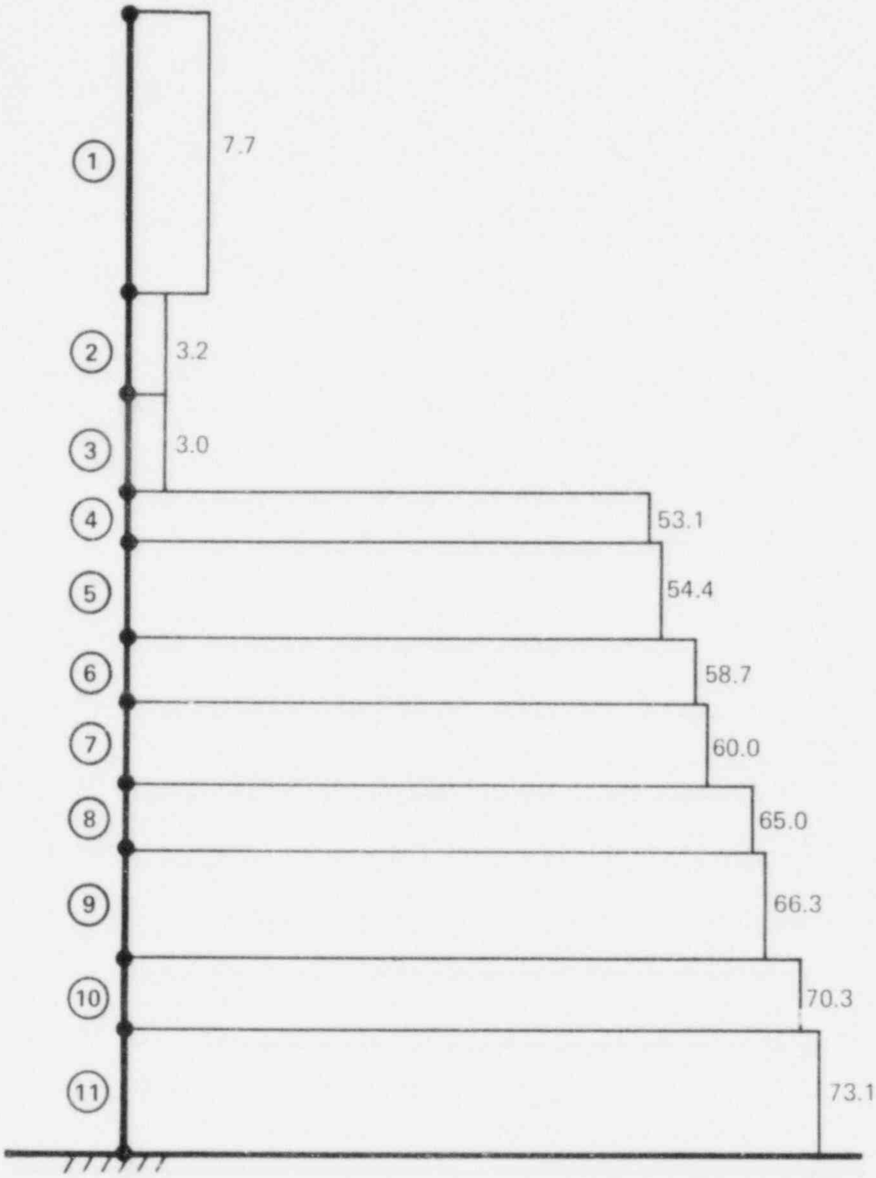
REV. 1, 09/82



LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE & CONTROL STRUCTURE VERTICAL AXIAL FORCES
($X10^3$ KIPS)
OBE+SRV (2% DAMPING)

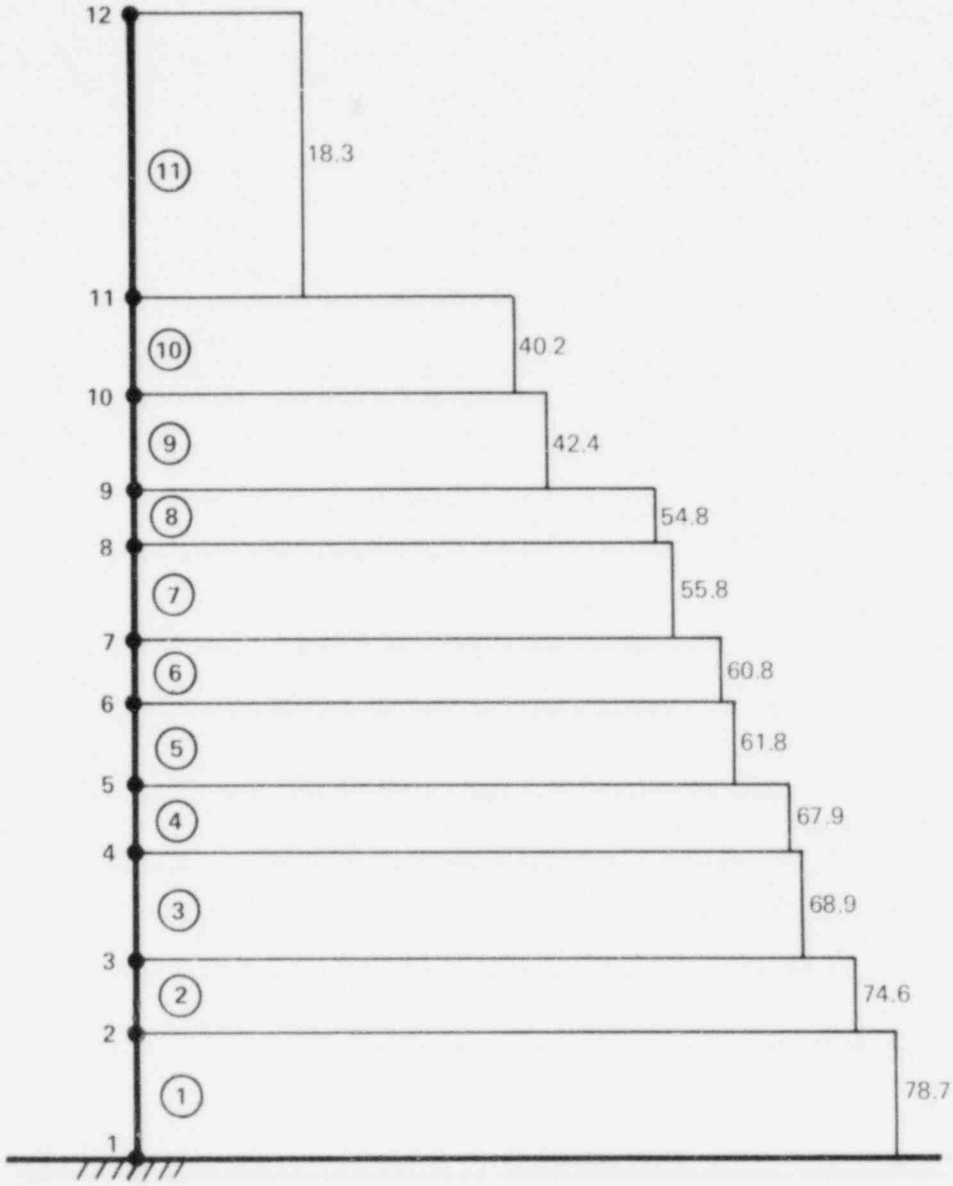
FIGURE E.1-22 REV 1, 09/82



LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE & CONTROL STRUCTURE VERTICAL AXIAL FORCES ($\times 10^3$ KIPS) DBE+SRV+LOCA (5% DAMPING)

FIGURE E.1-23 REV. 1, 09/82

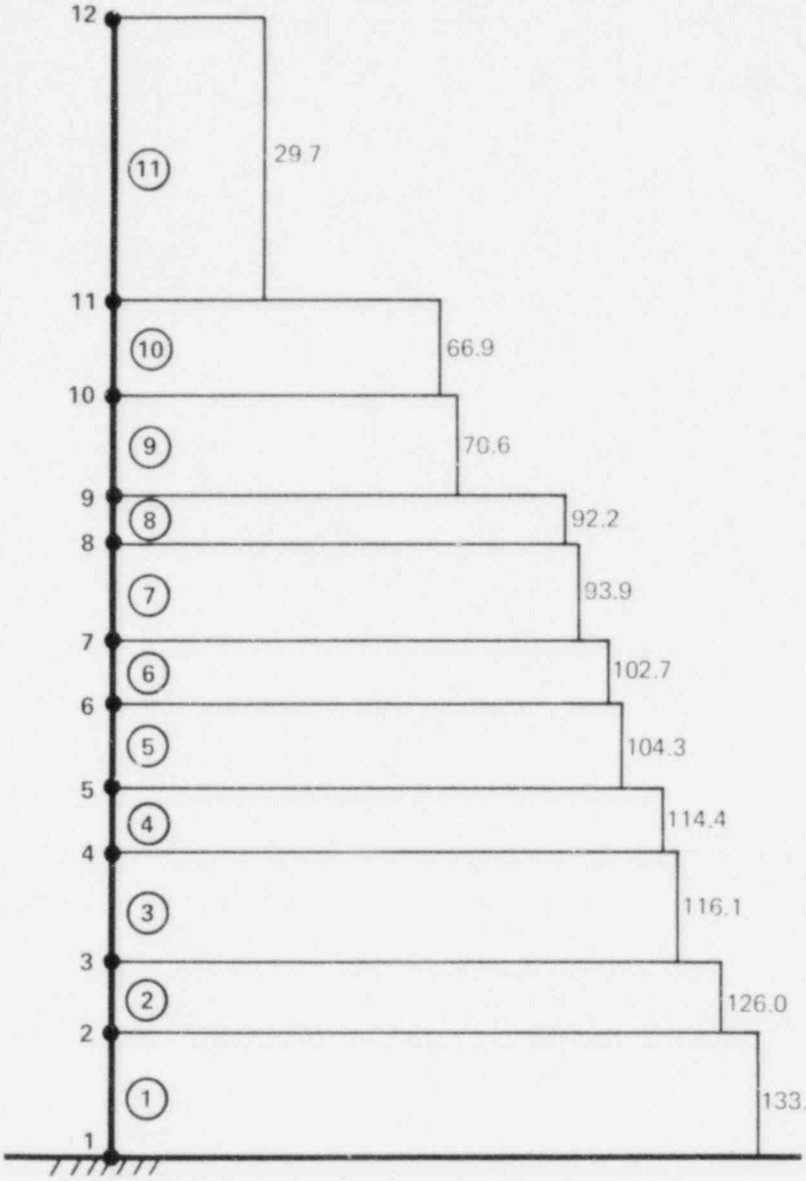


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE
&CONTROL STRUCTURE
N-S SHEAR FORCES
($X10^3$ KIPS)
OBE+SRV (2% DAMPING)

FIGURE F.1-24

REV.1, 09/82

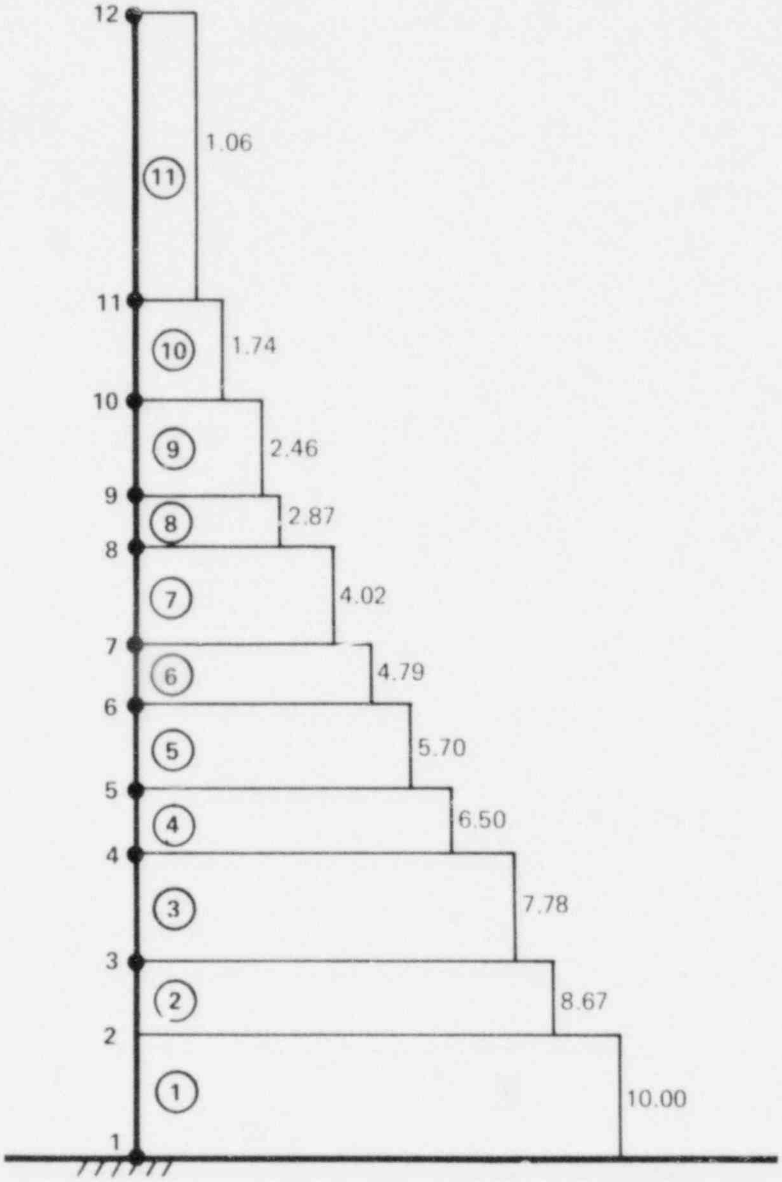


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE & CONTROL STRUCTURE N–S SHEAR FORCES ($\times 10^3$ KIPS) DBE+LOCA+SRV (5% DAMPING)

FIGURE E.1-25

REV 1, 09/82

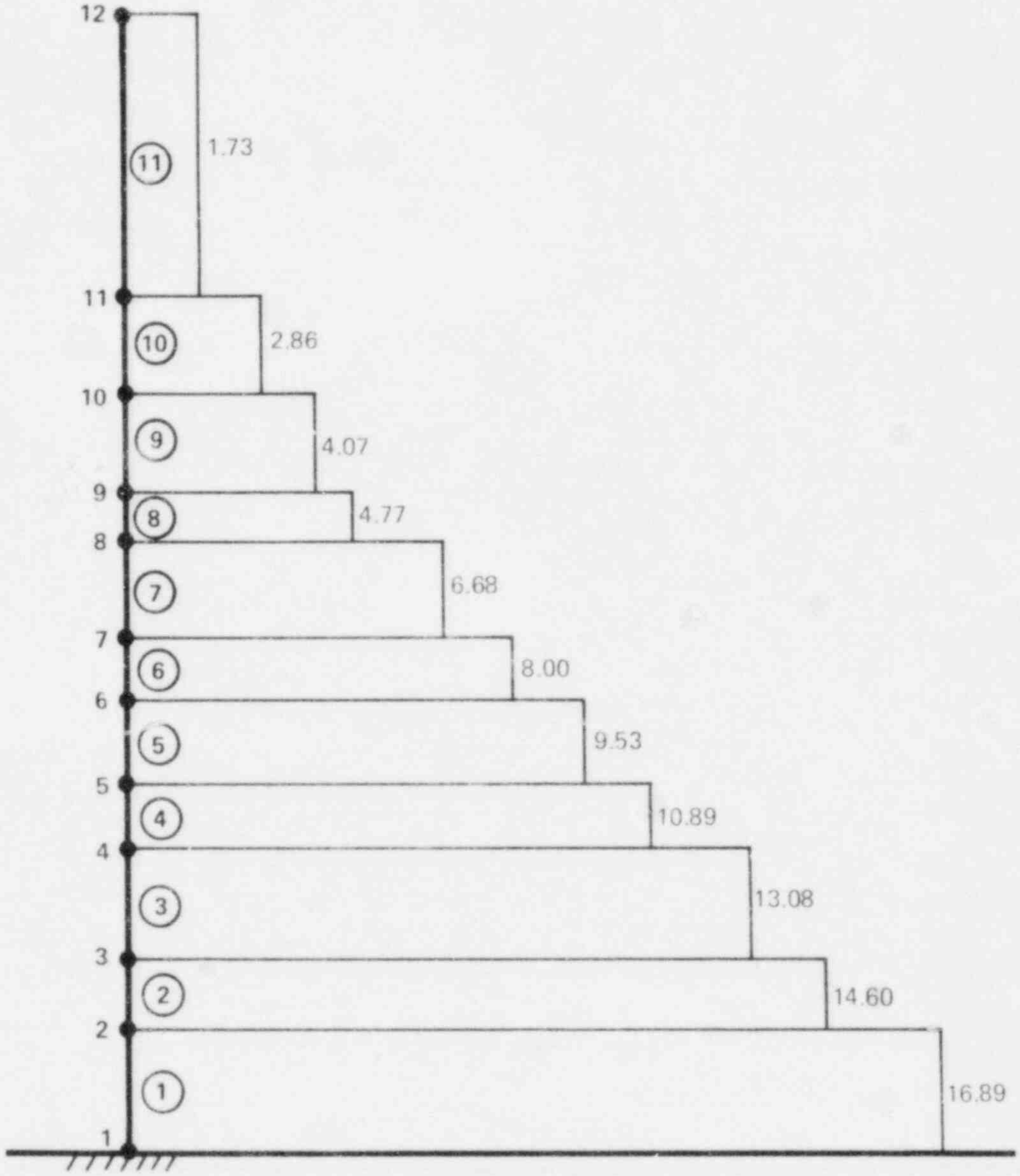


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE & CONTROL STRUCTURE N–S OVERTURNING MOMENTS (X10^6 K–FT) OBE+SRV (2% DAMPING)

FIGURE E.1-26

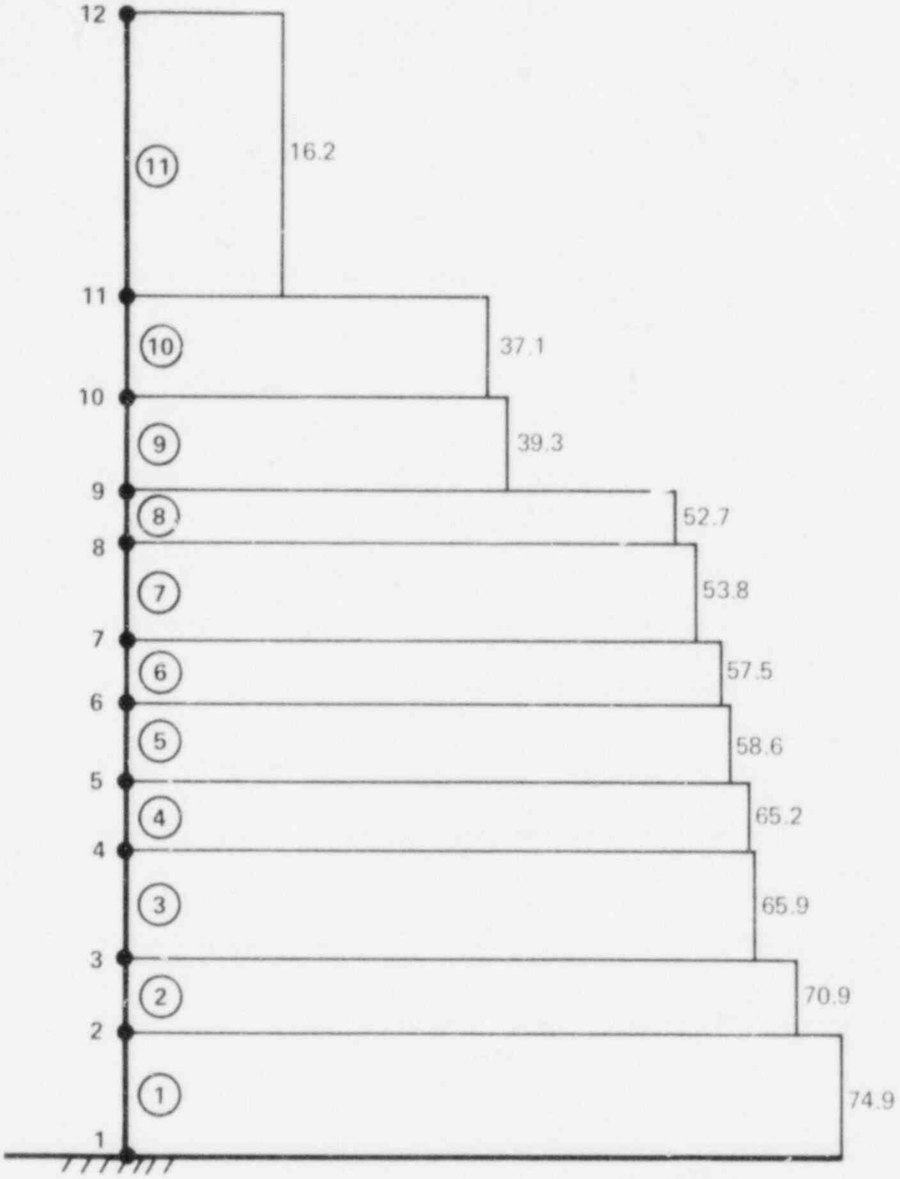
REV 1, 09/82



LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE & CONTROL STRUCTURE N–S OVERTURNING MOMENTS ($X10^6$ K-FT) DBE+LOCA+SRV (5% DAMPING)

FIGURE E.1-27 REV 1, 09/82

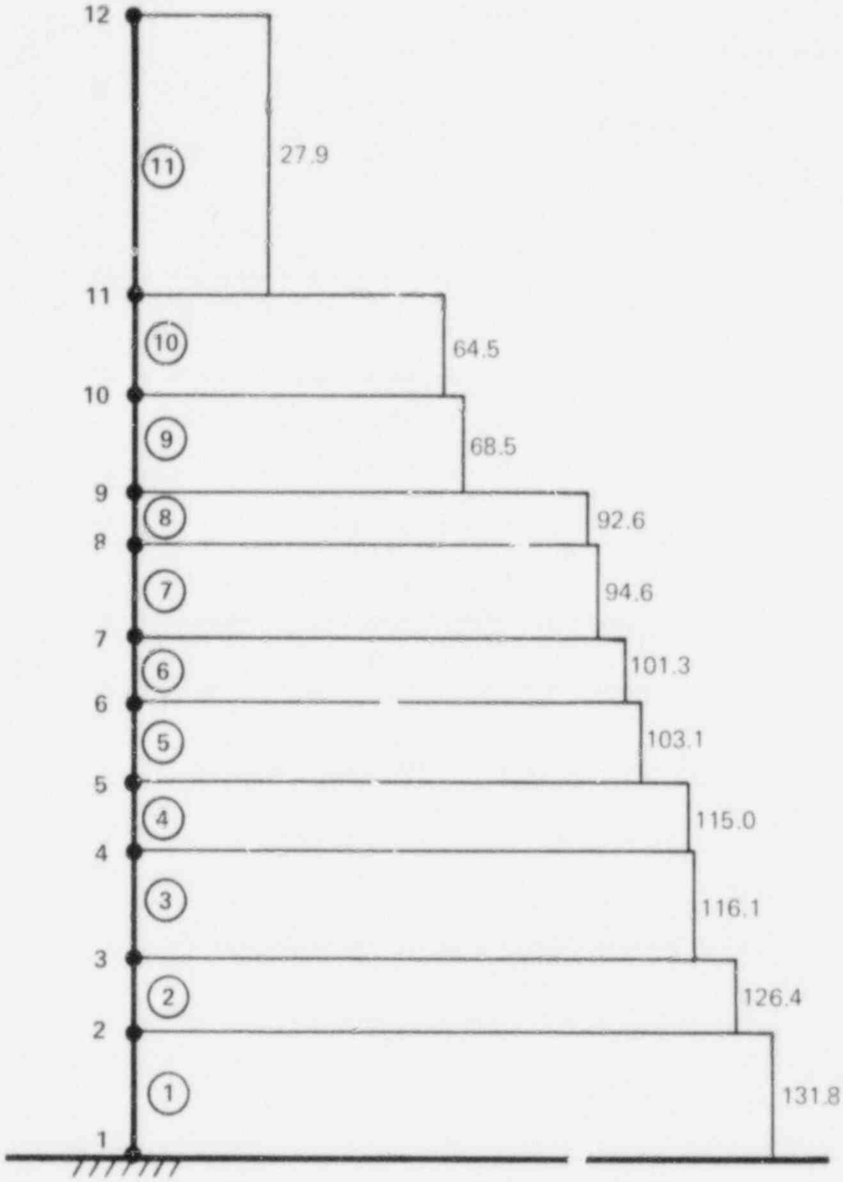


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE & CONTROL STRUCTURE E–W SHEAR FORCES
($\times 10^3$ KIPS)
OBE+SRV (2% DAMPING)

FIGURE E.1-28

REV 1, 09/82

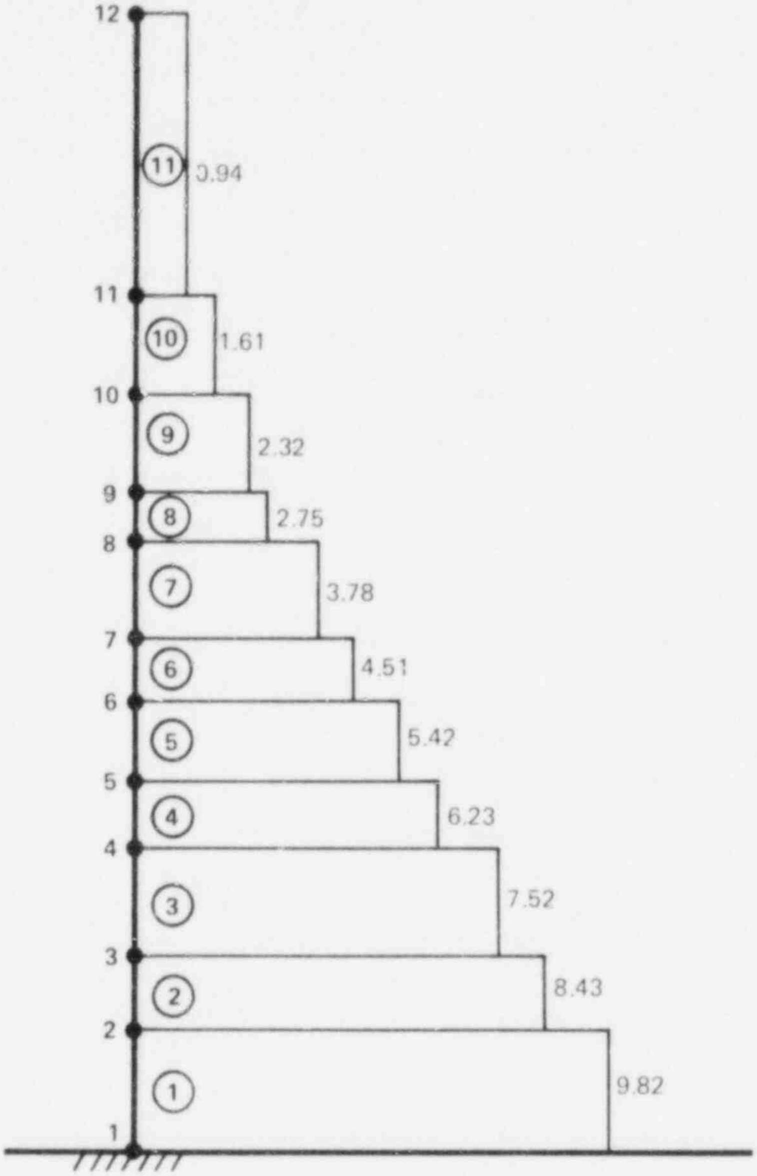


LIMERICK GENERATING STATION
UNITS 1 AND 2
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE & CONTROL STRUCTURE E–W SHEAR FORCES
($\times 10^3$ KIPS)
DBE+LOCA+SRV (5% DAMPING)

FIGURE E.1-29

REV 1, 09/82



LIMERICK GENERATING STATION
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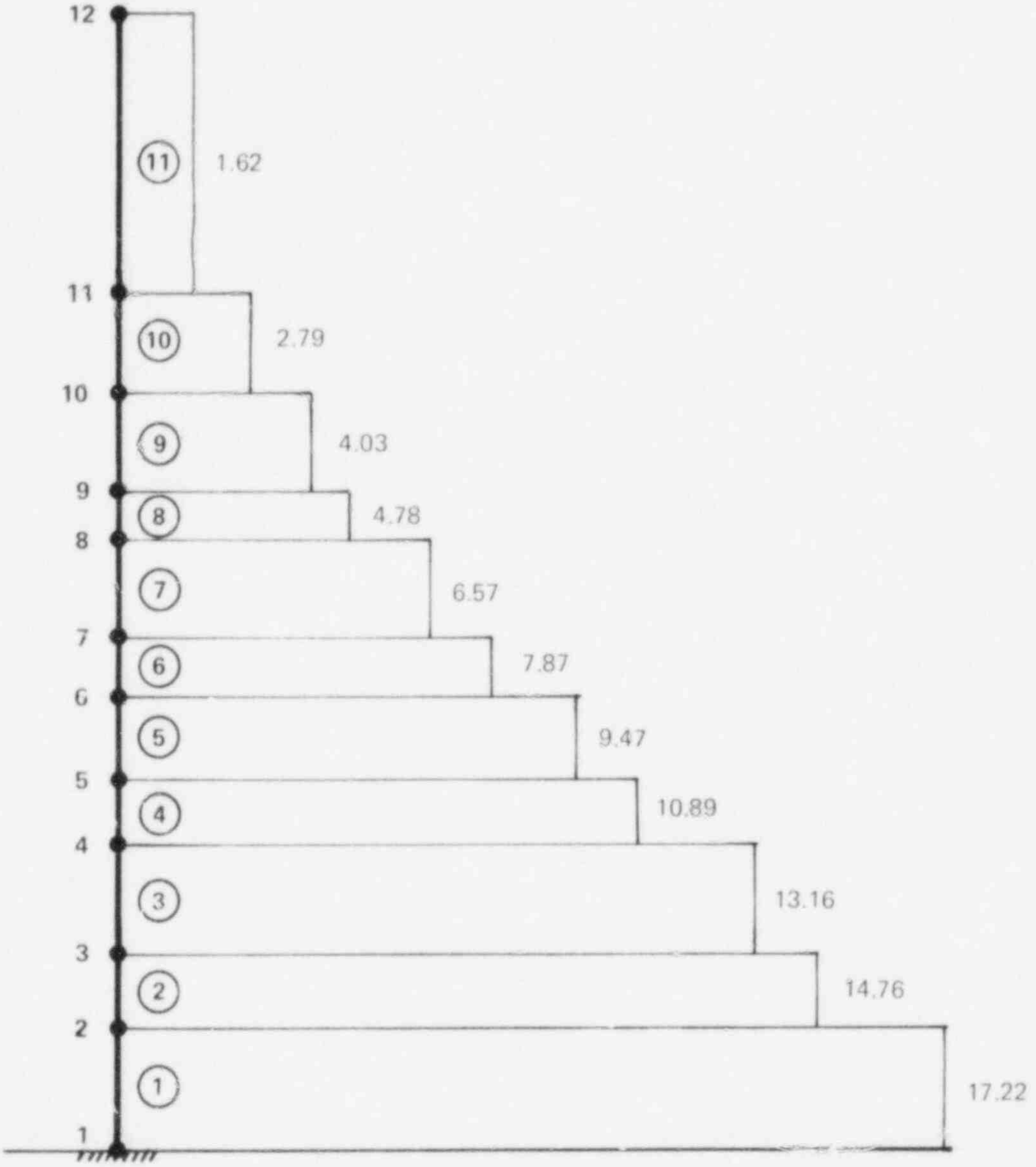
DESIGN ASSESSMENT REPORT

REACTOR ENCLOSURE & CONTROL STRUCTURE E–W OVERTURNING MOMENTS ($X10^6$ K-FT) OBE+SRV (2% DAMPING)

FIGURE E.1-30 REV. 1, 09/82



LIMERICK GENERATING STATION
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REACTOR ENCLOSURE &
CONTROL STRUCTURE
E-W OVERTURNING MOMENTS (X10^6 K-FT)
DBE+LOCA+SRV (5% DAMPING)

FIGURE E.1-31 REV.1, 09/82

REACTOR ENCLOSURE FLOOR SLABS

ELEMENT NUMBER	ELEVATION (FT)	SLAB THICKNESS (FT)	GOVERNING EQUATION(1)	REBAR(2) STRESS (KSI)	STRESS MARGIN (%)
1	201	1.5	1	13.13	75.7
2	201	2.5	1	30.55	43.4
3	217	1.5	7a	30.90	42.8
4	217	2.0	7a	27.70	48.7
5	253	1.25	7a	51.26	5.1
6	253	2.0	1	20.40	62.2
7	283	1.25	7a	42.74	20.9
8	283	2.75	1	28.13	47.9
9	313	1.75	1	30.52	43.5
10	313	2.0	7a	23.83	55.9
11	313	3.0	7a	28.16	47.9
12	333	1.25	1	21.22	60.7
13	333	1.67	1	15.47	71.4
14	352	2.0	7a	36.35	32.7
15	352	3.25	7a	11.18	79.3

NOTES: (1) Taken from Table 5.2-1 as follows:

Load Combination EQN 1 = 1.4D + 1.7L + 1.5 SRV
Load Combination EQN 7a = 1.0D + 1.0L + 1.0 ESS
+ 1.0 SRV + 1.0 LOCA

(2) Allowable Reinforcing Steel Stress = 54 KSI

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REACTOR ENCLOSURE MARGINS
FLOOR SLABS

FIGURE E.1-32 REV. 1, 09/82

REACTOR ENCLOSURE FLOOR STEEL BEAM(1)

ELEMENT NUMBER	ELEVATION (FT)	STEEL SIZE	GOVERNING EQUATION(2)	BENDING STRESS (KSI)	STRESS MARGIN(3) %
16	201	W27 x 145	1	23.00	4.2
17	201	W24 x 68	1	20.00	16.7
18	217	W33 x 141	1	21.90	8.6
19	217	W33 x 130	7	27.40	15.5
20	253	W24 x 76	1	22.66	5.6
21	253	W27 x 84	1	20.92	12.8
22	283	72" Girder	1	24.00	0.
23	283	W33 x 152	1	19.27	19.7
24	313	56" Girder	7	30.28	6.5
25	313	W36 x 300	7	29.44	9.1
26	331	W36 x 182	7	23.58	27.2
27	331	W21 x 73	7	20.31	37.3
28	352	W36 x 300	7	18.54	42.7
29	352	W24 x 68	7	16.94	47.7

NOTES: (1) All beams are A-36 steel.

(2) Taken from Table 5.3-1 as follows:

Load Combination EQN 1 = D + L + SRV
Load Combination EQN 7 = D + L + E'+ SRV + LOCA

(3) Allowable Bending Stresses for Governing Equations 1 and 7 are 24.0 KSI and 32.4 KSI, respectively.

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REACTOR ENCLOSURE MARGINS
FLOOR STEEL BEAM

FIGURE E.1-33 REV. 1, 09/82

REACTOR ENCLOSURE SUPPORTING COLUMNS

ELEVATION RANGE	LOCATION(1)	MATERIALS(2)	INTERACTION EQUATION	STRESS MARGIN%
177'-201'	29 & E	Steel	0.77	23
177'-201'	30.5 & E	Reinforced Concrete	-	8
201'-217'	29 & E	Steel	0.78	22
201'-217'	30.5 & E	Reinforced Concrete	-	1
217'-253'	30.5 & E	Steel	1.02	0
253'-283'	30.5 & E	Steel	0.88	12
283'-313'	30.5 & E	Steel	0.78	22
313'-333'	27.5 & E	Steel	0.97	3
313'-333'	30.5 & E	Steel	0.91	9
333'-352'	29 & E	Steel	0.65	35

NOTES: (1) Figure E.1-1 gives location reference

(2) For Steel Supports, Load Combination EQN (7) of Table 5.3-1 is used: D + L + E + LOCA + SRV + P.

For Reinforced Concrete Supports, Load Combination EQN (7) of Table 5.2-1 is used:
$D + L + E_o + LOCA + SRV + P_B$

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REACTOR ENCLOSURE MARGINS
SUPPORTING COLUMNS

FIGURE E.1-34

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REACTOR ENCLOSURE SHEAR WALLS

WALL ELEVATION (FT)	WALL MARK(1)	GOVERNING EQUATION(2)	COMBINED AXIAL & BENDING STRESS MARGIN (%) (3)	SHEAR STRESS MARGIN (%) (4)
177	Line 14.1	7a	67	1
177	Line 31.9	7a	67	1
177	D	7a	48	12
177	Line 23	7a	24	8
177	Line 21.5	7a	29	9

NOTES:

(1) Figure E.1-1 gives location reference

(2) Taken from Table 5.2-1 as follows:

Load Combination EQN 7a = D + L + Ess + SRV + LOCA

(3) Allowable Reinforcing Steel Stress = 54 KSI

(4) Allowable Reinforcing Steel Stress = 51 KSI

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REACTOR ENCLOSURE MARGINS
SHEAR WALLS

FIGURE E.1-35 REV. 1, 09/82

CONTROL STRUCTURE FLOOR SLABS

ELEMENT NUMBER	ELEVATION (FT)	SLAB THICKNESS (FT)	GOVERNING EQUATION(1)	REBAR STRESS(2) KSI	STRESS MARGIN (%)
30	200	1.5	1	14.47	73.2
31	200	6.0	1	37.64	30.3
32	217	1.25	1	14.15	73.8
33	237	1.0	1	31.10	42.4
34	237	1.0	1	30.89	42.8
35	254	1.0	1	27.86	48.4
36	269	1.5	1	12.15	77.5
37	289	1.5	1	10.26	81.0
38	304	1.0	1	22.95	57.5
39	332	1.5	1	16.92	68.7
40	332	2.0	1	41.4	23.3
41	350	1.5	1	16.65	69.2

NOTES: (1) Taken from Table 5.2-1 as follows:

Load Combination EQN 1 = 1.4D + 1.7L + 1.5 SRV

(2) Allowable Reinforcing Steel Stress = 54 KSI

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CONTROL STRUCTURE MARGINS
FLOOR SLABS

FIGURE E.1-36 REV. 1, 09/82

CONTROL STRUCTURE FLOOR STEEL BEAM(1)

ELEMENT NUMBER	ELEVATION (FT)	STEEL SIZE	GOVERNING EQUATION(2)	BENDING STRESS (KSI)	STRESS MARGIN(3) %
42	200	W24 x 130	1	23.78	0.9
43	217	W30 x 210	7	29.90	7.7
44	237	W36 x 300	7	27.60	14.8
45	254	W36 x 245	7	28.80	11.1
46	269	42" Girder	7	25.53	21.2
47	289	W36 x 160	7	27.90	13.9
48	304	W36 x 194	7	30.00	7.4
49	332	38" Girder	7	24.80	23.5
50	350	W18 x 105	7	10.30	68.2

NOTES: (1) All beams are A-36 steel.

(2) Taken from Table 5.3-1 as follows:

Load Combination EQN 1 = D + L + SRV
Load Combination EQN 7 = D + L + E' + SRV + LOCA

(3) Allowable bending stresses for governing equations 1 and 7 are 24.0 KSI and 32.4 KSI, respectively.

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CONTROL STRUCTURE MARGINS
FLOOR STEEL BEAM

FIGURE E.1-37 REV. 1, 09/82

CONTROL STRUCTURE SHEAR WALLS

WALL ELEVATION (FT)	WALL MARK	GOVERNING EQUATION(2)	COMBINED AXIAL & BENDING STRESS MARGIN (%)(3)	SHEAR STRESS MARGIN (%)(4)
177	Mh	7a	2	12
200	Mh	7a	39	2
269	J	1	44	24
239	J	1	48	19
177	Line 19.4	7a	23	0
239	Line 19.4	1	3.4	24
177	Line 26.6	7a	28	0

NOTES: (1) Figure E.1-1 gives location reference.

(2) Taken from Table 5.2-1 as follows:

Load Combination EQN 1 = 1.4D + 1.7L + 1.5 SRV
Load Combination EQN 7a = 1.0D + 1.0L + 1.0 E_{SS} + 1.0 SRV + 1.0 LOCA

(3) Allowable Reinforcing Steel Stress = 54 KSI
Allowable Concrete Compressive Stress = 2.8 KSI

(4) Allowable Reinforcing Steel Stress = 51 KSI

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CONTROL STRUCTURE MARGINS
SHEAR WALLS

FIGURE E.1-38 REV. 1, 09/82

CONTROL STRUCTURE STEEL PLATFORM (1)

ELEMENT NUMBER	ELEVATION (FT)	STEEL GRADE	GOVERNING EQUATION(2)	BENDING STRESS (KSI)	STRESS MARGIN(3) (%)
51	313	W10x21	2	14.7	38.8
52	313	W12x27	2	18.9	21.3
53	322	W12x27	2	10.7	55.4
54	340	W8x24	2	10.0	58.3
55	350	W8x24	2	17.6	26.7
56	350	W10x54	2	10.6	55.8

NOTES: (1) All beams are A-36 steel.
(2) Allowable bending stress = 24 KSI
(3) Taken from Table 5.3-1 as follows:

Load Combination EQN 2 = D + L + To + SRV

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CONTROL STRUCTURE MARGINS
STEEL PLATFORM

FIGURE E.1-39 REV. 1, 09/82