VOGTLE ELECTRIC GENERATING PLANT

GEORGIA POWER COMPANY

CONTAINMENT INTERNAL STRUCTURE
DESIGN REPORT

Prepared

by

Bechtel Power Corporation, Los Angeles, California

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VEGP-CONTAINMENT INTERNAL STRUCTURE
DESIGN REPORT

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Nomenclature and Abbreviations

ACI - American Concrete Institute
AISC - American Institute of Steel Construction
AISI - American Iron and Steel Institute
ASME - American Society of Mechanical Engineers
ASTM - American Society of Testing Materials
AWS - American Welding Society
HVAC - Heating, Ventilating, and Air Conditioning
IAD - Interaction Diagram
ISI - In-Service Inspection
MSLB - Main Steam Line Break
NSSS - Nuclear Steam Supply System
OBE - Operating Basis Earthquake
PSW - Primary Shield Wall
RCP - Reactor Coolant Pump
RCS - Reactor Coolant System
RPV - Reactor Pressure Vessel
SSE - Safe Shutdown Earthquake
SSW - Secondary Shield Wall

VEGP-CONTAINMENT INTERNAL STRUCTURE
DESIGN REPORT

1.0 INTRODUCTION

The Nuclear Regulatory Commission Standard Review Plan, NUREG-0800, requires the preparation of design reports for Category 1 structures.

This design report represents one of a series of 11 design reports and one seismic analysis report prepared for the Vogtle Electric Generating Plant (VEGP). These reports are listed below:

- Containment Building Design Report
- Containment Internal Structure Design Report
- Auxiliary Building Design Report
- Control Building Design Report
- Fuel Handling Building Design Report
- NSCW Tower and Valve House Design Report
- Diesel Generator Building Design Report
- Auxiliary Feedwater Pumphouse Design Report
- Category 1 Tanks Design Report
- Diesel Fuel Oil Storage Tank Pumphouse Design Report
- Category 1 Tunnels Design Report
- Seismic Analysis Report

The Seismic Analysis Report describes the seismic analysis methodology used to obtain the acceleration responses of Category 1 structures and forms the basis of the seismic loads in all 11 design reports.

The purpose of this design report is to provide the Nuclear Regulatory Commission with specific design and construction information for the containment internal structure, in order to assist in planning and conducting a structural audit. Quantitative information is provided regarding the scope of the actual design computations and the final design results.

The report includes a description of the structure and its function, design criteria, loads, materials, analysis and design methodology, and a design summary of representative key structural elements, including the governing design forces.

2.0 DESCRIPTION OF STRUCTURE

The containment internal structures (internals) consist of the concrete and steel structures located inside the containment building (see figures 1, 2 and 3). The internals do not include any part of the pressure boundary, which is formed by the containment building liner plate attached to the basemat, shell, and dome. The design details of the containment building are provided in the Containment Building Design Report.

2.1 GENERAL DESCRIPTION

The internals include the primary shield wall, secondary shield and pressurizer compartment walls, refueling canal walls, fill slabs, operating floor, structural steel annulus structure, in-service inspection (ISI) platforms, polar crane runway girders, and anchorage embedments for the nuclear steam supply system (NSSS) equipment supports. The NSSS equipment is comprised of the reactor pressure vessel (RPV), steam generators, reactor coolant pumps (RCP), and the pressurizer.

In addition to providing support for the NSSS components and related equipment and systems (electrical, piping, and heating, ventilating, and air conditioning [HVAC]), the concrete internals provide radiation shielding, a means for the underwater transfer of fuel assemblies between the reactor and the fuel handling building, and protection for the containment pressure boundary liner plate from postulated accident-generated missiles. The structural steel internals provide convenient platform levels for access/egress, ISI, and plant maintenance.

2.2 LOCATION AND FOUNDATION SUPPORT

The polar crane runway girders are supported by the containment shell. The remaining containment internals are supported by the containment building basemat. The Containment Building Design Report describes the location of and foundation support for the containment building basemat.

2.3 GEOMETRY AND DIMENSIONS

The major portions of the concrete internals are located inside, but not attached to, the shell liner plate (70-foot-nominal-inside radius). These extend from the basemat liner plate at elevation 169'-0" up to a maximum elevation of 268'-0". This envelope encompasses all portions of the concrete internals except for the reactor cavity fill slab at elevation 143'-6".

The structural steel internals are supported by the concrete internals and the containment building basemat, and extend from the basemat fill slab at elevation 171'-9" up to a maximum elevation of 261'-0". This range of elevations encompasses all structural steel except for the ISI platforms in the reactor cavity and the polar crane runway girders which are located at approximately elevation 321'-0".

A more detailed description of the individual portions of the concrete and steel internals is provided in sections 2.4 and 2.6.

2.4 KEY STRUCTURAL ELEMENTS

2.4.1 Primary Shield Wall (PSW) and Reactor Cavity

The primary shield walls enclose and support the reactor pressure vessel. The shield walls provide radiation shielding during normal operation, maintenance, and inspection. The space within the primary shield walls, which extends down into the depressed portion of the basemat, is called the reactor cavity. The reactor pressure vessel, up to its flange, is located in this cavity. The primary shield wall and reactor cavity are illustrated in figures 4 through 6.

The primary shield is a quasi-cylindrical, reinforced concrete structure extending from the basemat at elevation 169'-0" to approximately elevation 194'-0". The walls are anchored into the containment basemat with reinforcing steel. Continuity of reinforcing steel across the basemat pressure boundary liner plate is achieved with B-series Cadweld splices welded to both sides of the thickened liner plate (see figure 7).

The primary shield wall is designed with a small vent area around the nozzles into the reactor cavity in order to limit the flow of steam/water into the annular space around the reactor pressure vessel (RPV). This design limits the differential pressure loadings on the RPV and thus on the RPV supports. An annular ring with eight access ports is provided in the primary shield wall extending above and below the nozzle elevation for providing access to nozzle welds for ISI. Primary loop pipe penetrations through the primary shield wall are provided with special restraints to limit the postulated nozzle break area.

2.4.2 Refueling Canal

The refueling canal is a stainless steel-lined passageway that extends from the reactor area to a point near the containment shell at the fuel transfer tube. During refueling operations, the canal is filled with borated water which provides biological shielding and permits the underwater transfer of fuel assemblies between the reactor pressure vessel and the fuel handling building. The canal also provides a laydown area for the reactor internals after their removal during refueling operations.

The refueling canal is a reinforced concrete structure with the entire interior surface lined with 1/4-inch-thick-stainless steel plate (see figures 4 and 5). The upward extension of the primary shield from elevation 194'-0" to the operating floor at elevation 220'-0" forms a portion of the canal. Outside the primary shield walls, walls extend from approximately elevation 182' to the operating floor, to form the remainder of the canal.

2.4.3 Secondary Shield Wall (SSW)

The secondary shield walls together with the refueling canal walls and primary shield walls form the four steam generator compartments. Each steam generator compartment houses and supports a steam generator, a reactor coolant pump (RCP), and nuclear steam supply piping. Additionally, the steam generator compartment walls provide radiation shielding during plant operation and maintenance.

The secondary shield is a series of reinforced concrete walls anchored into the containment basemat in a manner similar to the primary shield walls to allow for load transfer to the basemat (see figure 7). The configuration of the steam generator compartment changes at the operating floor (elevation 220'-0"), as shown in sheets 2 and 3 of figure 1, and extends up to elevation 238'-0".

2.4.4 Pressurizer Compartment

The pressurizer compartment houses and supports the pressurizer vessel, provides biological shielding during plant operation and maintenance, and provides protection for the containment pressure boundary liner plate from postulated accident-generated missiles.

The pressurizer compartment is a rectangular reinforced concrete structure built integrally with the secondary shield wall on the outside of the loop 4 steam generator compartment (see figures 1 and 4).

The pressurizer compartment walls are anchored into the containment basemat in a manner similar to the primary shield walls to allow for load transfer to the basemat (see figure 7). The pressurizer compartment extends from the basemat up to its roof elevation 268'-0" and has large vent areas in its walls, near the basemat and its roof, to provide for the venting of compartment pressure resulting from postulated pipe breaks.

2.4.5 Operating Floor

The operating floor at elevation 220'-0", shown in figure 1, sheet 3, is the main floor of the containment and serves as the primary work and laydown area during refueling operations. The operating floor is constructed mainly of reinforced concrete slabs which provide biological shielding and laydown areas. The slab interior to the SSW is supported by the refueling canal walls and the SSW. The slab exterior to the SSW is supported by the SSW and the structural steel annulus structure.

Structural steel with grating covers all four RCP hatches and all areas exterior to the SSW which are not concrete.

2.4.6 Fill Slabs

Fill slabs are reinforced concrete floors placed immediately on top of the containment pressure boundary floor liner plate. The fill slabs provide a working surface and protect the floor liner plate.

The major fill slab is 2 feet 9 inches thick with top of concrete elevation at 171'-9" (see figures 2 and 3) and protects the basemat liner plate. A minor fill slab is 11-3/4 inches thick with top of concrete at elevation 143'-6", and is provided to protect the basemat liner plate in the reactor cavity.

2.4.7 Structural Steel Annulus Structure

The structural steel annulus structure is a seven level platform structure occupying the annulus between the SSW and the containment shell. This structure provides support for piping, cable tray, HVAC duct, conduit, instrumentation and equipment. It additionally provides a convenient means for access/egress, ISI, and maintenance.

The floor framing at each level is supported by the SSW and by columns anchored into the fill slab at elevation 171'-9" (see figures 1, 2 and 3). At the operating floor, the structural steel floor framing is integrated with the concrete slabs to serve as the primary work and laydown area during refueling operations (see figure 1, sheet 3).

Above the operating floor, floor framing is provided at two levels to support the containment coolers, containment auxiliary coolers, preaccess filtration units, hydrogen recombiners, and their associated electrical and HVAC systems. The floor framing provided at four levels below the operating floor do not support large equipment. At each level, the floor framing is covered by grating, except for the lowest level and the concrete areas of the operating floor level.

2.5 MAJOR EQUIPMENT

The following is a list of the major equipment located within the containment building.

Equipment	Quantity Per Unit
Reactor pressure vessel	1
Reactor coolant pumps	4
Steam generators	4
Pressurizer	1
Pressurizer relief tank	1
Accumulator tanks	4
Refueling machine	1
Polar crane	1
Containment cooling units	8
Hydrogen recombiners	2
Auxiliary cooling units	2
Preaccess filtration units	2

Figures 1, 2, 3, 4, 8, and 15 show the configuration and location of the equipment listed above.

2.6 SPECIAL FEATURES

This section describes the NSSS equipment support systems and the polar crane runway.

2.6.1 Reactor Pressure Vessel (RPV) Support System

The RPV is supported by four seats under two hot leg and two cold leg nozzles which are spaced approximately 90 degrees apart in the primary shield wall. The RPV supports are designed in such a way as to provide for radial thermal growth of the reactor coolant system (RCS), including the RPV, but so as to restrain the vessel against lateral and torsional movement during a loss-of-coolant accident (LOCA). The vertical loads are carried by the support seats to the embedded steel weldments under each support, while the radial and tangential loads are carried by the embedded steel weldments in the primary shield wall placed radially and tangentially to the wall. Reactor pressure vessel support seats and the associated embedded weldments are shown in figures 5, 6, 8, and 9.

2.6.2 Steam Generator Support System

The steam generator support system is shown in figure 8. The steam generator is vertically supported by four steel columns, pinned at both ends and bolted to support pads on the vessel and basemat embeds (see figure 1, sheet 1, and figure 10). A pipe restraint is provided on the hot leg near the steam generator inlet nozzle to prevent the formation of a plastic hinge at the primary shield wall and to limit the break area for a steam generator inlet nozzle break. A lower lateral component support is supplied by bearing blocks and a steel beam which spans the inside of the compartment walls (see figures 4 and 11). The upper lateral component support (see figure 12) consists of a bearing ring located near the center of gravity of the steam generator. The bearing ring is in turn restrained by a combination of hydraulic snubbers and a hard stop in the direction of thermal growth, and by hard stops in the perpendicular direction. The steam generator is supported such that a main steam line or feedwater line break does not result in a break in the RCS or vice versa.

2.6.3 Reactor Coolant Pump Support System

The reactor coolant pump component supports consist of three steel columns, pinned at both ends and bolted to support pads on the pump and basemat embeds. Figures 4 and 8 show the general arrangement and design features. Horizontal steel tie rods, anchored to the primary and secondary shield walls, are provided for lateral support (see figure 13).

2.6.4 Pressurizer Support System

The pressurizer is supported on a steel ring bearing plate bolted to the flange of the pressurizer support skirt. This ring, in turn, rests on a structural steel frame which is attached to steel embeds in the pressurizer compartment walls (see figure 8, sheet 2, and figure 14, sheets 2, 3, and 4). The pressurizer is also supported laterally at an upper level by four stops projecting from embeds within the pressurizer compartment walls (see figure 14, sheet 1).

2.6.5 Polar Crane Runway

The polar crane runway is composed of a series of 37 box girders arranged in a circular pattern around the containment. A circular rail (67'-0" radius) sets on top of the runway box girders and has a top of rail elevation 321'-10-5/8" (see figures 2, 3, and 16). The runway box girders are supported by a series of 37 equally spaced brackets which are considered as an integral part of the pressure boundary liner plate system. The bracket design details are provided in the Containment Building Design Report.

3.0 DESIGN BASES

3.1 CRITERIA

The following documents are applicable to the design of the containment internals.

3.1.1 Codes and Standards

- American Concrete Institute (ACI). Building Code Requirements for Reinforced Concrete, Standard ACI 318-71 including the 1974 Supplement.
    - Applicable to all concrete components of the internals.
- American Institute of Steel Construction (AISC), Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings, adopted February 12, 1969, and including Supplements 1, 2, and 3.
    - Applicable to all steel components of the internals.

3.1.2 Regulations

- 10 CFR 50, Domestic Licensing of Production and Utilization Facilities.

3.1.3 General Design Criteria (GDC)

- GDC 1, 2, 4, 5, and 50 of Appendix A to 10 CFR 50 and 10 CFR 50.55a.

3.1.4 Industry Standards

Nationally recognized industry standards, such as American Society of Testing Materials (ASTM), American Concrete Institute (ACI), and American Iron and Steel Institute (AISI), are used to specify material properties, testing procedures, fabrication, and construction methods.

3.2 LOADS

The containment internals are designed for all credible loadings. The loads are listed and defined in Appendix A and supplemented as follows.

Wind loads (W), tornado loads (W_t), blast loads (B), and probable maximum precipitation loads (N) are not applicable to the design of the internals because of the protection provided by the containment building, which is a sealed structure.

3.2.1 Normal Loads

3.2.1.1 Dead Loads (D)

Dead loads include the weight of steel framing, roofs, floors, walls, cable trays, HVAC ducts, piping, and permanent equipment. The vertical and lateral static pressure of liquids is also considered a dead load.

The dead load of major permanent equipment is in accordance with the manufacturer's vendor data, drawings, reports, and criteria, if any.

Based upon the actual density and size of piping, cable tray, HVAC ducts and their respective supports, uniform dead loads are determined for each floor level of the structural steel annulus structure. An example of these uniform dead loads is given in figure 17.

3.2.1.2 Live Loads (L)

Live loads on the internals include floor loads, laydown loads during plant shutdown, and crane lifted loads.

The floor live loads vary depending on the location and material of the floor. For all grating areas including the operating floor, the live load is 150 psf. This is applied on all floor grating areas except where permanent equipment is bolted to the structural steel. For concrete laydown and non-laydown areas of the operating floor, the live load is 300 psf.

For concrete laydown areas of the operating floor, the laydown load (during plant construction or plant shutdown) is 1300 psf or the actual load, whichever is greater. The actual laydown loads are based on dead weights provided by the suppliers and are applied to areas designated for each laydown item.

A concentrated load of 5 kips is applied to beams and girders to maximize moment and shear to provide design margin for additional support and construction loads.

3.2.1.3 Operating/Shutdown Thermal Loads (T_o)

During normal plant operation, thermal effects are generated by the heat of the reactor and the attenuation of gamma and neutron radiation originating from the reactor core. By providing an insulation and cooling system, these effects are limited to a uniform increase in temperature.

3.2.1.4 Operating/Shutdown Pipe Reactions (R_o)

Pipe reactions and reactions of equipment supports on the internal structures due to equipment/pipe nozzle loads during normal operating or shutdown conditions are considered as R_o loads.

3.2.2 Severe Environmental Loads

3.2.2.1 Operating Basis Earthquake, OBE (E)

Based on the plant site geologic and seismologic investigations, the peak ground acceleration for OBE is established as 0.12g. The free-field response spectra and the development of horizontal and vertical floor accelerations and response spectra at the basemat and selected elevations of the internals are discussed in the Seismic Analysis Report. Table 1 provides the OBE horizontal and vertical floor accelerations.

Operating basis earthquake damping values, as percentages of critical, applicable to the containment internals are as follows.

Welded steel structures	2
Bolted steel structures	4
Reinforced concrete structures	4

Hydrodynamic loads on the refueling canal walls and floor due to an OBE event during refueling are considered part of the OBE loading. The hydrodynamic loads are determined based upon reference 1 (section 8.0).

Operating basis earthquake seismic reactions for equipment are in accordance with the manufacturer's seismic qualification reports.

3.2.3 Extreme Environmental Loads

3.2.3.1 Safe Shutdown Earthquake, SSE (E')

Based on the plant site geologic and seismologic investigations, the peak ground acceleration for SSE is established as 0.20g. The free-field response spectra and the development of horizontal and vertical floor accelerations and response spectra at the basemat and selected elevations of the internals are discussed in the Seismic Analysis Report. Table 1 provides the SSE horizontal and vertical floor accelerations.

Safe shutdown earthquake damping values, as percentages of critical, applicable to the containment internals are as follows.

Welded steel structures	4
Bolted steel structures	7
Reinforced concrete structures	7

Hydrodynamic loads on the refueling canal walls and floor due to an SSE event during refueling are not applicable since the plant is shutdown.

Safe shutdown earthquake seismic reactions for equipment are in accordance with the manufacturer's seismic qualification reports.

3.2.4 Abnormal Loads

3.2.4.1 Accident Pressure (P_a)

The subcompartment walls of the containment internals (principally, the primary shield walls, the steam generator compartment walls, and the pressurizer compartment walls) are designed to withstand the transient differential pressures due to any postulated high-energy line break.

3.2.4.2 Thermal Loads under Accident Conditions (T_a)

For the primary shield wall design, under LOCA conditions, the steady-state operating thermal gradient (T_o) is considered to act in conjunction with the accident pressure differential because the low thermal conductivity of the concrete prevents rapid changes in the temperature profile through the wall. The peak pressure differential is of short duration since equalization immediately begins to take place through the primary shield wall passages into the steam generator compartments and the free volume of the containment. As such, the initial temperature effects (T_a) due to a LOCA are considered negligible and the operating thermal effects (T_o) are used for design.

A similar situation occurs for the SSW and pressurizer compartment walls; therefore, T_a effects due to LOCA are considered negligible and the operating thermal effects (T_o) are used for design.

3.2.4.3 Pipe/Equipment Reactions (R_a)

Pipe reactions and reactions of equipment supports on the internal structures due to equipment/pipe nozzle loads under thermal conditions during postulated accident conditions are considered as R_a loads.

3.2.4.4 Pipe Rupture Loads (Y_j, Y_r, and Y_m)

The containment internals are designed to withstand the loads imparted on the structure by the postulated high-energy line breaks.

3.3 LOAD COMBINATIONS AND STRESS/STRENGTH LIMITS

The load combinations and allowable stress limits for structural steel and strength limits for concrete are as listed in Appendix B.

As previously discussed, wind loads (W), tornado loads (W_t), blast loads (B), and probable maximum precipitation loads (N) are not applicable to the containment internals; therefore, these loading terms are excluded from the load combinations listed in Appendix B.

3.4 MATERIALS

The following materials and material properties are used in the design of the containment internals.

3.4.1 Concrete

• Compressive strength	$f'_c = 5$ ksi
• Modulus of elasticity	$E_c = 3{,}865$ ksi
• Shear modulus	$G = 1{,}610$ ksi
• Poisson's ratio	$\nu = 0.17 - 0.25$

3.4.2 Reinforcement - ASTM A615, Grade 60

• Minimum yield stress	$F_y = 60$ ksi
• Minimum tensile strength	$F_{ult} = 90$ ksi
• Minimum elongation	7 to 9% in 8 inches

3.4.3 Structural Steel

3.4.3.1 ASTM A36

• Minimum yield stress	$F_y = 36$ ksi
• Minimum tensile strength	$F_{ult} = 58$ ksi
• Modulus of elasticity	$E_s = 29{,}000$ ksi

3.4.3.2 ASTM A500, Grade B Structural Tubing

• Minimum yield stress	F_y = 46 ksi
• Minimum tensile strength	F_{ult} = 58 ksi
• Modulus of elasticity	E_s = 29,000 ksi

3.4.3.3 ASME SA-516, Grade 70

• Minimum yield stress	F_y = 38 ksi
• Minimum tensile strength	F_{ult} = 70 ksi
• Modulus of elasticity	E_s = 29,000 ksi

3.4.3.4 ASME SA-537, Class 1 (2-1/2 inch thickness and less)

• Minimum yield stress	F_y = 50 ksi
• Minimum tensile strength	F_{ult} = 70 ksi
• Modulus of elasticity	E_s = 29,000 ksi

3.4.3.5 ASTM A588 (4 inch thickness and less)

• Minimum yield stress	F_y = 50 ksi
• Minimum tensile strength	F_{ult} = 70 ksi
• Modulus of elasticity	E_s = 29,000 ksi

3.4.4 Structural Bolts

The following bolts are used in structural steel connections in the internals. The minimum yield stress and minimum tensile stress vary depending on the bolt diameter and the values used are in accordance with the appropriate edition of the specification.

3.4.4.1 ASTM A325 (1/2 inch to 1 inch diameter inclusive)

• Minimum yield stress	F_y = 92 ksi
• Minimum tensile strength	F_{ult} = 120 ksi

3.4.4.2 ASTM A325 (1-1/8 inch to 1-1/2 inch inclusive)

• Minimum yield stress	F_y = 81 ksi
• Minimum tensile strength	F_{ult} = 105 ksi

3.4.4.3 ASTM A354, Grade BD (2-1/2 inch diameter and less)

- Minimum yield stress $F_y = 130$ ksi
- Minimum tensile strength $F_{ult} = 150$ ksi

3.4.4.4 ASTM A490

- Minimum yield stress $F_y = 130$ ksi
- Minimum tensile strength $F_{ult} = 150$ ksi

3.4.5 Steel Liner Plate

3.4.5.1 ASTM A240, Type 304L (Stainless steel refueling canal liner plate)

- Minimum yield stress $F_y = 25$ ksi
- Minimum tensile strength $F_{ult} = 70$ ksi
- Modulus of elasticity $E_s = 29,000$ ksi

3.4.5.2 ASTM A36 (Carbon steel primary shield 1/4 inch thick liner plate)

- Minimum yield stress $F_y = 36$ ksi
- Minimum tensile strength $F_{ult} = 58$ ksi
- Modulus of elasticity $E_s = 29,000$ ksi

3.4.5.3 ASTM A537, Class 1 (Carbon steel primary shield 5/8 inch and 1 inch thick liner plate)

- Minimum yield stress $F_y = 50$ ksi
- Minimum tensile strength $F_{ult} = 70$ ksi
- Modulus of elasticity $E_s = 29,000$ ksi

3.4.6 Anchor Bolts and Headed Anchor Studs

3.4.6.1 ASTM A36 and ASME SA-36

- Minimum yield stress $F_y = 36$ ksi
- Minimum tensile strength $F_{ult} = 58$ ksi

3.4.6.2 ASTM A108

- Minimum yield stress $F_y = 50$ ksi
- Minimum tensile strength $F_{ult} = 60$ ksi

3.4.6.3 ASTM A193, Grade B7 (2-1/2 inch diameter and less)

- Minimum yield stress $F_y = 105$ ksi
- Minimum tensile strength $F_{ult} = 125$ ksi

3.4.6.4 ASTM A307

- Minimum yield stress is not applicable
- Minimum tensile strength $F_{ult} = 60$ ksi

3.4.6.5 ASTM A320, Grade B8, Class 1

- Minimum yield stress $F_y = 30$ ksi
- Minimum tensile strength $F_{ult} = 75$ ksi

3.4.6.6 ASTM A354, Grade BD (2-1/2 inch diameter and less)

- Minimum yield stress $F_y = 130$ ksi
- Minimum tensile strength $F_{ult} = 150$ ksi

3.4.6.7 ASME SA-540, Grade B23

A. Class 1

  - Minimum yield stress $F_y = 150$ ksi
  - Minimum tensile strength $F_{ult} = 165$ ksi

B. Class 2

  - Minimum yield stress $F_y = 140$ ksi
  - Minimum tensile strength $F_{ult} = 155$ ksi

C. Class 4

  - Minimum yield stress $F_y = 120$ ksi
  - Minimum tensile strength $F_{ult} = 135$ ksi

4.0 STRUCTURAL ANALYSIS

This section describes the structural analysis methodologies employed to determine design forces at key locations of the containment internals using the applicable loads and load combinations specified in section 3.0.

The structural analysis is performed either by manual or computer analysis. In the manual analysis, the building structure or sub-structure is considered as an assemblage of slabs, beams, walls, and columns and the analysis is performed using standard structural analysis techniques. In the computer analysis, the building structure or sub-structure is modeled as an assemblage of finite elements and the analysis is performed using the standard finite element method and the Bechtel Structural Analysis Program (BSAP), which is a general purpose computer program for linear-type finite element analyses. This program uses the direct stiffness approach to perform linear elastic analyses of one-, two-, or three-dimensional structural models.

For manual analyses, the analysis techniques, boundary conditions, and application of loads are provided to illustrate the method of analysis. For computer analyses, the finite element modeling techniques, boundary conditions, application of loads, and computer plots of the finite element model are provided to illustrate the overall method of analysis.

For both manual and computer analyses, representative results are provided to illustrate the overall behavior of the structure and the magnitude of design forces acting at the key locations.

4.1 PRIMARY SHIELD WALL (PSW)

4.1.1 Analysis Methodology and Computer Model

The primary shield wall is analyzed with the BSAP computer program using a three-dimensional fixed-base finite element model which represents the structure with seven layers of eight node brick elements (see figure 18). The openings in the PSW for the hot and cold leg NSSS piping are modeled as rectangular openings as shown in figure 18, sheets 1, 6, 7, and 9. The neutron detector slots are modeled as shown in figure 18, sheets 2, 3, and 4, to simulate the gaps in the interior face of the PSW. The steel bumpers for RPV lateral restraint are approximated by brick elements as shown in figure 18, sheet 5.

The refueling canal slab is not included in the PSW model, but the slab stiffness is represented with boundary elements (translational liner springs). The entire PSW model consists of 1,892 nodal points, 1,029 brick elements, 48 boundary elements, and 32 truss elements.

A static analysis is performed on 27 primary load cases described in the following section.

4.1.2 Application of Loads

Live loads (L) and piping loads (R_o and R_a) are insignificant for the PSW design and are excluded from the BSAP analysis. Pipe rupture missile loads (Y_m) affect localized areas only and are therefore excluded from the BSAP analysis.

A comparison between the OBE (E) and SSE (E') seismic events in conjunction with their appropriate load factors and load combinations results in the SSE event being excluded from the BSAP analysis because the load combinations which include OBE govern.

4.1.2.1 Dead Load (D)

The self weight of the modeled structural elements is accounted for by means of the element mass density input parameter. The weight of the reactor pressure vessel is accounted for by applying the Westinghouse supplied dead load reactions to the appropriate support locations. The reactions are applied to the model as nodal loads and brick surface pressure loads.

The dead load of the walls and floors attached to the PSW, but not included in the PSW model, is accounted for by using the results of the secondary shield wall (SSW) analysis. Since the nodes of the SSW and PSW analyses do not coincide, the nodal forces from the SSW analysis are redistributed to the appropriate PSW nodes based upon their tributary length.

4.1.2.2 Operating Basis Earthquake, OBE (E)

The accelerations on the PSW for this three directional seismic event are input as three separate primary load cases. Static equivalent accelerations for the vertical and two horizontal directions are applied to the mass of each individual element of the model based on the maximum accelerations applicable to the PSW.

The seismic loads on the PSW due to attached (but not modeled) walls and floors are accounted for by using the results of the SSW analysis. Since the nodes of the PSW and SSW analyses do not coincide, the nodal forces from the SSW analysis are redistributed to the appropriate PSW nodes based on their tributary length. The redistributed PSW three-directional nodal loads are included in the appropriate OBE primary load cases such that the directional characteristics of each load case are maintained.

The seismic reactions on the PSW due to the RPV are applied as nodal loads and brick surface pressure loads based upon Westinghouse supplied reactions. Due to the nature of the reactor pressure vessel seismic restraints and the geometry of the PSW, the horizontal seismic reactions are applied as four separate primary load cases (north, south, east, and west).

4.1.2.3 Accident Pressure Loading (P_a)

The subcompartment accident pressure loadings for the worst case break in each quadrant are analyzed as four separate primary load cases. A dynamic load factor of 1.2 is applied to all pressure differentials to account for the dynamic effect of this loading.

The pressure loads are applied to the interior compartments of the PSW as brick element surface pressure loads.

The Westinghouse supplied RPV support reactions induced by subcompartment pressurization are applied to the model as brick element surface pressure loads.

4.1.2.4 Operating Thermal Loads (T_o)

The operating temperature of the PSW concrete, excluding the reactor cavity, is basically a uniform 120 degrees through the wall thickness. The design concrete construction temperature is 70 degrees. Thus, a uniform temperature increase of 50 degrees is applied to all brick elements in the finite element model.

Additionally, thermal loads occur on the PSW due to the thermal growth of the reactor pressure vessel. These loads are applied to the model as either nodal loads or brick element surface pressure loads depending on the characteristics of the reactor pressure vessel support.

4.1.2.5 Accident Thermal Loads (T_a)

Due to the thickness of the PSW and the low thermal conductivity of the concrete, the worst case concrete thermal load will not act concurrently with the other abnormal loads. Since it takes a considerable amount of time before a significant concrete loading change due to T_a occurs, the operating thermal load (T_o) is used in conjunction with the accident loads.

4.1.2.6 Pipe Rupture Load (Y_r)

The PSW is subjected to LOCA induced RPV support reactions and hot and cold leg restraint reactions. The dynamic effects of these Westinghouse supplied reactions are considered in their dynamic analyses.

The reactor pressure vessel support reactions are applied to the model as nodal loads or brick element surface pressure loads. The hot and cold leg restraint reactions are applied as nodal loads to the appropriate nodes in the hot and cold leg PSW openings.

4.1.2.7 Pipe Rupture Load (Y_j)

A hot or cold leg break causes jet impingement loads on the inspection tunnel portion of the PSW. These jet impingement loads (envelope values for the hot/cold breaks in each quadrant are used) are applied to the model as brick element surface pressure loads.

Additionally, the above described jets impact the reactor pressure vessel. The Westinghouse supplied loads are applied to the model as nodal loads or brick element surface pressure loads depending on the characteristics of the reactor pressure vessel support.

A dynamic load factor of 1.2 is applied to all jet impingement loads to account for their dynamic effect.

4.1.3 Analysis Results

Resultant forces are evaluated at every point in the PSW. Analysis results are presented in this report for a selected number of key locations and other representative locations (see figure 19). Refer to table 2 for analysis results.

4.2 SECONDARY SHIELD WALL (SSW)

4.2.1 Analysis Methodology and Computer Model

The SSW, pressurizer compartment walls, the operating floor, and refueling canal walls/slab are analyzed with the BSAP computer program using a three dimensional fixed-base finite element model. The PSW and structural steel columns are also included in the model, but only to account for their stiffnesses since they are both analyzed by separate, more refined models. See figure 20, sheets 1 through 6, for the computer plots of this finite element model.

This model uses shell elements to represent all structural elements except for the structural steel columns and the concrete pressurizer column which are modeled using beam elements. The structural steel columns are shown in figure 20, sheet 6.

The entire model consists of 2,229 nodal points and 2,591 shell, boundary, and beam elements which results in 12,627 degrees of freedom. A static analysis is performed on 38 primary load cases as described in the following section.

4.2.2 Application of Loads

A comparison between the OBE and SSE seismic events in conjunction with their appropriate load factors and load combinations results in the SSE event being excluded from the BSAP analysis because the OBE event governs.

Pipe rupture missile loads (Y_m) affect localized areas only and are therefore excluded from the BSAP analysis.

4.2.2.1 Dead Load (D)

The self weight of the modeled structural elements is accounted for by means of the element mass density input parameter.

The dead loads for the steam generators, reactor coolant pumps, and reactor pressure vessel have little or no influence on the structural elements under analysis; hence, they are not considered. The Westinghouse supplied pressurizer dead load is distributed through the pressurizer support beams to the pressurizer compartment walls and is applied to the model as concentrated nodal loads.

The dead loads for the structural steel, grating, HVAC ducts, cable trays, piping, and equipment are accounted for by distributing the dead load mass to the affected nodes by conventional tributary area methods. See figure 17 for sample floor dead loads on structural steel.

4.2.2.2 Live Load (L)

The live load on the concrete portions of the operating floor is applied to the slab plate elements as downward acting pressure loads. The live loads on the structural steel grating areas are applied to the model as concentrated nodal loads determined by distributing the load to the affected nodes by conventional tributary area methods.

NSSS equipment laydown loads (occurring only during refueling) are applied to the appropriate operating floor nodes as concentrated forces. All other non-laydown areas of the operating floor have the normal concrete slab live loads applied concurrently with the laydown loads.

4.2.2.3 Operating Thermal Loads (T_o)

The operating temperature of the concrete internal structures is basically 120 degrees uniform through the wall/slab thickness. The design concrete construction temperature is 70 degrees. Thus, a uniform temperature increase of 50 degrees is applied to all concrete elements of the model.

4.2.2.4 Operating/Shutdown Pipe Reactions (R_o)

Individual pipe support loads are insignificant with respect to the overall structural response and are excluded from the BSAP analysis. However, the pressurizer applies a significant load (induced by operating thermal load) into the lower pressurizer support. This Westinghouse supplied load is distributed through the support beams to the pressurizer compartment walls and is applied to the model as concentrated three directional nodal loads.

4.2.2.5 Operating Basis Earthquake, OBE (E)

The accelerations on the structural elements for this three-directional seismic event are input as three separate primary load cases. Static equivalent accelerations for the vertical and two horizontal directions are applied to the mass of each individual element and to the dead load mass (structural steel, grating, HVAC ducts, cable trays, piping and equipment) which is distributed to the affected nodes as discussed in the dead load section.

The loads on the structure due to the seismic accelerations on the 25 percent live load (that is assumed to exist during a seismic event) are applied to the model as either shell element pressure loads or nodal loads.

The structural responses for the three-directional seismic loads discussed above are combined by the Square Root of the Sum of the Squares (SRSS). The SRSS results are then combined with the NSSS equipment seismic loads by the Absolute Sum method. The NSSS loads, supplied by Westinghouse, are applied to the model as concentrated loads applied to the nodes corresponding to the concrete/support interface.

The control rod drive mechanism (CRDM) tie rods provide lateral support to the reactor integrated head during a seismic event. These Westinghouse supplied loads are applied to the appropriate operating floor nodes as concentrated forces.

The hydrodynamic loads due to a seismic event occurring during refueling are applied to the refueling canal walls/slab as pressure loads. The hydrostatic loads are conservatively lumped in with the hydrodynamic loads. This is conservative because the load factor for this hydrodynamic load is 1.9, whereas the load factor the hydrostatic load is 1.4.

4.2.2.6 Accident Pressure (P_a)

Five worst case accident pressures are investigated. Three of these cases involve LOCAs in the lower steam generator compartments. The other two cases involve the worst case break in the upper steam generator compartment and the worst case break in the pressurizer compartment. Dynamic load factors of 1.2 are applied to all pressures, and the pressures are applied to the finite element model as nodal loads and plate element pressure loads.

4.2.2.7 Accident Thermal Loads (T_a)

Due to the thickness of the concrete walls/slabs and the low thermal conductivity of the concrete, the worst case thermal load will not act concurrently with the other abnormal loads. Since it takes a considerable amount of time before a significant concrete loading change due to T_a occurs, the operating thermal load (T_o) is used in conjunction with the accident loads.

4.2.2.8 Accident Pipe/Equipment Reactions (R_a)

NSSS equipment loads, supplied by Westinghouse, due to nozzle loads induced by thermal conditions for postulated accident cases occur on the upper and lower steam generator supports, and reactor coolant pump tie rods. These loads are applied to the finite element model as concentrated nodal loads.

During normal operation, air flows down the airshafts from the containment coolers. During a LOCA, the airshaft flow reverses which results in the immediate closure of the backdraft dampers located at the top of the airshafts (elevation 220'-0"). The resultant uplift load is applied to the operating floor as concentrated nodal loads. A dynamic load factor of 1.2 is applied to the uplift loads.

4.2.2.9 Pipe Rupture Jet Impingement Loads (Y_j)

Seven jet impingement loads are investigated as the worst case loadings on various structural walls. Four of these involve postulated primary loop breaks. Two cases involve postulated main steam line breaks, and one case involves a postulated main feedwater break.

The jet impingement cases are input as seven separate primary load cases. Dynamic load factors of 1.2 are applied to all jet impingement loads, and these final loads are applied to the finite element model as plate element pressure loads.

4.2.2.10 Pipe Rupture Restraint Loads (Y_r)

Eleven separate primary load cases are investigated to account for pipe whip restraint reactions or NSSS equipment reactions caused by a postulated pipe break. All loads are applied to the model as concentrated nodal loads.

The worst case loads for the steam generator (upper and lower lateral supports), reactor coolant pump tie rods, and pressurizer (upper and lower supports) are all investigated and these loads are combined with the applicable jet impingement load cases.

Five of the eleven primary load cases involve possible worst case pipe whip restraint reactions. Of these, four cases are for main steam line restraints and one case is for a main feedwater line restraint.

4.2.3 Analysis Results

Resultant forces are evaluated at every point in the SSW, pressurizer compartment walls, refueling canal walls and slab, and selected portions of the operating floor. Analysis results are presented in this report for a selected number of key locations and other representative locations (see figure 21). Refer to table 3 for the analysis results.

4.3 STRUCTURAL STEEL ANNULUS STRUCTURE

4.3.1 Analysis Methodology

The structural steel framing described in section 2.4.7 consists of girders, beams, columns, and horizontal and vertical bracing.

Horizontal bracing is analyzed manually using standard pinned-end truss techniques. Vertical bracing and the associated columns are analyzed by the BSAP computer program on a two-dimensional model which encompasses all seven levels of the annulus structure. Appropriate end boundary conditions are selected consistent with the end connections of each member.

Girders and beams are designed manually using standard beam formulas for determining moments and shears. The beams and girders are analyzed as simply supported members (horizontally and vertically) which is representative of the boundary conditions at their support points.

4.3.2 Application of Loads

An evaluation of load magnitudes, load factors, and load combinations is performed to determine the load combination that governs the design. It is determined that load combination equation 5, as specified in Table B.2 in Appendix B, governs over all other load combinations.

4.3.2.1 Dead Load (D)

The uniform dead loads as discussed in section 3.2.1.1 and as shown in figure 17 (example uniform dead load intensities for elevation 207'/210') are converted to equivalent beam linear loads using the tributary area method.

4.3.2.2 Live Load (L)

The grating floor loads discussed in section 3.2.1.2 are converted from uniformly distributed floor loads to equivalent linear beam loads using the tributary area method. To provide additional design margin, a 5 kip concentrated load is applied to each beam/girder to maximize design shear and moment.

4.3.2.3 Piping Loads (R_o)

Piping loads are applied to the beams/girders in all three orthogonal directions (local to the member). These loads are based upon the worst design case between concentrated loads versus uniform loads.

4.3.2.4 Operating Basis Earthquake, OBE (E)

Three-directional seismic loads are applied to the beams/girders based upon multiplying the beam/girder tributary mass (all dead load plus 25 percent live load) by the maximum floor acceleration at that level.

Member axial loads due to truss action of the framing system and local torsional effects due to the eccentric application of horizontal seismic loads (horizontal seismic loads due to grating dead load plus 25 percent floor live load are applied to the top flange) are also considered.

4.3.3 Analysis Results

Resultant forces are evaluated for the critical member (i.e., the longest, most heavily loaded) for each member size. Analysis results are presented for two key girders and one key column.

The key members include a built-up box girder at elevation 184'-0", a girder which supports large equipment loads, and a column (which supports large equipment and is part of a vertical truss subsystem). The analysis results for the governing load combination are presented in table 4.

4.3.4 Three-Dimensional Confirmatory Analysis

A confirmatory analysis of the main structural steel is performed to evaluate the global effects of the annulus structure on the design of key structural members and to verify the column reaction forces at the fill slab.

4.3.4.1 Analysis Methodology and Computer Model

The analysis is performed by the BSAP computer program using a three-dimensional finite element model which models the steel columns, girders, beams, bracing, and the concrete slabs at the operating floor (see figure 22). Figure 22, sheet 1, shows a typical framing plan below the operating floor (elevation 210'-0", north half) and the north half of the operating floor framing plan (elevation 220'-0").

Figure 22, sheets 2 and 3, shows the framing at the upper two equipment levels (north half is shown, south half is similar). The upper plot on each sheet shows how the equipment is accounted for in the finite element model.

The steel columns, girders, beams, and bracing are modeled with beam elements. Member end releases are employed to properly depict the end conditions of each member. The major equipment is modeled with truss elements. The operating floor concrete slabs are modeled with plate elements.

The entire model consists of 1,778 nodes, 3,151 beam elements, 120 plate elements, and 78 truss elements. A static analysis is performed on all loads except the seismic loads for which a combined static and a response spectrum analysis is performed.

4.3.4.2 Application of Loads

4.3.4.2.1 Dead Load (D). The weight of each modeled structural element is accounted for by means of the element mass density input parameter. All other dead loads (permanent equipment and uniform floor loads) are applied to the members as uniform linear loads based upon the tributary area method.

4.3.4.2.2 Live Load (L). Uniform floor live loads on grating areas are converted to equivalent uniform linear loads based upon the tributary area method. Uniform floor live loads on concrete areas of the operating floor are applied to the plate elements as pressure loads.

Operating floor laydown loads are applied to the plate elements as pressure loads.

4.3.4.2.3 Subcompartment Pressurization (P). Portions of the operating floor concrete slab areas are subjected to pressure loads due a main steam line break (MSLB). These loads are applied to the plate elements as pressure loads.

4.3.4.2.4 Seismic Loads, (E and E'). The mass due to dead loads (excluding structural dead load) and 25 percent of the floor live loads are manually lumped to the adjacent nodes based on the tributary area method. The mass of the structural members is calculated and lumped to nodal points automatically by the BSAP computer program. The three-directional seismic loads are calculated by BSAP based upon the maximum floor acceleration for the vertical and two horizontal directions.

4.3.4.2.5 Localized Loads. Loads which influence only localized areas of the structural steel framing are not included as primary load cases for the three-dimensional model BSAP finite element analysis. For example, pipe rupture loads (Y_j, Y_r, and Y_m) are not included since only one break is postulated to occur at a time and the effect of the pipe rupture load is localized. These localized effects are analyzed manually and the results superimposed with the computer analysis results.

Adjustments in the layout of the structural steel framing are made to avoid interaction between structural members and the jet impingement zones of influence from postulated pipe breaks for the two largest high energy lines (i.e., main steam and main feedwater) outside the SSW. Jet impingement loads from smaller line breaks are accommodated by the load resisting capabilities (three orthogonal directions) of the framing and by the allowable stress increases shown in Table B.2 of Appendix B.

4.3.4.3 Results for Three-Dimensional Confirmatory Analysis

Representative analysis results are provided in table 5.

4.4 OPERATING FLOOR

As shown in figure 1, sheet 3, the operating floor consists of concrete slab areas and structural steel framing with grating areas. All structural steel areas are analyzed as discussed in section 4.3. Selected concrete slab areas are analyzed by computer as part of the SSW BSAP finite element analysis (see section 4.2 and figure 20). The remaining concrete slabs are analyzed manually.

4.4.1 Analysis Methodology

A typical, manually analyzed slab is at the reactor head laydown area. This slab is analyzed by conventional one-way or two-way slab techniques.

4.4.2 Application of Loads

An evaluation of load magnitudes, load factors, and load combinations is performed to determine the load combination that governs the reactor head laydown area slab. Due to the very large laydown load (live load), it is determined that load combination 3, Table B.1 of Appendix B, governs over all other load combinations.

$$1.4D + 1.7L + 1.9E \qquad (3)$$

The floor live load (applicable only to non-laydown areas) and slab dead load are applied as uniform loads. Laydown live loads are evaluated under two conditions as discussed in section 3.2.1.2. The slab is initially analyzed using a uniform laydown load of 1.3 ksf which is designated as an upperbound load which encompasses all credible refueling operation laydown loads. Secondly, the slab is analyzed with the actual integrated reactor head laydown loads as supplied by Westinghouse. These actual loads consist of the integrated head dead weight and the resultant seismic loads should an OBE event occur during refueling. The actual loads are then applied to the six support pedestals.

4.4.3 Analysis Results

The analysis results for the governing load combination are presented in table 6.

4.5 NSSS SUPPORTS/ANCHORAGES

NSSS supports/anchorages (see figures 4, 5, 6, and 8 through 14) are analyzed either manually (RPV, RCP, steam generator, and upper pressurizer support anchorage) or by the BSAP computer program (lower pressurizer support/anchorage). The pressurizer supports/anchorages are discussed herein since the upper support anchorage is representative of the NSSS anchorage manual analyses and the lower support represents a computer analysis method.

4.5.1 Analysis Methodology

4.5.1.1 Upper Pressurizer Support Anchorage

This support provides lateral restraint only (no vertical restraint). The support (see figure 8, sheet 2, and figure 14, sheet 1) is analyzed, designed, and provided by Westinghouse. The anchorage, provided by Bechtel, is analyzed using the Westinghouse supplied reactions. Conventional manual techniques are used to analyze all anchorage components.

4.5.1.2 Lower Pressurizer Support/Anchorage

This support (see figure 8, sheet 2, and figure 14 sheets 2, 3, and 4) provides both lateral and vertical restraint. The steel support frame and anchorages are analyzed and designed by Bechtel using Westinghouse supplied pressurizer reactions. The frame is analyzed with the BSAP computer program using two finite element models as shown in figure 14, sheets 5 and 6.

The model shown in figure 14, sheet 5, (hereafter termed the "pressurizer stiffness model") takes into consideration the stiffness of the pressurizer by using the rigid link (multipoint constraint) method. The master node corresponds to the vertical centerline of the pressurizer vessel. The finite element model has a total of 16 beam elements and 25 nodes.

The second model (figure 14, sheet 6), hereafter termed the "local effect model", conservatively ignores the stiffness provided by the pressurizer, but takes into consideration the local effects (i.e., torsion) caused by the vessel anchor bolt configuration. This model has a total of 40 beam elements and 44 nodes.

Boundary conditions for each model are selected which represent the actual connection details.

4.5.2 Application of Loads

4.5.2.1 Upper Pressurizer Support Anchorage

The Westinghouse supplied reactions include the axial force, shear force, and bending moment at the face of the anchorage. These reactions include the effects of dead load, thermal load, seismic load, and pipe rupture load.

4.5.2.2 Lower Pressurizer Support/Anchorages

The Westinghouse supplied reactions at the base of the pressurizer (skirt flange) are distributed to the support frame based on the bolts pattern. These reactions include the effects of dead load, thermal load, seismic load, and pipe rupture load.

Loads are applied to the "pressurizer stiffness model" as concentrated nodal forces at the pressurizer center of gravity node. Loads are applied to the "local effect model" as concentrated forces at the nodes corresponding to the anchor bolt locations. For both models, the self weight of the support frame is accounted for by means of the element mass density input parameter.

4.5.3 Analysis Results

The governing load combination is equation 11 from Appendix B, tables B.1 (for concrete design) and B.2 (for steel design).

4.5.3.1 Upper Pressurizer Support Anchorage

The analysis results for the governing load combination are presented in figure 23.

4.5.3.2 Lower Pressurizer Support/Anchorage

The analysis results for the governing load combination are presented in figure 24.

4.6 POLAR CRANE SUPPORT SYSTEM

The polar crane support system described in section 2.6.5 consists of the runway box girders (which directly support the polar crane) and the brackets (which support the runway box girders). The brackets are anchored into the containment shell and are discussed in the Containment Building Design Report, whereas the runway box girders are entirely inside of the pressure boundary and are discussed in this design report.

4.6.1 Analysis Methodology

A typical girder (all 37 girders are identical) is presented in figure 16. A manual calculation is performed using standard beam formulas for determining girder moments and shears. The girder is analyzed as a simply supported beam (horizontally and vertically) which is representative of the boundary conditions, at its support points.

4.6.2 Application of Loads

Most of the loads listed in section 3.2 are not applicable to the girder due to its location, design features, etc. For example, pressure loads are not applicable since vents (see figure 16) are provided to equalize this loading. The load combinations listed in Table B.2 of Appendix B reduce to the following:

	Equation
D + L (construction lift with impact)	1
D + L (service lift) + E	2
D + L (service lift) + E'	7

All loads listed above (excluding construction lift with impact) are obtained from the supplier's seismic report. The governing girder design loads occur when the polar crane trolley is positioned at its "end-of-travel", (main hook is 12 feet from the runway rail centerline). The polar crane wheels and seismic restraints are positioned such that the resultant shears, moments, and torsion on the girder are maximized.

The dead load of the runway box girder and its associated three component seismic inertia loads are additionally considered in the total applied load on the girder.

An evaluation of load magnitudes, load factors and applicable load combinations is performed to determine the governing load combination for the analysis and design of the girder. It is determined that load combination equation 2 containing OBE governs; therefore, all other load combinations are excluded from further consideration.

4.6.3 Analysis Results

The analysis results for the governing load combination are presented in figure 25.

5.0 STRUCTURAL DESIGN

This section provides the design methodology and a summary of design results for selected critical structural elements. The structural elements are designed either manually or by computer in accordance with the applicable sections of the codes listed in section 3.1.1.

5.1 PRIMARY SHIELD WALL (PSW)

5.1.1 Design Methodology

The PSW (excluding shear reinforcement) is designed by computer in accordance with the strength provisions of the ACI 318 Code. The design requirements considered in proportioning the PSW are strength and radiation shielding.

The computer design is accomplished using the OPTCON module of program BSAP-POST. BSAP-POST (which consists of a collection of modules that perform specific independent tasks) is a general purpose, post-processor program for the BSAP finite element analysis program. BSAP-POST reads computed BSAP results, which are usually stored on a magnetic tape, into an internal common data storage base and optionally performs one or several additional operations (e.g. plotting) or calculations (e.g. creating load combinations or designing reinforced concrete members).

In general, the OPTCON processor is a reinforced concrete analysis and design program for doubly reinforced concrete sections which creates reinforced concrete interaction diagrams (IAD) based on the maximum allowable resistance of a section for given stress and strain limitations (code allowables). Any load combination whose design axial force and corresponding moment (load set) fall within the IAD indicates all stress and strain code criteria are satisfied.

OPTCON also has the capability of calculating the thermal moment, considering the concrete cracking and reinforcement yielding effects, due to a given linear thermal gradient (i.e., a difference in temperature between the two concrete faces). For each load combination, the state of stress and strain is determined before the thermal load is applied. Then the thermal moment is approximated based upon an iterative approach which considers equilibrium and compatibility conditions, and is based on the assumption that the section is free to expand axially without any constraints. The final force-moment set (which includes the cracked section final thermal moment) is checked to verify that it falls within the code allowable IAD.

For sections with a liner plate, OPTCON has the capability to include the effects on the section due to a hot liner plate, and to include any applicable liner plate stress/strain criteria in the formulation of the IAD.

The term "utilization factor" or UF refers to the amount of resistance of the IAD that has been used relative to the zero curvature line. The zero curvature line refers to a line defined by a series of points whose force-moment load set creates constant strain across the section, a neutral axis at infinity, and a strain diagram curvature of zero. A UF of 100 indicates that the section is 100 percent utilized by the design load.

The combination of co-directional responses due to three component earthquake effects are performed using the Square Root of the Sum of the Squares (SRSS) method, i.e., $R = \left(R_i^2 + R_j^2 + R_k^2\right)^{1/2}$ or the Component Factor method, i.e.,

$$R = \pm R_i \pm 0.4 R_j \pm 0.4 R_k$$
$$R = \pm 0.4 R_i \pm R_j \pm 0.4 R_k$$
$$R = \pm 0.4 R_i \pm 0.4 R_j \pm R_k$$

wherein 100 percent of the design forces from any one of the three components of the earthquake is considered in combination with 40 percent of the design forces from each of the other two components of the earthquake.

Load combination equations for the design of the PSW are shown in Appendix B, Table B.1. Load combination equations 2, 5, 8, 12, and 13 are non-governing because wind, tornado, blast, and probable maximum precipitation are not applicable to the internal structure as discussed in section 3.2. An evaluation of load magnitudes, load factors, and load combinations is performed which determines that the possible governing load combinations are equations 9 and 10 from Table B.1 of Appendix B.

5.1.2 Design Results

The design results for the representative key elements for the governing load combinations are presented in table 7.

5.1.3 Design Details

Representative design details are provided in figure 26.

5.1.4 Transverse Shear

Transverse (out-of-plane) shear results are obtained for each primary load case from the BSAP finite element analysis. The primary load case shears are combined in accordance with the load combinations listed in Appendix B, Table B.1 to obtain the design values. Shear ties are designed manually in accordance with the ACI 318 Code.

5.2 SECONDARY SHIELD WALL (SSW)

5.2.1 Design Methodology

The SSW (excluding shear reinforcement) is designed by computer in accordance with the strength provisions of the ACI 318 Code. The computer design is accomplished using the OPTCON module of the BSAP-POST computer program as described in section 5.1.1. The design requirements considered in proportioning the SSW are strength and radiation shielding.

The co-directional responses due to three component earthquake effects are combined as discussed in section 5.1.1.

Load combination equations for the design of the concrete components included in the SSW finite element model are shown in Appendix B, Table B.1. The BSAP finite element analysis primary load case results are combined using the OPTCON module of the BSAP-POST computer program.

Load combination equations 2, 5, 8, 12, and 13 are non-governing because wind, tornado, blast, and probable maximum precipitation are not applicable to the internal structures as discussed in section 3.2. An evaluation of load magnitudes, load factors, and load combinations is performed which determines that the possible governing load combinations are equations 6, 9, and 10 from Appendix B, Table B.1.

Thermal effects are accounted for in the OPTCON module of the BSAP-POST computer program as described in section 5.1.1.

5.2.2 Design Results

The design results for the representative key elements for the governing load combinations are presented in table 8.

5.2.3 Design Details

Representative design details are provided in figure 27.

5.2.4 Transverse and Membrane Shear

Transverse (out-of-plane) and membrane (in-plane) shear results are obtained for each primary load case from the BSAP finite element analysis. The primary load case shears are combined in accordance with the load combinations listed in Appendix B, Table B.1 to obtain the design values. Shear ties are designed manually in accordance with the ACI 318 Code.

5.3 STRUCTURAL STEEL ANNULUS STRUCTURE

5.3.1 Design Methodology

The structural steel is designed manually in accordance with the AISC Specification. The design requirements considered in proportioning the members are strength and stability.

The resultant design forces for the selected representative elements are discussed in section 4.3.3 and summarized in table 4. Standard design techniques are used to determine tension, compression, shear, and bending stresses, section compactness, local buckling, and overall buckling.

5.3.2 Design Results

The design results for the representative key elements for the governing load combination are presented in table 9.

5.3.3 Design Details

Representative design details are provided in figure 28.

5.4 OPERATING FLOOR

5.4.1 Design Methodology

The operating floor slabs are designed either manually or by computer in accordance with the strength provisions of the ACI 318 Code. The computer designed slabs are included as part of the SSW design (section 5.2).

A typical manually analyzed (see section 4.4) and designed slab is at the reactor head laydown area. The resultant design forces for the slab are shown in table 6. Standard reinforced concrete design techniques are used to size and detail the reinforcement.

5.4.2 Design Results

The design results for the governing load combination are presented in table 10.

5.4.3 Design Details

Representative design details are provided in figure 29.

5.5 NSSS SUPPORTS/ANCHORAGES

5.5.1 Design Methodology

The NSSS supports/anchorages are designed manually in accordance with the AISC Specification. The design requirement considered in proportioning the anchorages is strength. The design requirements considered in proportioning the lower pressurizer support frame are strength and stability.

The resultant design forces are shown in figures 23 and 24 for the upper and lower pressurizer supports respectively. Standard design techniques are used to determine axial, bending, pure shear and torsional shear stresses.

5.5.2 Design Results

The design results for the upper pressurizer support anchorage and lower pressurizer support/anchorage are presented in table 11.

5.5.3 Design Details

Design details for the upper pressurizer support anchorage are provided in figure 14, sheet 1. Details for the lower pressurizer support/anchorage are provided in figure 14, sheets 2, 3, and 4.

5.6 POLAR CRANE SUPPORT SYSTEM

5.6.1 Design Methodology

The polar crane runway girders (all 37 girders are identical) are designed manually in accordance with the AISC Specification. The design requirements considered in proportioning the girders are strength, stability, and deflection limitations.

The resultant design forces for the girder are shown on figure 25. Standard design techniques are used to determine tension, compression, shear, and bending stresses, section compactness, local buckling, overall buckling, and deflection.

5.6.2 Design Results

The design results for the governing load combination are presented in table 12.

5.6.3 Design Details

Representative design details are provided in figure 16.

6.0 MISCELLANEOUS ANALYSIS AND DESIGN

6.1 STABILITY ANALYSIS

As described in section 2.0, the containment internals and containment building share a common foundation. See the Containment Building Design Report for a discussion of the containment building stability analysis.

6.2 REFUELING CANAL LINER PLATE

As described in section 2.4.2, the refueling canal is lined with stainless steel plate. Concrete forms are used during the construction of the refueling canal walls, and the liner plate is later welded to existing embedded strip plates. This "wallpaper type" liner plate serves no structural function.

Anchorages through the liner plate and the embedded strips are manually analyzed using standard techniques, and are designed in accordance with the ACI Code and AISC Specification.

7.0 CONCLUSION

The analysis and design of the containment internal structures includes all credible loading conditions and complies with all applicable design requirements.

8.0 REFERENCE

1. U.S. Atomic Energy Commission, Nuclear Reactors and Earthquakes, Division of Technical Information, Report TID-7024, August 1963.

TABLE 1

CONTAINMENT INTERNALS SEISMIC ACCELERATION VALUES

		Floor Accelerations (g's)[a]					
		OBE			SSE		
		Horizontal		Vert.	Horizontal		Vert.
Elev.	Description	E-W	N-S		E-W	N-S	
163.9'	Basemat	0.14	0.13	0.23	0.21	0.20	0.38
195.0'	Fig 21, Sheet 2	0.15	0.15	0.29	0.21	0.22	0.45
218.0'	Operating Floor	0.17	0.20	0.32	0.24	0.27	0.48
236.0'	(South)	0.18	0.23	0.27	0.25	0.30	0.41
236.0'	(North)	0.18	0.23	0.27	0.25	0.30	0.43
258.0'	(South)	0.21	0.28	0.27	0.32	0.37	0.41
258.0'	(North)	0.21	0.29	0.27	0.31	0.38	0.43

(a) The actual acceleration values used in the design of the structure may be higher than the values shown.

TABLE 2

PSW BSAP FINITE ELEMENT ANALYSIS RESULTS (Sheet 1 of 2)

Analysis Results for PSW Concrete - PSW/Basemat Junction

Grid Element Number (a)	Horizontal Reinforcement				Vertical Reinforcement			
	Primary Load Case Number	Type of Load (b)	Axial Force F_y (k/ft)	Moment M_y (ft-k/ft)	Primary Load Case Number	Type of Load (b)	Axial Force F_z (k/ft)	Moment M_z (ft-k/ft)
1	1	D	-20	1	1	D	-81	19
	2	E	-16	-63	2	E	-83	-419
	3	E	13	48	3	E	40	327
	4	E	10	1	4	E	44	12
	5	E	3	-29	5	E	-6	-157
	7	E	1	-19	7	E	4	-144
	9	E	-7	0	9	E	-18	29
	12	P_a	17	16	12	P_a	31	9
	18	Y_r	-17	-104	18	Y_r	-60	-503
	23	T_o	3	-11	23	T_o	9	-41
	26	Y_j	0	-3	26	Y_j	1	-2
5	1	D	-16	0	1	D	-108	22
	2	E	-23	-61	2	E	-69	-263
	3	E	10	17	3	E	23	77
	4	E	9	3	4	E	45	12
	5	E	0	-17	5	E	-10	-92
	7	E	1	-2	7	E	6	-27
	9	E	-5	4	9	E	-62	45
	12	P_a	19	34	12	P_a	29	-19
	19	Y_r	-17	-32	19	Y_r	-266	-98
	23	T_o	2	1	23	T_o	-11	-9
	26	Y_j	0	-2	26	Y_j	-1	-9

(a) Refer to figure 19.

(b) Refer to Appendix A for definition of loads.

TABLE 2

PSW BSAP FINITE ELEMENT ANALYSIS RESULTS (Sheet 2 of 2)

Analysis Results for PSW Concrete - PSW/Basemat Junction

Grid Element Number (a)	Horizontal Reinforcement				Vertical Reinforcement			
	Primary Load Case Number	Type of Load (b)	Axial Force F_y (k/ft)	Moment M_y (ft-k/ft)	Primary Load Case Number	Type of Load (b)	Axial Force F_z (k/ft)	Moment M_z (ft-k/ft)
28	1	D	-9	-8	1	D	-93	4
	2	E	33	61	2	E	107	321
	3	E	1	15	3	E	-8	96
	4	E	8	1	4	E	45	6
	6	E	1	-23	6	E	-17	-140
	8	E	6	-2	8	E	2	-8
	9	E	-5	0	9	E	-24	22
	10	P_a	19	16	10	P_a	30	-138
	15	Y_r	-8	-76	15	Y_r	-123	-354
	23	T_o	6	-6	23	T_o	1	-22
	24	Y_j	0	-2	24	Y_j	-4	-18
31	1	D	-13	-4	1	D	-78	9
	2	E	21	61	2	E	56	300
	3	E	13	17	3	E	33	74
	4	E	6	2	4	E	35	0
	6	E	3	-18	6	E	3	-125
	7	E	3	-12	8	E	8	-14
	9	E	-5	-1	9	E	-23	20
	11	P_a	22	27	10	P_a	28	-111
	17	Y_r	-7	-88	15	Y_r	-20	-328
	23	T_o	4	-1	23	T_o	15	-25
	25	Y_j	0	-1	24	Y_j	-2	-14

(a) Refer to figure 19.

(b) Refer to Appendix A for definition of loads.

TABLE 3

SSW BSAP FINITE ELEMENT ANALYSIS RESULTS (Sheet 1 of 10)

Horizontal Moment (Mx)

Key Location (See fig. 21)	Element Number	Mx (ft-k/ft)	Primary Load Case
B1	728 740 739 738 737	50 9 -91 -56 87	Subcompartment pressure due to LOCA in the pressurizer compartment (primary load case 37).
B2	1004 1016 1015 1014 1013	41 6 -77 -42 75	Subcompartment pressure due to LOCA in the pressurizer compartment (primary load case [illegible]7).
B3	1267 1279 1278 1277 1276	32 -10 -72 0 59	Subcompartment pressure due to LOCA in the pressurizer compartment (primary load case 37).
B4	1503 1504 1505 1506	39 -25 -43 24	Subcompartment pressure due to LOCA in the pressurizer compartment (primary load case 37).
C1	883 882 881 880 879	407 39 23 -46 -37	LOCA load (primary load case 4).
C2	1397 1398 1399	-141 27 133	NSSS load due to a high energy line break (primary load case 7).
E1	867 868 869	-34 46 -59	Subcompartment pressure due to LOCA in the pressurizer compartment (primary load case 37).
E2	1670 1669 1668	[illegible] [illegible] 22	Subcompartment pressure due to LOCA in the pressurizer compartment (primary load case 37).

TABLE 3

SSW BSAP FINITE ELEMENT ANALYSIS RESULTS (Sheet 2 of 10)

<u>Horizontal Moment (Mx)</u>

Key Location (See fig. 21)	Element Number	Mx (ft-k/ft)	Primary Load Case
A1	1173	5	NSSS load due to a high energy line break (primary load case 7).
	1174	1	
	1175	3	
	1176	15	
	1177	35	
	1178	35	
	1179	-9	
	1180	-39	
	1181	-46	
	1182	-30	
	1183	-22	
	1184	-21	
	1185	-22	
	1186	-2	
	1187	11	
	1188	10	
	1189	17	
D1	884	131	LOCA load (primary load case 4)
	885	-20	
	886	-73	
	887	-32	
	888	-2	
	889	-6	
	890	-19	
D2	1479	8	Main feedwater line break (primary load case 16)
	1480	7	
	1481	18	
	1482	0	
	1483	-19	
	1484	-19	

TABLE 3

SSW BSAP FINITE ELEMENT ANALYSIS RESULTS (Sheet 3 of 10)

Vertical Moment (My)

Key Location (See fig. 21)	Element Number	My (ft-k/ft)	Primary Load Case
A2	1318	-22	LOCA load (primary load case 6)
	1180	-7	
	1055	1	
	917	12	
	779	56	
	636	126	
	493	6	
	366	-31	
B5	1763	-6	Subcompartment pressure due to LOCA in the pressurizer compartment (primary load case 37).
	1741	-6	
	1719	-8	
	1697	-9	
	1673	-11	
	1589	-9	
	1505	-9	
	1417	-5	
	1278	-8	
	1146	-20	
	1015	-15	
	877	-18	
	739	-36	
	596	-84	
	459	-32	
	331	-15	
	210	-4	
	84	31	
D3	1331	-136	Subcompartment pressure due to LOCA (hot leg break) in loop 4 (primary load case 13).
	1153	50	
	1025	97	
	887	-72	
	749	-141	
	606	30	
	466	130	
	341	122	
	220	7	
	94	-231	

TABLE 3

SSW BSAP FINITE ELEMENT ANALYSIS RESULTS (Sheet 4 of 10)

Vertical Moment (My)

Key Location (See fig. 21)	Element Number	My (ft-k/ft)	Primary Load Case
C3	1853	1	NSSS load due to a high energy line break (primary load case 7)
	1569	9	
	1485	18	
	1397	-49	
	1284	2	LOCA load (primary load case 4)
	1149	-13	
	1021	15	
	883	499	
	745	329	
	602	94	
	462	15	
	337	-9	
	216	-88	
	90	-318	

Transverse Shear Stress

Key Location (See fig 21)	Elem No.	Response Comp	Seismic Load				Combined Response
			E-W (X)	N-S (Y)	Vertical (Z)	NSSS Equip.	
C3	90	S_{yz}	0.5	1.0	0.6	0.2	1.5
		S_{xz}	9.9	1.6	0.5	12.8	22.8
D1	887	S_{yz}	0.3	0.4	0.1	0.7	1.2
		S_{xz}	0.1	7.7	0.7	5.5	13.2

TABLE 3

SSW BSAP FINITE ELEMENT ANALYSIS RESULTS (Sheet 5 of 10)

DISPLACEMENTS: (Units in Feet and Radians)

Key Location (See Fig 21)	Node No.	Response Component	Seismic Load				Combined Results
			East-West (X)	North-South (Y)	Vertical (Z)	NSSS Equip.	
D4	1064	Δ_x	3.5×10^{-4}	2.3×10^{-5}	5.0×10^{-6}	3.6×10^{-4}	7.1×10^{-4}
		Δ_y	6.4×10^{-6}	5.4×10^{-4}	2.0×10^{-5}	5.3×10^{-4}	1.1×10^{-3}
		Δ_z	1.6×10^{-5}	1.3×10^{-4}	1.0×10^{-4}	4.6×10^{-5}	2.1×10^{-4}
		θ_x	1.4×10^{-6}	5.1×10^{-5}	1.5×10^{-6}	5.7×10^{-5}	1.1×10^{-4}
		θ_y	0.00	0.00	0.00	0.00	0.00
		θ_z	2.3×10^{-6}	2.8×10^{-6}	8.1×10^{-7}	1.4×10^{-5}	1.7×10^{-5}
E3	2932	Δ_x	1.2×10^{-3}	2.5×10^{-4}	1.1×10^{-4}	2.7×10^{-4}	1.5×10^{-3}
		Δ_y	3.0×10^{-4}	2.2×10^{-3}	2.0×10^{-4}	1.4×10^{-5}	2.3×10^{-3}
		Δ_z	3.2×10^{-4}	7.1×10^{-4}	3.5×10^{-4}	4.6×10^{-5}	9.0×10^{-4}
		θ_x	1.2×10^{-5}	5.8×10^{-5}	6.8×10^{-6}	5.2×10^{-6}	6.5×10^{-5}
		θ_y	0.00	0.00	0.00	0.00	0.00
		θ_z	2.0×10^{-6}	7.6×10^{-6}	6.9×10^{-7}	4.4×10^{-5}	5.2×10^{-5}

TABLE 3

SSW BSAP FINITE ELEMENT ANALYSIS RESULTS (Sheet 6 of 10)

Forces:

Key Location (See Fig 21)	Element Number	Element Type	Node Number	Response Component	Seismic Load				Combined Results
					E-W (X)	N-S (Y)	Vert. (Z)	NSSS Equip.	
D3	220	Plate	-	S_{xx}(k/ft)	1.2	5.1	2.1	2.4	8.0
				S_{yy}(k/ft)	1.2	27.5	21.4	13.8	48.7
				S_{xy}(k/ft)	20.8	2.5	0.0	21.8	42.8
				$M_{xx}(\frac{k-ft}{ft})$	0.2	2.8	0.4	2.3	5.2
				$M_{yy}(\frac{k-ft}{ft})$	0.7	19.8	0.7	25.9	45.7
				$M_{xy}(\frac{k-ft}{ft})$	1.0	1.5	0.5	4.9	6.8
E4	2	Beam	530	P_x (k)	173.1	245.7	109.8	53.3	373.2
				V_y (k)	13.2	1.4	1.9	8.4	21.8
				V_z (k)	0.5	19.0	1.1	2.2	21.3
				M_x(k-ft)	2.6	5.0	0.9	7.3	13.0
				M_y(k-ft)	3.2	79.3	1.5	10.4	89.9
				M_z(k-ft)	50.1	0.8	5.6	43.0	93.4
			830	P_x (k)	173.1	245.7	107.3	53.3	372.4
				V_y (k)	11.0	1.4	1.9	8.4	19.6
				V_z (k)	0.5	16.9	1.1	2.2	19.2
				M_x(k-ft)	2.6	5.0	0.9	7.3	13.0
				M_y(k-ft)	5.9	10.4	4.0	0.8	13.4
				M_z(k-ft)	10.4	7.7	3.8	1.2	14.7

TABLE 3

SSW BSAP FINITE ELEMENT ANALYSIS RESULTS (Sheet 7 of 10)

Plate Element Nodal Force:

Key Location (See Fig 21)	Element Number	Element Type	Node Number	Response Component	Seismic Load				Combined Results
					E-W (X)	N-S (Y)	Vertical (Z)	NSSS Equip.	
A3	775	Plate	1989	F_x	33.1	56.7	23.7	17.0	86.7
				F_y	24.3	25.8	1.6	5.4	40.9
				F_z	1.3	3.4	0.1	2.9	6.6
				M_x	3.5	19.0	0.9	7.9	27.3
				M_y	0.8	21.8	1.5	8.5	30.4
				M_z	0.0	0.0	0.0	0.0	0.0
			1689	F_x	9.1	29.3	22.9	12.6	50.9
				F_y	27.2	34.8	0.4	3.9	48.0
				F_z	1.0	4.4	0.3	1.7	6.2
				M_x	0.1	9.5	1.3	4.7	14.3
				M_y	3.0	16.4	1.8	1.1	17.9
				M_z	0.0	0.0	0.0	0.0	0.0
			1688	F_x	39.6	53.7	25.2	15.3	86.5
				F_y	25.1	24.8	1.3	5.8	41.1
				F_z	0.2	0.4	0.3	5.0	5.5
				M_x	0.5	6.6	0.7	7.1	13.8
				M_y	3.1	18.1	1.5	6.8	25.2
				M_z	0.0	0.0	0.0	0.0	0.0
			1988	F_x	15.6	26.3	24.5	10.8	50.0
				F_y	28.0	33.8	0.1	4.2	48.2

Units: F_x, F_y, and F_z (k/ft)
M_x, M_y, and M_z (ft-k/ft)

TABLE 3

SSW BSAP FINITE ELEMENT ANALYSIS RESULTS (Sheet 8 of 10)

Plate Element Nodal Force:

Key Location (See Fig 21)	Element Number	Element Type	Node Number	Response Component	Seismic Load				Combined Results
					E-W (X)	N-S (Y)	Vertical (Z)	NSSS Equip.	
A3	775	Plate	1988	F_z	0.4	0.6	0.0	6.2	6.9
				M_x	2.7	22.3	0.2	13.1	35.6
				M_y	2.9	23.7	1.8	6.2	30.1
				M_z	0.0	0.0	0.0	0.0	0.0
C4	1148	Plate	2856	F_x	32.7	44.2	27.9	35.9	97.6
				F_y	50.9	93.6	3.5	17.5	124.1
				F_z	7.1	6.4	1.2	40.1	49.7
				M_x	28.1	22.7	7.4	35.5	72.4
				M_y	14.9	23.6	6.7	37.5	66.2
				M_z	0.0	0.0	0.0	0.0	0.0
			2556	F_x	63.4	112.4	33.9	4.6	138.0
				F_y	54.4	64.8	5.5	30.4	115.2
				F_z	0.2	21.3	2.2	30.2	51.6
				M_x	3.8	40.1	3.3	58.8	99.2
				M_y	0.6	22.5	0.1	3.6	26.1
				M_z	0.0	0.0	0.0	0.0	0.0
			2555	F_x	23.1	37.1	21.7	21.1	69.8
				F_y	22.6	60.7	0.6	2.1	66.9
				F_z	2.0	22.3	4.4	24.1	47.0
				M_x	18.8	13.1	1.0	105.3	128.2

For units, see sheet 7.

TABLE 3

SSW BSAP FINITE ELEMENT ANALYSIS RESULTS (Sheet 9 of 10)

<u>Plate Element Nodal Force</u>:

Key Location (See Fig 21)	Element Number	Element Type	Node Number	Response Component	Seismic Load				Combined Results
					E-W (X)	N-S (Y)	Vertical (Z)	NSSS Equip.	
C4	1148	Plate	2555	M_y	3.5	7.4	2.9	24.6	33.3
				M_z	0.0	0.0	0.0	0.0	0.0
			2855	F_x	73.0	119.5	27.7	19.4	162.2
				F_y	26.2	32.0	8.3	15.0	57.1
				F_z	8.9	7.4	3.3	46.1	58.2
				M_x	46.1	4.1	4.6	138.6	185.2
				M_y	7.3	2.1	3.3	26.9	35.1
				M_z	0.0	0.0	0.0	0.0	0.0
D3	341	Plate	1064	F_x	47.8	61.8	51.6	84.7	178.3
				F_y	42.7	4.1	3.6	32.7	75.8
				F_z	0.7	4.3	0.4	7.6	11.9
				M_x	0.7	2.6	1.5	4.8	7.8
				M_y	3.1	12.6	2.0	7.6	20.7
				M_z	0.0	0.0	0.0	0.0	0.0
			764	F_x	42.9	68.9	50.5	13.2	108.8
				F_y	51.8	14.2	3.3	63.3	117.2
				F_z	1.6	4.0	0.5	4.3	8.7
				M_x	0.4	3.5	0.9	6.6	10.2
				M_y	2.8	20.7	0.0	44.0	64.9
				M_z	0.0	0.0	0.0	0.0	0.0

For units, see sheet 7.

TABLE 3

SSW BSAP FINITE ELEMENT ANALYSIS RESULTS (Sheet 10 of 10)

Plate Element Nodal Force:

Key Location (See Fig 21)	Element Number	Element Type	Node Number	Response Component	Seismic Load				Combined Results
					E-W (X)	N-S (Y)	Vertical (Z)	NSSS Equip.	
D3	341	Plate	763	F_x	50.3	65.8	53.1	90.0	188.4
				F_y	43.6	6.8	4.5	39.7	84.0
				F_z	1.7	10.3	1.4	18.8	29.3
				M_x	1.2	3.6	1.0	0.9	4.8
				M_y	0.5	20.4	0.3	49.3	69.7
				M_z	0.0	0.0	0.0	0.0	0.0
			1063	F_x	40.3	72.8	52.0	7.9	106.0
				F_y	52.7	11.5	2.4	70.3	124.3
				F_z	0.9	10.1	1.3	22.0	32.3
				M_x	2.0	3.6	1.9	4.0	8.6
				M_y	0.5	14.5	2.9	16.9	31.7
				M_z	0.0	0.0	0.0	0.0	0.0

For units, see sheet 7.

TABLE 4

STRUCTURAL STEEL MANUAL ANALYSIS RESULTS

Built-up Box Girder

V_y = Vertical shear = 202 kips

M_z = Moment about horizontal axis of girder = 317 ft-kips

P = Axial load = 40 kips

T = Torsion due to possible construction tolerances = 280 in.-kips

Girder (supporting large equipment at elevation 238')

Static Loading:

M_{xx} = 86.1 k-ft (due to equipment dead load)

6.9 k-ft (due to floor live load)

54.0 k-ft (due to R_o loads)

Seismic Loading:

P_a = 60 kips (due to truss action)

M_{xx} = 61 k-ft (due to $E_{VERT.}$)

89 k-ft (due to E_{E-W})

160 k-ft (due to E_{N-S})

Column

Maximum axial load = 547 kips

See table 9 for design results.

The governing load combination is equation 5 from Appendix B, Table B.2.

TABLE 5

STRUCTURAL STEEL FINITE ELEMENT ANALYSIS RESULTS (Sheet 1 of 3)

Maximum Column Loads

	Column Number (See Fig. 28 Sht. 1)	Load Combination (See Table B.2 Appendix B)
OBE:		
Compression = 447 kips	15	10
Tension = 15 kips	4	10
SSE:		
Compression = 477 kips	15	11
Tension = 37 kips	15	7

TABLE 5

STRUCTURAL STEEL FINITE ELEMENT ANALYSIS RESULTS (Sheet 2 of 3)

This table identifies columns which create uplift on the fill slab and provides the loads of all adjacent columns

Load Combination (See Table B.2)	Column No. (See Fig. 28 Sheet 1)	Combined Reaction		Load Components (See Appendix A)				
		Type	Magnitude (K)	D (K)	L (K)	Equip. D (K)	P_a (K)	Seismic[a] (K)
5	29	Compression (C)	22.5	65.5(C)	87.7(C)	4.9(C)	NA	69.7(T)
	1	Tension (T)	5.3	85.4(C)	105.0(C)	16.9(C)	NA	133.8(T)
	2	C	26.4	98.8(C)	179.9(C)	24.2(C)	NA	124.1(T)
	3	C	7.6	97.1(C)	98.3(C)	23.9(C)	NA	138.1(T)
	4	T	6.8	84.2(C)	85.8(C)	23.9(C)	NA	136.3(T)
	5	C	18.2	47.3(C)	71.3(C)	0.2(C)	NA	47.2(T)
5	10	C	9.5	15.6(C)	21.7(C)	0.0(C)	NA	11.6(T)
	11	C	22.0	63.6(C)	71.5(C)	19.7(C)	NA	79.2(T)
	14	C	10.8	35.6(C)	39.9(C)	8.2(C)	NA	43.1(T)
	15	T	6.9	130.2(C)	142.0(C)	45.1(C)	NA	217.7(T)
	16	C	18.7	37.0(C)	54.8(C)	0.2(C)	NA	31.9(T)
7	29	C	11.6	65.5(C)	87.7(C)	4.9(C)	NA	80.6(T)
	1	T	22.2	85.4(C)	105.0(C)	16.9(C)	NA	150.6(T)
	2	C	8.4	98.8(C)	109.9(C)	24.2(C)	NA	142.2(T)
	3	T	10.4	97.1(C)	98.3(C)	23.9(C)	NA	156.1(T)
	4	T	26.2	84.2(C)	85.8(C)	23.9(C)	NA	155.7(T)
	5	C	10.6	47.3(C)	71.3(C)	0.2(C)	NA	54.8(T)
7	10	C	6.7	15.6(C)	21.7(C)	0.0(C)	NA	14.4(T)
	11	C	9.1	63.6(C)	71.5(C)	19.7(C)	NA	92.1(T)
	14	C	4.1	35.6(C)	39.9(C)	8.2(C)	NA	49.7(T)
	15	T	36.8	130.2(C)	142.0(C)	45.1(C)	NA	247.7(T)
	16	C	13.4	37.0(C)	54.8(C)	0.2(C)	NA	37.1(T)
10	29	C	25.1	65.5(C)	87.7(C)	4.9(C)	2.6(C)	69.7(T)
	1	C	3.1	85.4(C)	105.0(C)	16.9(C)	8.4(C)	133.8(T)
	2	C	30.9	98.8(C)	109.9(C)	24.2(C)	4.5(C)	124.1(T)
	3	C	8.0	97.1(C)	98.3(C)	23.9(C)	0.5(C)	138.1(T)
	4	T	14.8	84.2(C)	85.8(C)	23.9(C)	8.1(T)	136.3(T)
	5	C	18.1	47.3(C)	71.3(C)	0.2(C)	0.2(T)	47.2(T)
11	29	C	14.3	65.5(C)	87.7(C)	4.9(C)	2.6(C)	80.6(T)
	1	T	13.8	85.4(C)	105.0(C)	16.9(C)	8.4(C)	150.6(T)

(a) To determine if the seismic load is E or E', refer to the load combinations in Table B.2, Appendix B.

TABLE 5

STRUCTURAL STEEL FINITE ELEMENT ANALYSIS RESULTS (Sheet 3 of 3)

This table identifies columns which create uplift on the fill slab and provides the loads of all adjacent columns

Load Combination (See Table B.2)	Column No. (See Fig. 28 Sheet 1)	Combined Reaction		Load Components (See Appendix A)				
		Type	Magnitude (K)	D (K)	L (K)	Equip. D (K)	P_a (K)	Seismic[a] (K)
11	2	C	12.9	98.8(C)	109.9(C)	24.2(C)	4.5(C)	142.2(T)
	3	T	9.9	97.1(C)	98.3(C)	23.9(C)	0.5(C)	156.1(T)
	4	T	34.2	84.2(C)	85.8(C)	23.9(C)	8.1(T)	155.7(T)
	5	C	10.5	47.3(C)	71.3(C)	0.2(C)	0.2(T)	54.8(T)
	10	C	6.7	15.6(C)	21.7(C)	0.0(C)	0.0(C)	14.4(T)
	11	C	8.7	63.6(C)	71.5(C)	19.7(C)	0.4(T)	92.1(T)
	14	C	3.6	35.6(C)	39.9(C)	8.2(C)	0.5(T)	49.7(T)
	15	T	18.4	130.2(C)	142.0(C)	45.1(C)	18.4(C)	247.7(T)
	16	C	13.3	37.0(C)	54.8(C)	0.2(C)	0.1(T)	37.1(T)

(a) To determine if the seismic load is E or E', refer to the load combinations in Table B.2, Appendix B.

TABLE 6

REPRESENTATIVE OPERATING FLOOR ANALYSIS RESULTS

Reactor head laydown slab: (2'-9" thick portion)

Slab frequency: 52 cps

Laydown loads:

Uniform load = 1.3 ksf

Pedestal load per Westinghouse,

Dead load = 75 kips
OBE load = 74 kips
Total = 149 kips per pedestal

Resultant forces[a]:

V_u = Maximum out-of-plane shear

= 54.6 kips/ft

M_u = Design moment based on two-way slab analysis

Maximum (-) M_{uy} = 176 ft-k/ft

Maximum (-) M_{ux} = 230 ft-k/ft

Maximum (+) M_{ux} = 140 ft-k/ft

---

[a] The governing load combination is equation 3 from Appendix B, Table B.1.

TABLE 7

PSW DESIGN RESULTS

OPTCON Results for Primary Shield Concrete - Elevation 169.0' to 174.5'												
	Horizontal Reinforcement						Vertical Reinforcement					
				Reinf. Provided						Reinf. Provided		
Grid[a] Element Number	Load[b] Combination Equation	F_y (k/ft)	M_y (k-ft/ft)	A_s (in.^{2}/ft)	A'_s (in.^{2}/ft)	Util.[c] Factor (%)	Load[b] Combination Equation	F_z (k/ft)	M_z (k-ft/ft)	A_s (in.^{2}/ft)	A'_s (in.^{2}/ft)	Util.[c] Factor (%)
1	10	-30	-242	8.25	6.5	8.4	10	-202	-1450	8.00	7.06	35.0
5	10	-35	-87	8.25	6.5	4.2	10	-459	-590	5.14	5.29	17.3
28	10	-18	-166	8.25	6.5	8.8	10	-322	-1121	5.14	7.06	34.1
31	10	-4	-129	8.25	6.5	7.1	10	-8	-1019	5.14	7.06	40.0

(a) Refer to figure 19, PSW/basemat junction.

(b) Refer to Table B.1, Appendix B for the load combination equation.

(c) For a description of the utilization factor, see section 5.1.1.

TABLE 8

SSW DESIGN RESULTS

Critical Elements with Thermal Effects Included

Element Number (a)	Governing Load Combination (See Table B.1)	Without Thermal		Thermal Loads		Reinforcement Provided (in.^{2}/ft)		Util. Factor (b) (%)	Location
		Axial Force (k/ft)	Moment (ft-k/ft)	Axial Force (k/ft)	Moment (ft-k/ft)	A_s	A'_s		
90(V)	10	-163	-1064	-18	-126	4.82	4.28	96.9	SW. Sec. Shield Wall (see fig. 21, sht 5)
94(V)	10	-15	-649	41	-161	4.80	4.80	79.0	S. Sec. Shield Wall (see fig. 21, sht 7)
328(V)	6	-232	6	178	99	4.46	4.55	20.3	W. Sec. Shield Wall (see fig. 21, sht 3)
367(V)	6	14	-48	15	8	2.08	2.08	11.6	S. Canal Wall (see fig. 21, sht 2)
745(H)	10	318	621	-7	-8	6.08	6.40	80.0	SW. Sec. Shield Wall (see fig. 21, sht 5)
746(H)	10	372	170	-20	16	6.56	4.96	42.5	S. Sec. Shield Wall (see fig. 21, sht 7)
780(H)	6	86	-202	-37	17	2.08	2.08	57.2	S. Canal Wall (see fig. 21, sht 2)
1016(H)	10	157	-136	1	7	4.14	4.14	41.2	W. Sec. Shield Wall (see fig. 21, sht 3)

(a) V = Vertical reinforcement
H = Horizontal reinforcement

(b) For a description of the utilization factor, see section 5.1.1.

TABLE 9

STRUCTURAL STEEL DESIGN RESULTS

Member[a]	Stresses		
	Actual (ksi)	Allowable (ksi)	$\frac{\text{Actual}}{\text{Allowable}}$
Built-up Box Girder			
Compression, P	0.7	21.0	.03
Bending, M_z	13.6	24.0	$\underline{.57}$
Combined stresses:			.60 <1.0
Pure shear, V_y	9.6	14.5	.66
Torsional shear, T	1.0	14.5	$\underline{.07}$
Combined stresses:			.73 <1.0
Web crippling	10.4	27.0	.39
Girder (supporting large equipment)			
Static loading:			
Bending, M_{xx} (equip dead load)	1.6		
(live load)	0.1		
(R_o loads)	$\underline{1.0}$		
Combined (additive):	2.7	24.0	.11
Seismic loading:			
Bending, M_{xx} (E_{vert})	1.1		
(E_{e-w})	1.6		
(E_{n-s})	$\underline{2.9}$		
Combined (SRRS)	3.5	24.0	.15
Compression, P_a	1.0	20.4	$\underline{.05}$
			.31 <1.0
Column			
Compression, P	9.6	18.2	.53 <1.0

See table 4 for design forces

The governing load combination is equation 5 from Appendix B, Table B.2.

(a) See figure 28 for design details for these representative members.

TABLE 10

REPRESENTATIVE OPERATING FLOOR DESIGN RESULTS

Reactor head laydown slab: (2'-9" thick portion)

Design forces:

See table 6. The governing load combination is equation 3 from Appendix B, Table B.1.

Shear reinforcing:

A_s (required) = 0.13 in.^{2}/ft (each way)

A_s (provided) = #4 ties at 12 inches each way
= 0.20 in.^{2}/ft (each way)

Flexure reinforcing:

A_s (required) = 1.56 in.^{2}/ft (top and bottom each way)

A_s (provided) = 1- #11 @ 12" (top and bottom each way)
= 1.56 in.^{2}/ft (top and bottom each way)

TABLE 11

UPPER AND LOWER PRESSURIZER SUPPORT DESIGN RESULTS (Sheet 1 of 2)

Upper Pressurizer Support Anchorage:

(Refer to figure 23 for design forces, and figure 14, sheet 1, for design details)

Anchorage Component	Actual	Allowable	$\frac{\text{Actual}}{\text{Allowable}}$
Anchor bolt shear	333^k	395^k	.84
Concrete pullout	514^k	854^k	.60
Concrete bearing	5.6 ksi	5.95 ksi	.94
Stiffener plates			
Bending stress	29.3 ksi	45 ksi	.65
Shear stress	11.0 ksi	25 ksi	.44
	Required	Provided	$\frac{\text{Required}}{\text{Provided}}$
Anchor plate thickness	1.66"	2.00"	.83
Shear plate thickness	1.54"	1.75"	.88

The governing load combination is equation 11 from Appendix B, Tables B.1 (for concrete) and B.2 (for steel).

TABLE 11

UPPER AND LOWER PRESSURIZER SUPPORT DESIGN RESULTS (Sheet 2 of 2)

Lower Pressurizer Support/Anchorage:

(Refer to figure 24 for design forces, and figure 14, sheets 2, 3, and 4, for design details)

Support Component	Stresses		
	Actual (ksi, UNO)	Allowable (ksi, UNO)	Actual / Allowable
Main Girder:			
Bending, M_y	40.7		
Bending, M_z	0.1		
Combined bending:	40.8	45.0	.91
Compression, P_x	0.1	29.2	.00
Combined stresses:			.91 <1.0
Shear, V_y	0.1		
Shear, V_z	14.5		
Torsional shear, M_x	0.9		
Combined stresses (added)	15.5	25.0	.62 <1.0
Main Girder Connection:			
Bolt Design (shear per bolt)	41.4^k	47.7^k	.87 <1.0
Connection plate design			
Axial force, P	9.4		
Bending, M_y	18.2		
Combined stresses:	27.6	45.0	.61 <1.0
Shear, V_z	16.1	25.0	.64 <1.0
Main Girder Connection Anchorage:			
Concrete bearing (due to vertical shear)	1.95	2.98	.65 <1.0
Concrete bearing at anchor plate	4.54	5.96	.76 <1.0
Concrete pullout capacity	302^k	451^k	.67 <1.0
	Required	Provided	Required / Provided
Anchor plate thickness (req'd versus prov'd)	t = 1.31"	t = 1.50"	.87

The governing load combination is equation 11 from Appendix B, Tables B.1 (for concrete design) and B.2 (for steel design).

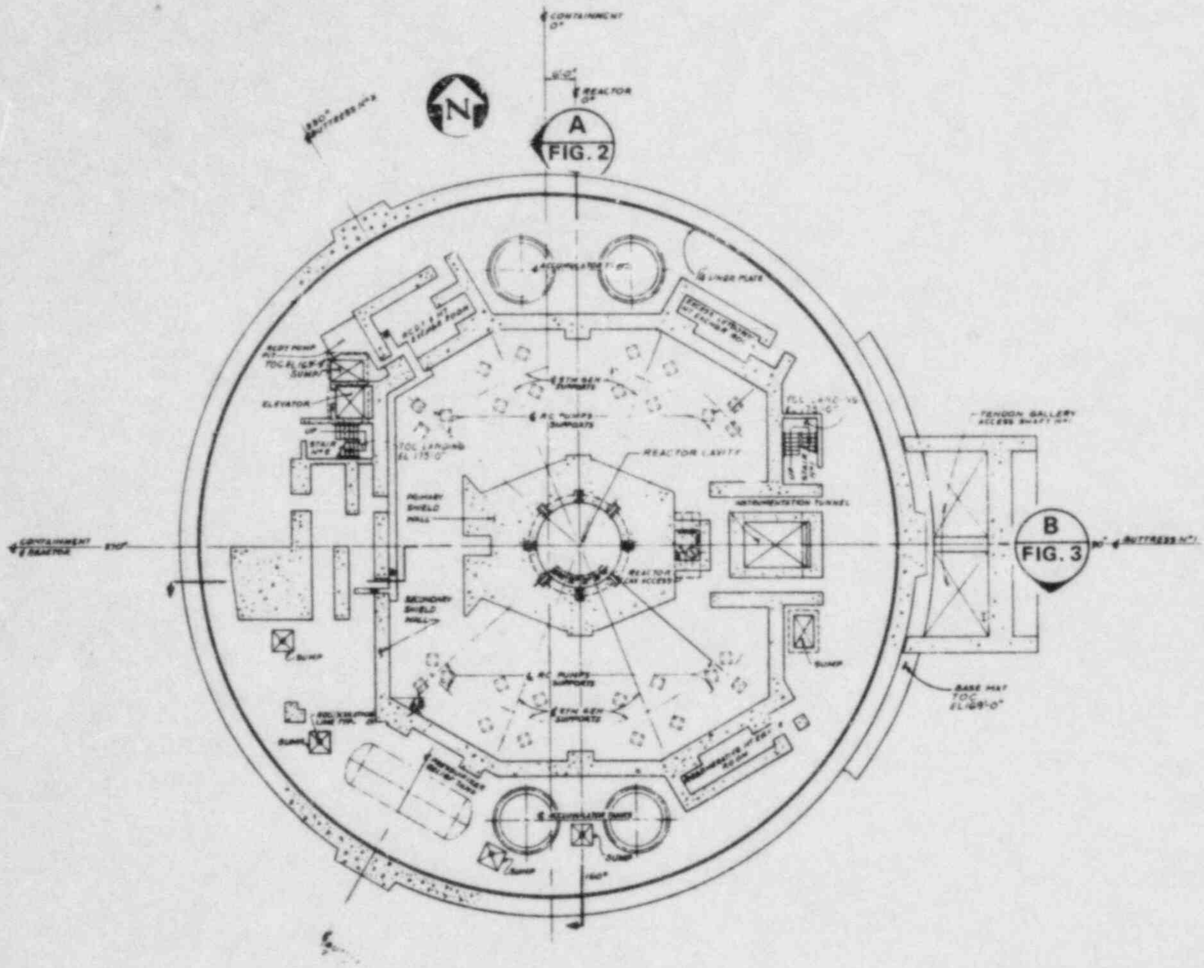
TABLE 12

POLAR CRANE RUNWAY GIRDER DESIGN RESULTS

	Stresses		
	Actual (ksi)	Allowable (ksi)	Actual / Allowable
Top Flange			
Compression	2.5	21.1	.12
Bending, M_x	6.9	21.6	.32
Bending, M_z	7.1	21.6	.33
Combined stresses			.76 <1.0
Shear	4.3	14.5	.30
Webs			
Shear	3.8	14.5	.26
Bottom Flange			
Tension	1.1	21.6	.05
Bending, M_x	9.0	21.6	.42
			.47 <1.0
Brace			
Compression	15.5	21.0	.74

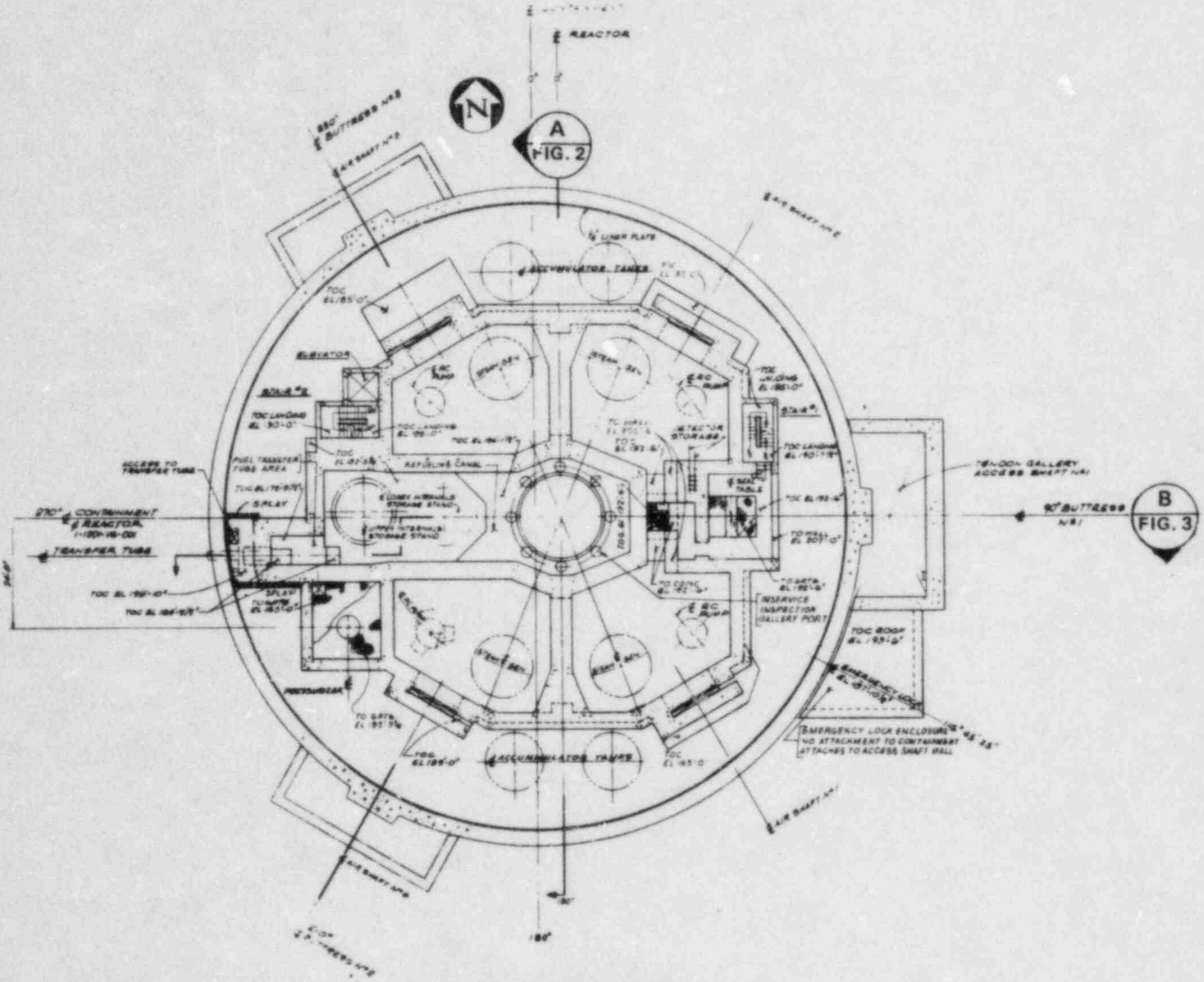
Girder material: ASTM A36.

The governing load combination is equation 2 from Appendix B, table B.2.



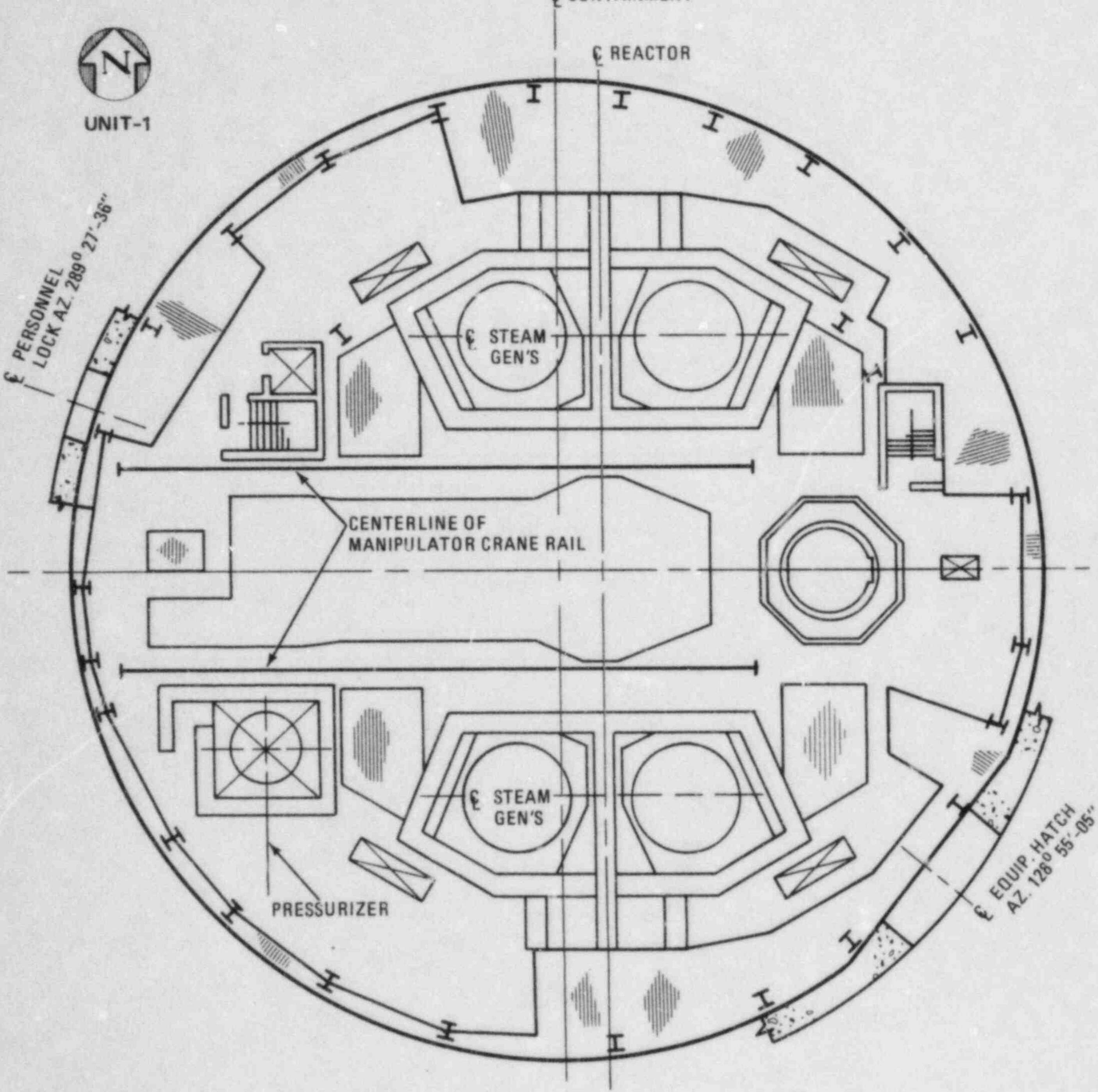
PLAN AT ELEVATION 171'-9"

Figure 1
CONTAINMENT PLAN VIEW (UNIT 1)
(Sheet 1 of 3)



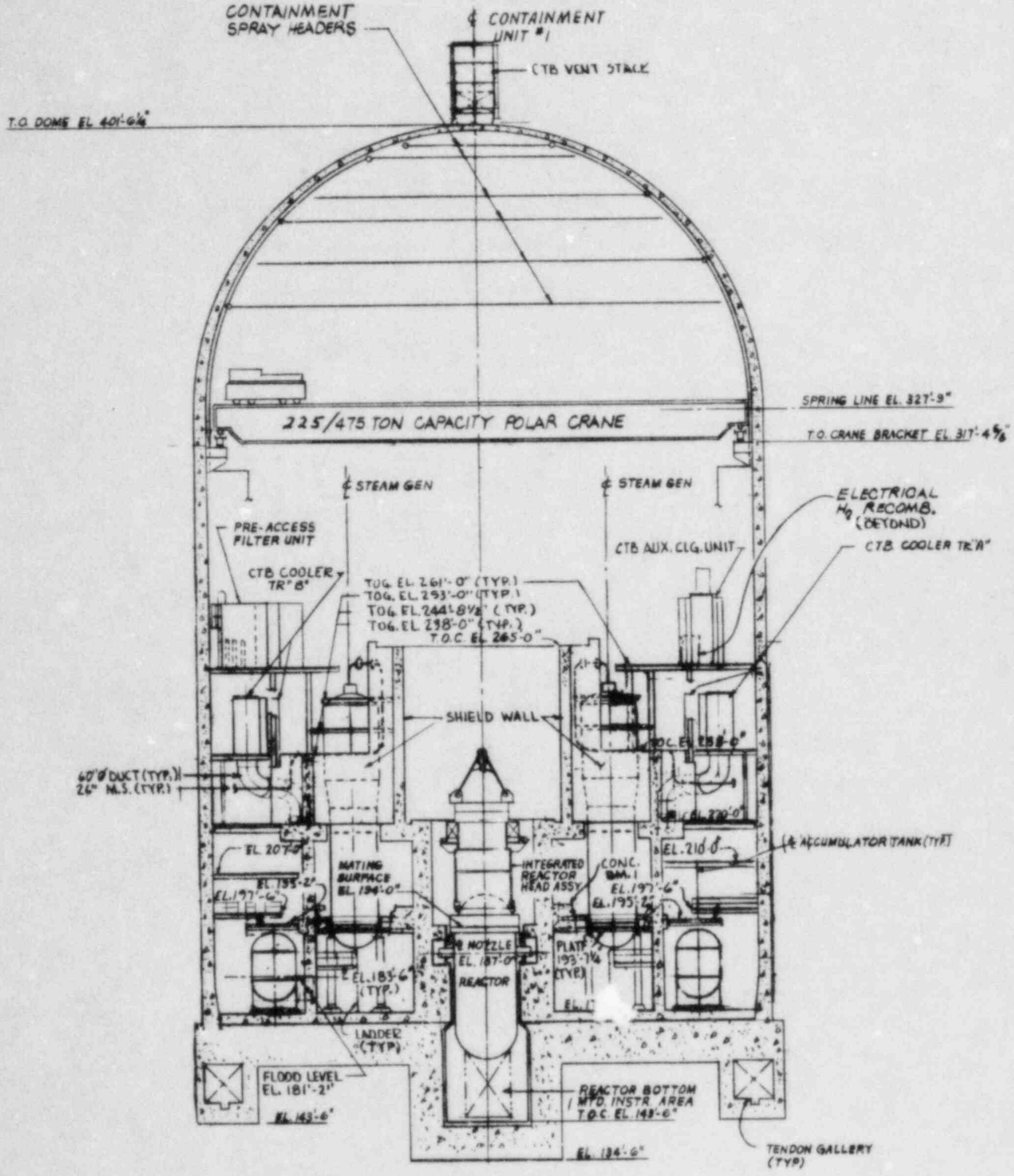
PLAN AT ELEVATION 195'-0"

Figure 1
CONTAINMENT PLAN VIEW (UNIT 1)
(Sheet 2 of 3)



PLAN AT ELEVATION 220'
(OPERATING FLOOR)

Figure 1
CONTAINMENT PLAN VIEW (UNIT 1)
(Sheet 3 of 3)



SECTION A
FIG. 1

Figure 2
CONTAINMENT SECTION (UNIT 1)

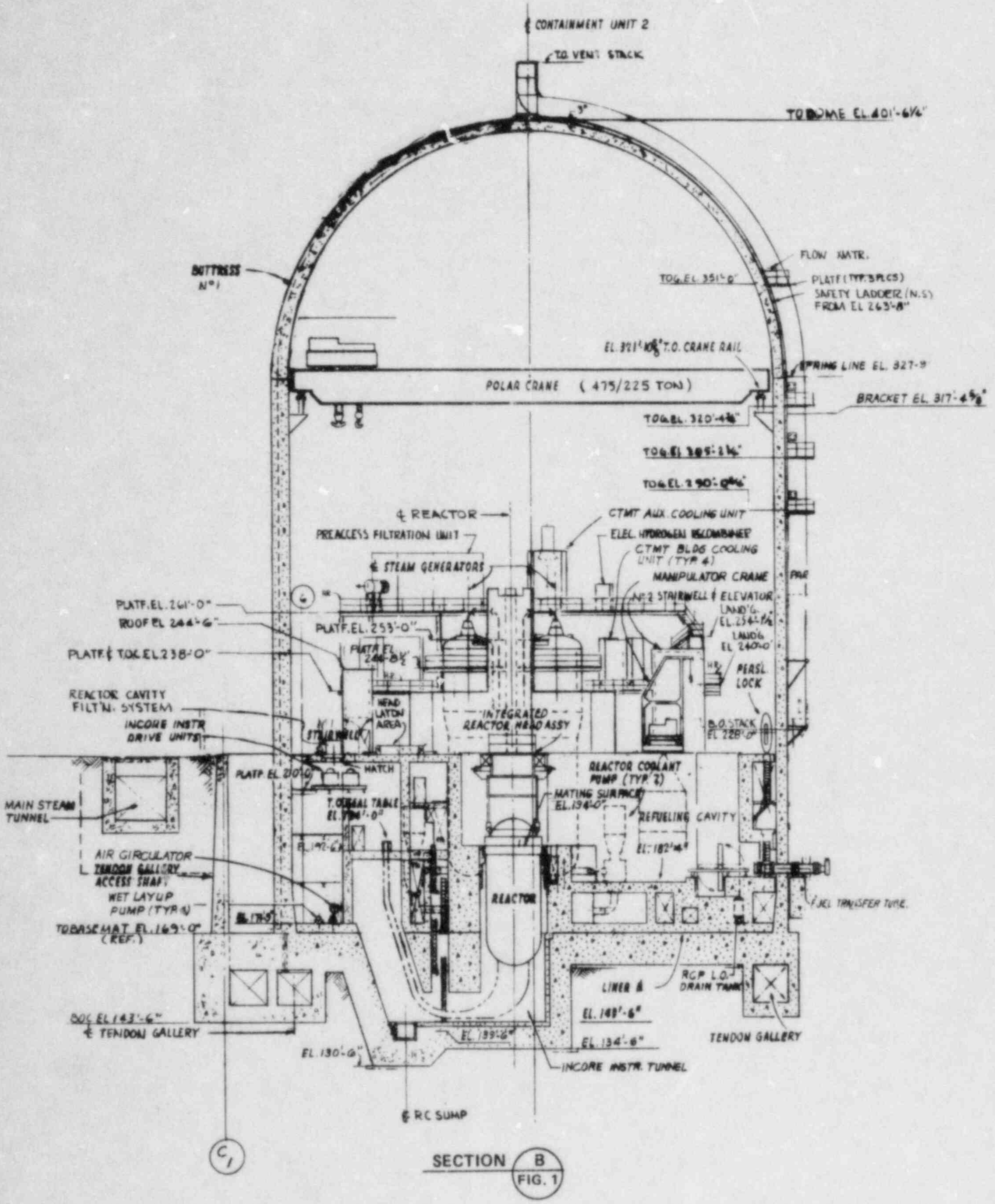
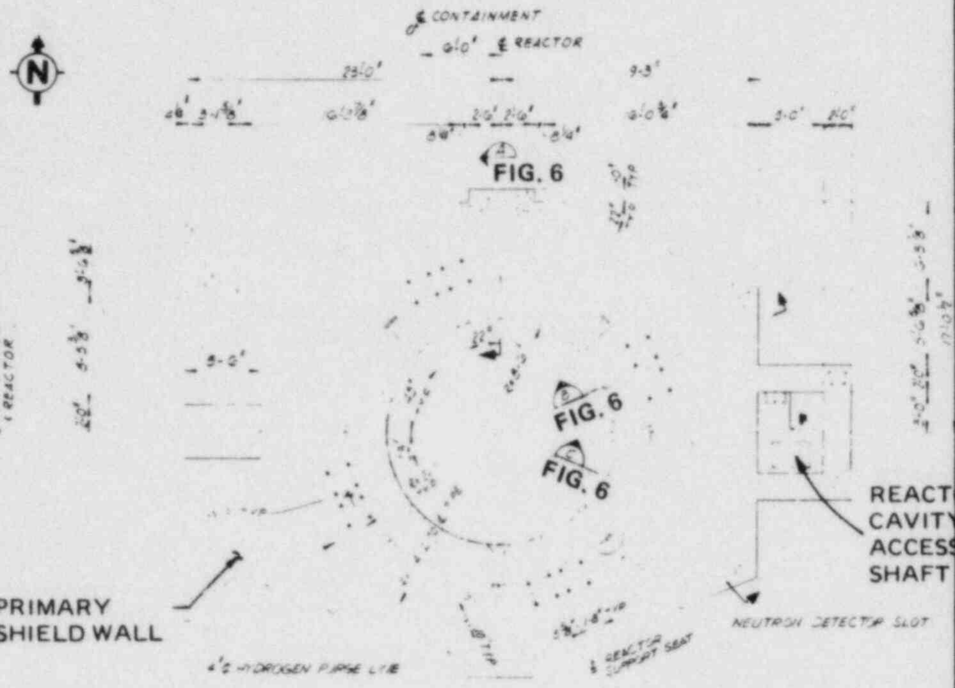
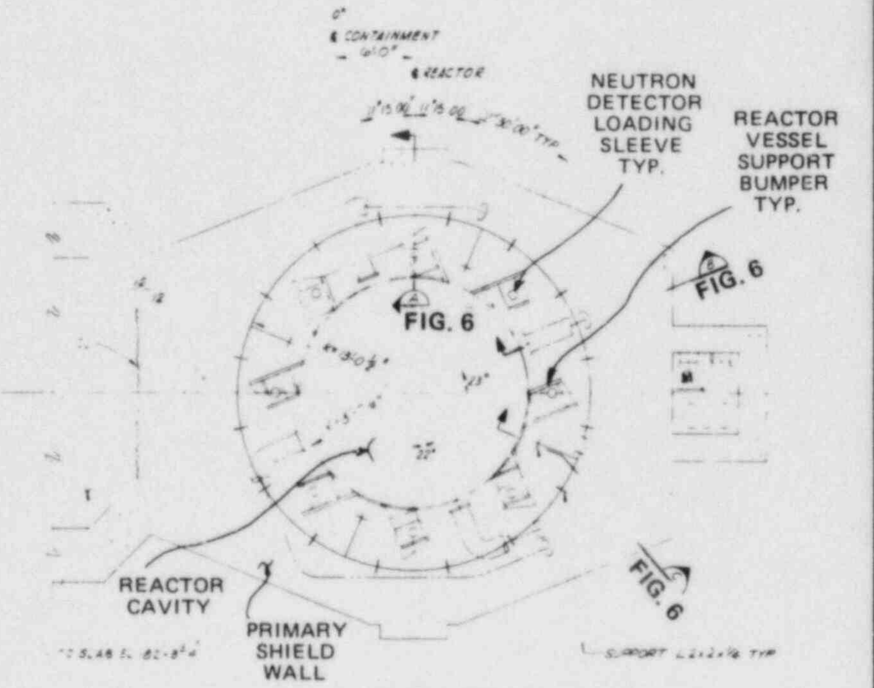


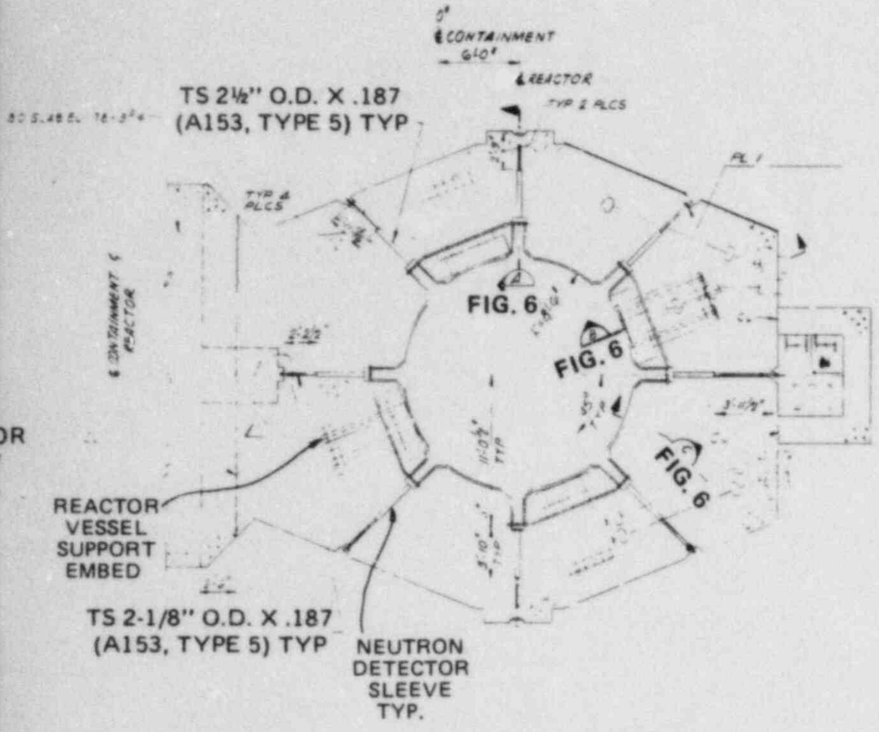
Figure 3
CONTAINMENT SECTION (UNIT 1)



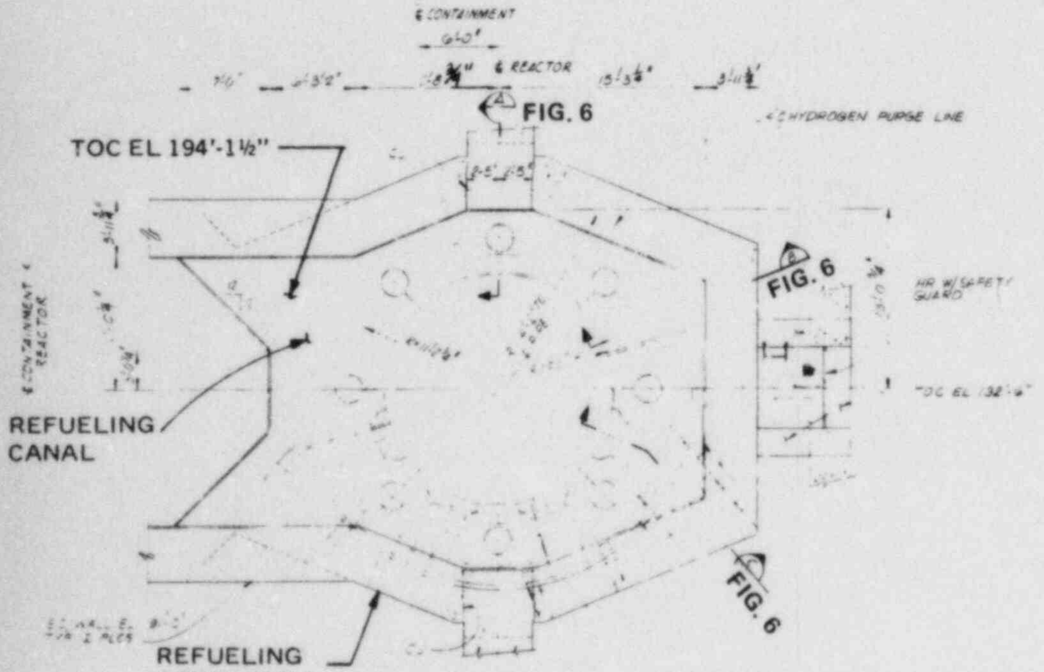
PLAN AT EL 171'-9"



PLAN AT EL 183'-2"

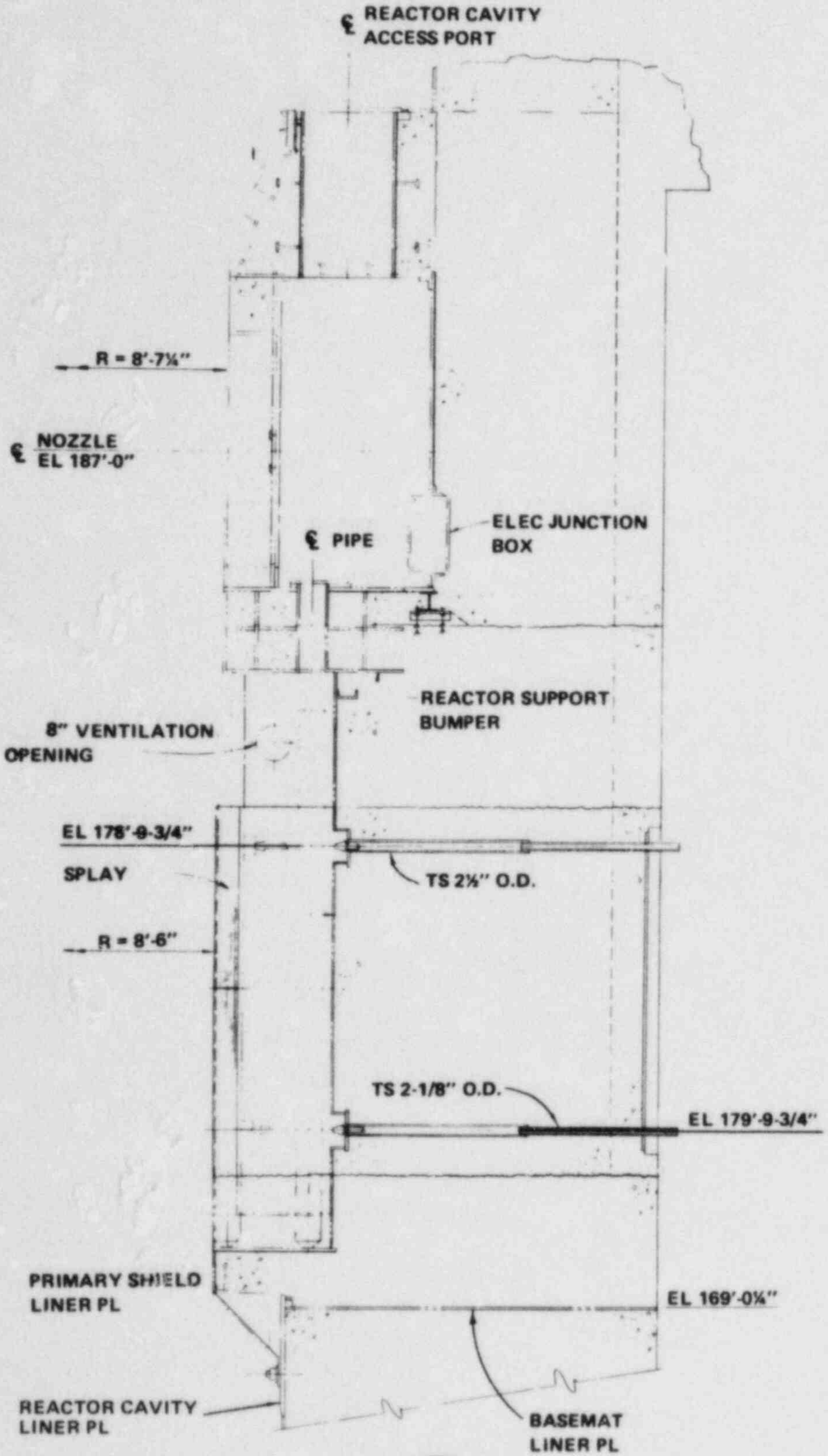


PLAN AT 179'-5½"

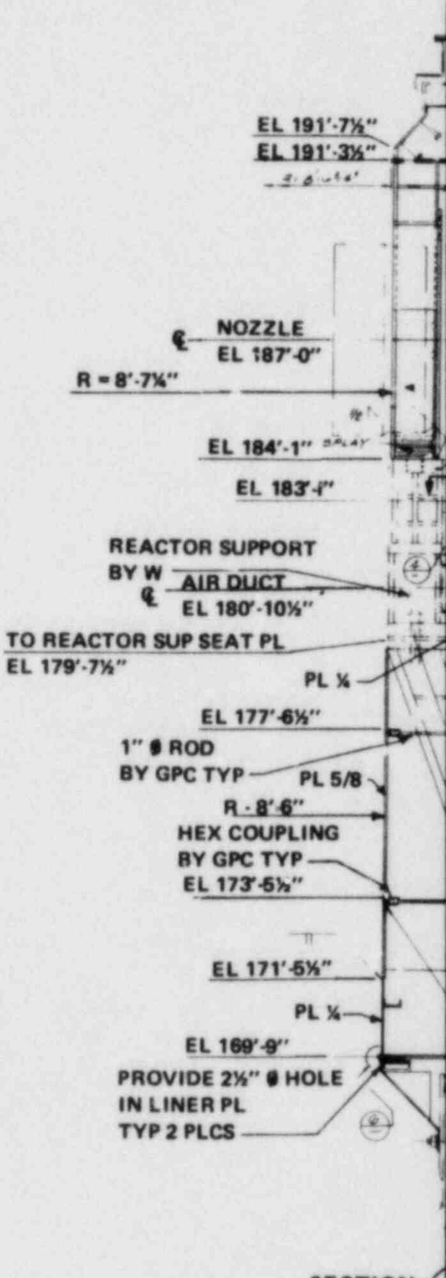


PLAN AT EL 194'-1½"

Figure 5
PRIMARY SHIELD WALL AND REACTOR
CAVITY PLAN VIEWS (UNIT 1)



SECTION A
FIG. 5



SECTION
F

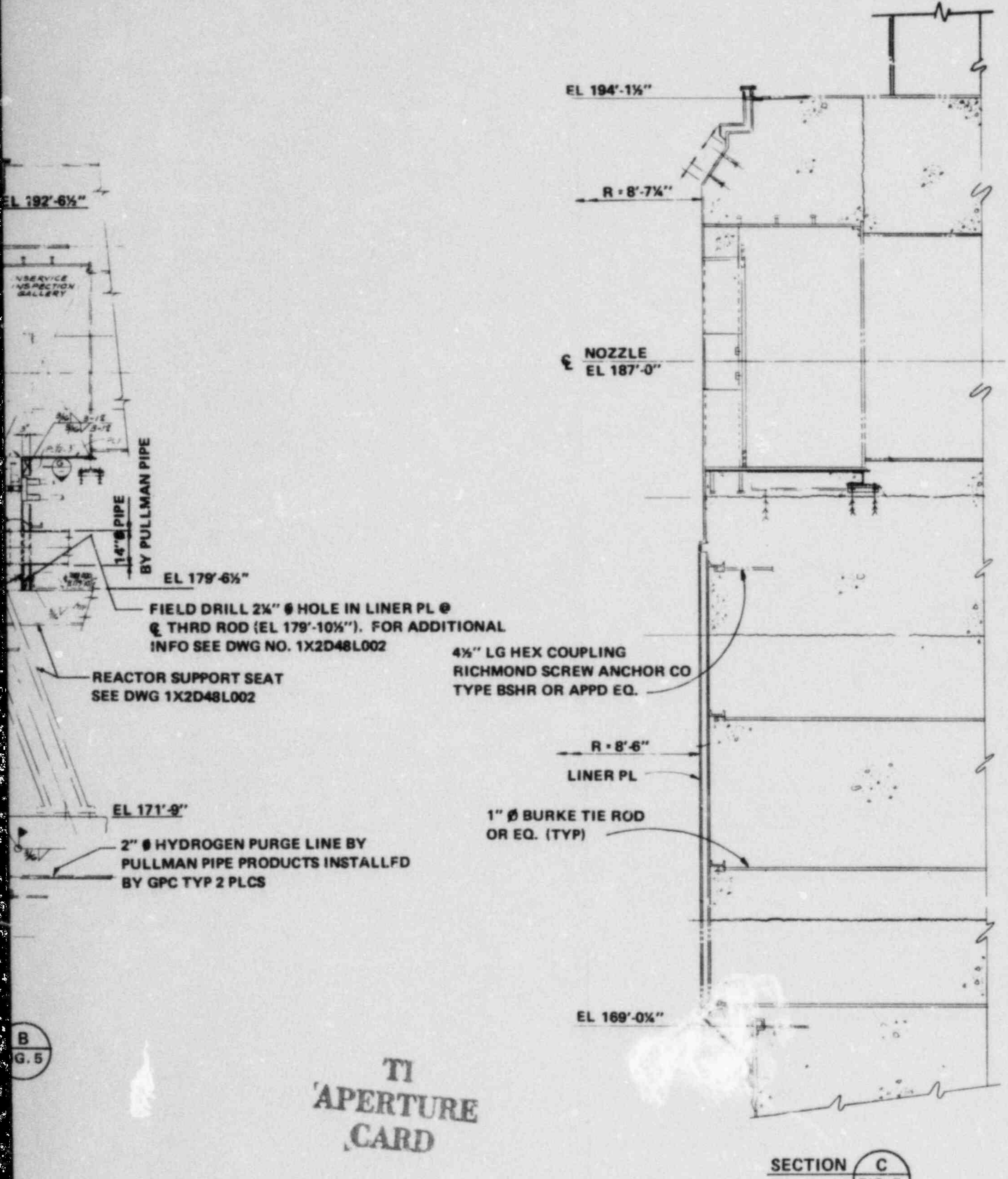
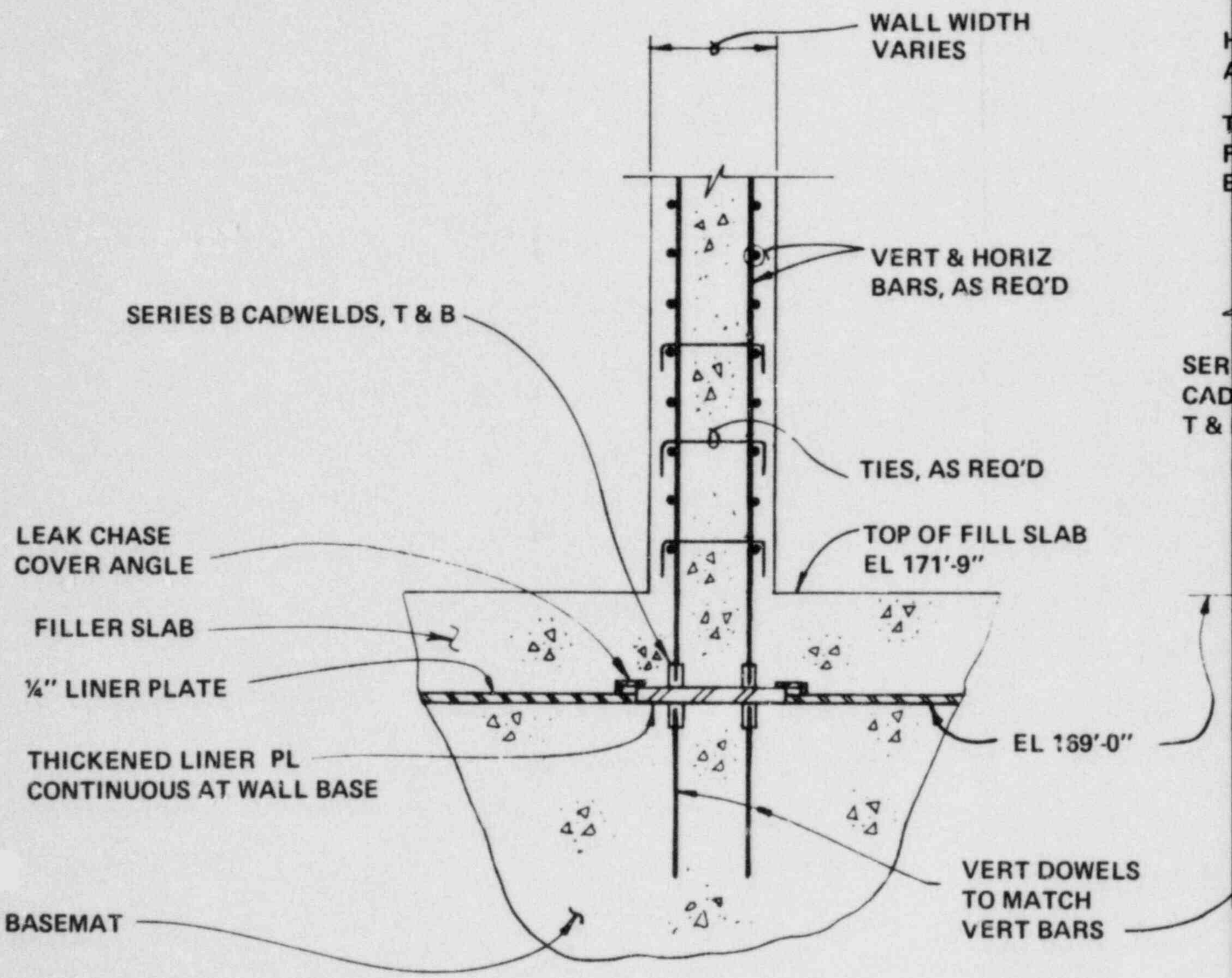


Figure 6
PRIMARY SHIELD WALL AND REACTOR
CAVITY SECTIONS VIEWS (UNIT 1)



SECONDARY SHIELD WALL SECTION

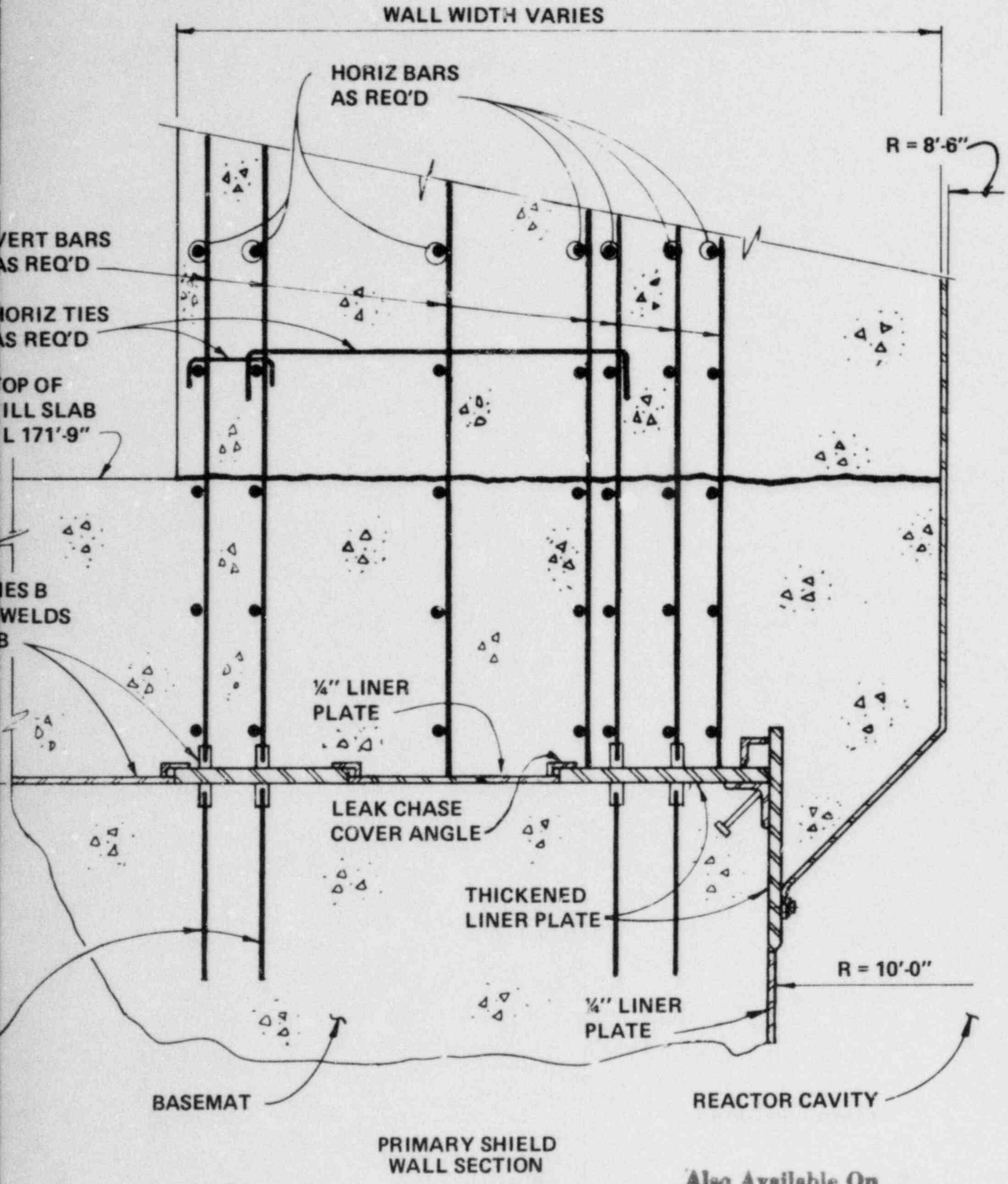
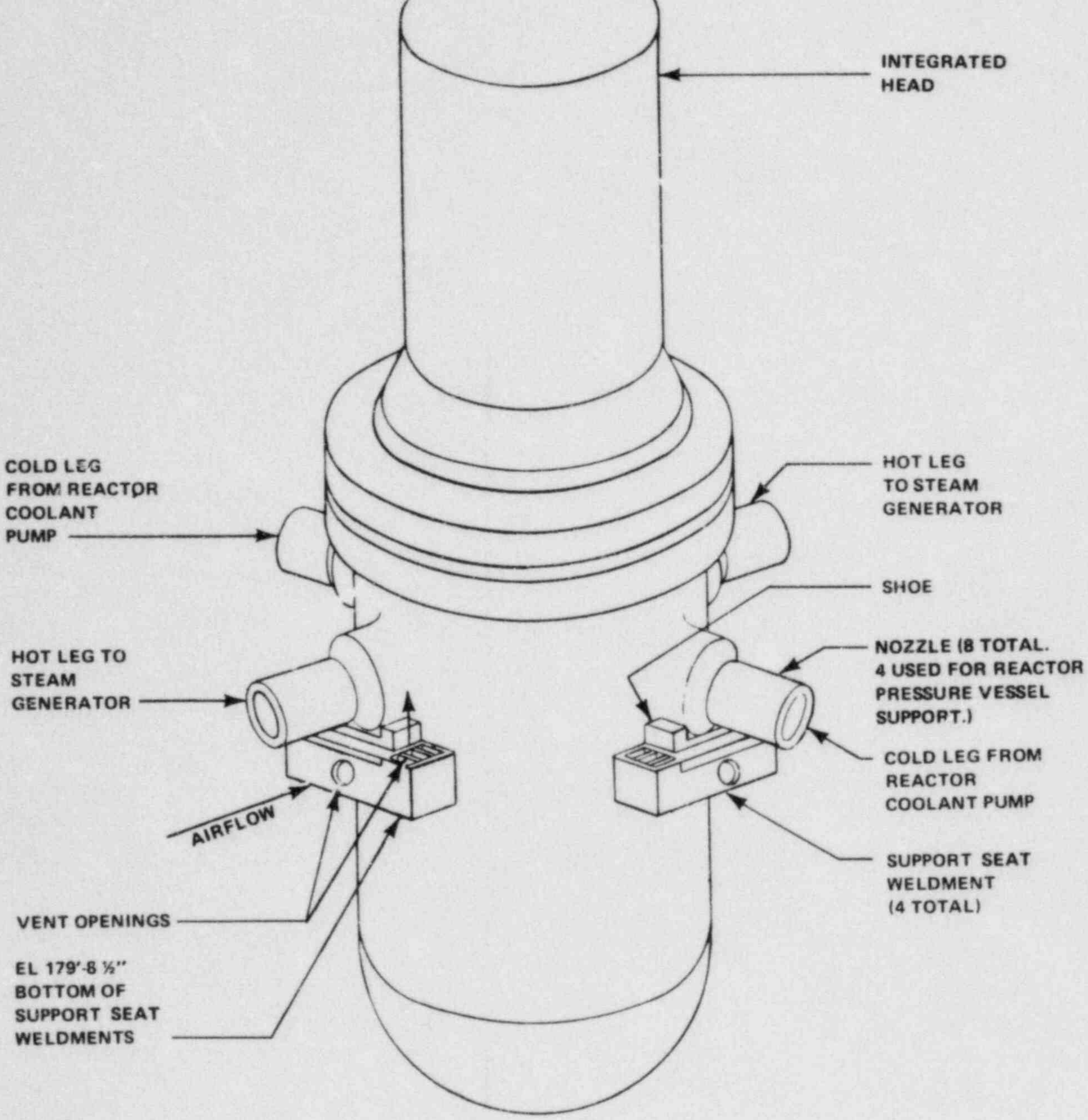
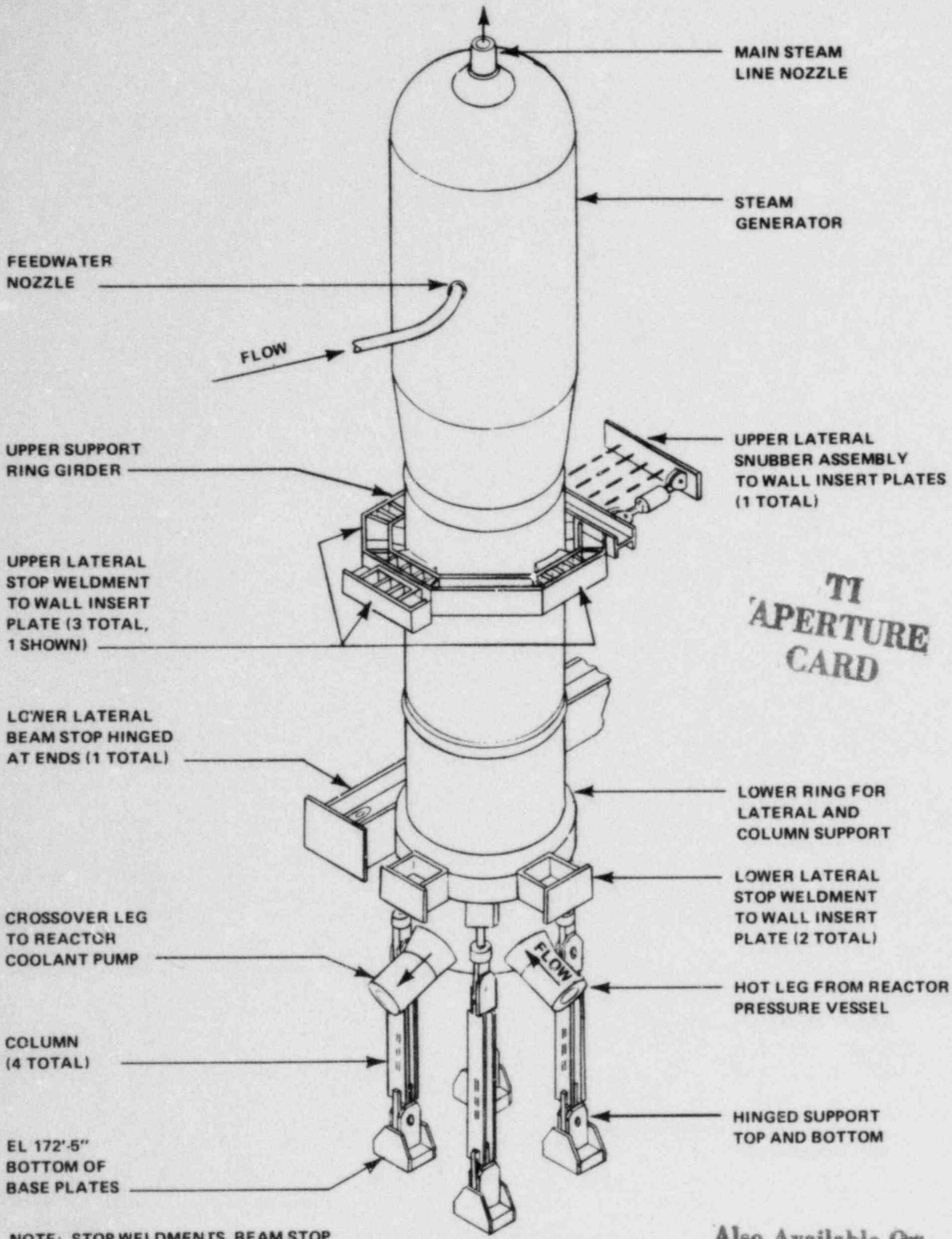


Figure 7
PRIMARY AND SECONDARY SHIELD WALL
ANCHORAGE TO BASEMAT



REACTOR
PRESSURE
VESSEL

(ONLY SUPPORT NOZZLES SHOWN)



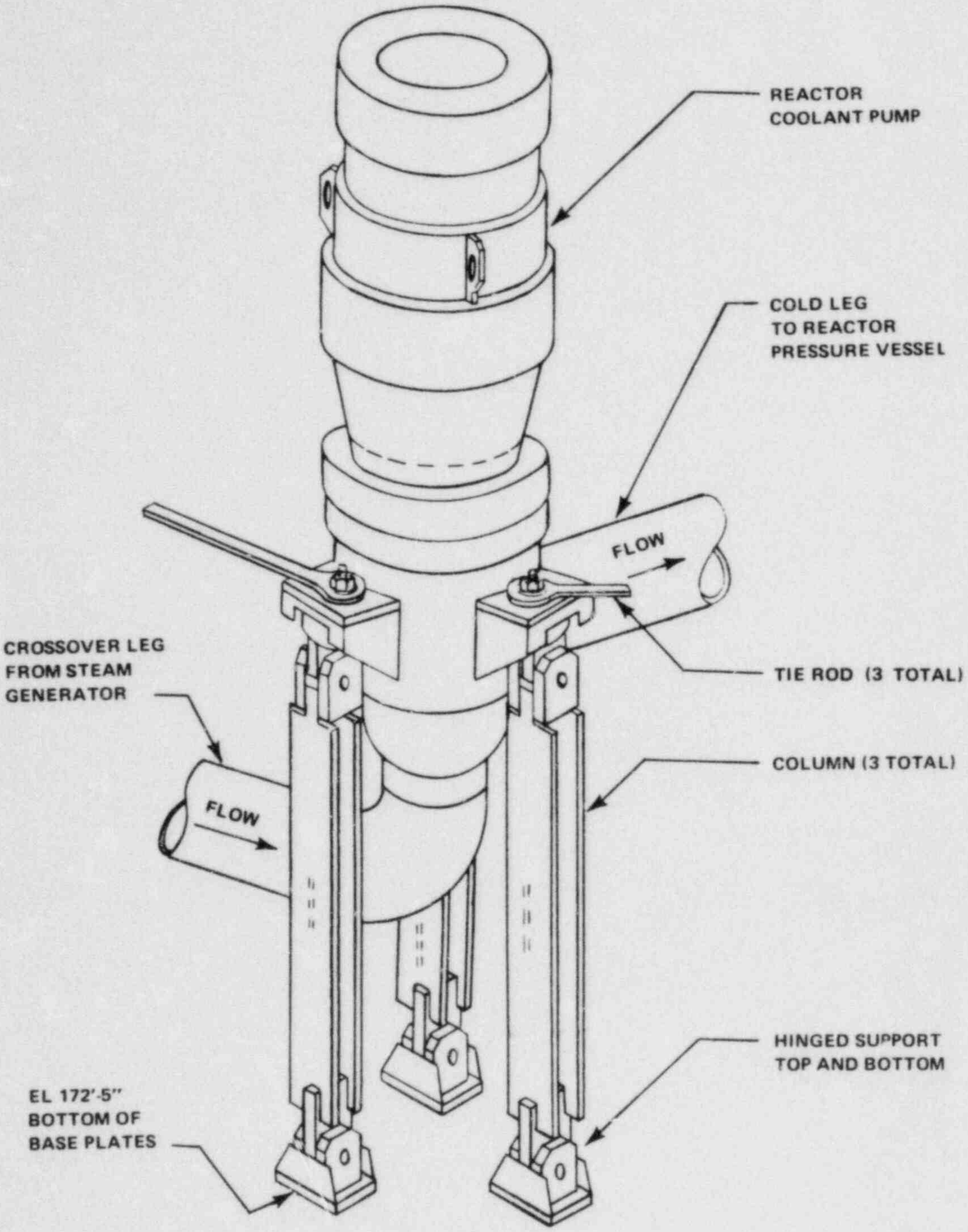
TI
APERTURE
CARD

NOTE: STOP WELDMENTS, BEAM STOP AND SNUBBER ARE SEPARATE FROM VESSEL

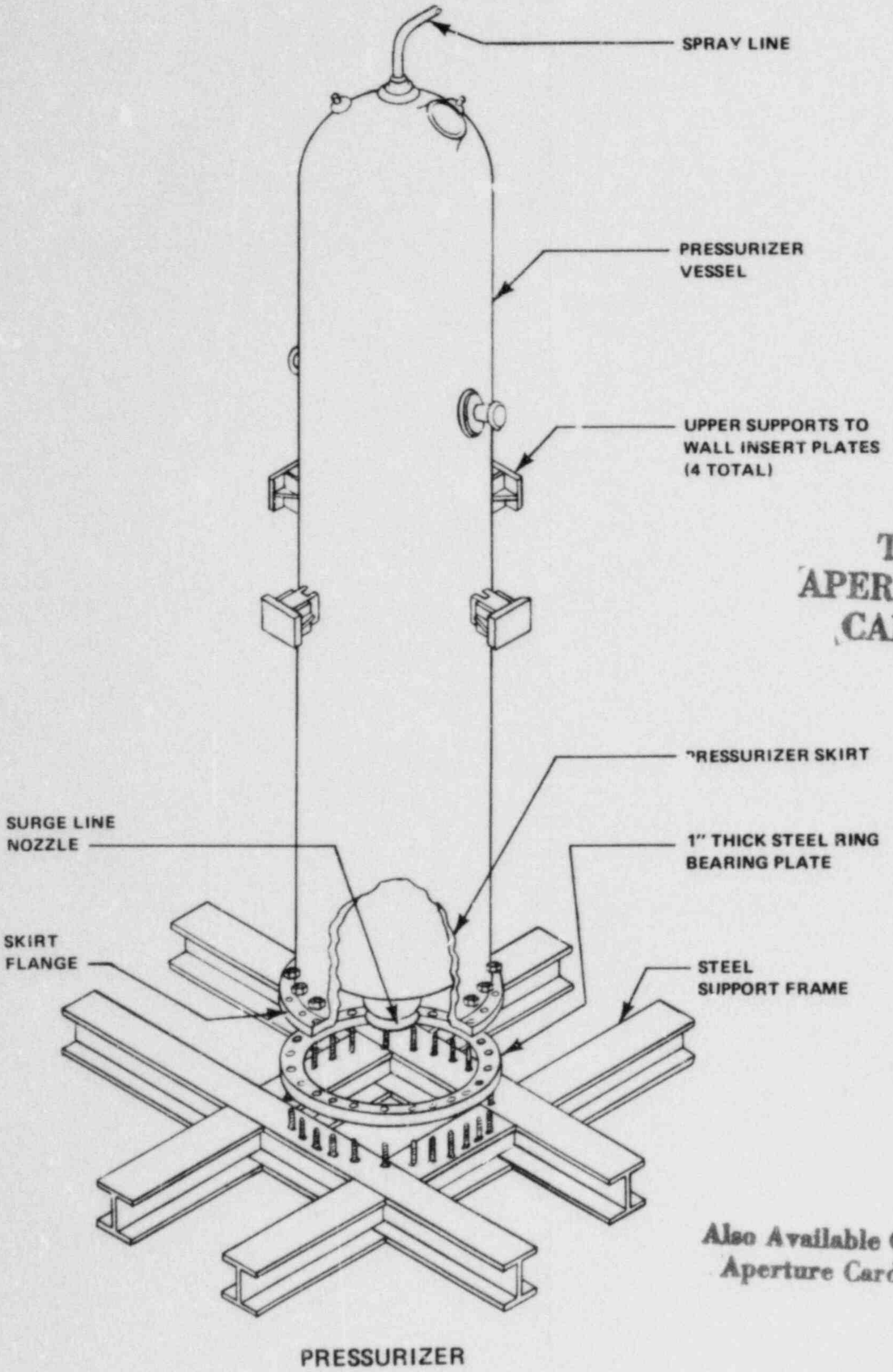
Also Available On
Aperture Card

STEAM
GENERATOR

Figure 8
SCHEMATIC VIEWS OF REACTOR COOLANT
SYSTEM COMPONENT SUPPORTS
(Sheet 1 of 2)



REACTOR
COOLANT
PUMP



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APERTURE
CARD

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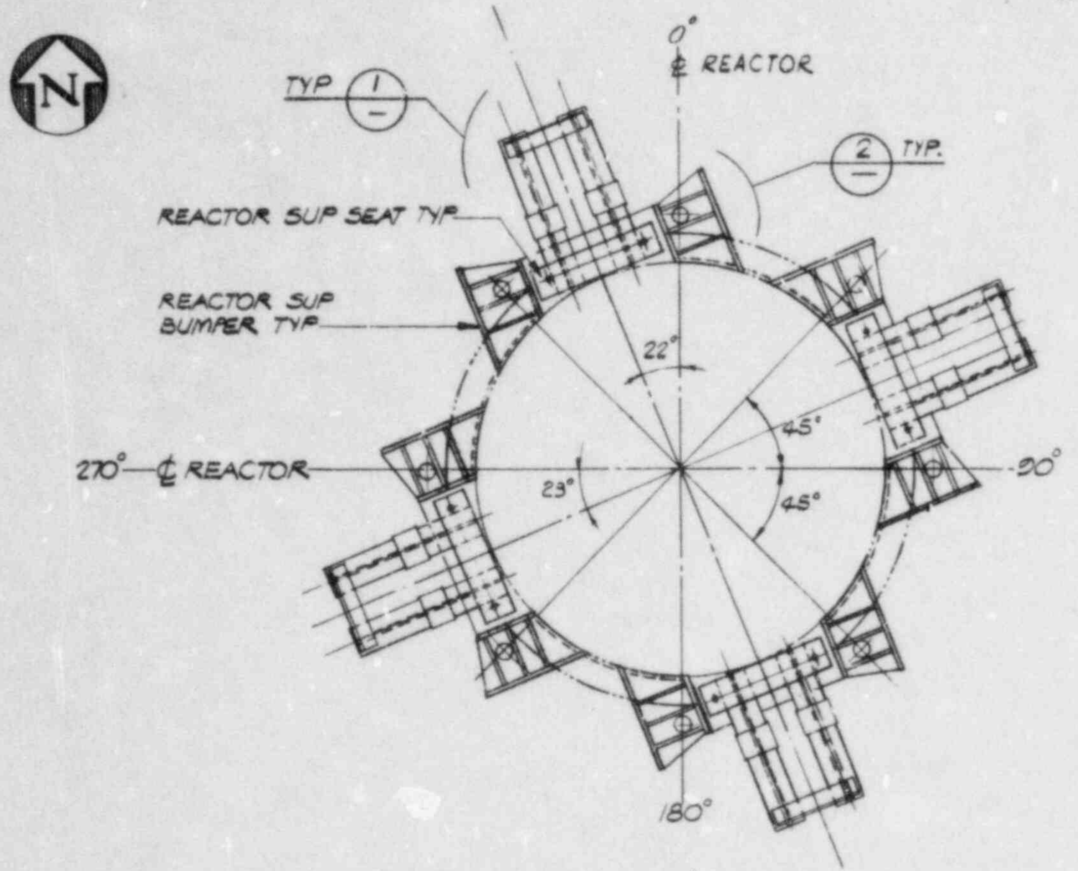
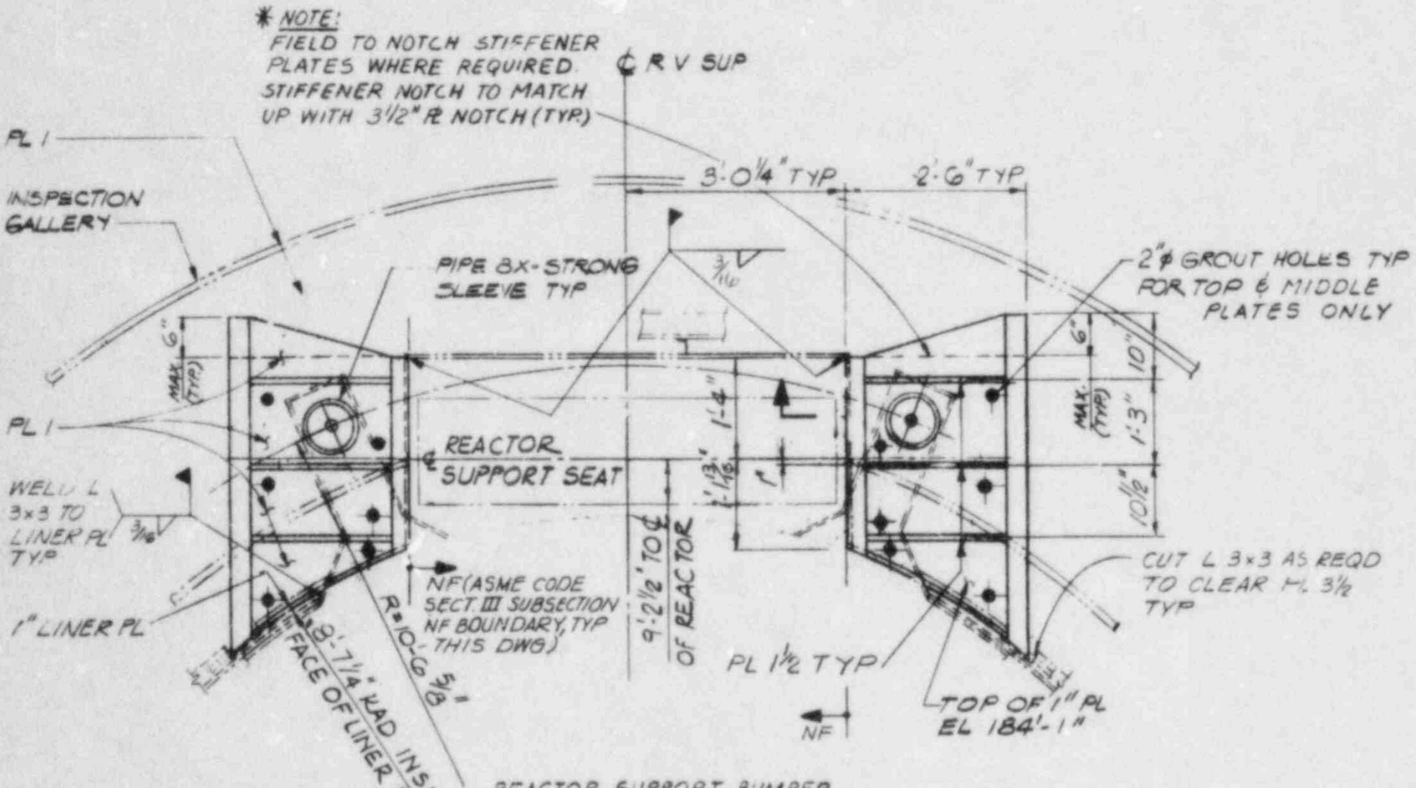
Aperture Card

Figure 8
SCHEMATIC VIEWS OF REACTOR COOLANT SYSTEM COMPONENT SUPPORTS
(Sheet 2 of 2)



VESSEL SUP SEAT & BUMPER SUP PLAN



REACTOR SUPPORT BUMPER

DETAIL 2

Figure 9
REACTOR PRESSURE VESSEL
SUPPORT EMBEDMENTS
(Sheet 1 of 2)

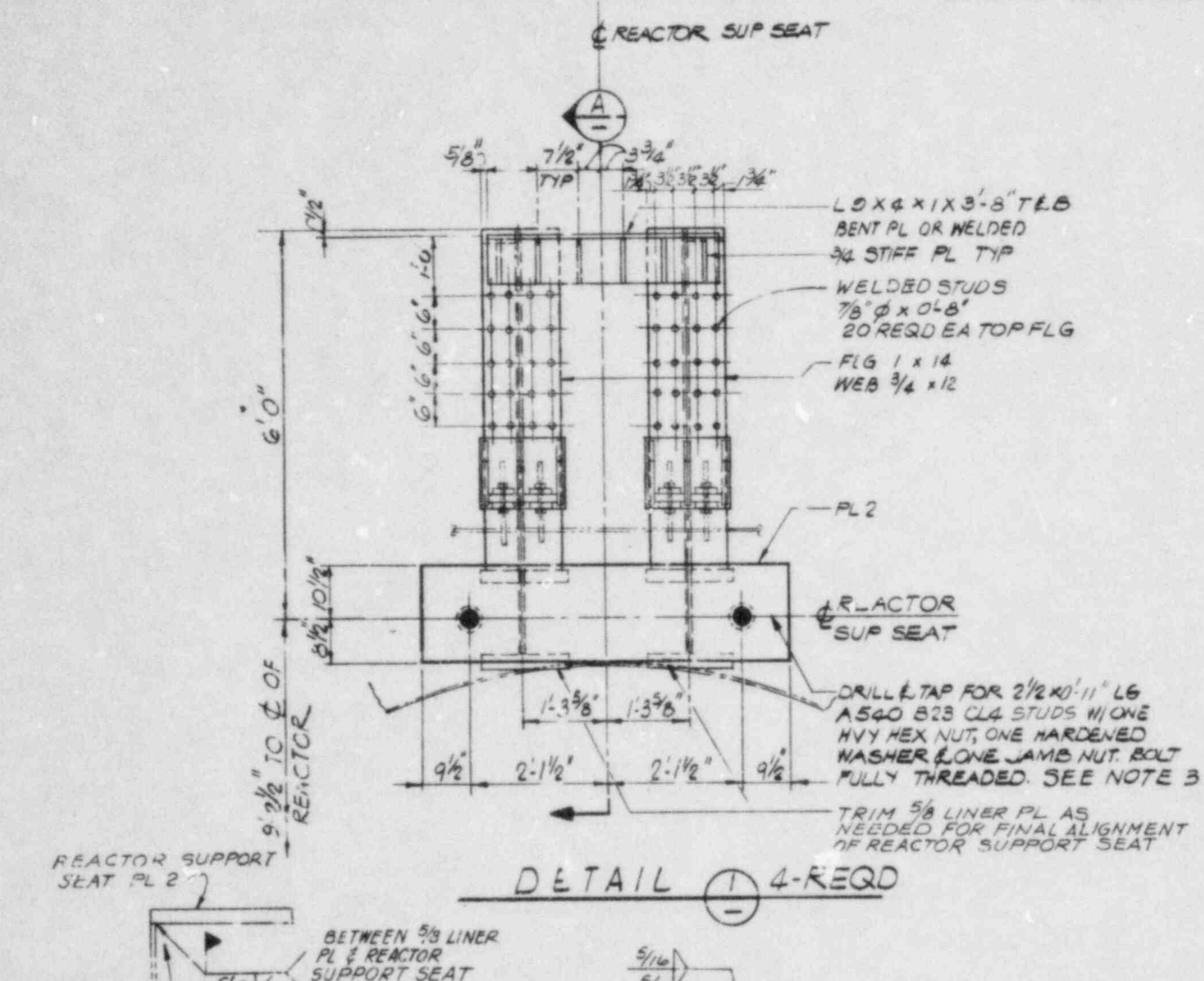
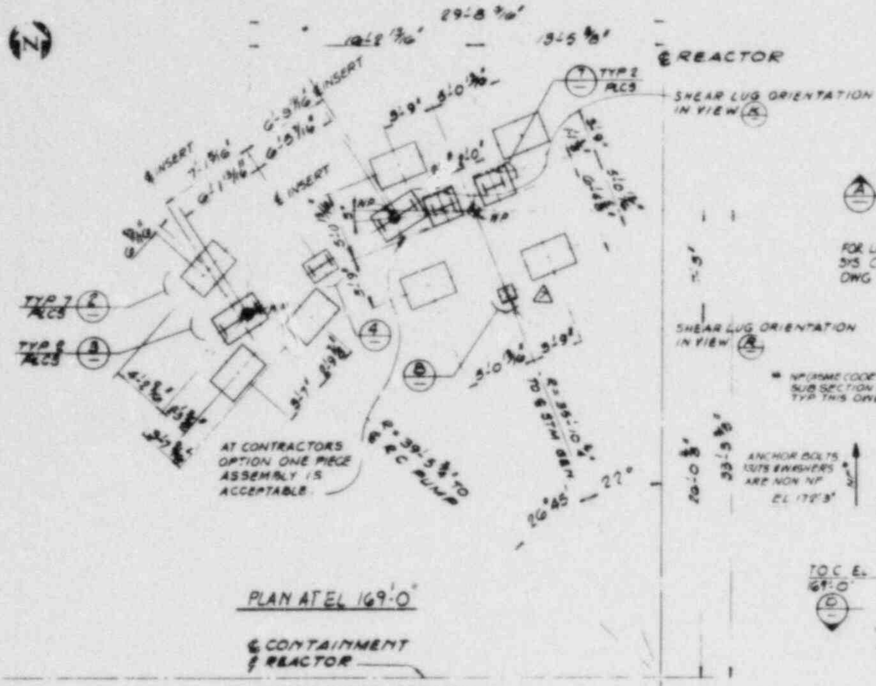
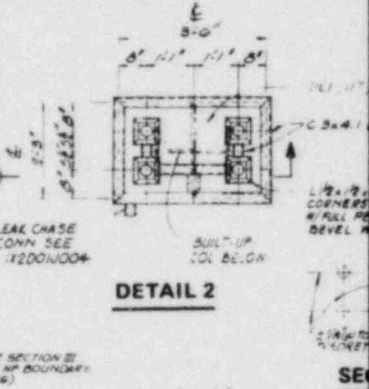


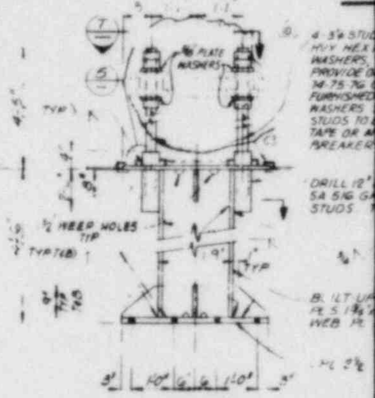
Figure 9
REACTOR PRESSURE VESSEL
SUPPORT EMBEDMENTS
(Sheet 2 of 2)



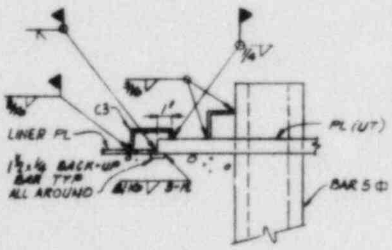
PLAN AT EL 169'-0"



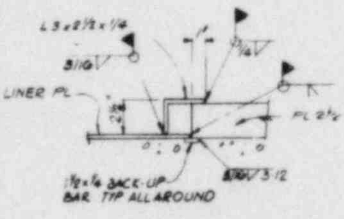
DETAIL 2



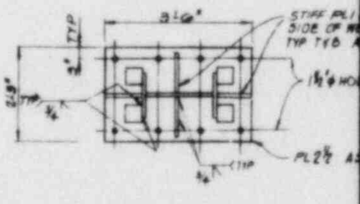
SECTION A



DETAIL 5



DETAIL 6



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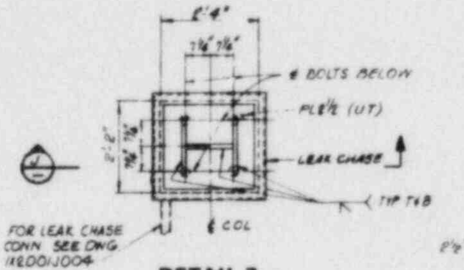
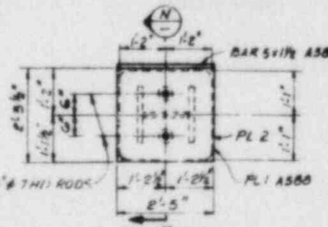
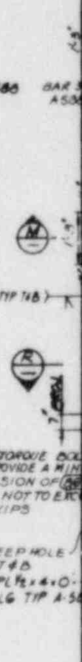
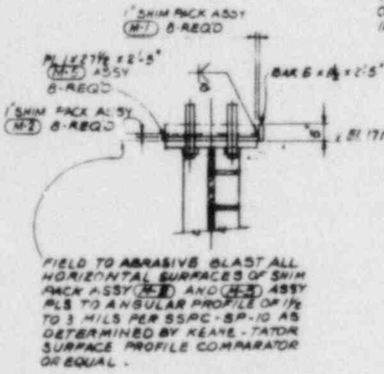


DETAIL 7

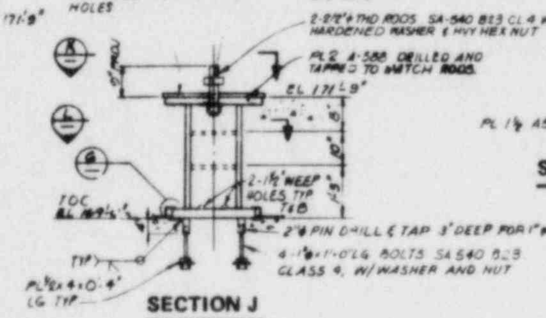


VIEW K

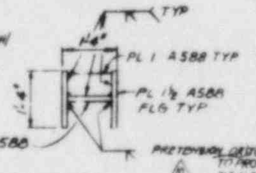




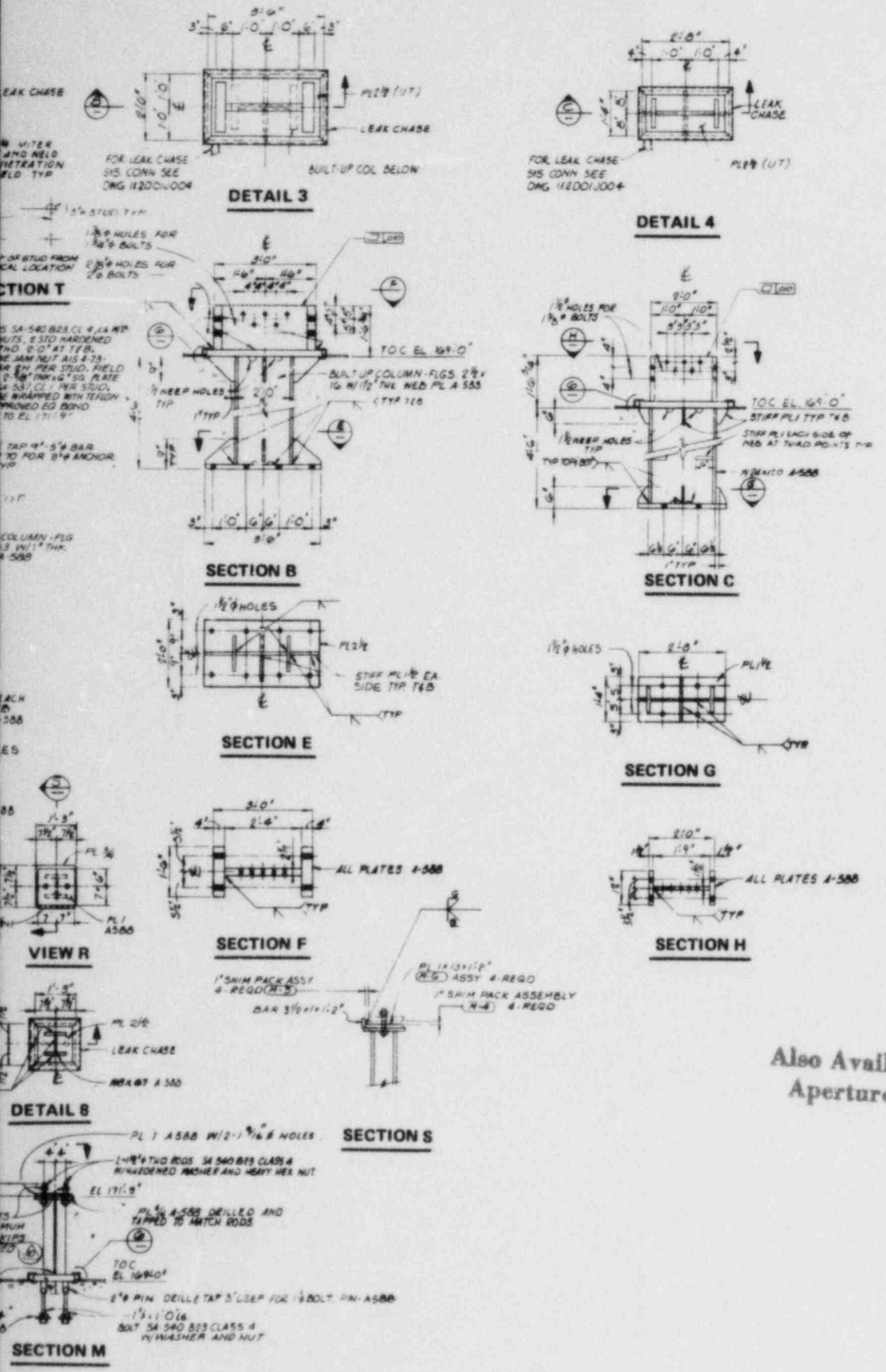
SECTION N



SECTION J



SECTION L



APERTURE CARD

Also Available On
Aperture Card

Figure 10
NSSS SUPPORT ANCHORAGE
TO BASEMAT (UNIT 1)

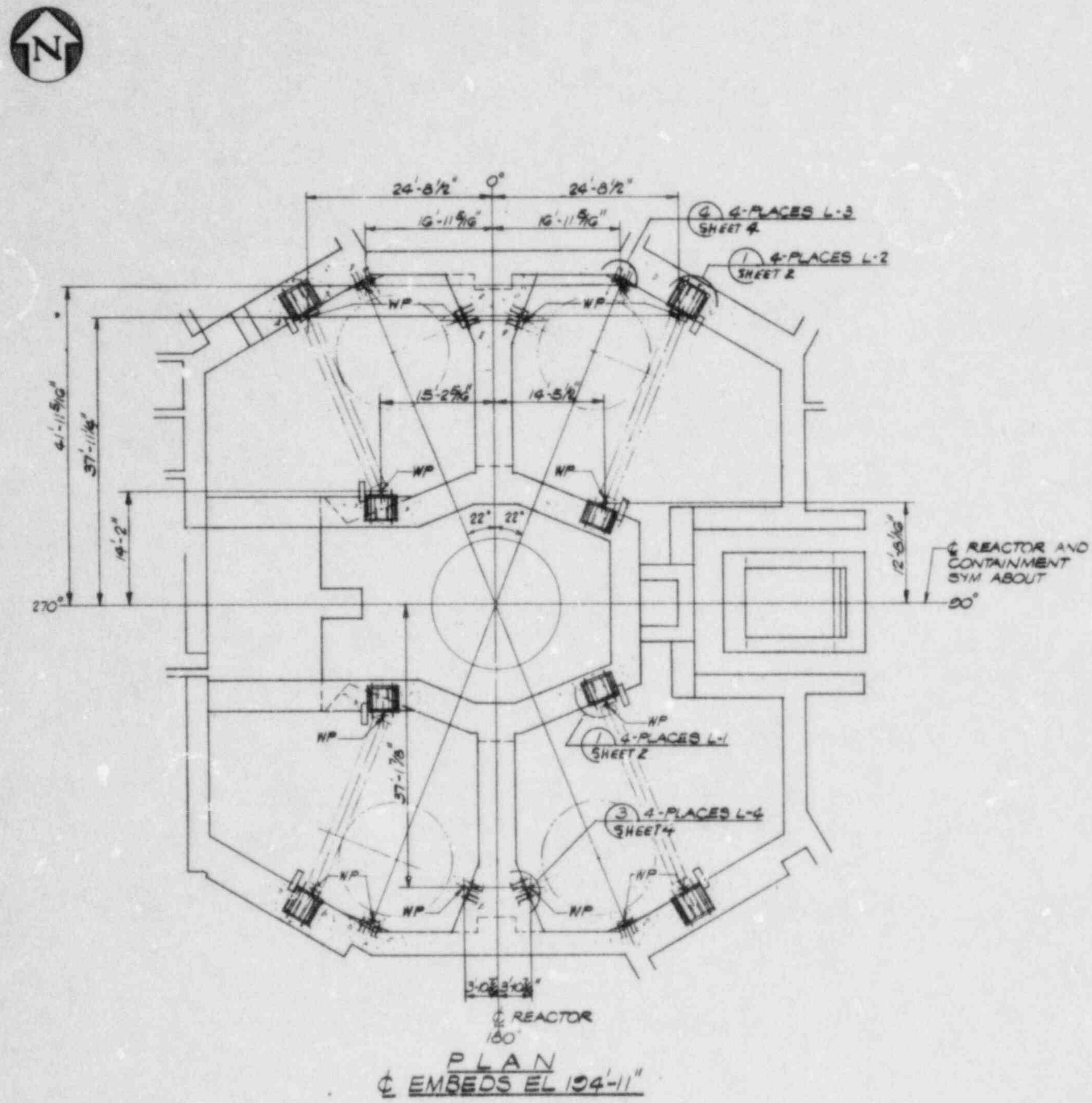
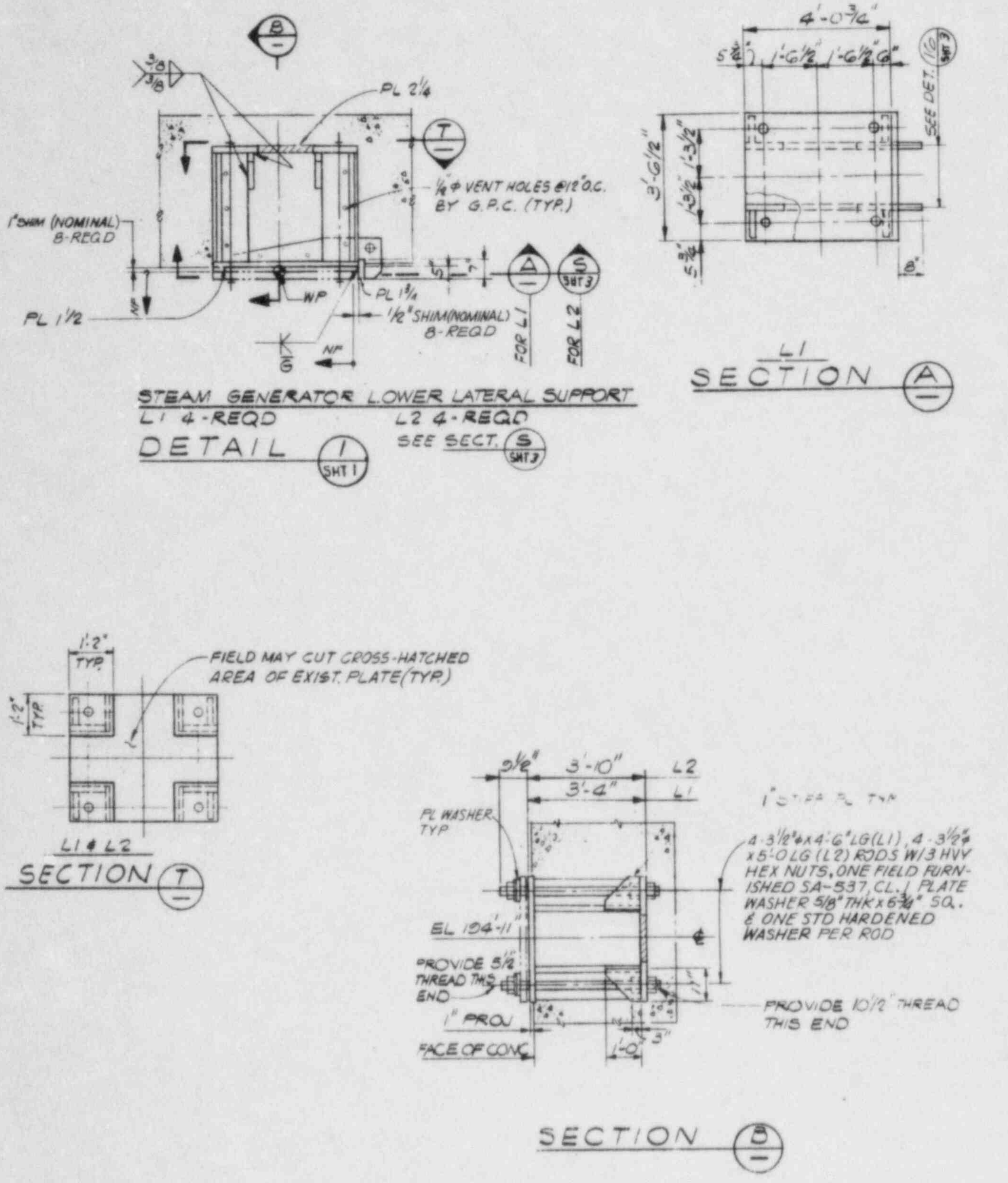


Figure 11
STEAM GENERATOR LOWER
LATERAL SUPPORT EMBEDMENTS
(Sheet 1 of 4)



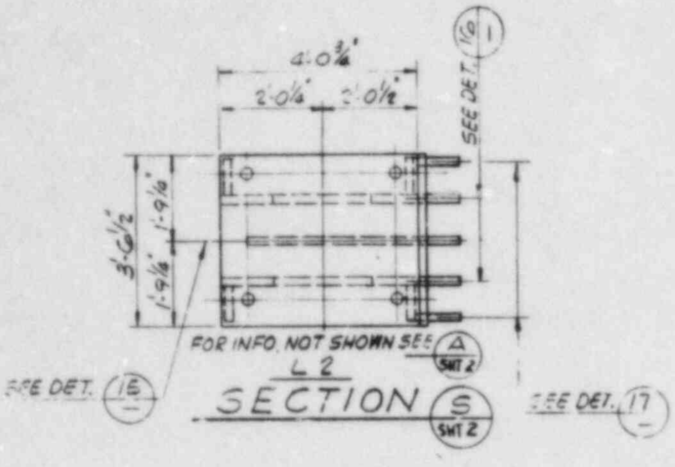
STEAM GENERATOR LOWER LATERAL SUPPORT
L1 4-REQD L2 4-REQD
DETAIL 1 SHT 1
SEE SECT. S SHT 3

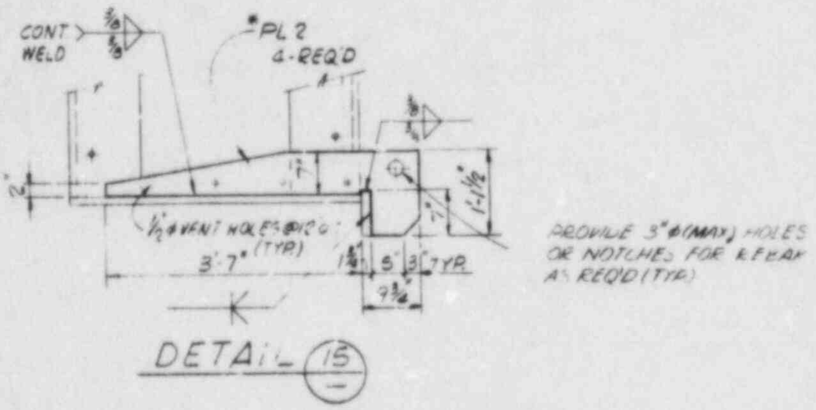
L1
SECTION A

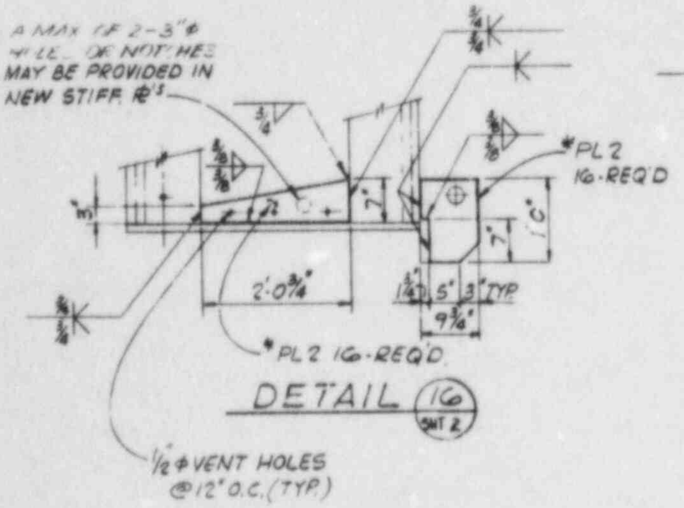
L1 & L2
SECTION T

SECTION B

Figure 11
STEAM GENERATOR LOWER
LATERAL SUPPORT EMBEDMENTS
(Sheet 2 of 4)







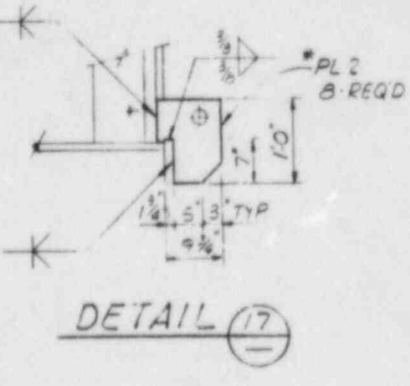
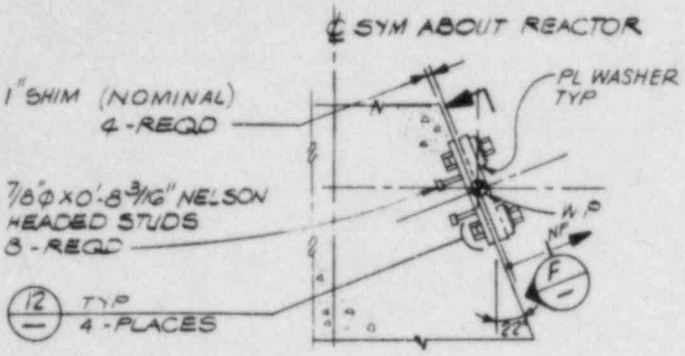
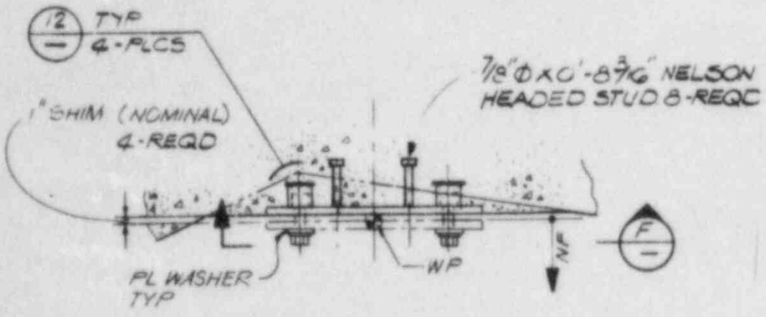


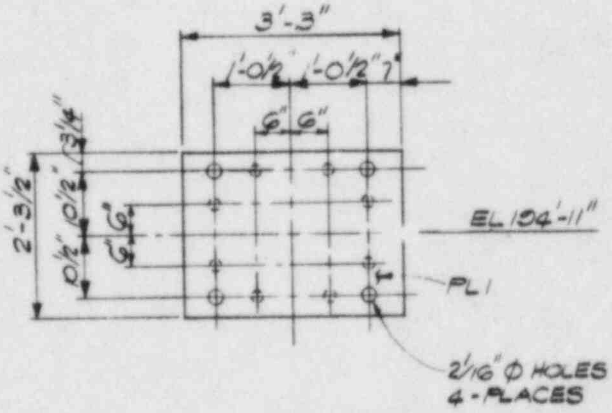
Figure 11
STEAM GENERATOR LOWER
LATERAL SUPPORT EMBEDMENTS
(Sheet 3 of 4)



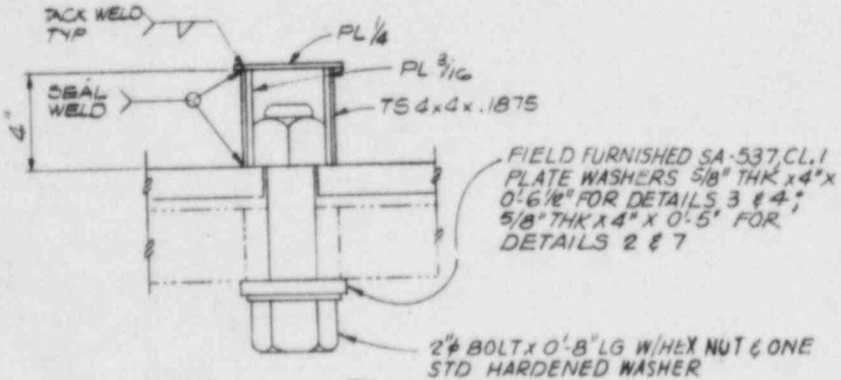
STEAM GEN LOWER LATERAL SUPPORT EL 194'-11" L4
L4 4-REQD
DETAIL 3 SHT 1



STEAM GENERATOR LOWER SUPPORT
L3 4-REQD
DETAIL 4 SHT 1



SECTION F —



DETAIL 12 —

Figure 11
STEAM GENERATOR LOWER
LATERAL SUPPORT EMBEDMENTS
(Sheet 4 of 4)

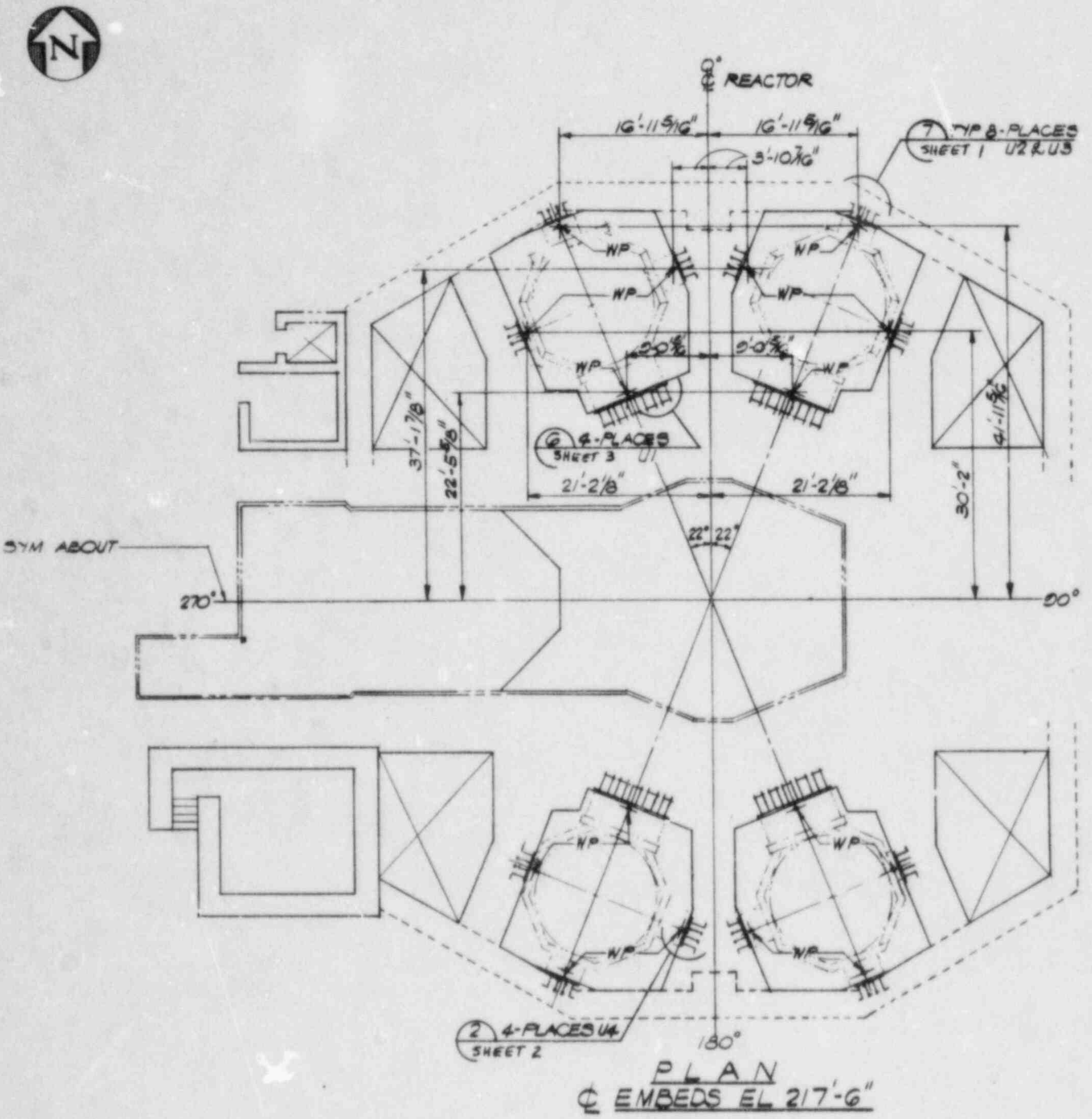
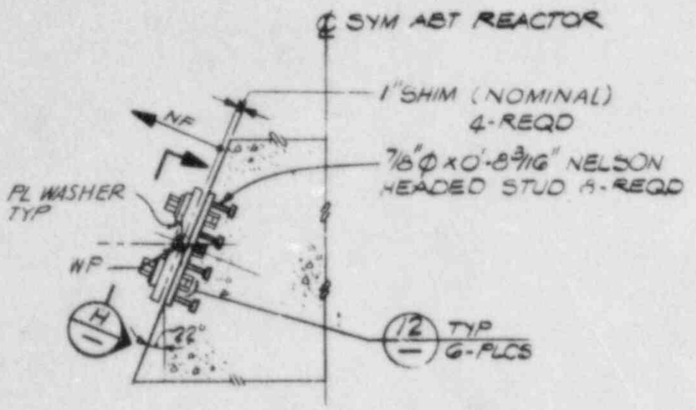
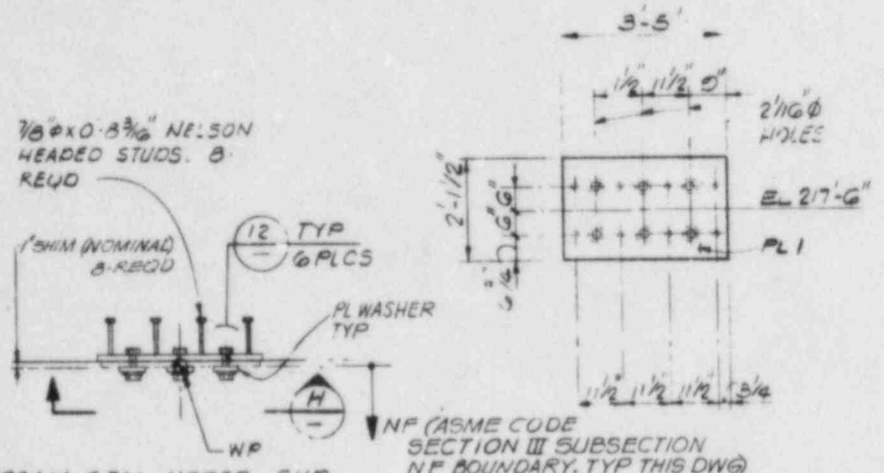


Figure 12
STEAM GENERATOR UPPER
LATERAL SUPPORT EMBEDMENTS
(Sheet 1 of 3)



STEAM GEN UPPER LATERAL SUPPORT EL 217'-6" U4

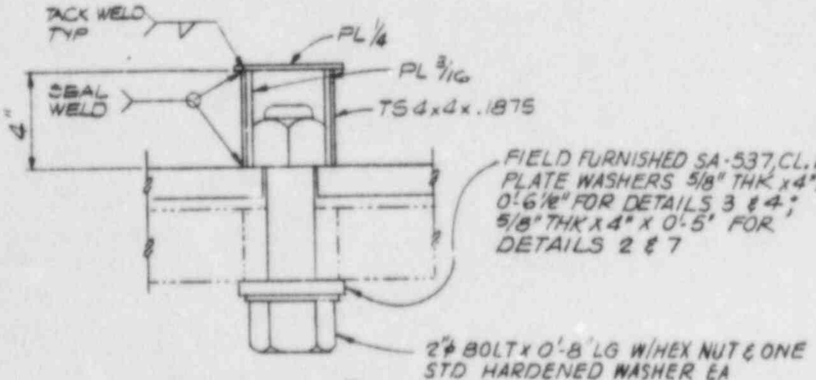
DETAIL 2 SHT 1



STEAM GEN. UPPER SUP
U2 4-REQD U3 4-REQD

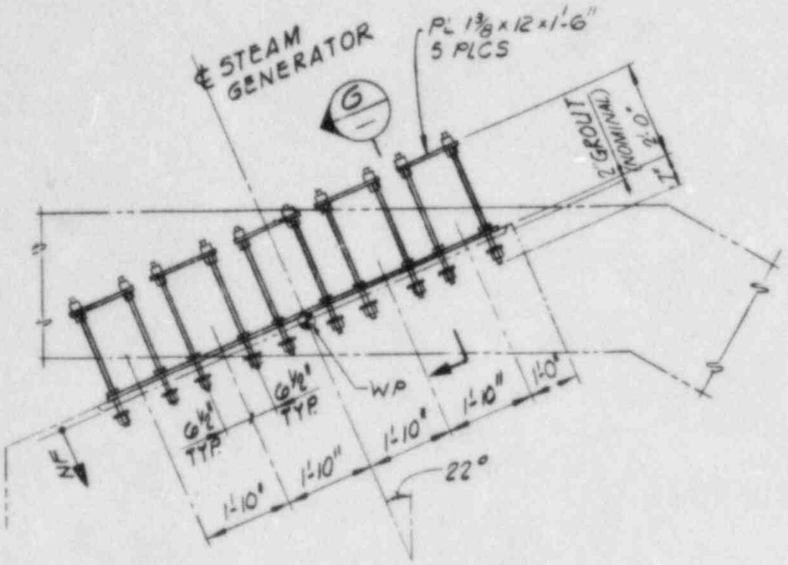
DETAIL 7 SHT 1

SECTION H



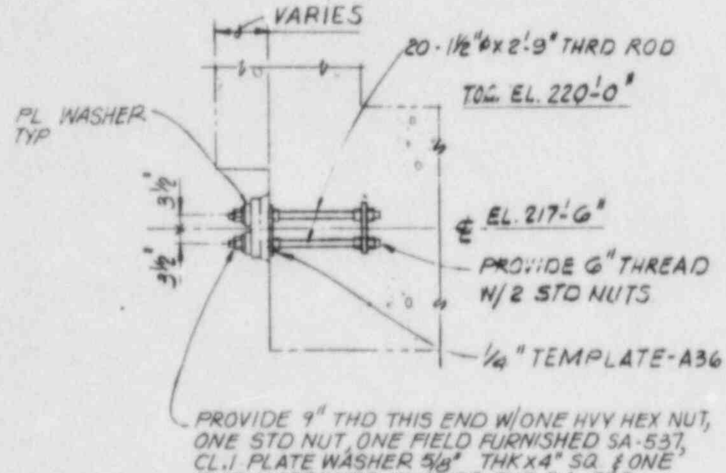
DETAIL 12

Figure 12
STEAM GENERATOR UPPER
LATERAL SUPPORT EMBEDMENTS
(Sheet 2 of 3)



STEAM GENERATOR UPPER LATERAL SUPPORT
4 · REQ'D

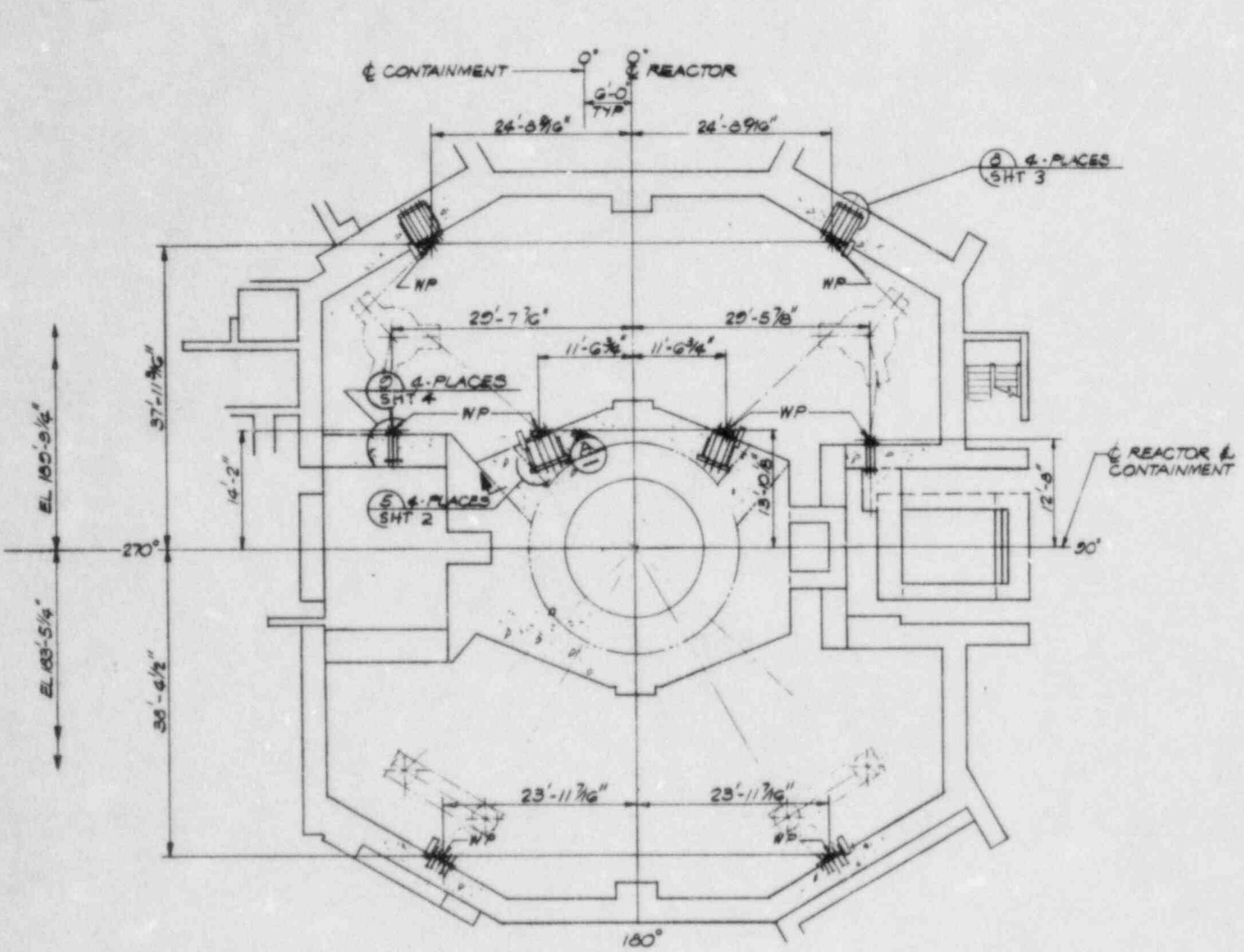
DETAIL 6 (SHT 1)



PROVIDE 9" THD THIS END W/ONE HVY HEX NUT,
ONE STD NUT, ONE FIELD FURNISHED SA-537,
CL.1 PLATE WASHER 5/8" THK x 4" SQ & ONE
FLAT HARDENED WASHER TYP EA ROD

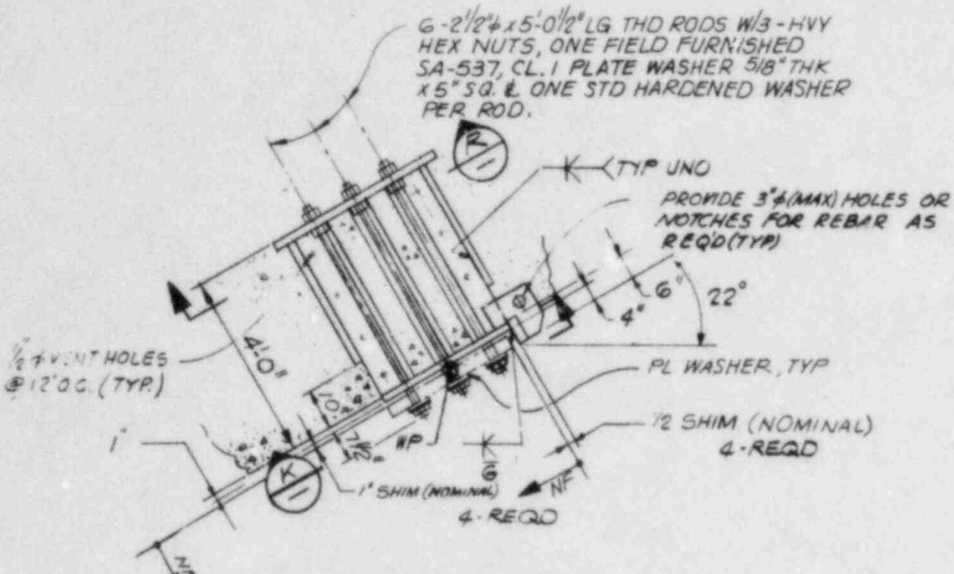
SECTION 6

Figure 12
STEAM GENERATOR UPPER
LATERAL SUPPORT EMBEDMENTS
(Sheet 3 of 3)

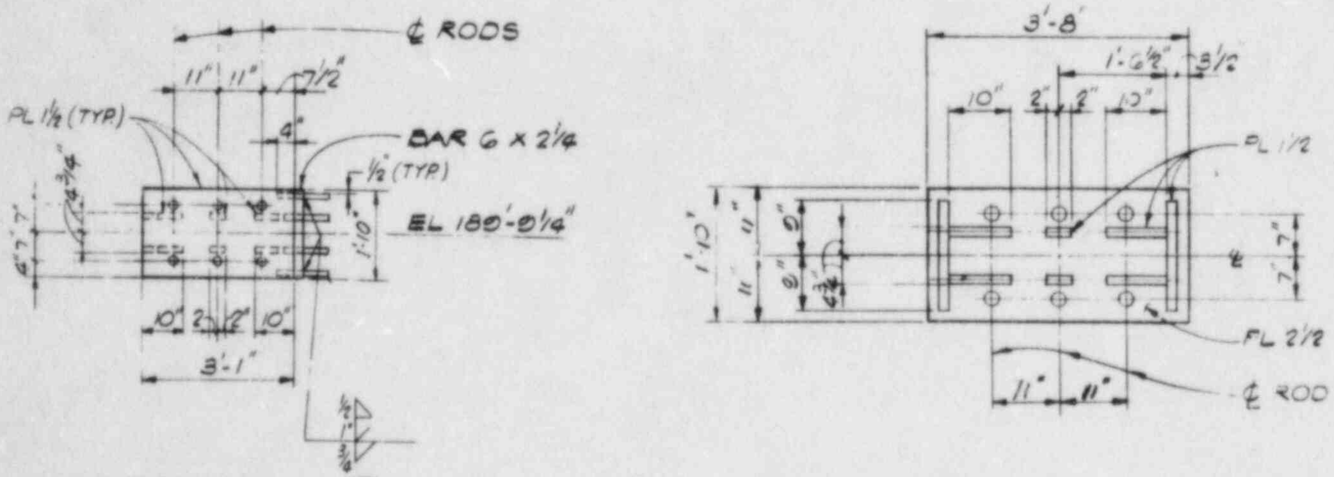


PLAN
℄ EMBEDS EL 183'-5 1/4" AND EL 189'-9 1/4"

Figure 13
REACTOR COOLANT PUMP
LATERAL SUPPORT EMBEDMENTS
(Sheet 1 of 4)



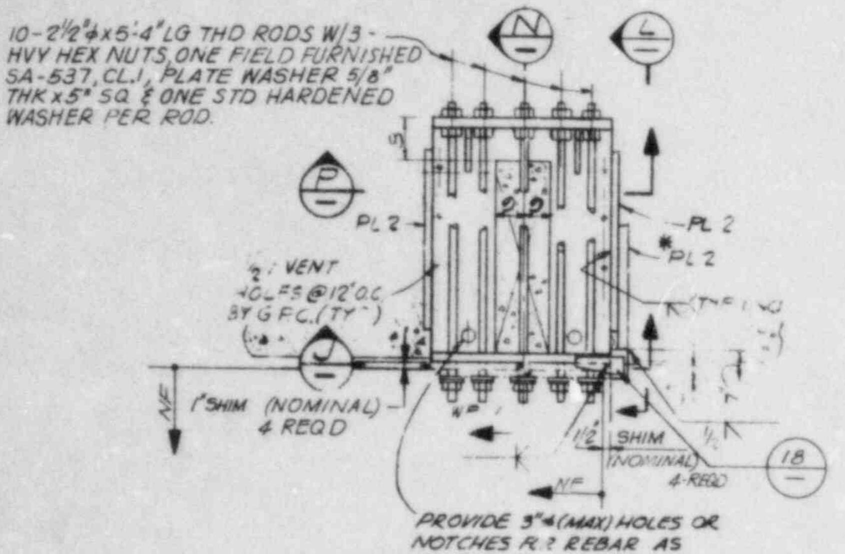
REACTOR COOLANT PUMP TIE ROD SUPPORT
T-3 4-REQD
DETAIL 5 SHT 1



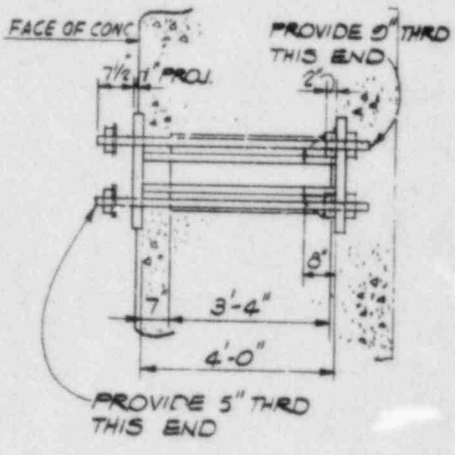
SECTION K

SECTION R

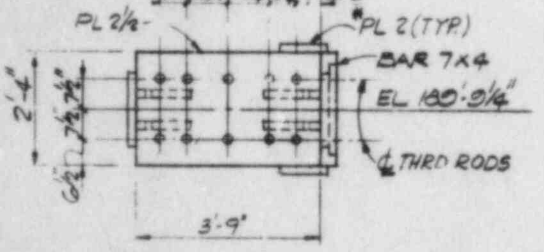
Figure 13
REACTOR COOLANT PUMP
LATERAL SUPPORT EMBEDMENTS
(Sheet 2 of 4)



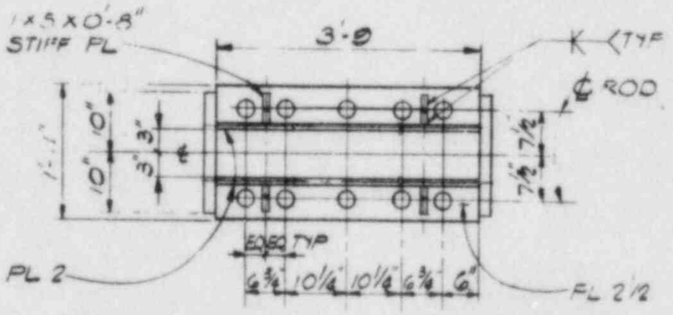
REACTOR COOLANT PUMP TIE ROD SUP
T-2 4-REQD
DETAIL 8 SHT 1



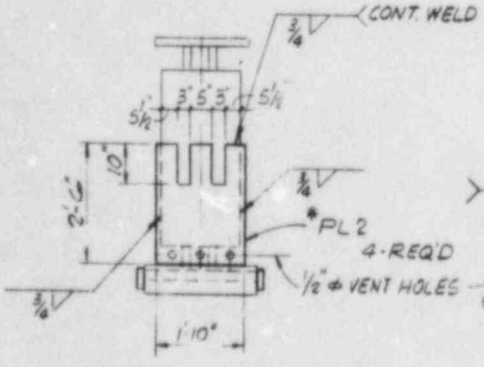
SECTION N



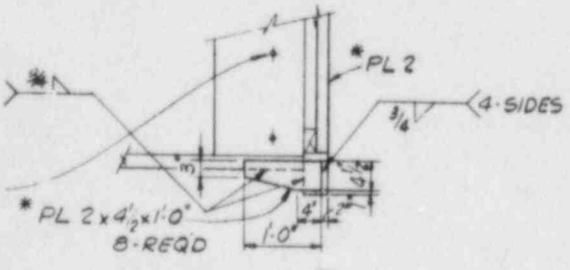
SECTION J



SECTION P

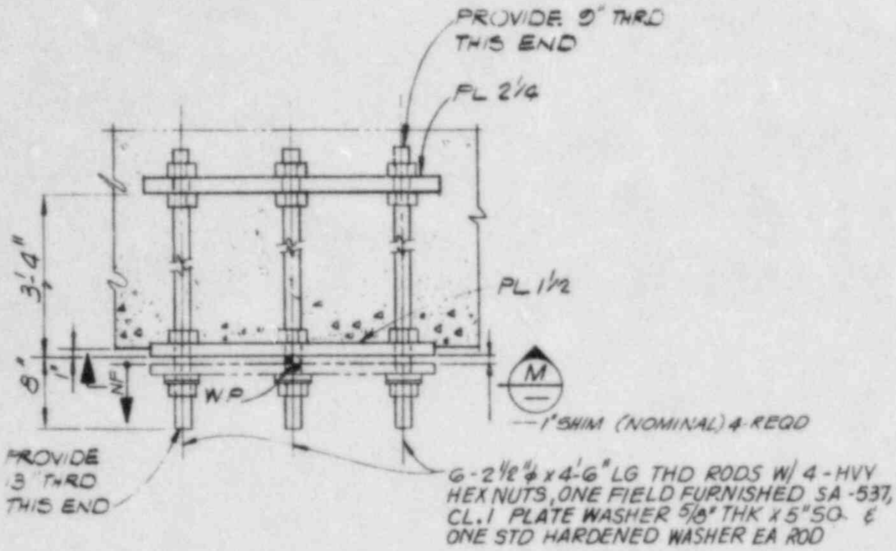


SECTION L



DETAIL 18

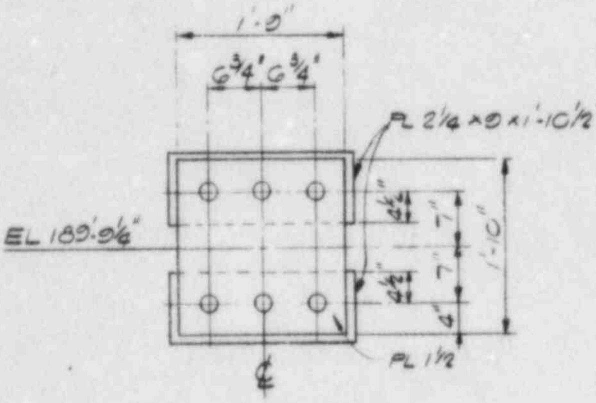
Figure 13
REACTOR COOLANT PUMP
LATERAL SUPPORT EMBEDMENTS
(Sheet 3 of 4)



REACTOR COOLANT PUMP TIE ROD SUP

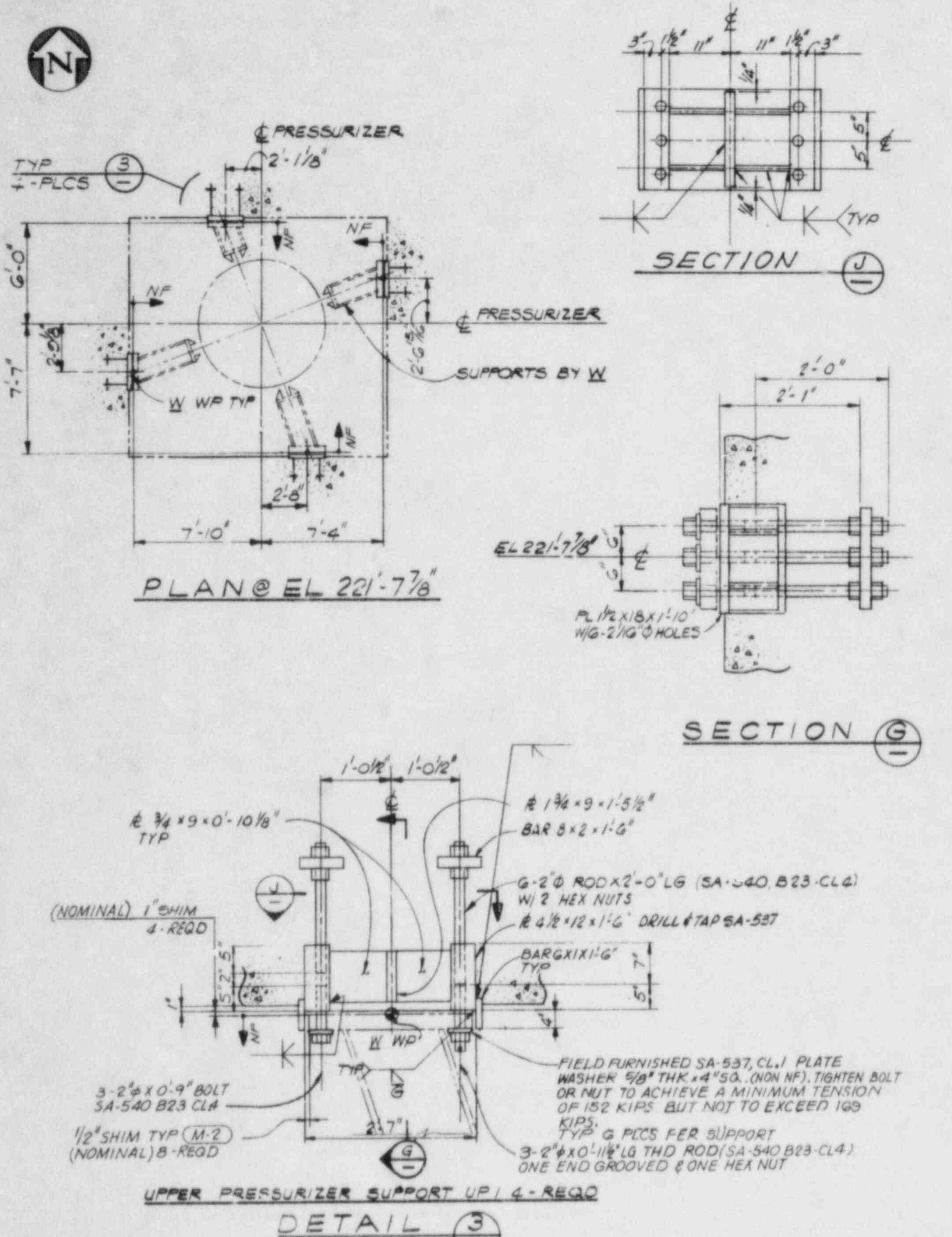
T-1 4-REQD

DETAIL 9 SHT 1



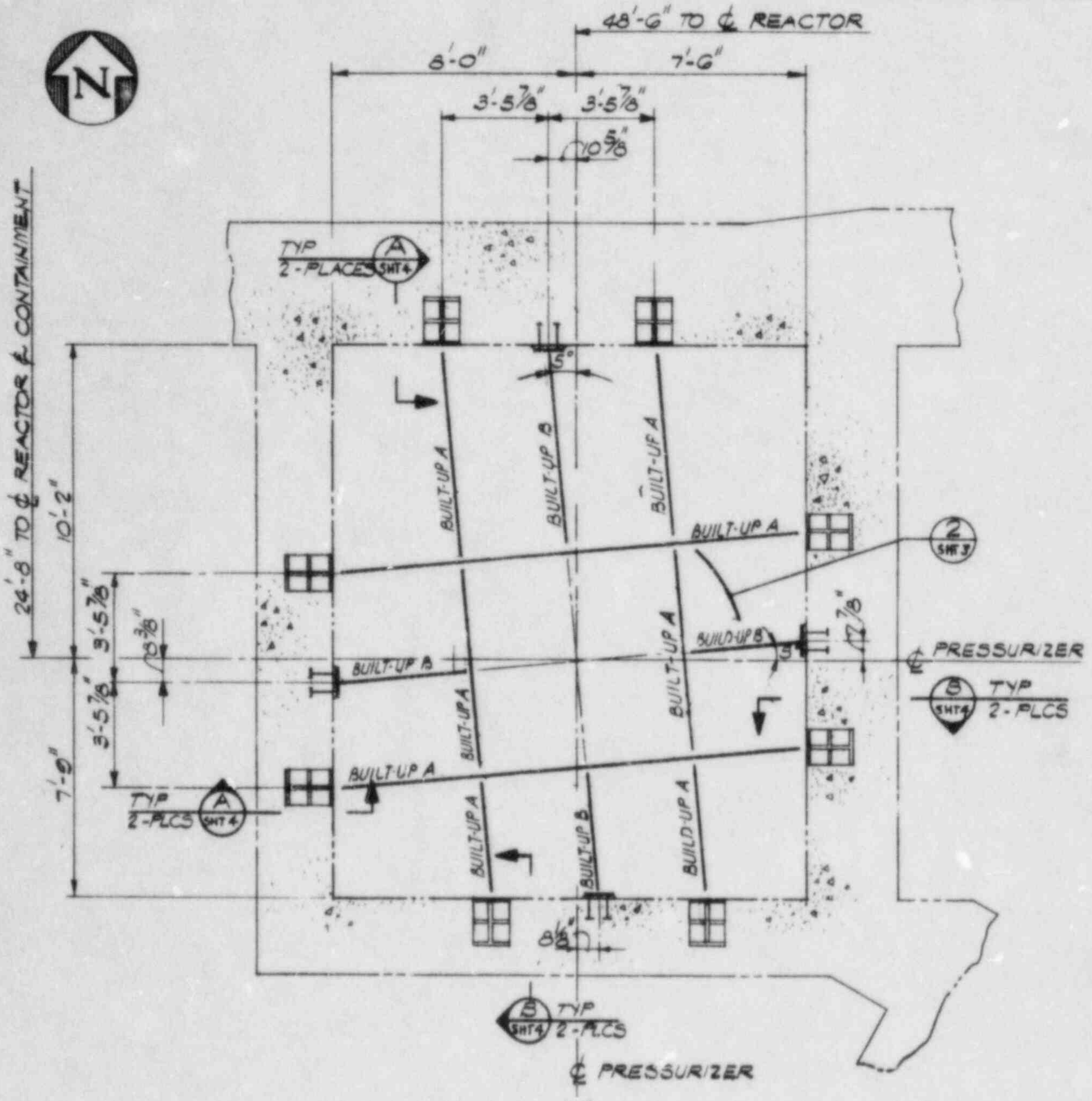
SECTION M

Figure 13
REACTOR COOLANT PUMP
LATERAL SUPPORT EMBEDMENTS
(Sheet 4 of 4)



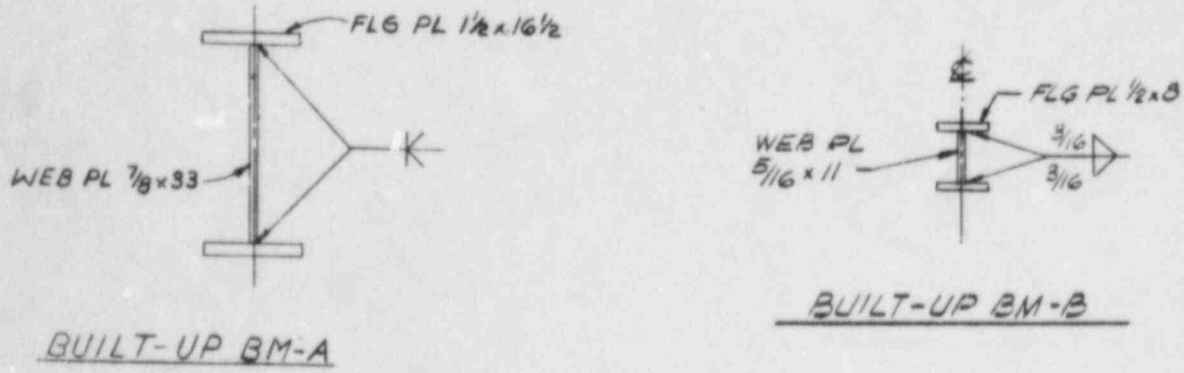
UPPER LATERAL SUPPORT EMBEDMENTS

Figure 14
PRESSURIZER SUPPORT AND ANCHORAGE
(Sheet 1 of 6)



TOS EL (-) 1 1/4"

PLAN AT EL 195'-9 3/4"

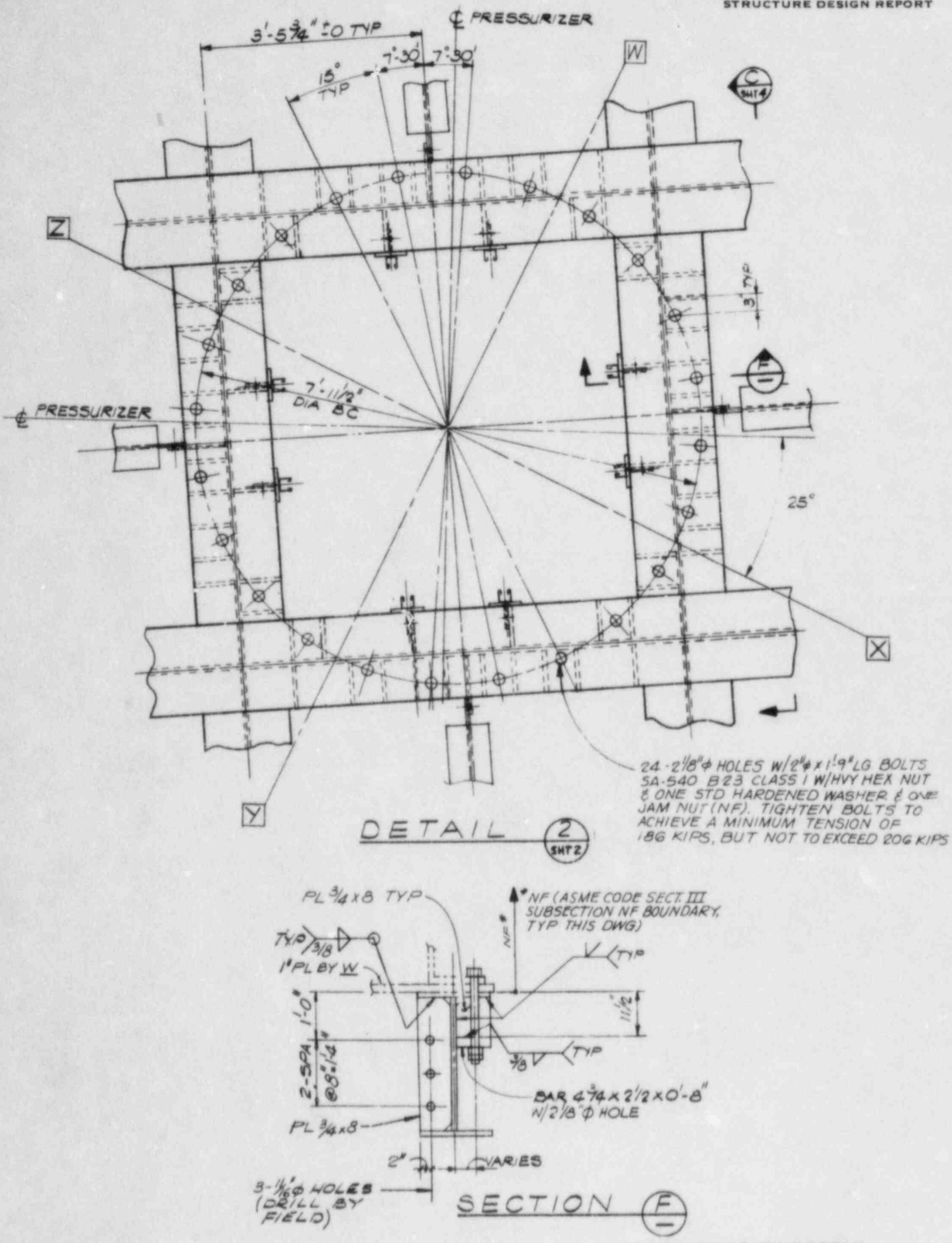


BUILT-UP BM-A

BUILT-UP BM-B

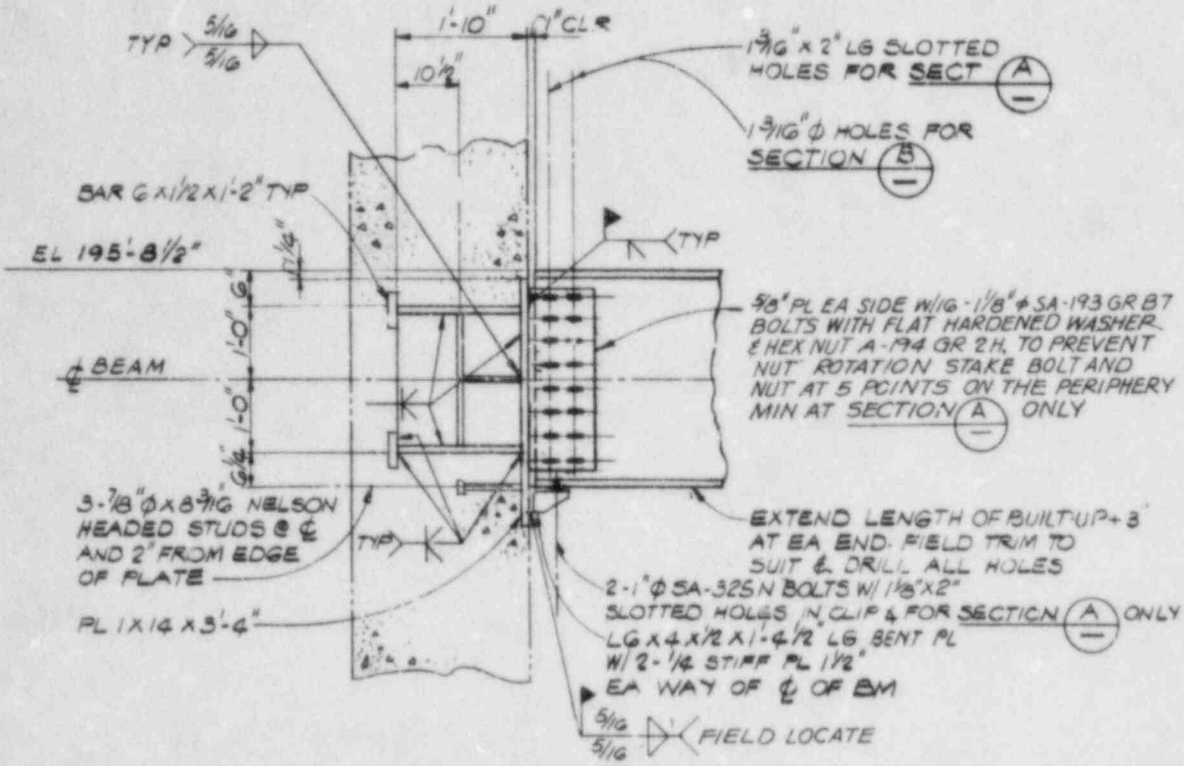
LOWER SUPPORT

Figure 14
PRESSURIZER SUPPORT AND ANCHORAGE
(Sheet 2 of 6)

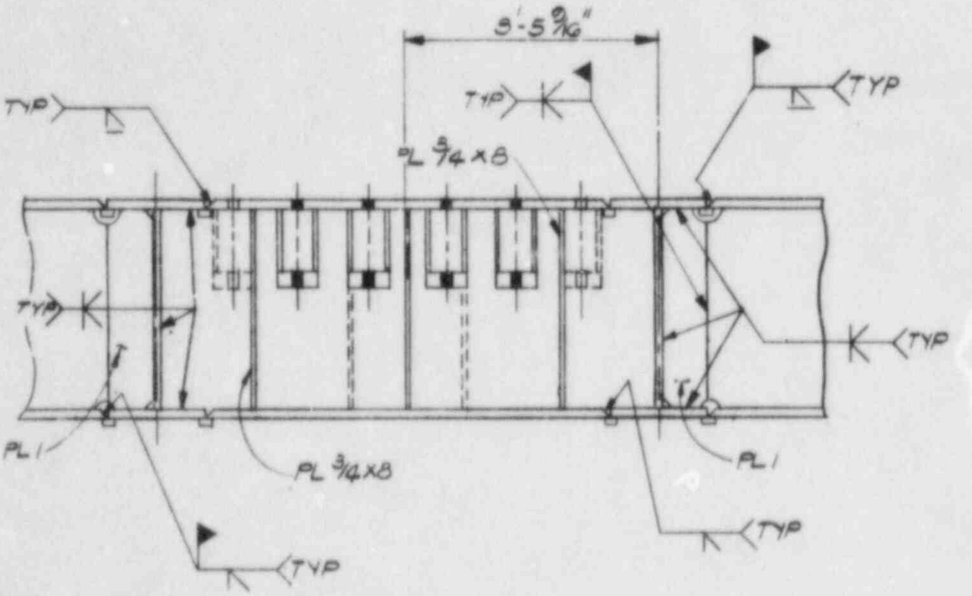


SKIRT/FRAME BOLTING DETAIL

Figure 14
PRESSURIZER SUPPORT AND ANCHORAGE
(Sheet 3 of 6)



SECTION A B
SHEET 2



SECTION C
SHT 3

EMBEDMENT AND CONNECTION DETAILS

Figure 14
PRESSURIZER SUPPORT AND ANCHORAGE
(Sheet 4 of 6)

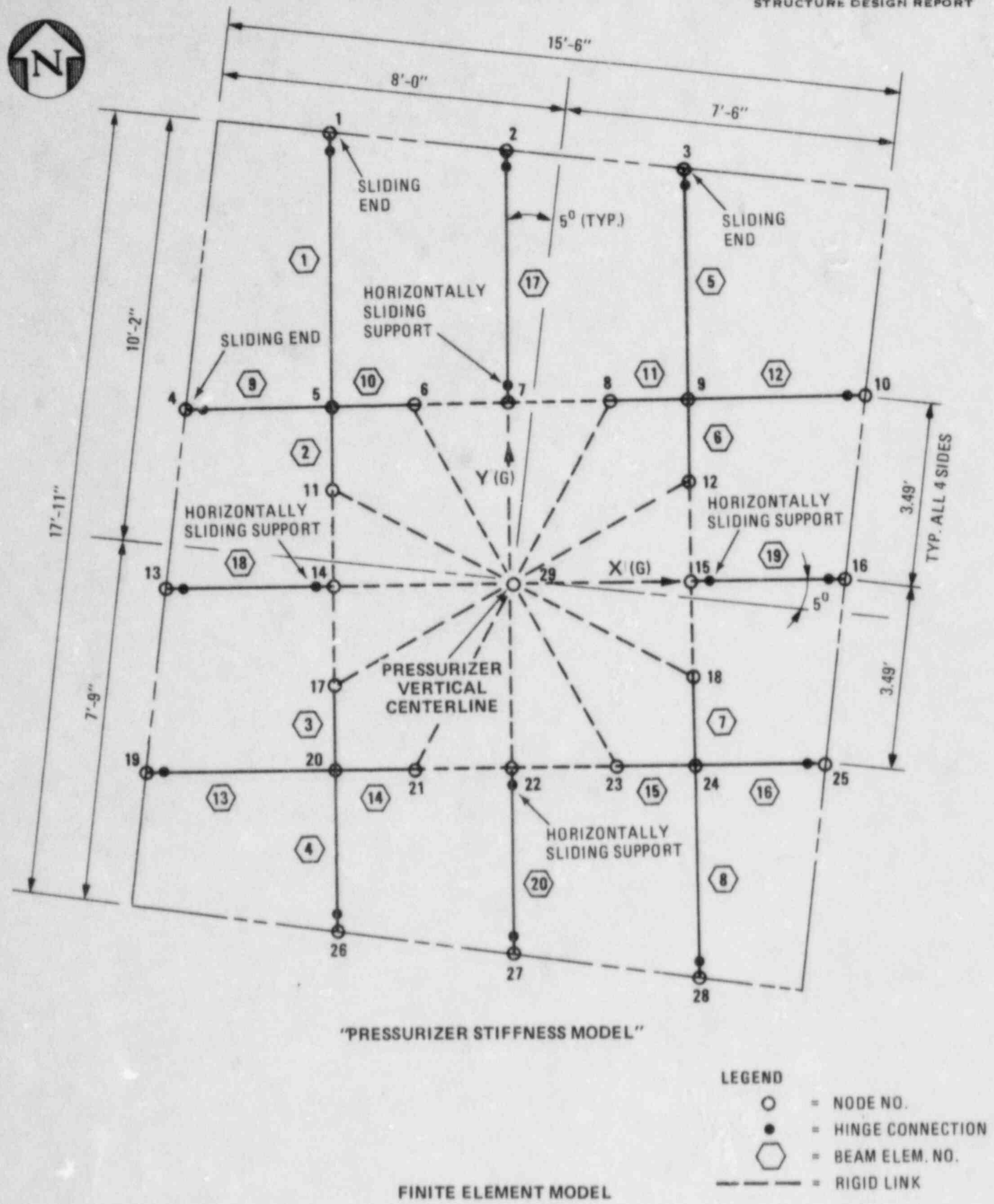
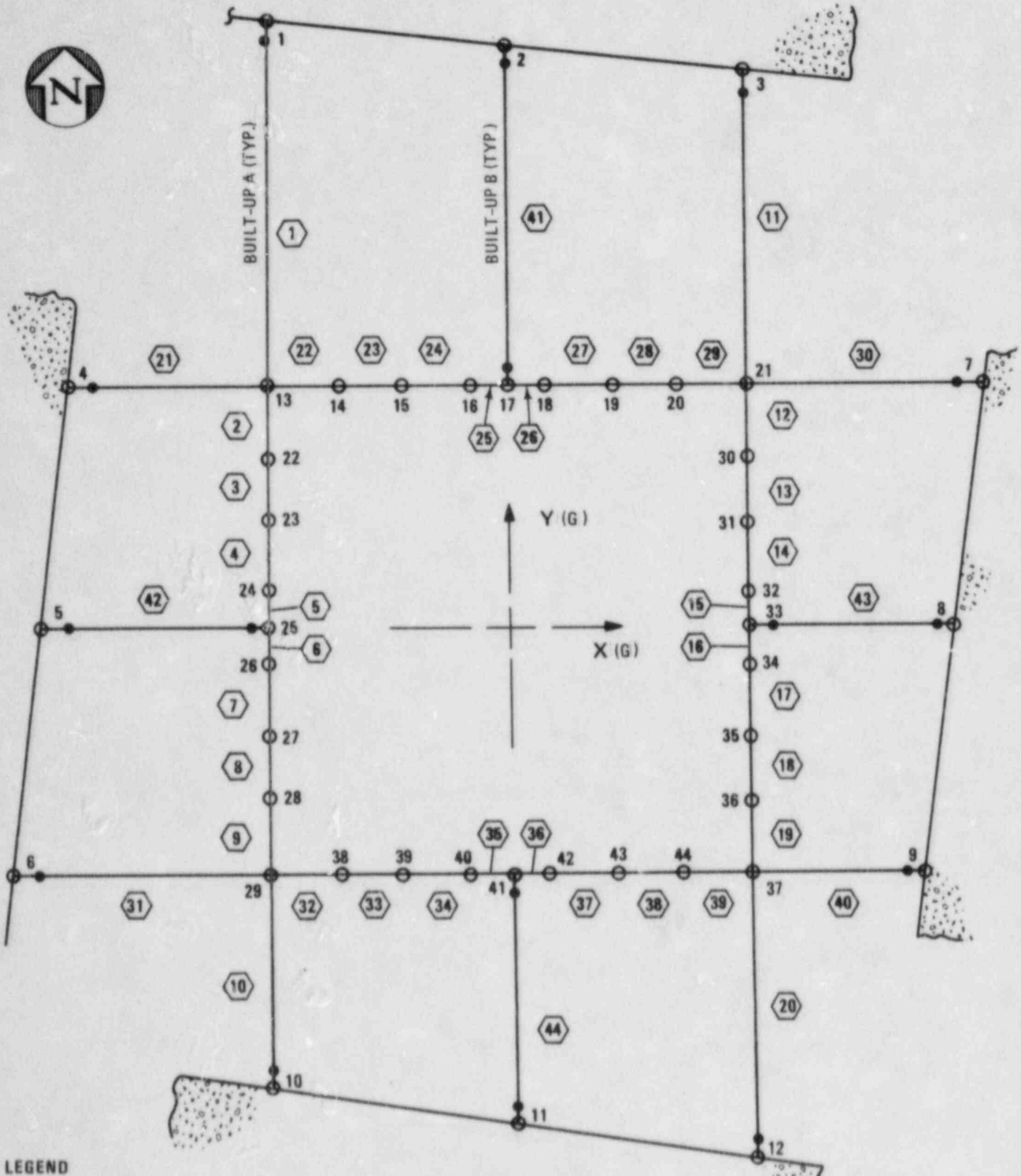


Figure 14
PRESSURIZER SUPPORT
AND ANCHORAGE
(Sheet 5 of 6)



LEGEND

○ = NODE

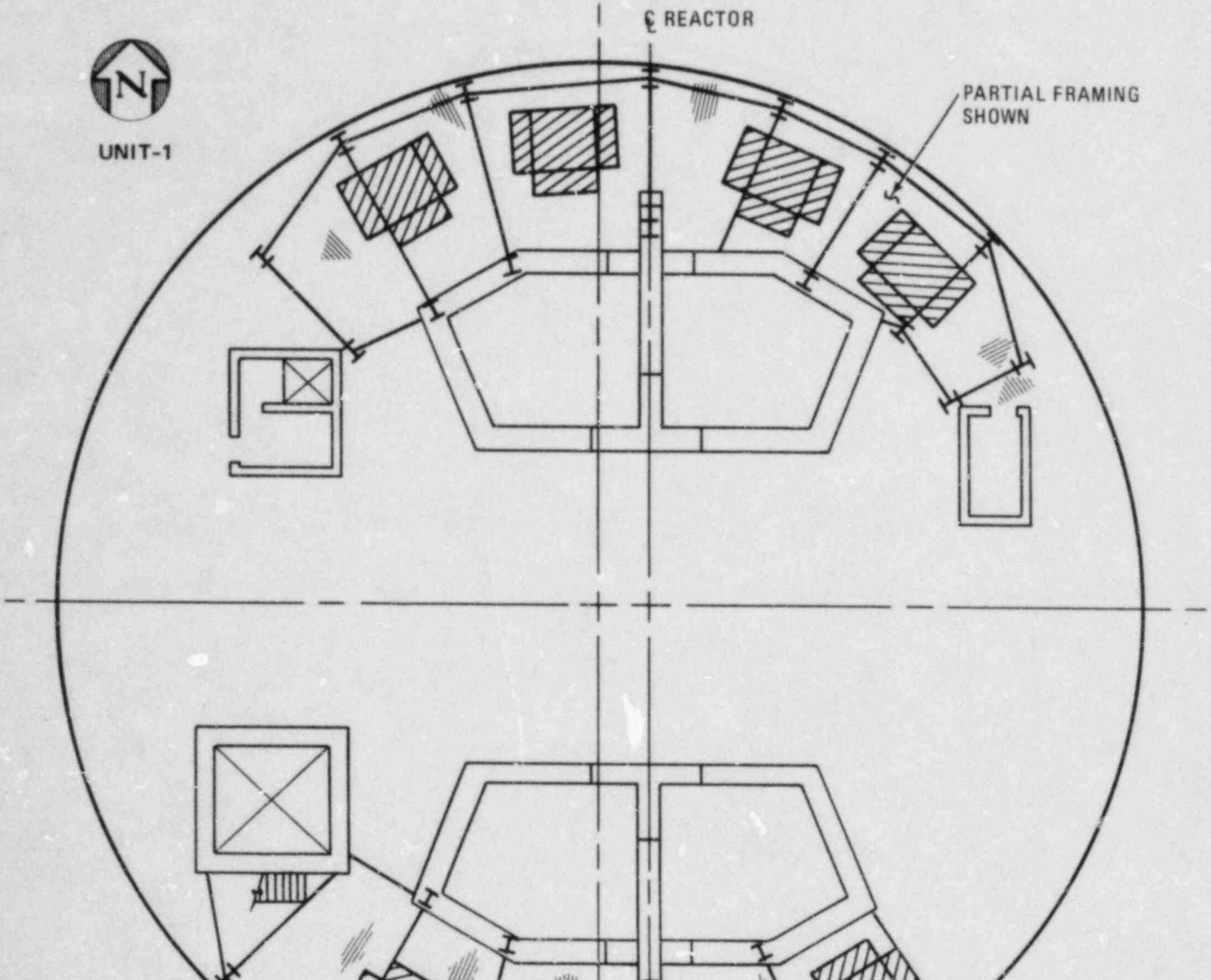
⬡ = BEAM ELEM.

● = HINGE CONN.

"LOCAL EFFECT MODEL"

FINITE ELEMENT MODEL

Figure 14
PRESSURIZER SUPPORT
AND ANCHORAGE
(Sheet 6 of 6)



PLAN AT ELEVATION 238'

Figure 15
MAJOR EQUIPMENT ABOVE
THE OPERATING FLOOR
(Sheet 1 of 2)

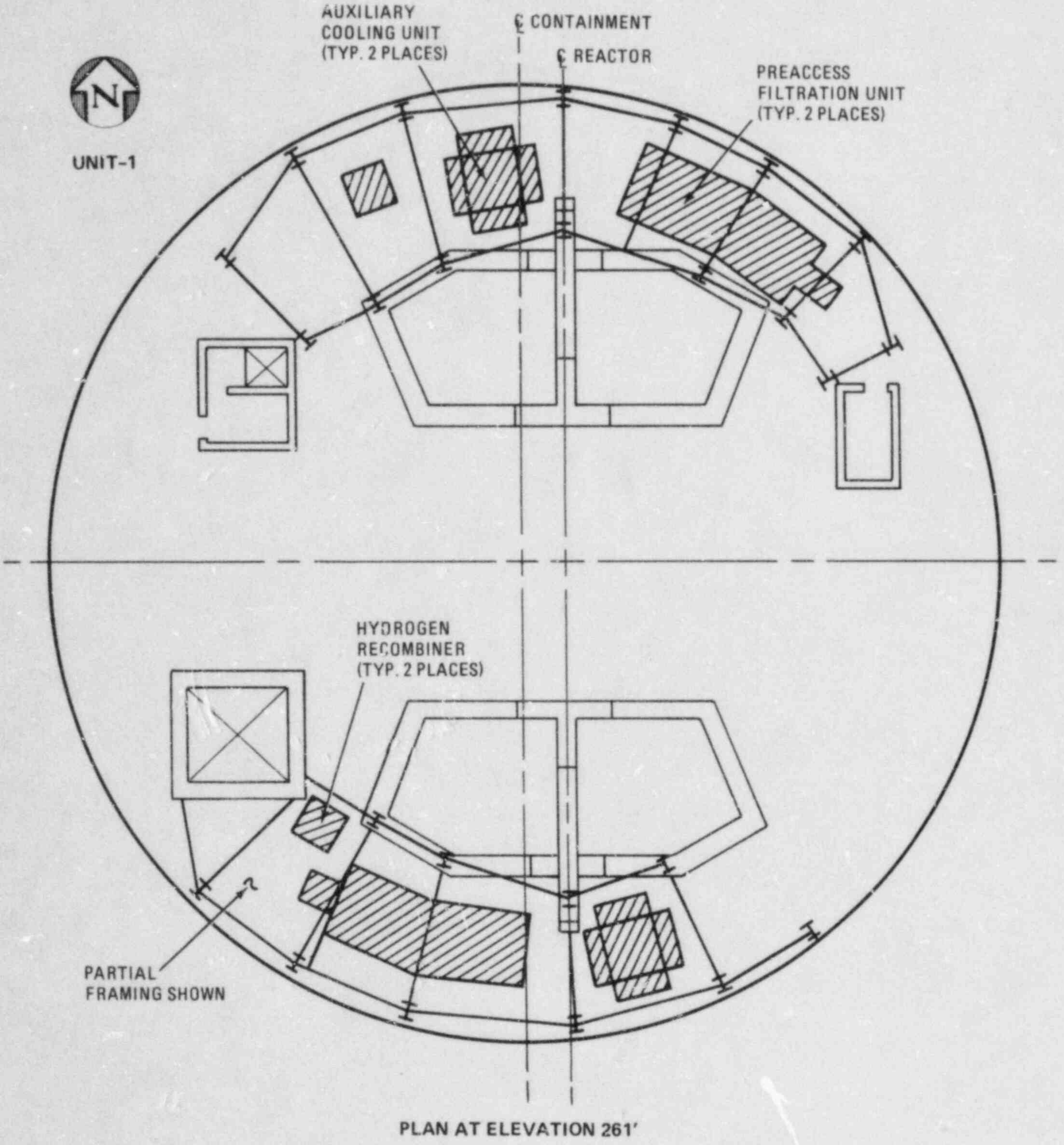


Figure 15
MAJOR EQUIPMENT ABOVE
THE OPERATING FLOOR
(Sheet 2 of 2)

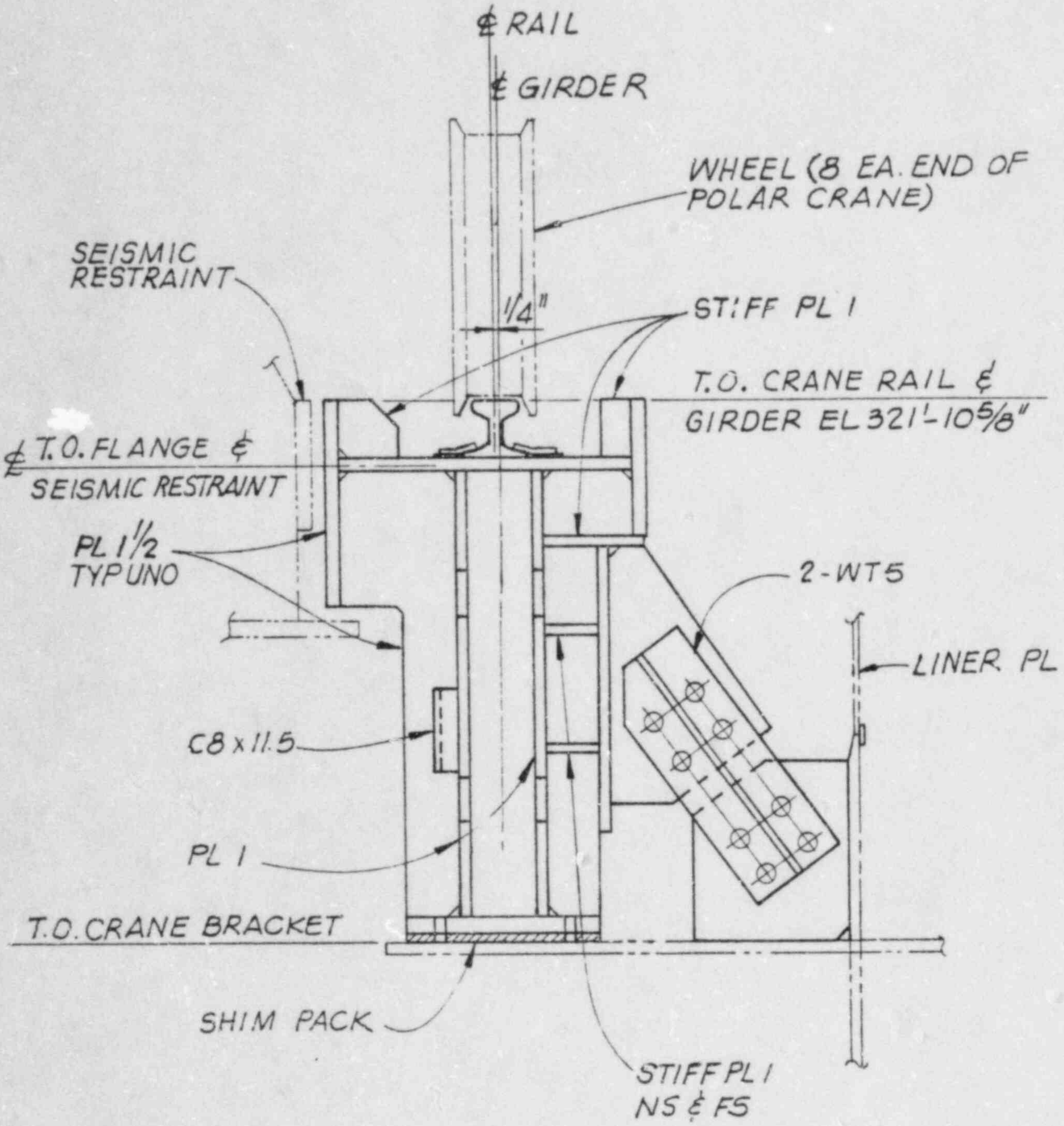


Figure 16
POLAR CRANE RUNWAY GIRDER
(Sheet 1 of 2)

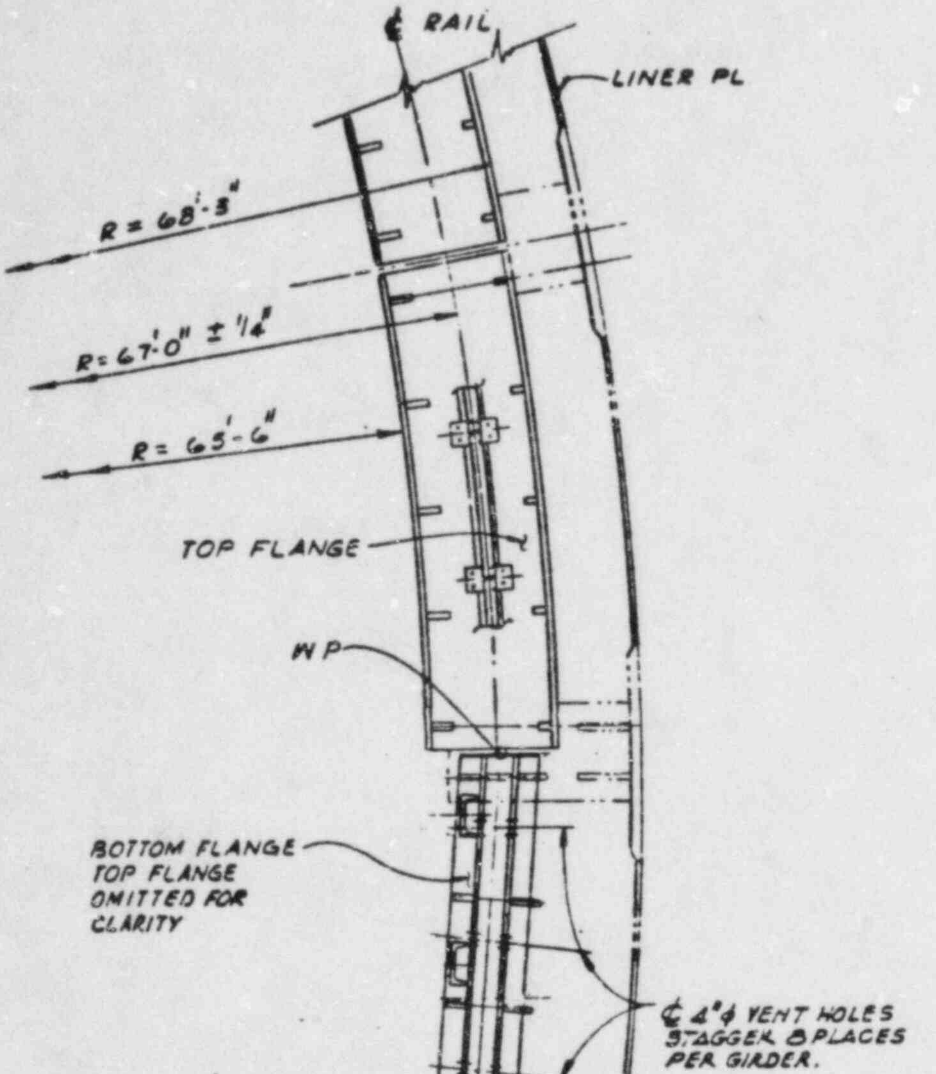
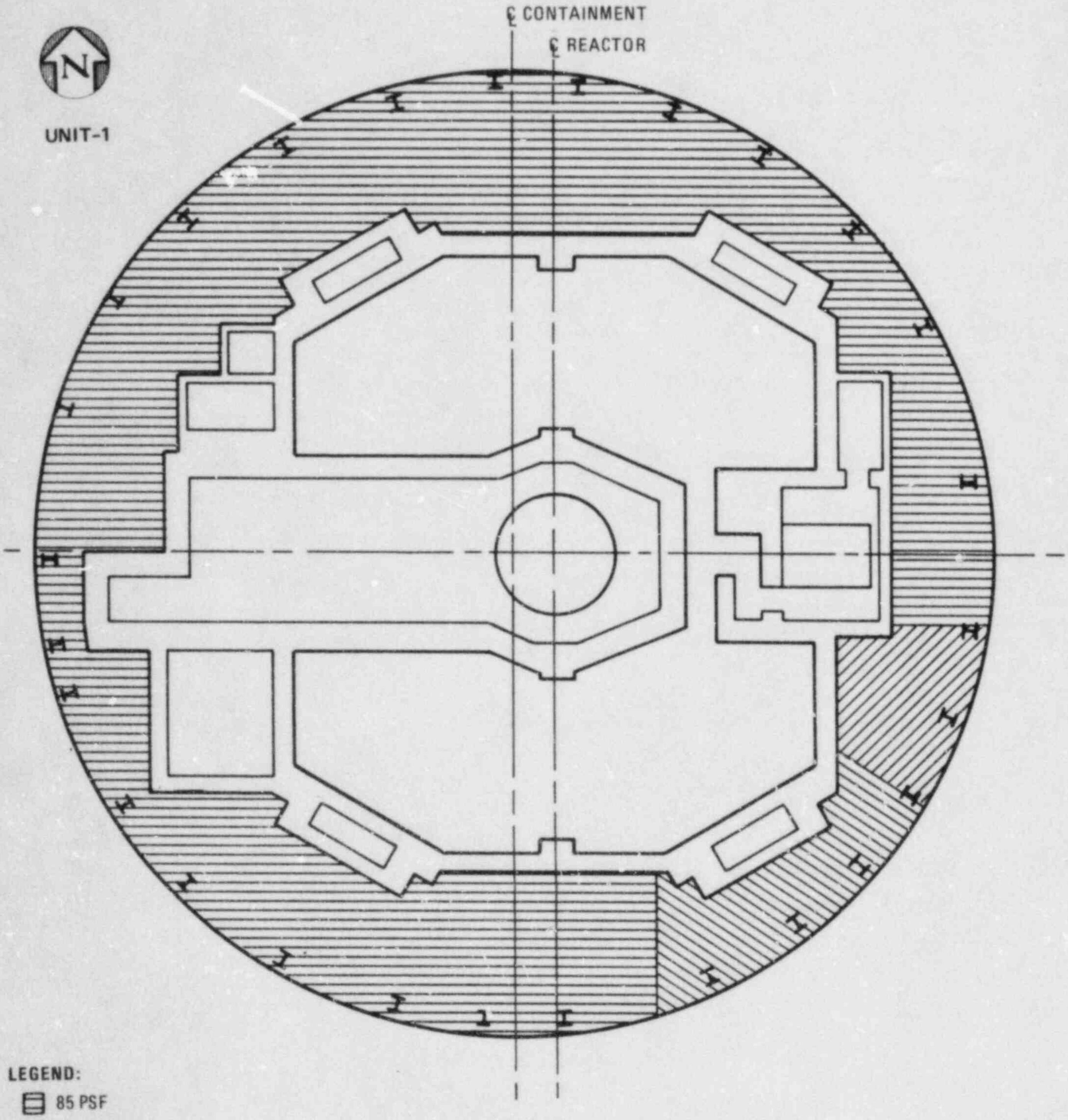


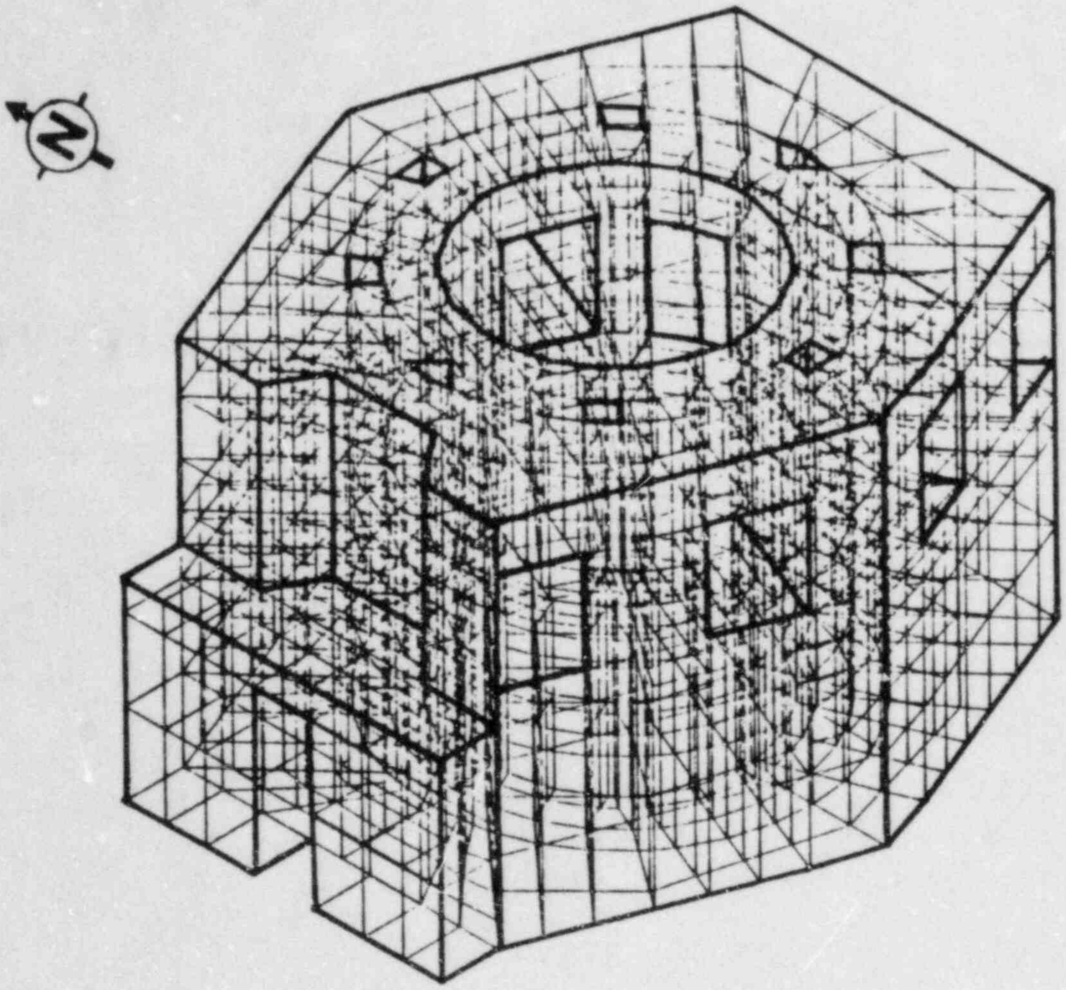
Figure 16
POLAR CRANE RUNWAY GIRDER
(Sheet 2 of 2)



LEGEND:
▤ 85 PSF
▨ 100 PSF
▧ 130 PSF

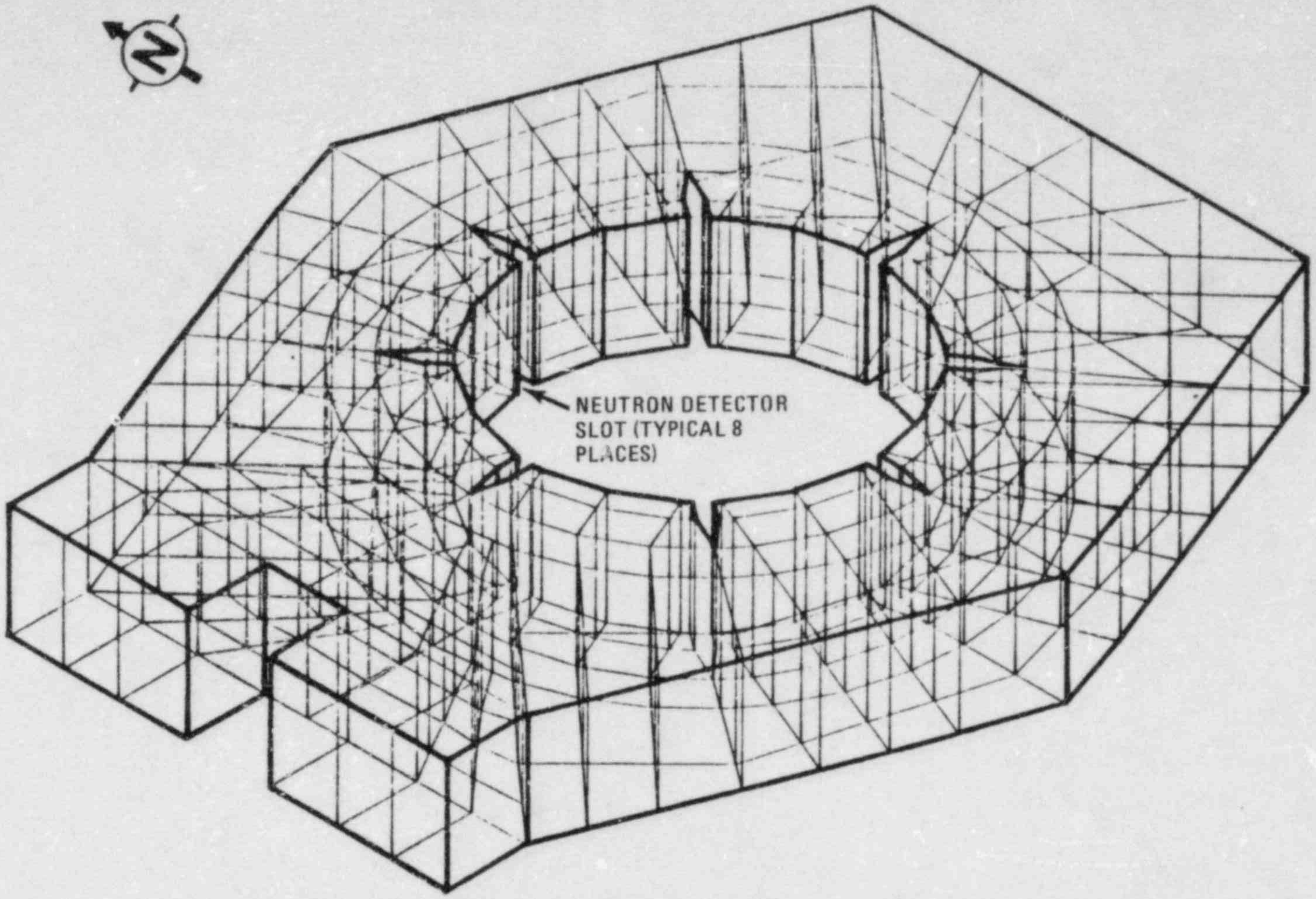
PLAN AT PLATFORM ELEV. 207'/210'

Figure 17
CONTAINMENT TOTAL DEAD LOAD
IN ANNULUS AREA



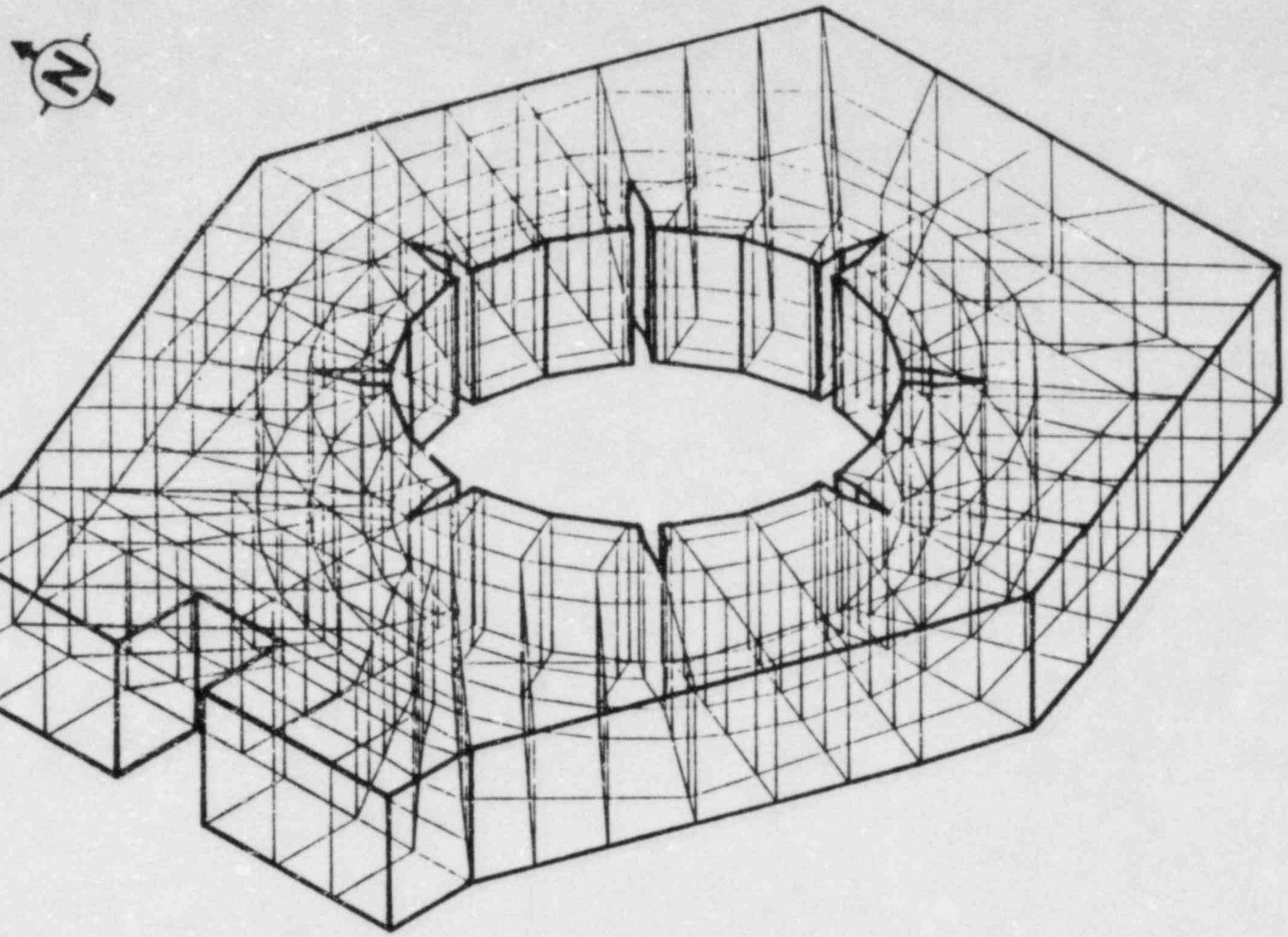
ISOMETRIC VIEW

Figure 18
PRIMARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 1 of 9)



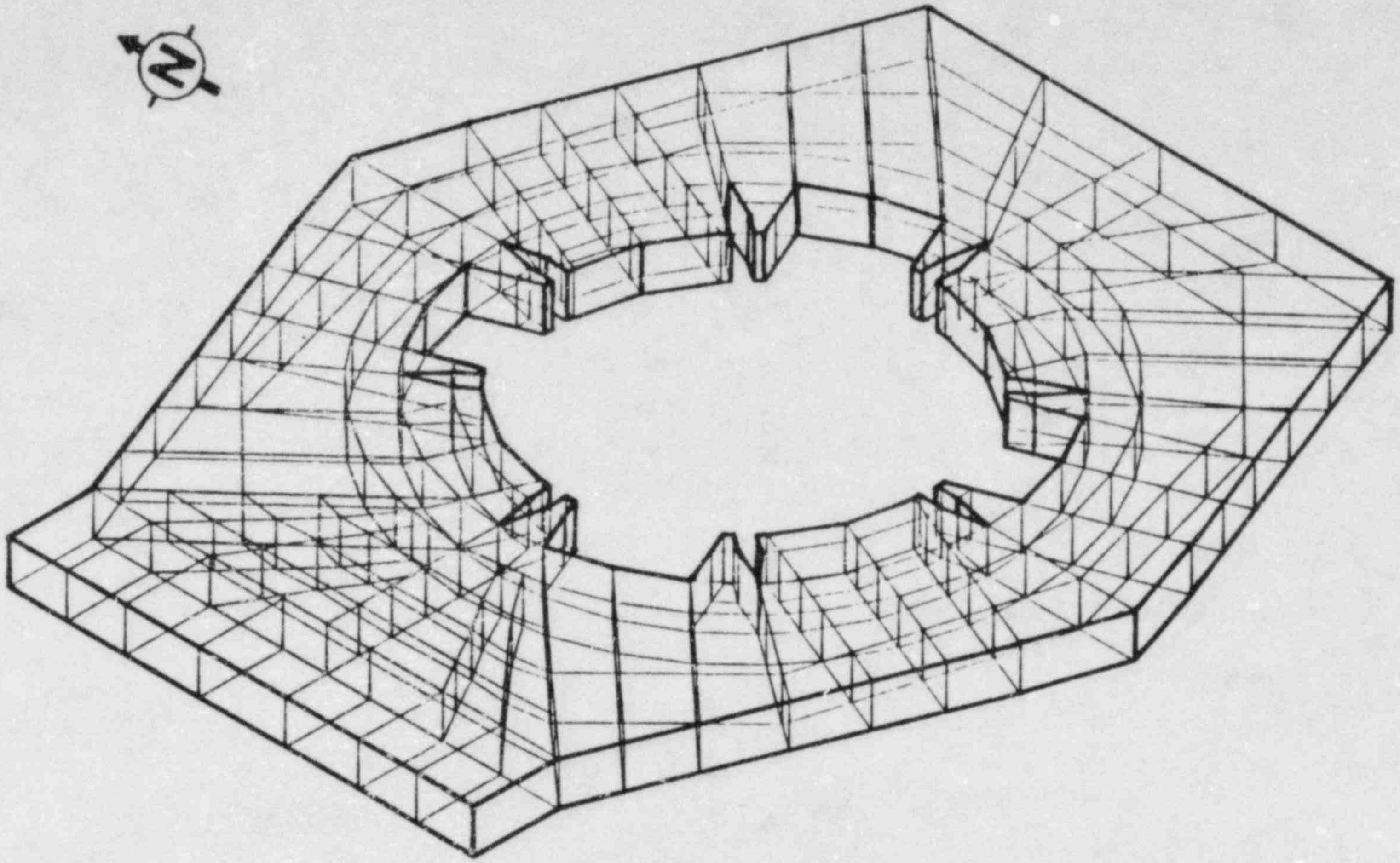
EL. 169 TO EL. 174.5 FT.

Figure 18
PRIMARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 2 of 9)



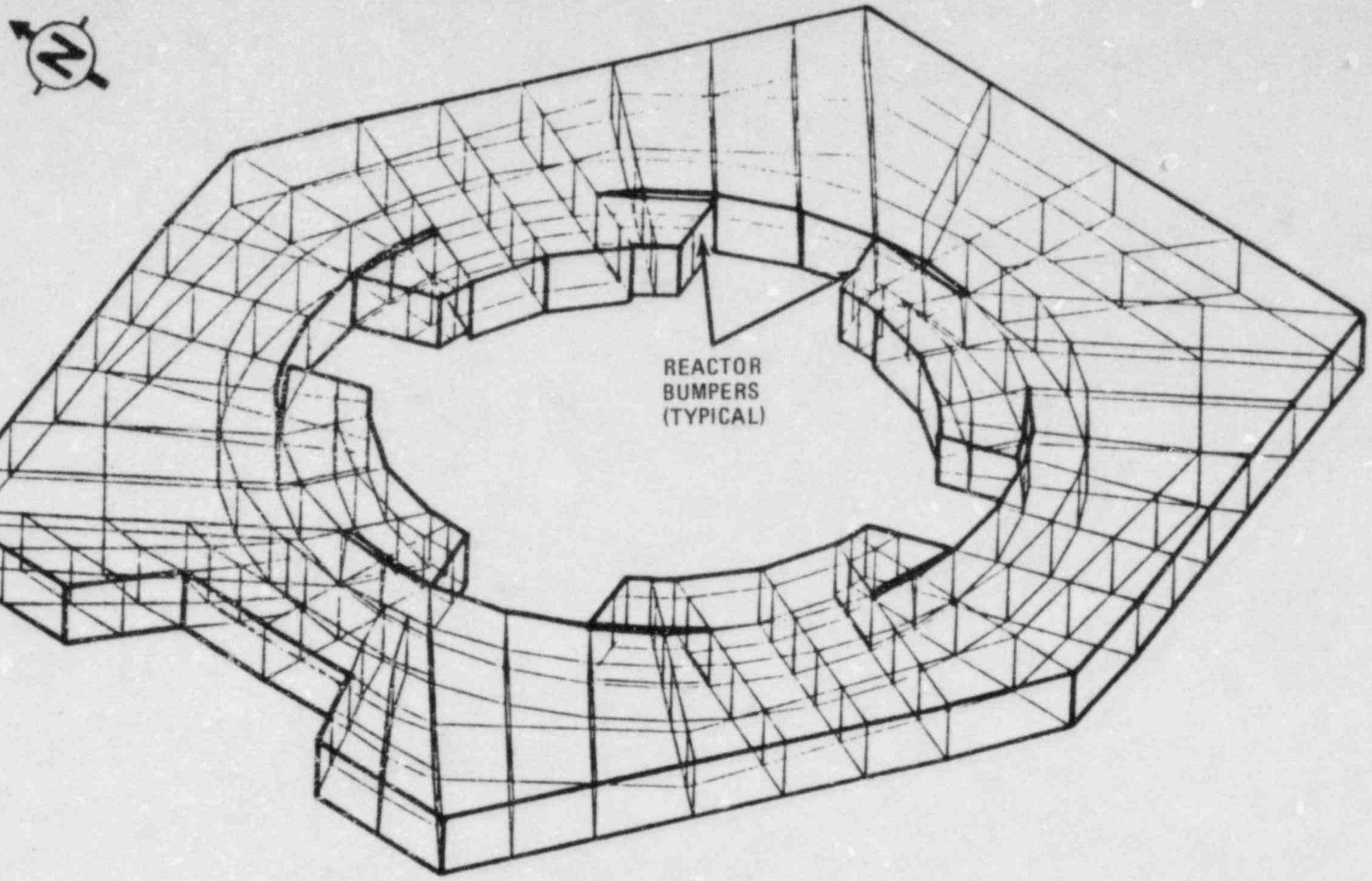
EL. 174.5 TO EL. 180 FT.

Figure 18
PRIMARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 3 of 9)



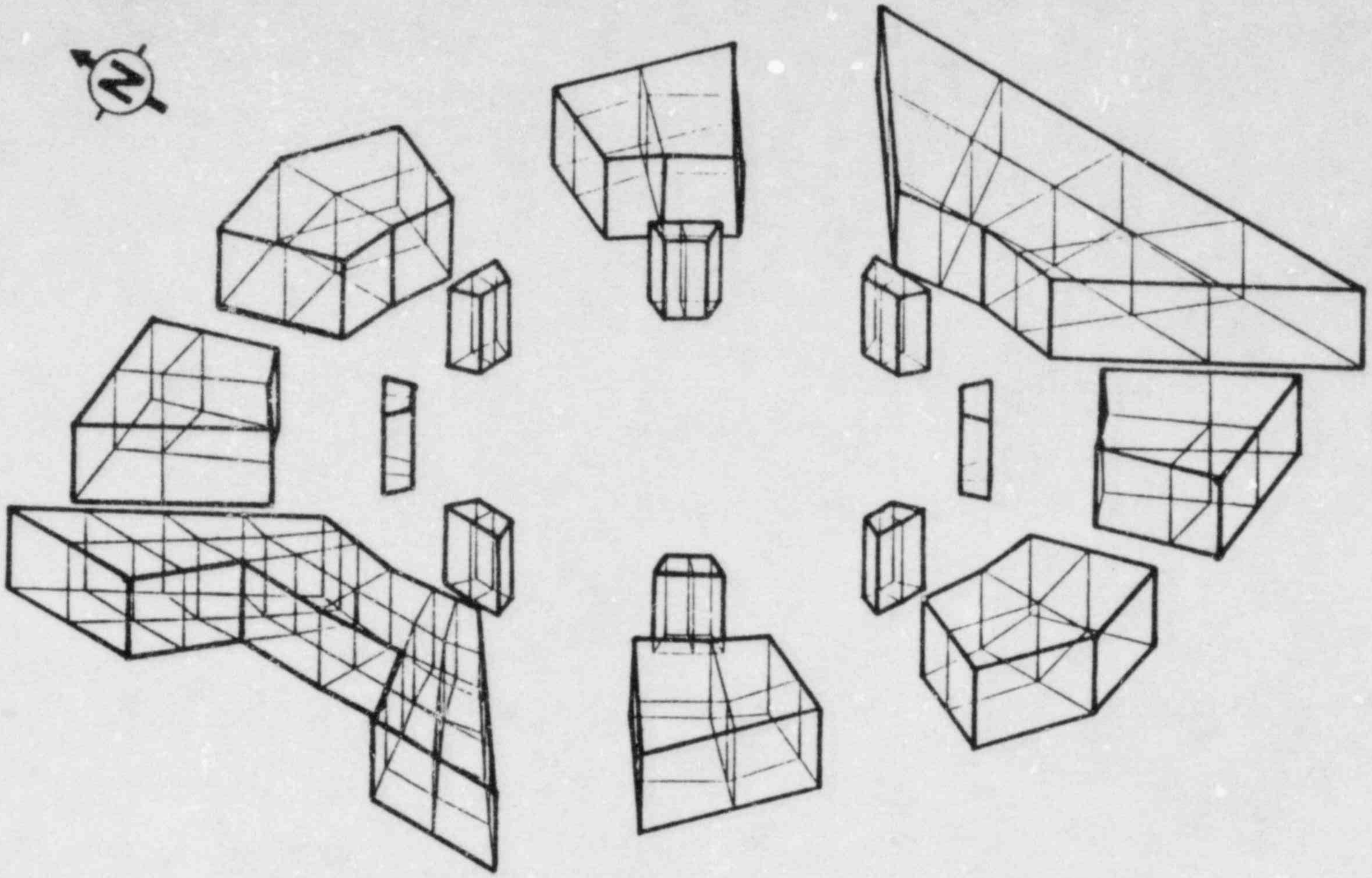
EL. 180 TO EL. 182 FT.

Figure 18
PRIMARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 4 of 9)



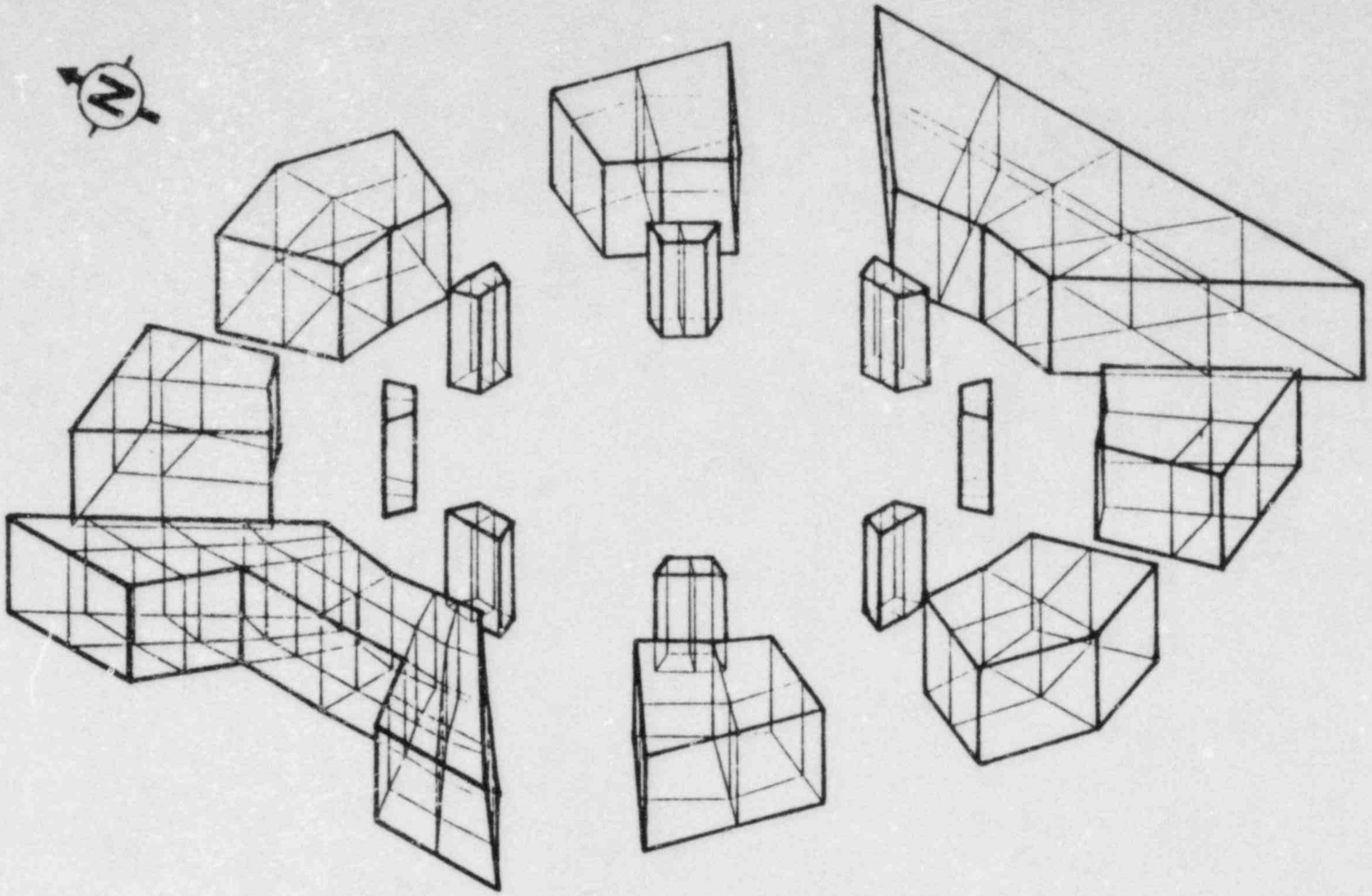
EL. 182 TO EL. 184 FT.

Figure 18
PRIMARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 5 of 9)



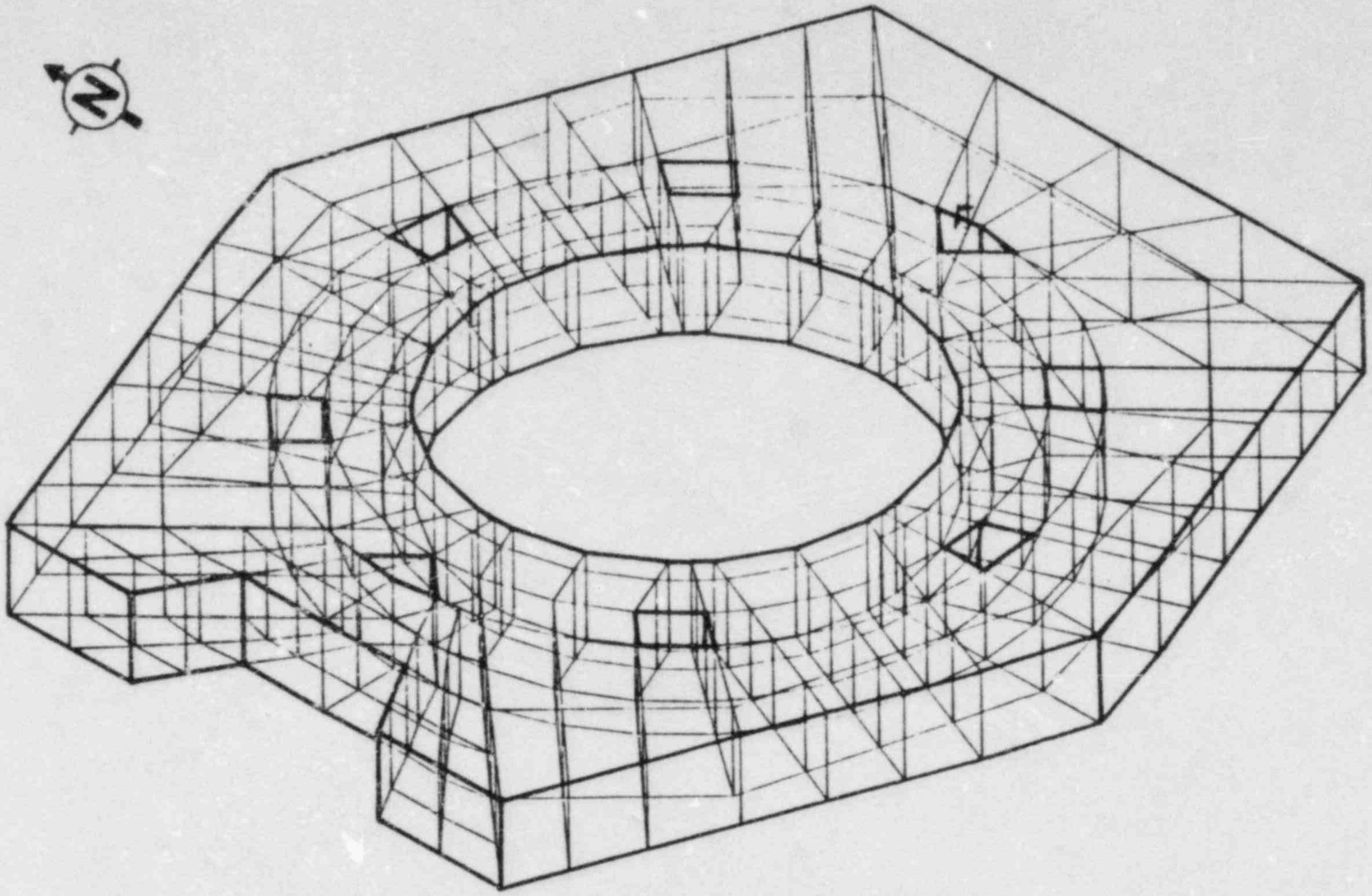
EL. 184 TO EL. 187 FT.

Figure 18
PRIMARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 6 of 9)



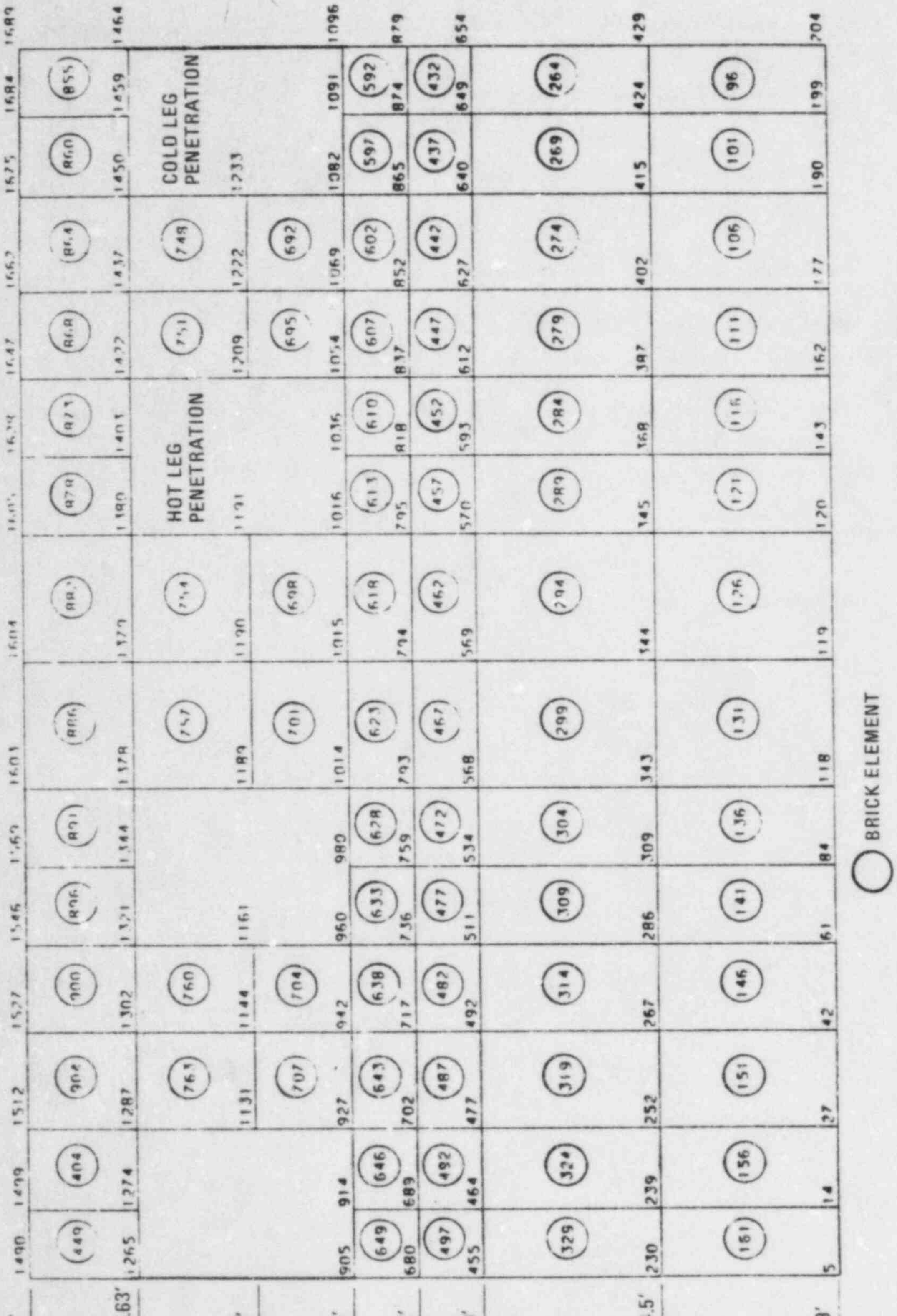
EL. 187 TO EL. 191 FT.

Figure 18
PRIMARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 7 of 9)



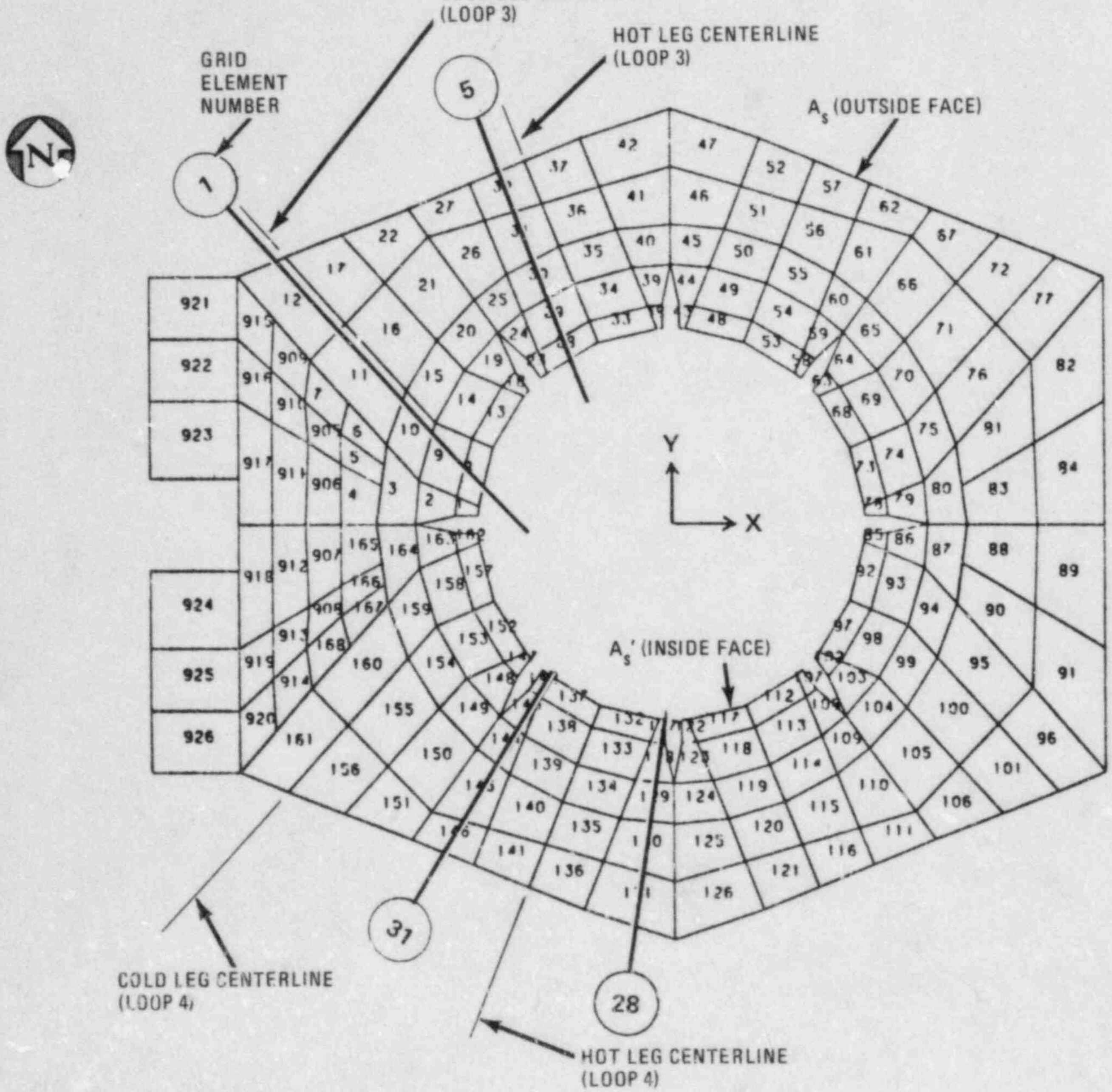
EL. 191 TO EL. 194 FT.

Figure 18
PRIMARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 8 of 9)



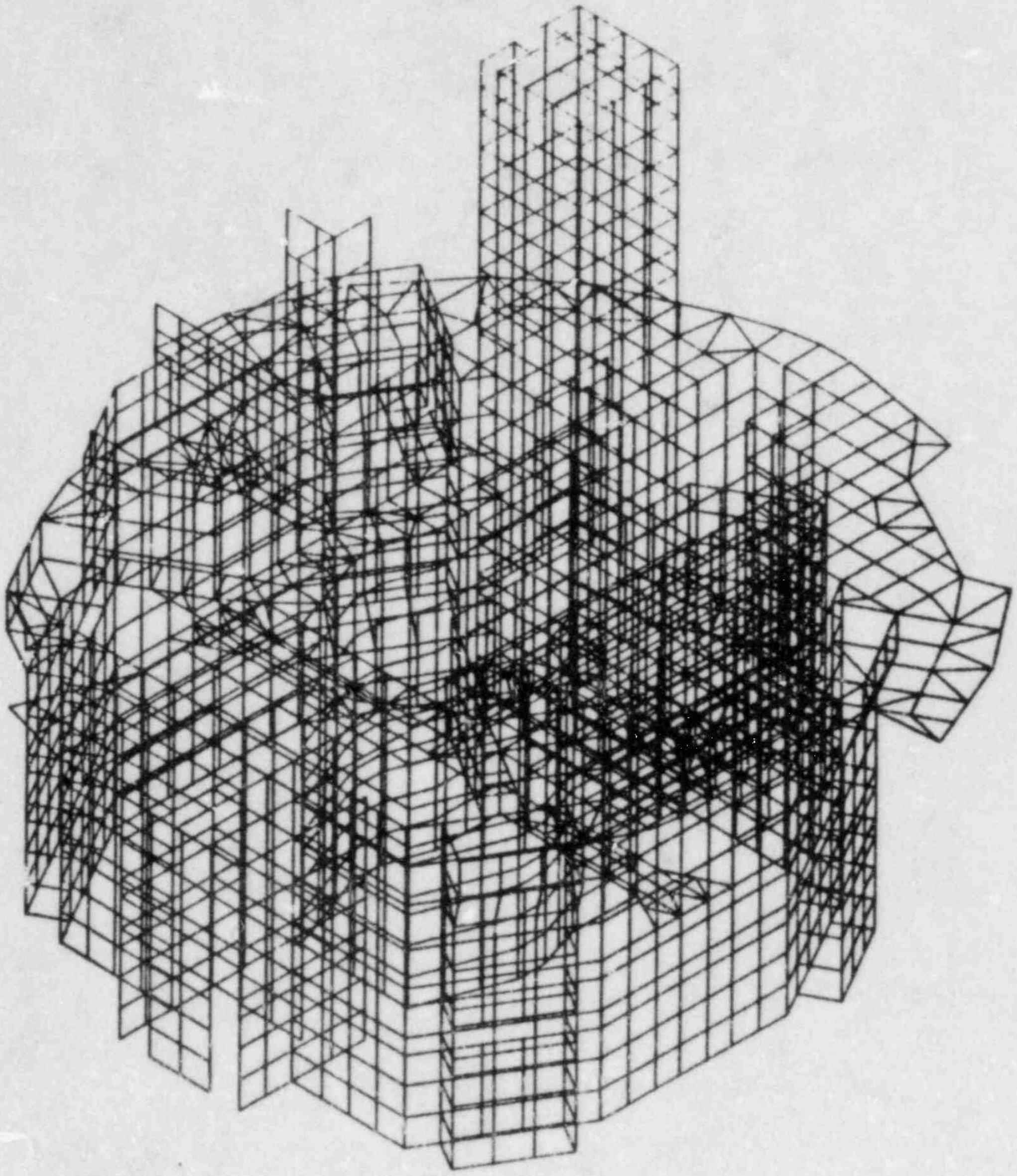
DEVELOPED ELEVATION VIEW OF THE EXTERIOR SOUTH FACE (LOOKING NORTH)

Figure 18
PRIMARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 9 of 9)



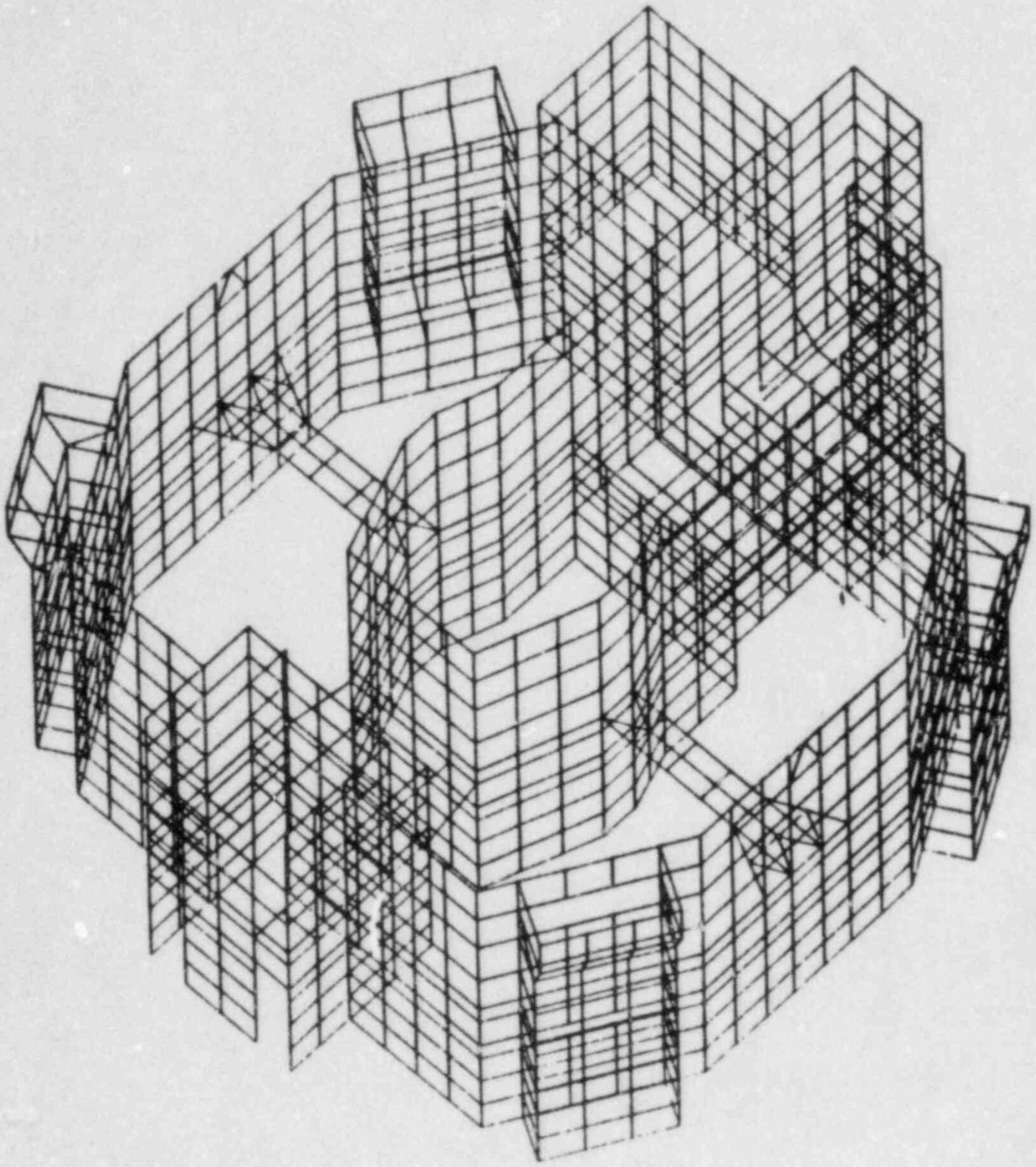
PLAN
(ELEMENTS AT PSW/BASEMAT JUNCTION)

Figure 19
PSW FINITE ELEMENT MODEL
KEY LOCATIONS



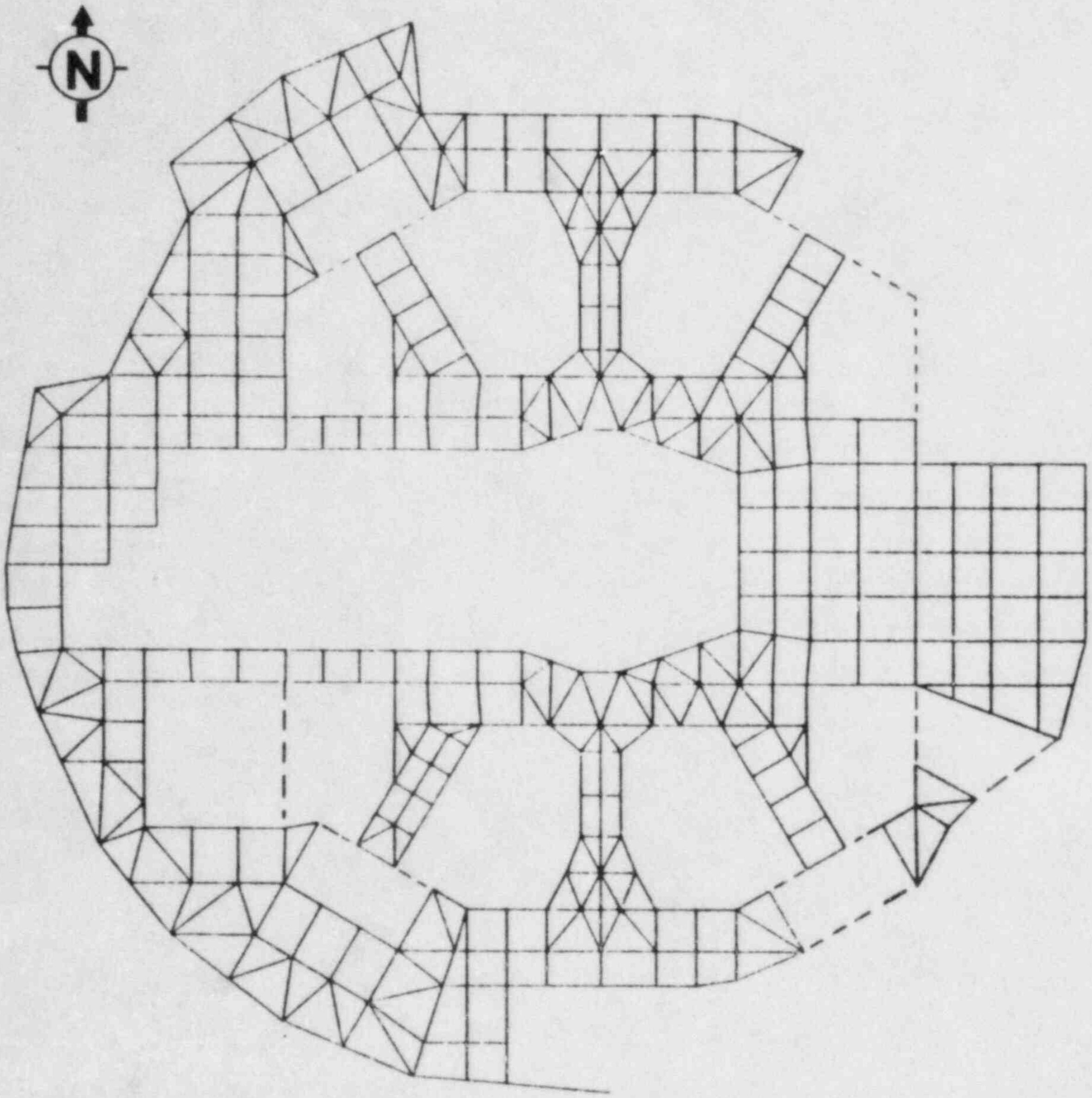
ISOMETRIC VIEW OF ALL CONCRETE
PORTIONS OF THE MODEL

Figure 20
SECONDARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 1 of 6)



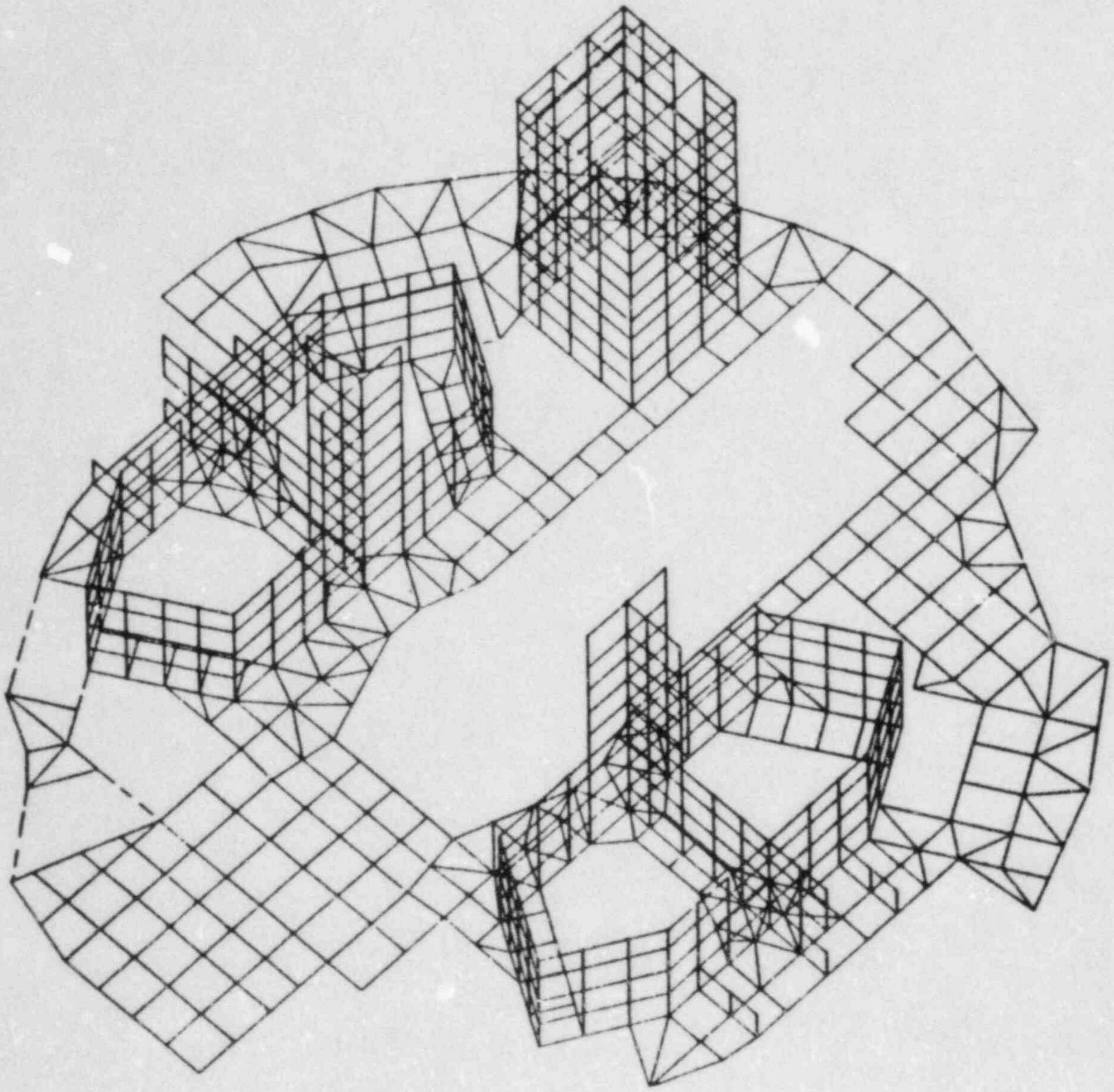
ISOMETRIC VIEW OF ALL CONCRETE
PORTIONS OF THE MODEL BELOW EL. 219'-0"

Figure 20
SECONDARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 2 of 6)



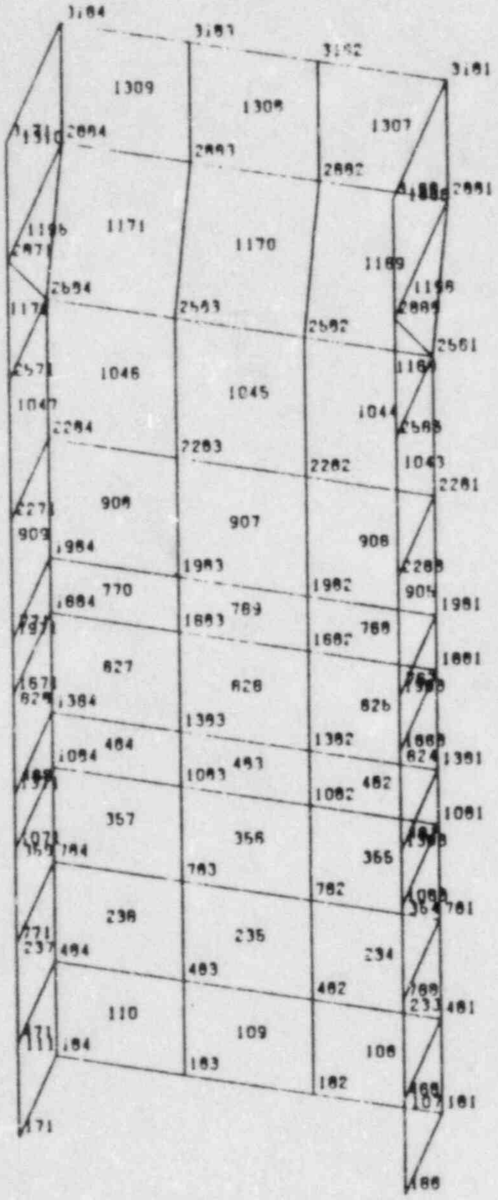
OPERATING FLOOR SLAB @ ELEVATION 219.0'

Figure 20
SECONDARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 3 of 6)



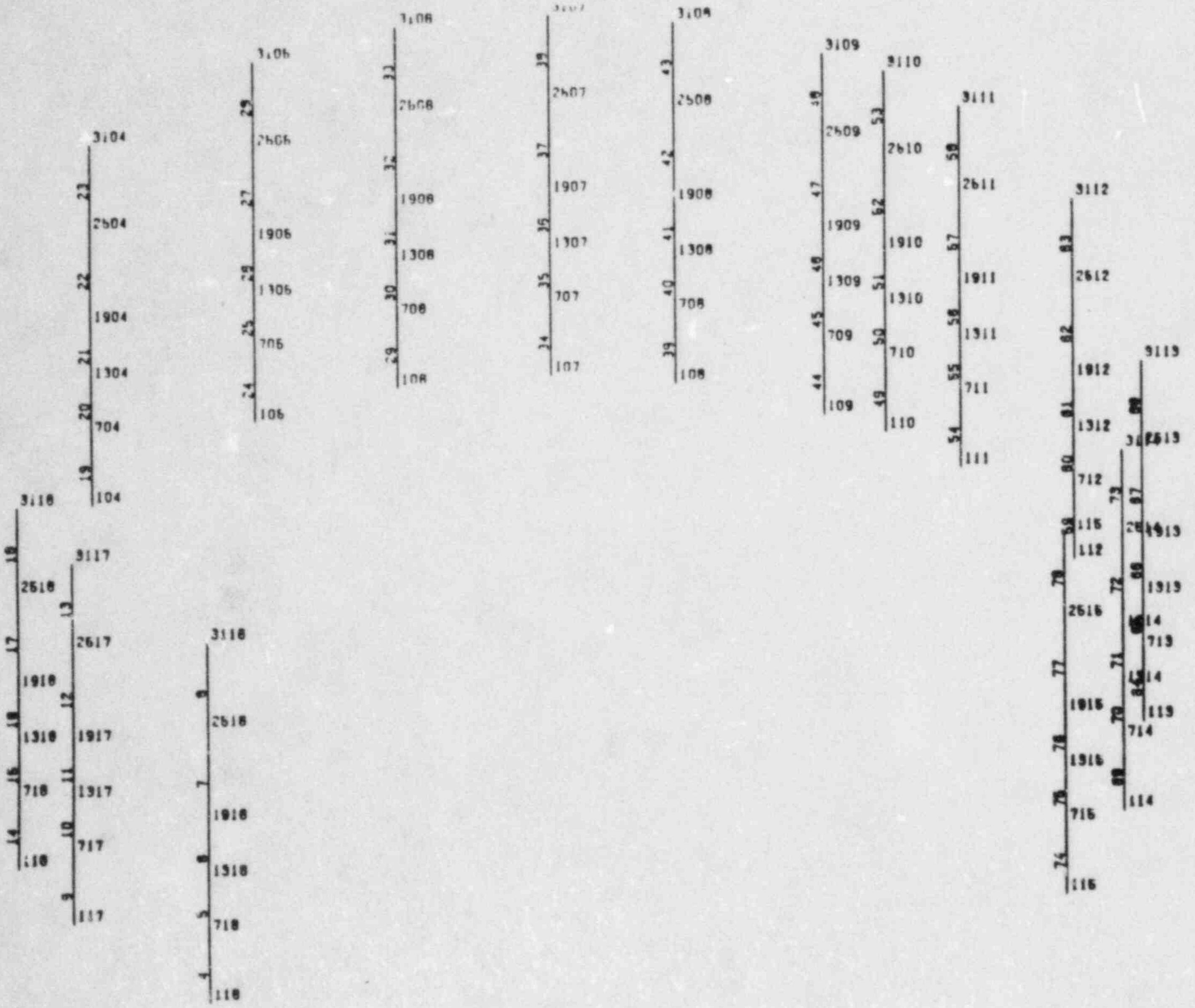
ISOMETRIC VIEW OF ALL CONCRETE PORTIONS OF THE MODEL AT EL. 219'-0" AND ABOVE

Figure 20
SECONDARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 4 of 6)



SOUTHEAST AIR SHAFT (#1)

Figure 20
SECONDARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 5 of 6)



STEEL COLUMNS

Figure 20
SECONDARY SHIELD WALL
FINITE ELEMENT MODEL
(Sheet 6 of 6)

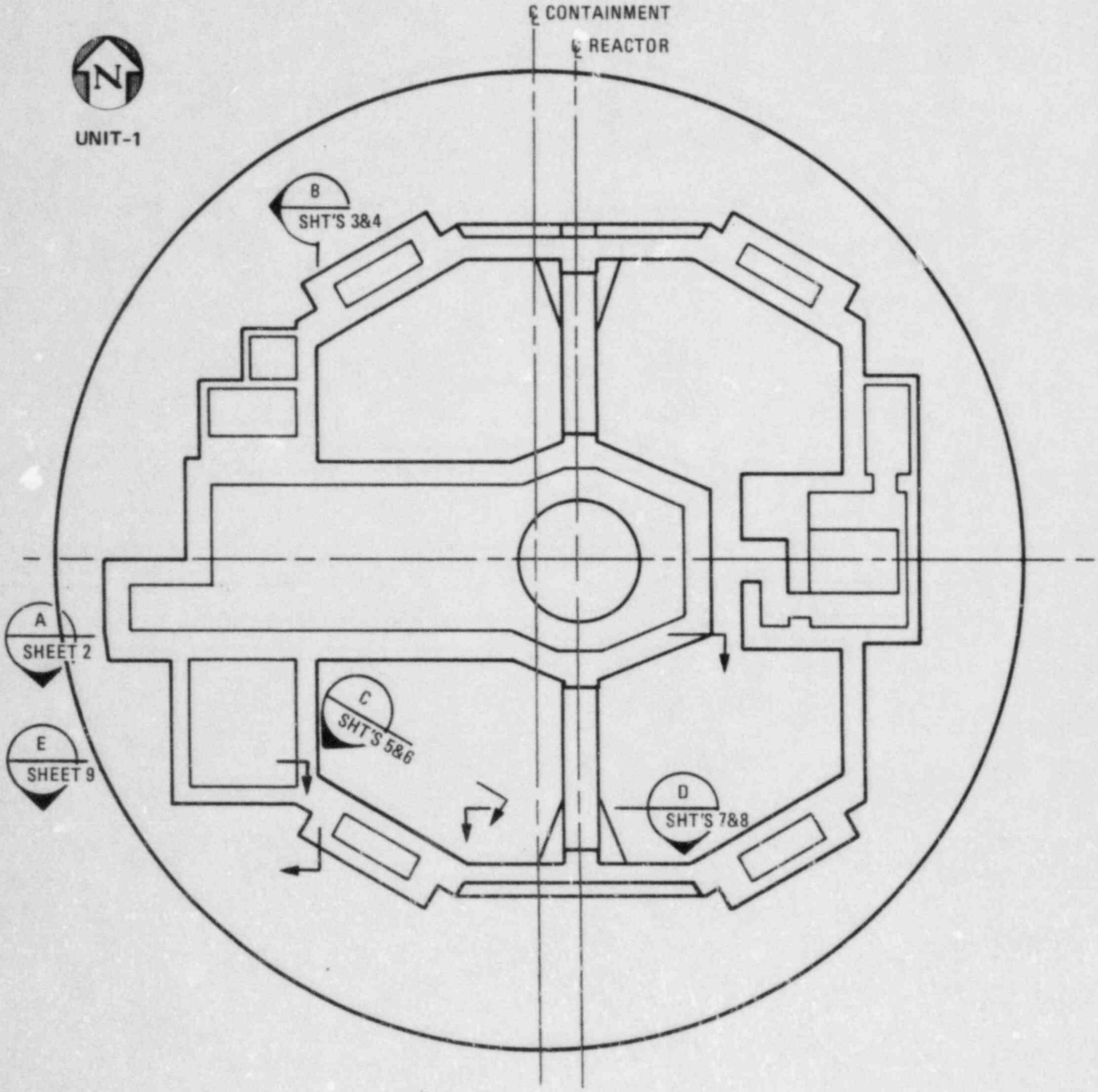
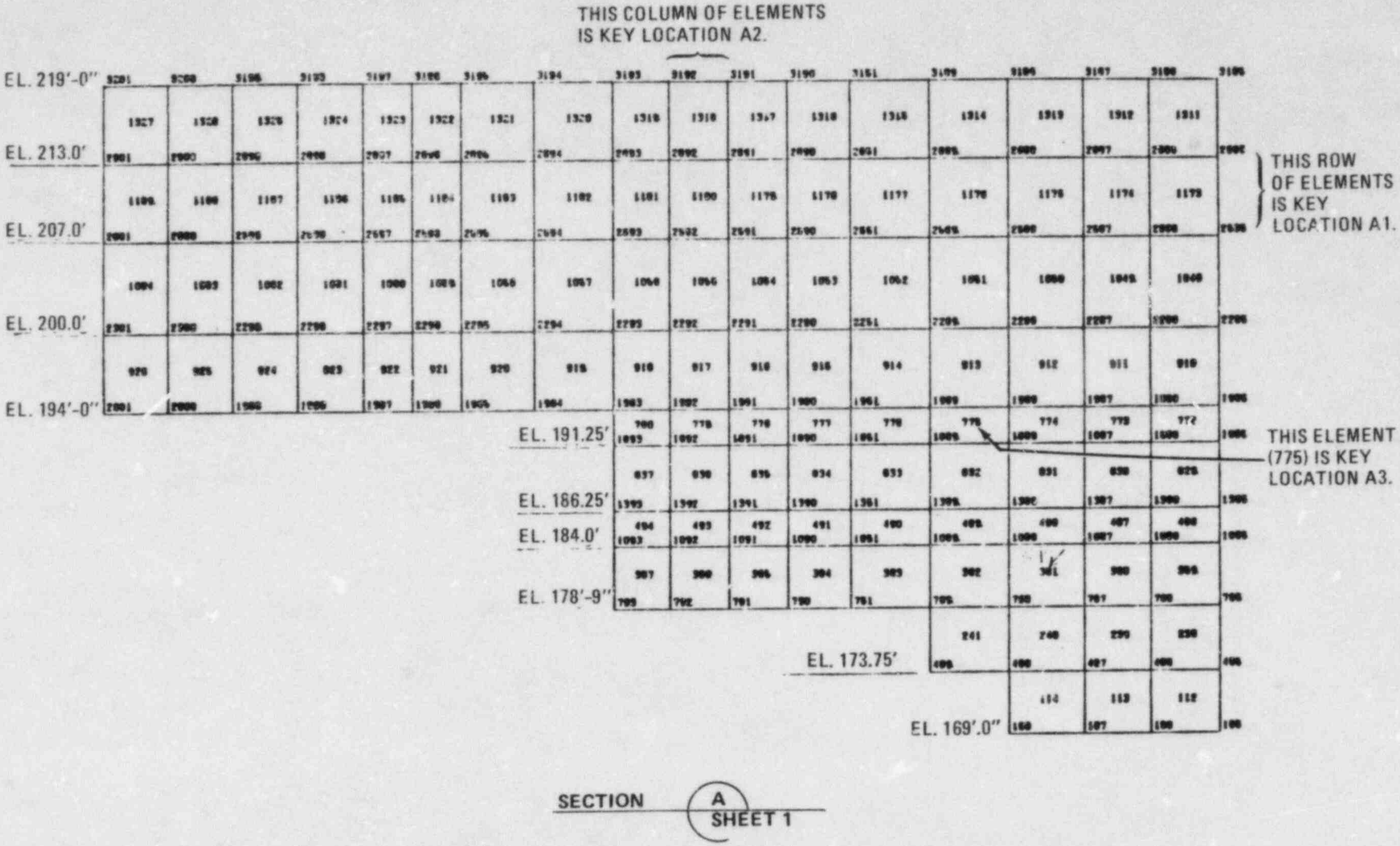


Figure 21
SSW FINITE ELEMENT
MODEL KEY LOCATIONS
(Sheet 1 of 9)



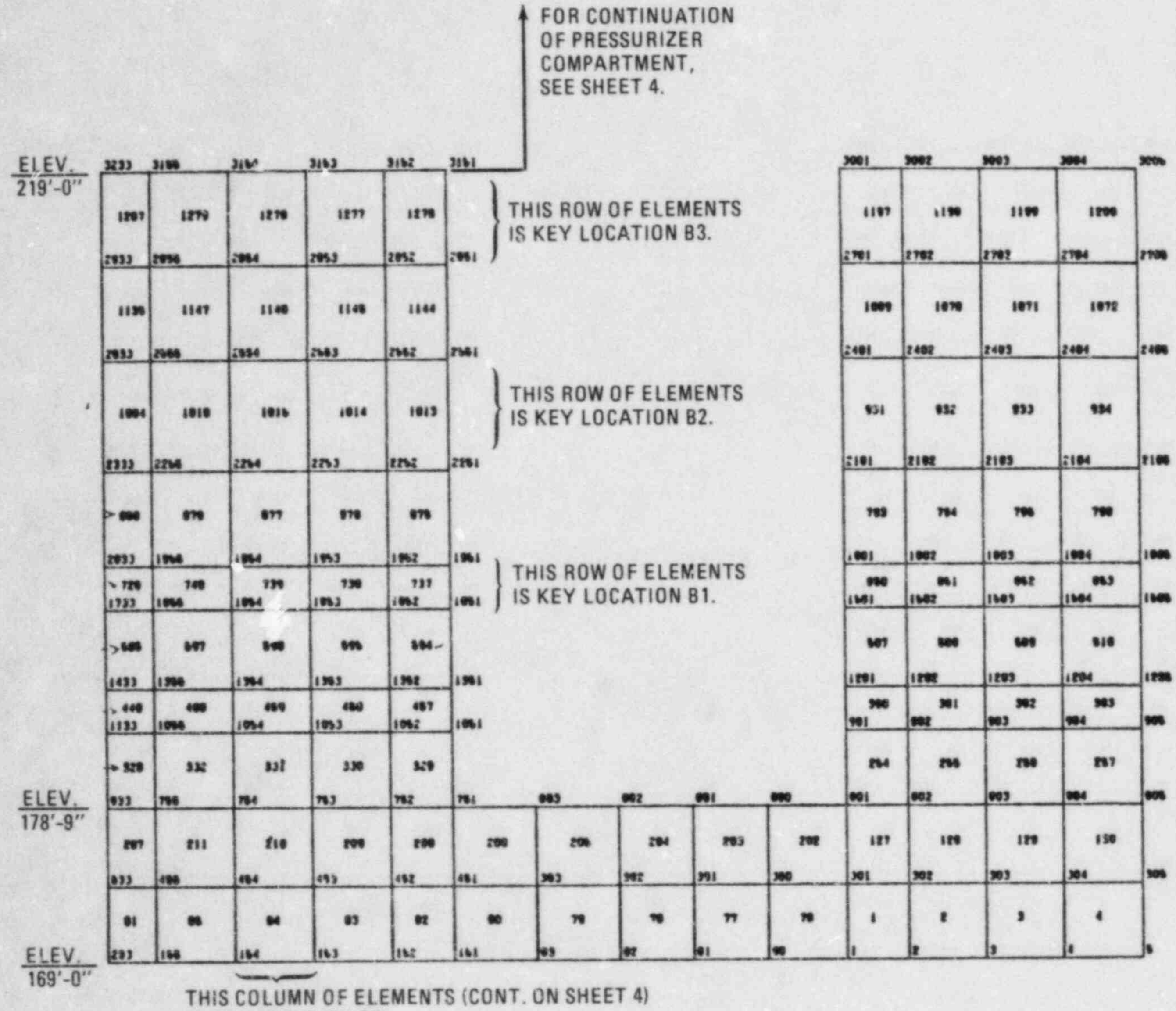
THIS COLUMN OF ELEMENTS IS KEY LOCATION A2.

THIS ROW OF ELEMENTS IS KEY LOCATION A1.

THIS ELEMENT (775) IS KEY LOCATION A3.

SECTION A SHEET 1

Figure 21
SSW FINITE ELEMENT
MODEL KEY LOCATIONS
(Sheet 2 of 9)



FOR CONTINUATION OF PRESSURIZER COMPARTMENT, SEE SHEET 4.

THIS ROW OF ELEMENTS IS KEY LOCATION B3.

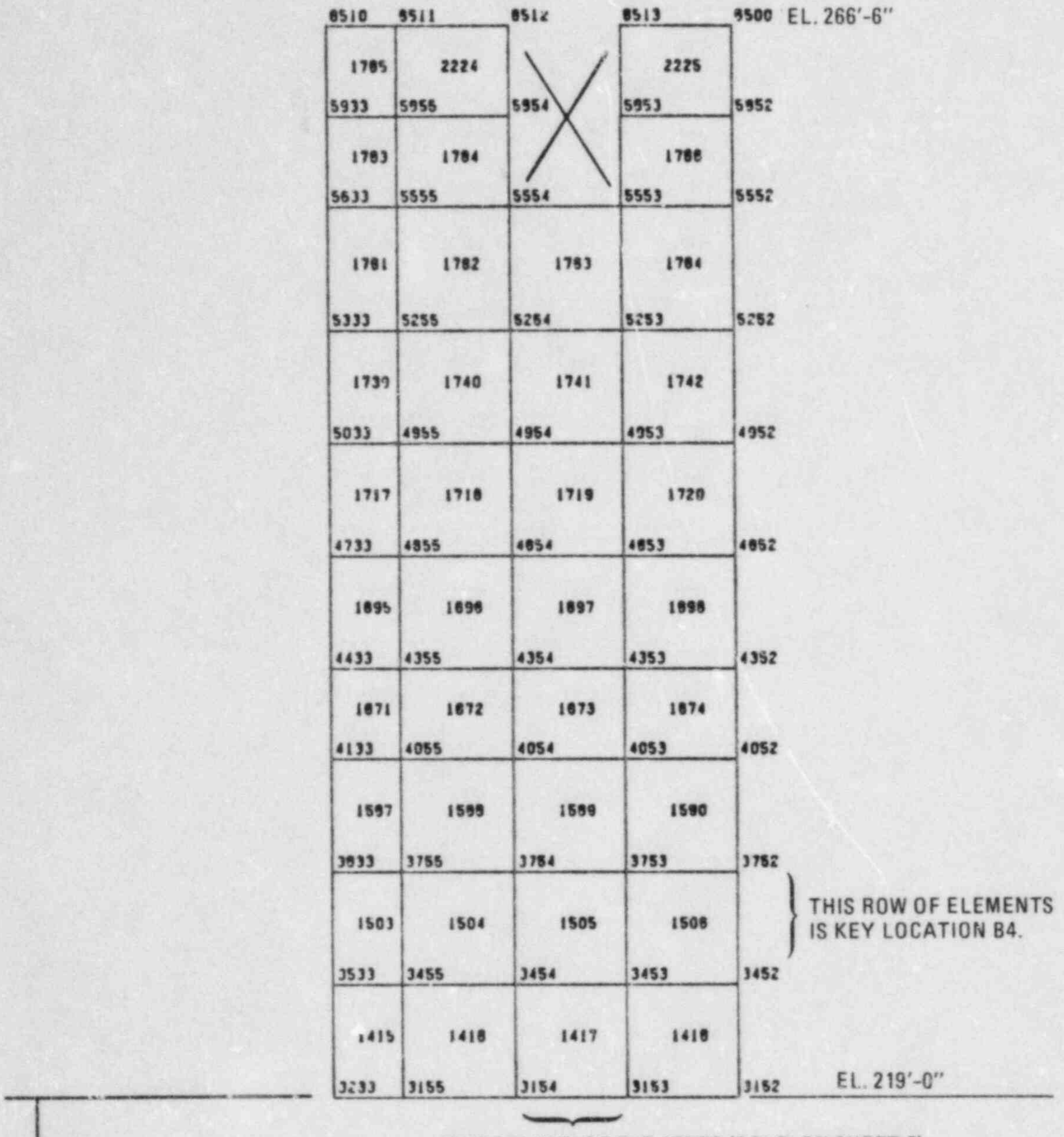
THIS ROW OF ELEMENTS IS KEY LOCATION B2.

THIS ROW OF ELEMENTS IS KEY LOCATION B1.

THIS COLUMN OF ELEMENTS (CONT. ON SHEET 4) IS KEY LOCATION B5.

SECTION B
SHEET 1

Figure 21
SSW FINITE ELEMENT
MODEL KEY LOCATIONS
(Sheet 3 of 9)



THIS ROW OF ELEMENTS
IS KEY LOCATION B4.

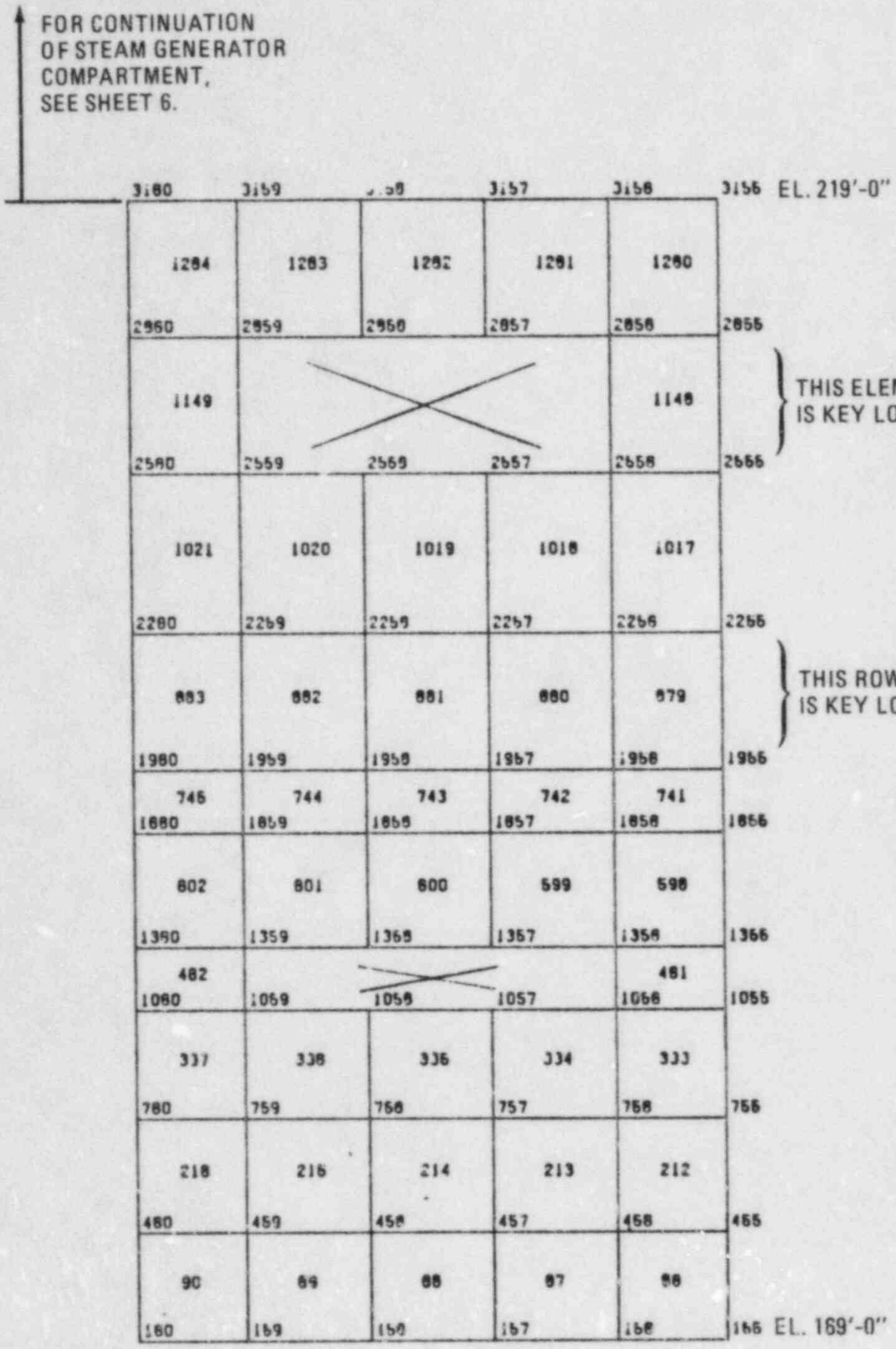
FOR CONTINUATION,
SEE SHEET 3

THIS COLUMN OF ELEMENTS (CONT. ON SHEET 3)
IS KEY LOCATION B5.

SECTION B
SHEET 1

Figure 21
SSW FINITE ELEMENT
MODEL KEY LOCATIONS
(Sheet 4 of 9)

FOR CONTINUATION
OF STEAM GENERATOR
COMPARTMENT,
SEE SHEET 6.



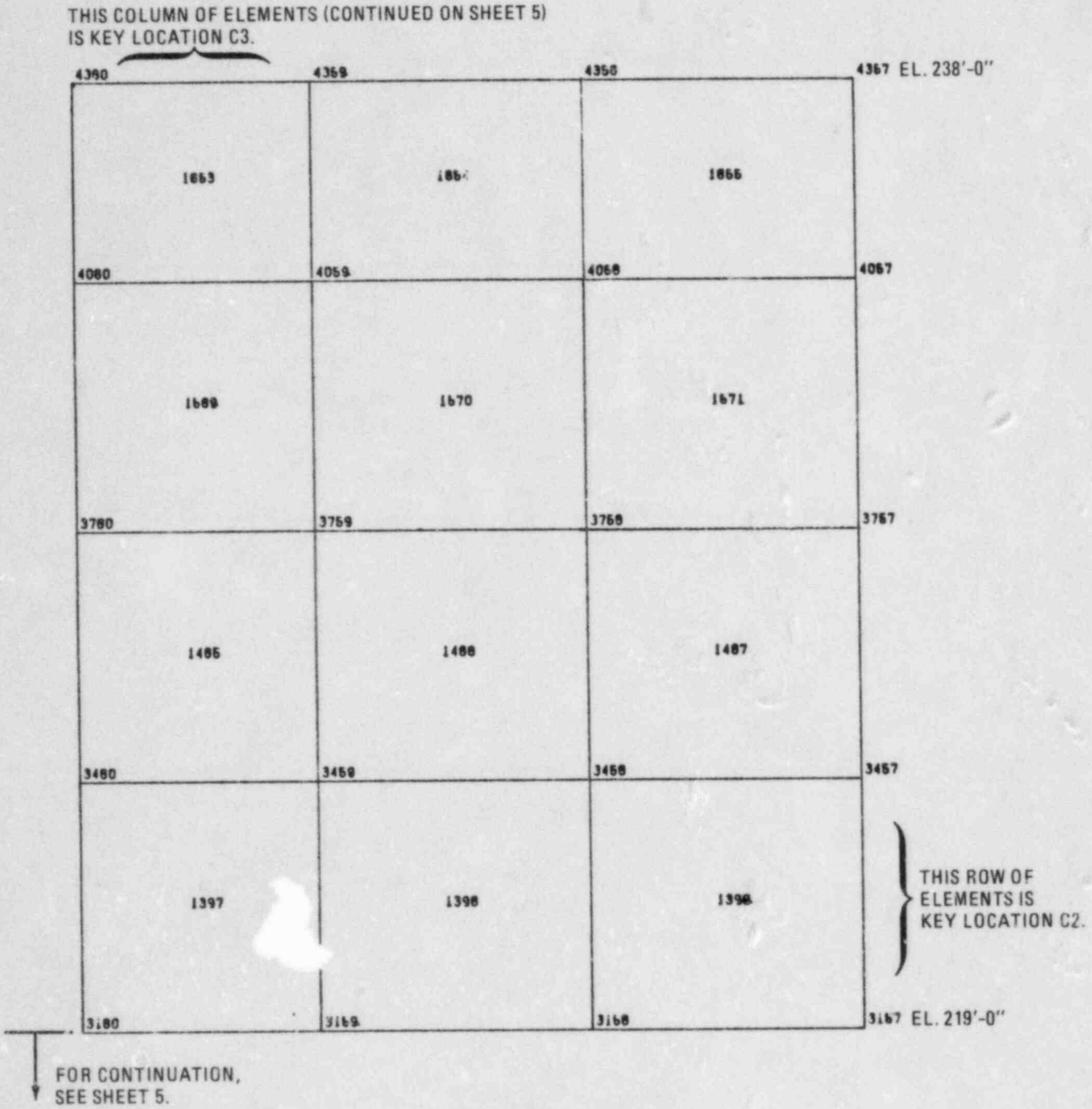
THIS ELEMENT (1148)
IS KEY LOCATION C4.

THIS ROW OF ELEMENTS
IS KEY LOCATION C1.

THIS COLUMN OF ELEMENTS (CONT. ON SHEET 6)
IS KEY LOCATION C3.

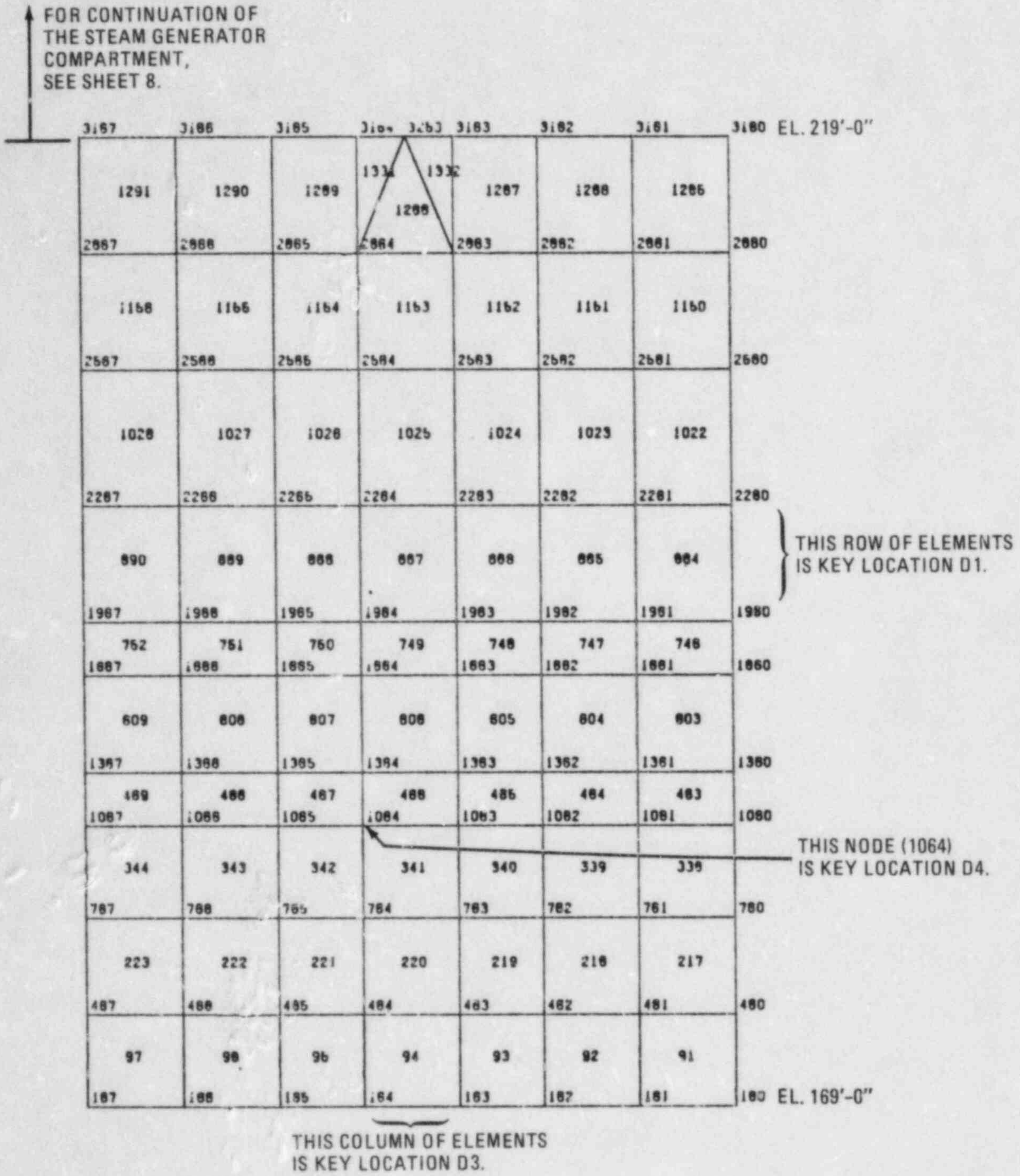
SECTION C
SHEET 1

Figure 21
SSW FINITE ELEMENT
MODEL KEY LOCATIONS
(Sheet 5 of 9)



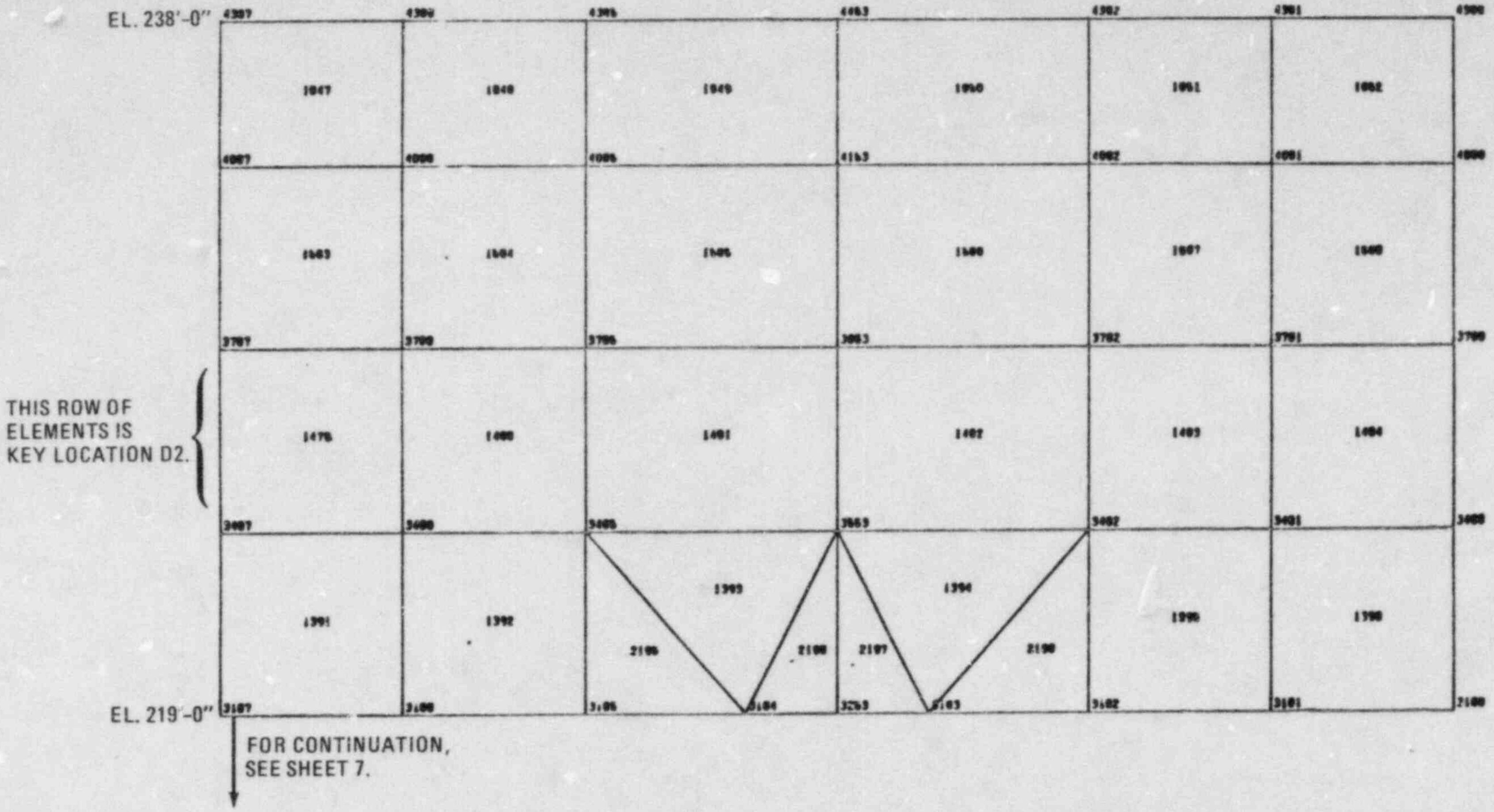
SECTION C
SHEET 1

Figure 21
SSW FINITE ELEMENT
MODEL KEY LOCATIONS
(Sheet 6 of 9)



SECTION D SHEET 1

Figure 21
SSW FINITE ELEMENT
MODEL KEY LOCATIONS
(Sheet 7 of 9)



SECTION D / SHEET 1

Figure 21
SSW FINITE ELEMENT
MODEL KEY LOCATIONS
(Sheet 8 of 9)

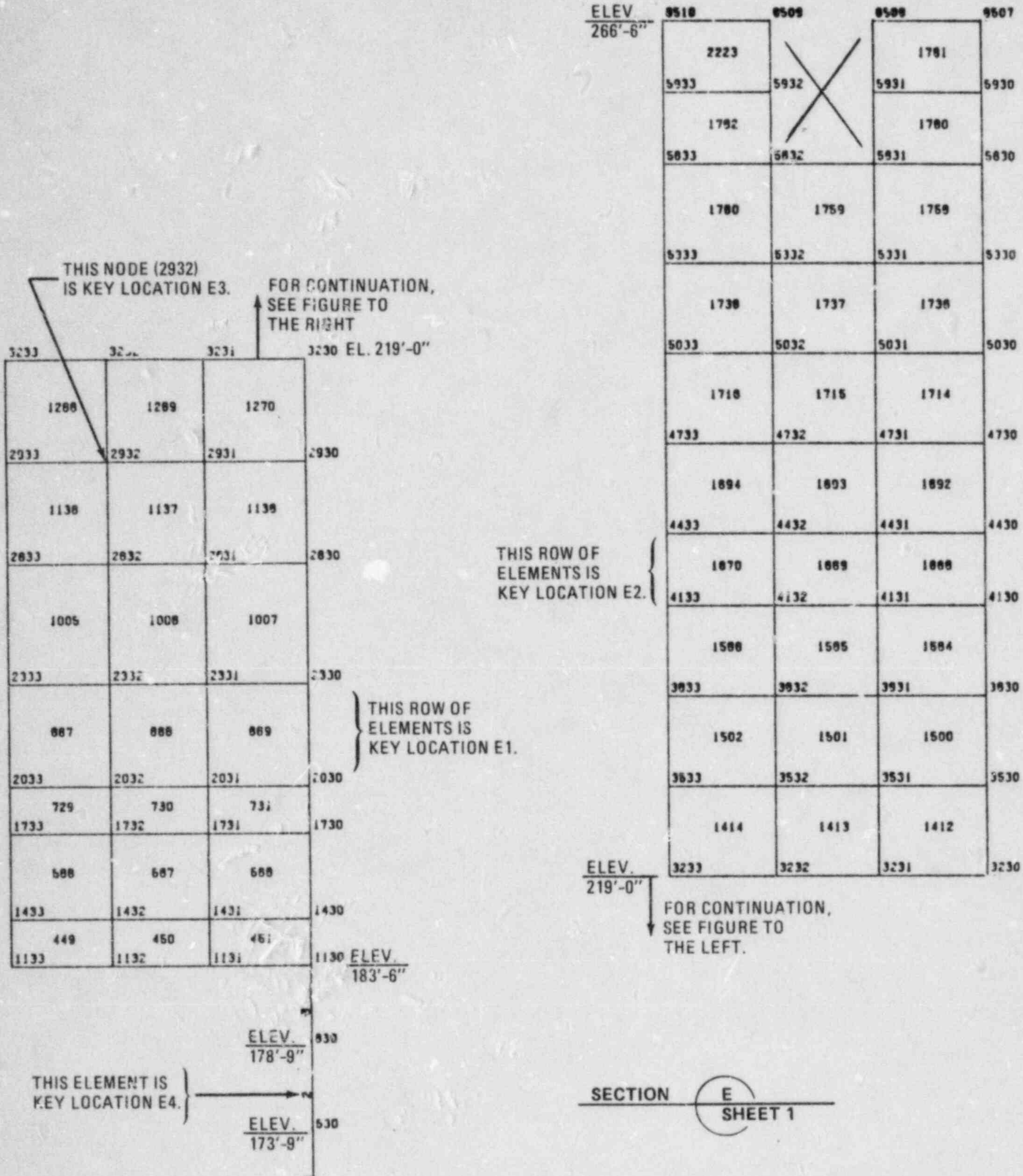
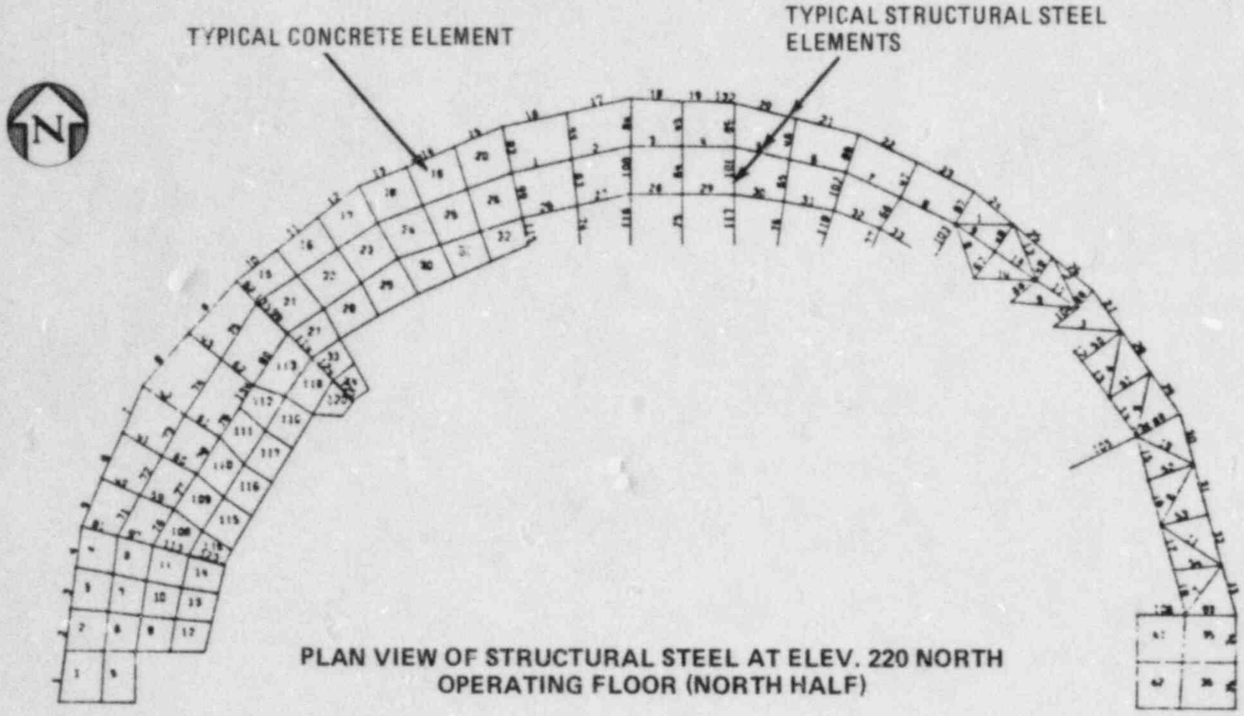
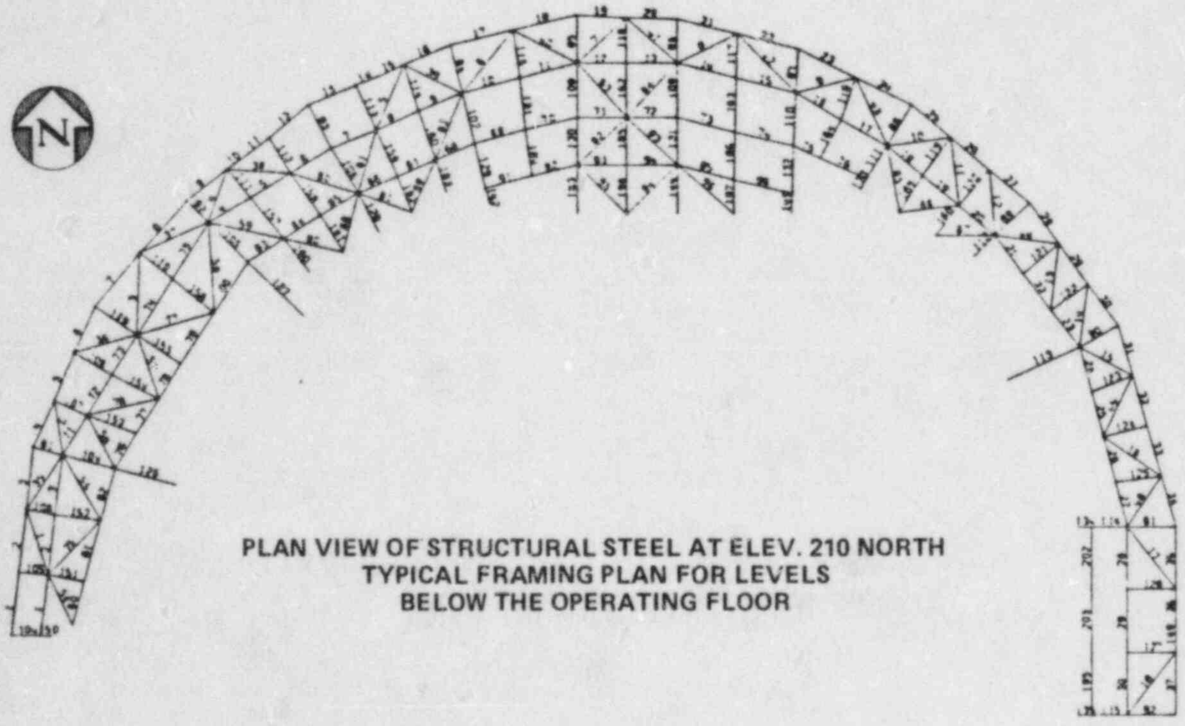


Figure 21
SSW FINITE ELEMENT
MODEL KEY LOCATIONS
(Sheet 9 of 9)

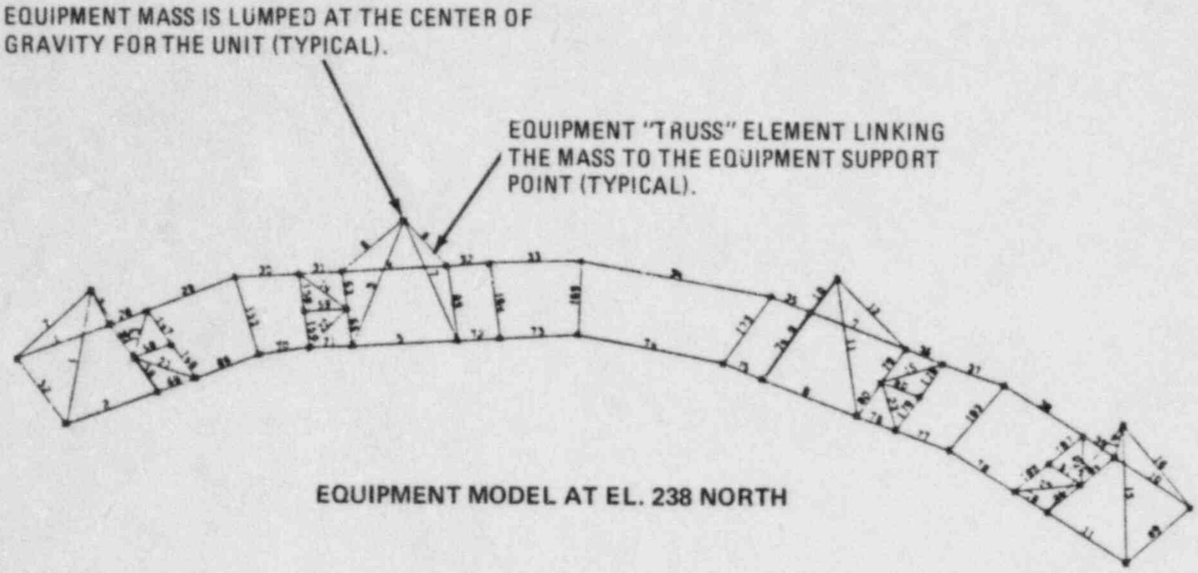


PLAN VIEW OF STRUCTURAL STEEL AT ELEV. 220 NORTH
OPERATING FLOOR (NORTH HALF)



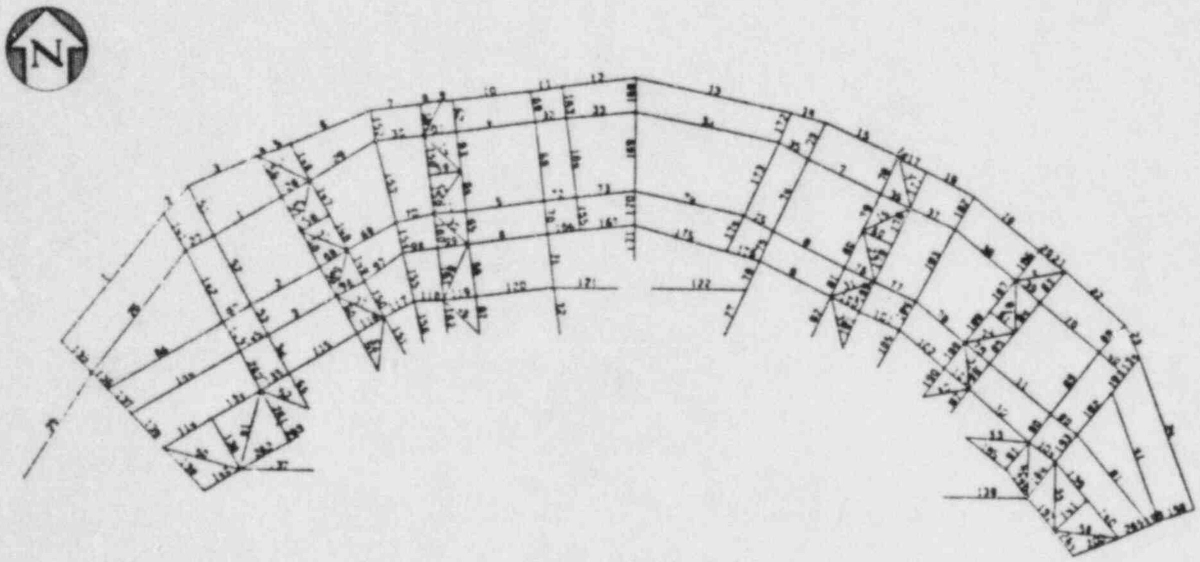
PLAN VIEW OF STRUCTURAL STEEL AT ELEV. 210 NORTH
TYPICAL FRAMING PLAN FOR LEVELS
BELOW THE OPERATING FLOOR

Figure 22
STRUCTURAL STEEL
FINITE ELEMENT MODEL
(Sheet 1 of 4)


EQUIPMENT MASS IS LUMPED AT THE CENTER OF GRAVITY FOR THE UNIT (TYPICAL).

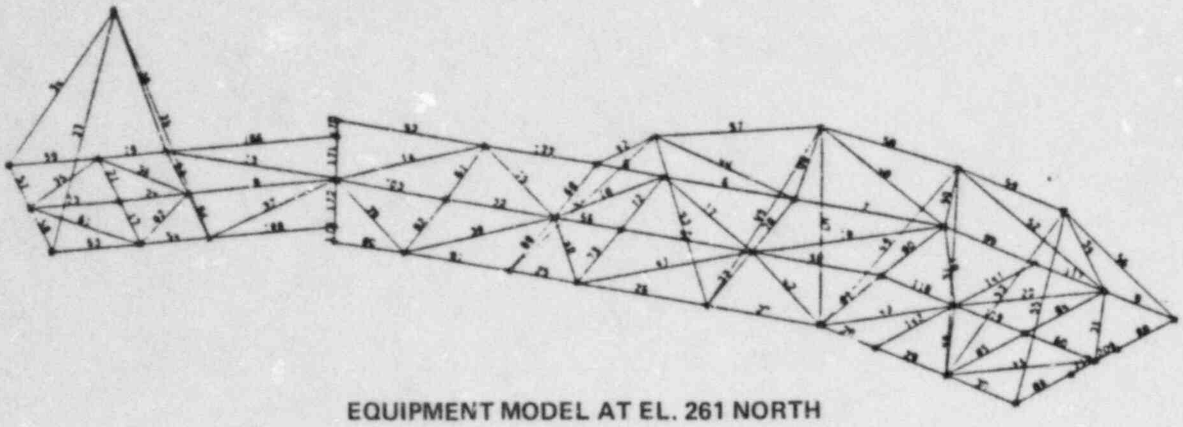
EQUIPMENT "TRUSS" ELEMENT LINKING THE MASS TO THE EQUIPMENT SUPPORT POINT (TYPICAL).

EQUIPMENT MODEL AT EL. 238 NORTH

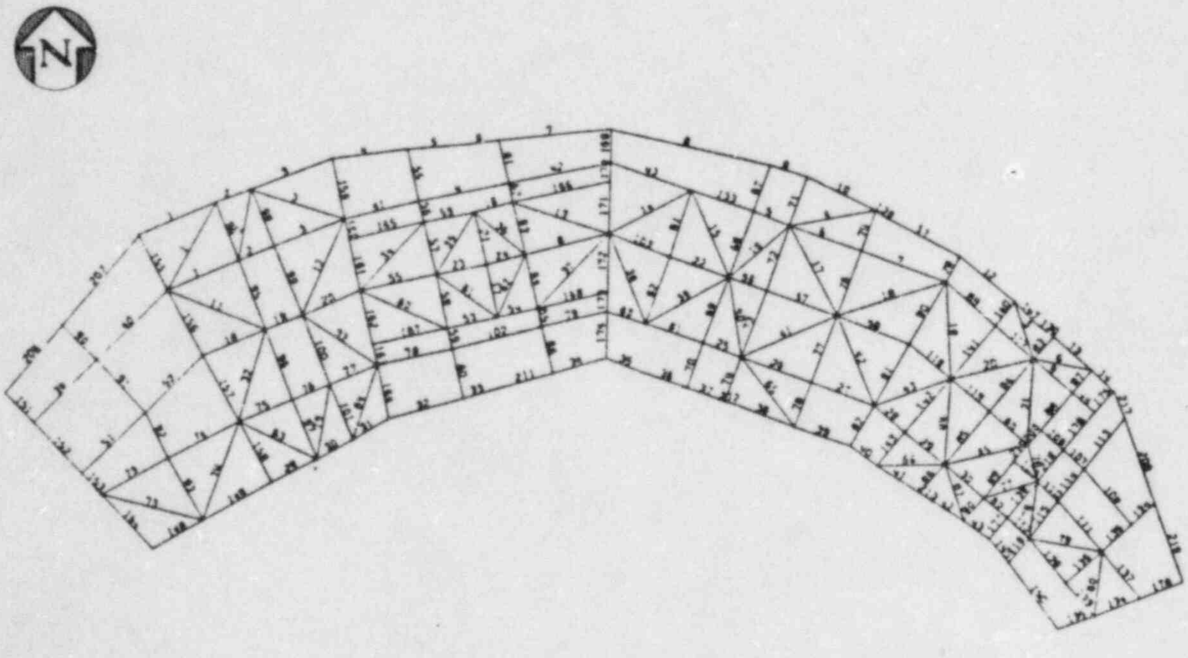


PLAN VIEW OF STRUCTURAL STEEL AT ELEV. 238 NORTH

Figure 22
STRUCTURAL STEEL
FINITE ELEMENT MODEL
(Sheet 2 of 4)

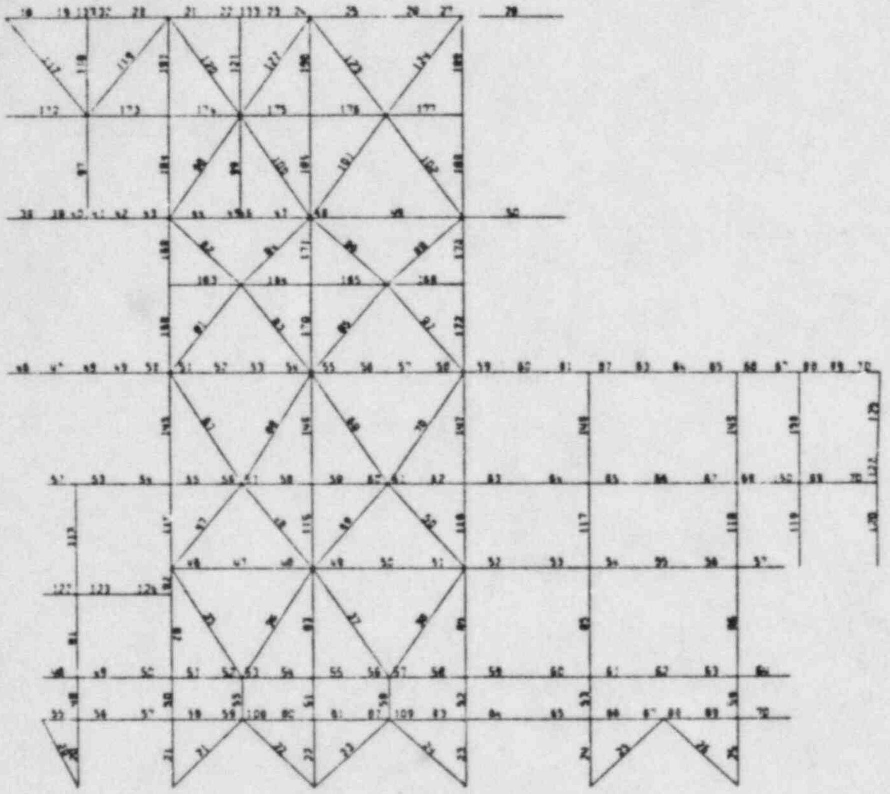


EQUIPMENT MODEL AT EL. 261 NORTH



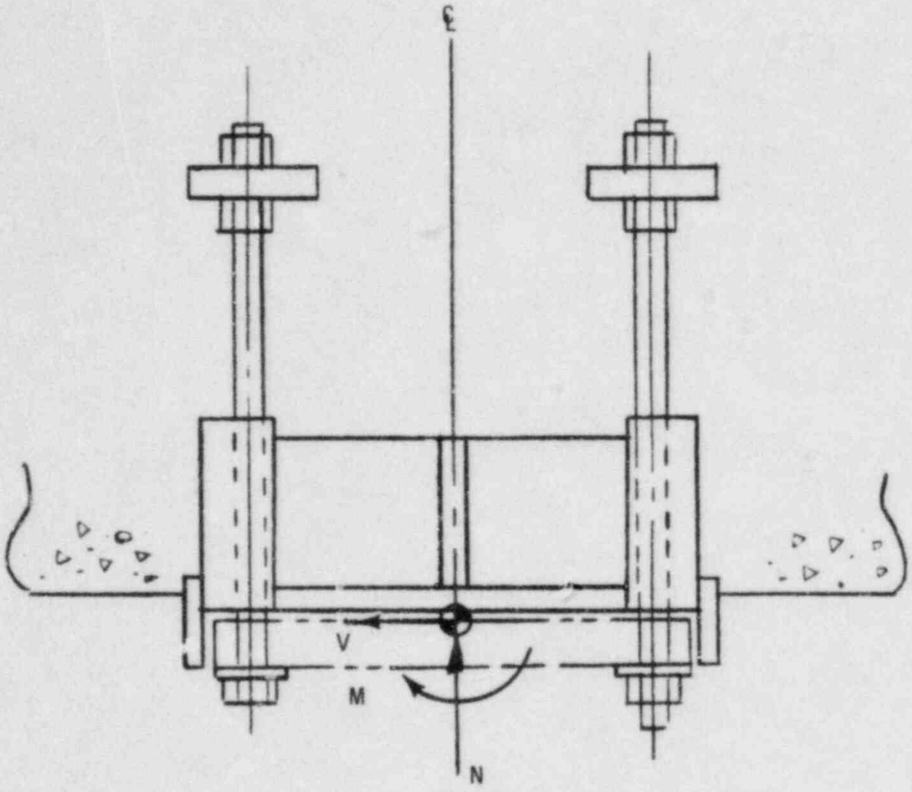
PLAN VIEW OF STRUCTURAL STEEL AT ELEV. 261 NORTH

Figure 22
STRUCTURAL STEEL
FINITE ELEMENT MODEL
(Sheet 3 of 4)



ELEVATION VIEW OF STRUCTURAL STEEL SOUTH-WEST QUADRANT
VIEWED FROM INSIDE

Figure 22
STRUCTURAL STEEL
FINITE ELEMENT MODEL
(Sheet 4 of 4)



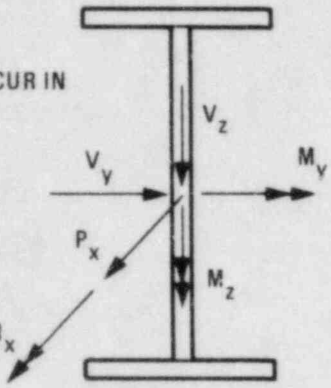
PLAN

N = 470 KIPS (COMPRESSION ONLY)
V = ± 333 KIPS (HORIZONTAL SHEAR)
M = ± 12850 IN-KIPS (MOMENT ABOUT VERTICAL CENTERLINE)

Figure 23
UPPER PRESSURIZER SUPPORT
ANALYSIS RESULTS

DESIGN FORCES FOR MAIN SUPPORT GIRDER

MAXIMUM FORCES OCCUR IN
BEAM NUMBER 10.



P_x = 4 KIPS
V_y = 3 KIPS
V_z = 418 KIPS
M_x = 26 IN-KIPS
M_y = 39,300 IN-KIPS
M_z = 10 IN-KIPS

DESIGN FORCES FOR THE MAIN GIRDER CONNECTION

BOLT DESIGN: P = PULLOUT = 333 KIPS
V_z = VERTICAL SHEAR = 573 KIPS

CONNECTION PLATE DESIGN:
P = PULLOUT = 333 KIPS
V_z = VERTICAL SHEAR = 573 KIPS
M_y = MOMENT DUE TO ECCENTRIC APPLICATION OF V_z
= 3080 IN-KIPS

DESIGN FORCES FOR THE MAIN GIRDER CONNECTION ANCHORAGE

P_x = ANCHORAGE PULLOUT = 333 KIPS
V_y = HORIZONTAL SHEAR = 0 KIPS
V_z = VERTICAL SHEAR = 573 KIPS
M_x = TORSION = 215 IN-KIPS
M_y = MOMENT DUE TO THE ECCENTRIC APPLICATION OF V_z
= 3080 IN-KIPS
M_z = MOMENT ABOUT THE VERTICAL AXIS = 187 IN-KIPS.

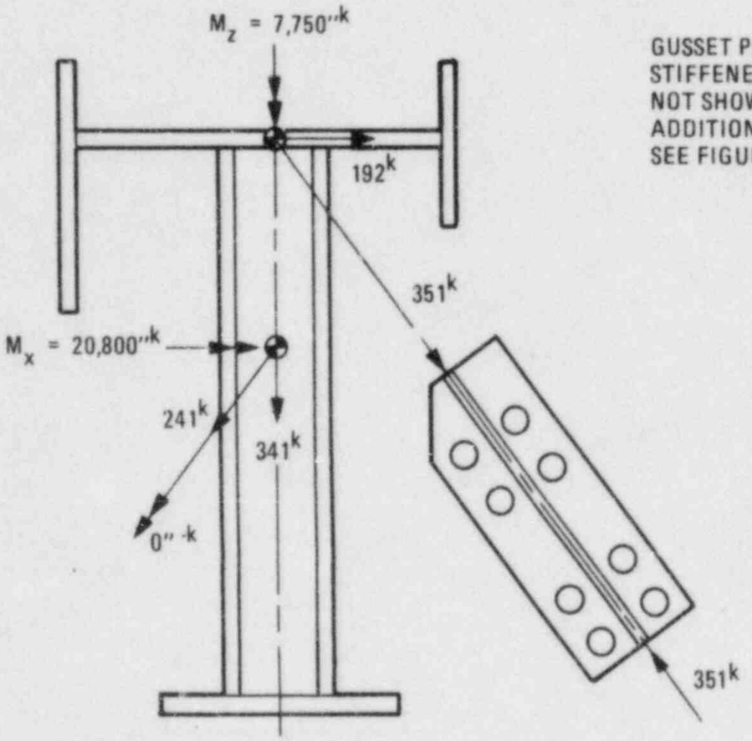
Figure 24
LOWER PRESSURIZER SUPPORT
ANALYSIS RESULTS

GOVERNING LOAD COMBINATION EQUATION 2: (D + L + OBE)

	APPLIED LOADS		
LOAD DIRECTION	HORIZONTAL LOAD (a) (PERPENDICULAR TO RUNWAY GIRDER)	HORIZONTAL LOAD (b) (PARALLEL TO RUNWAY GIRDER)	VERTICAL LOAD (c) PER WHEEL
POINT OF APPLICATION	CENTERLINE OF RUNWAY GIRDER TOP FLANGE	TOP OF RUNWAY RAIL	TOP OF RUNWAY RAIL
LOAD MAGNITUDE	208 KIPS	203 KIPS	222 KIPS

(a) THERE ARE TWO LATERAL STOPS (SEISMIC RESTRAINTS) PER POLAR CRANE END.
(b) APPLIED BY THE DRIVE/BRAKE WHEELS (TWO PER POLAR CRANE END).
(c) EIGHT WHEELS PER POLAR CRANE END.

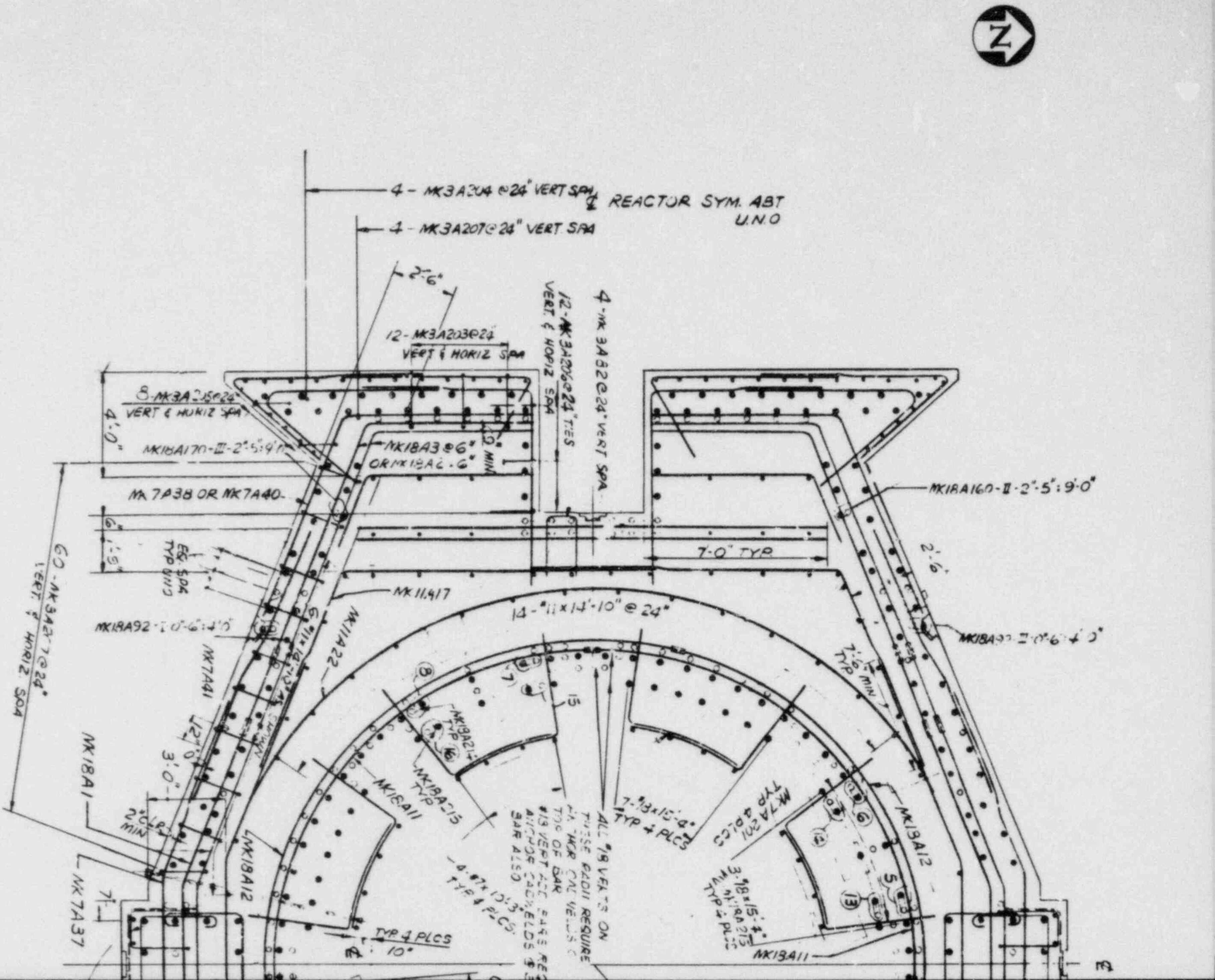
ANALYSIS RESULTS:



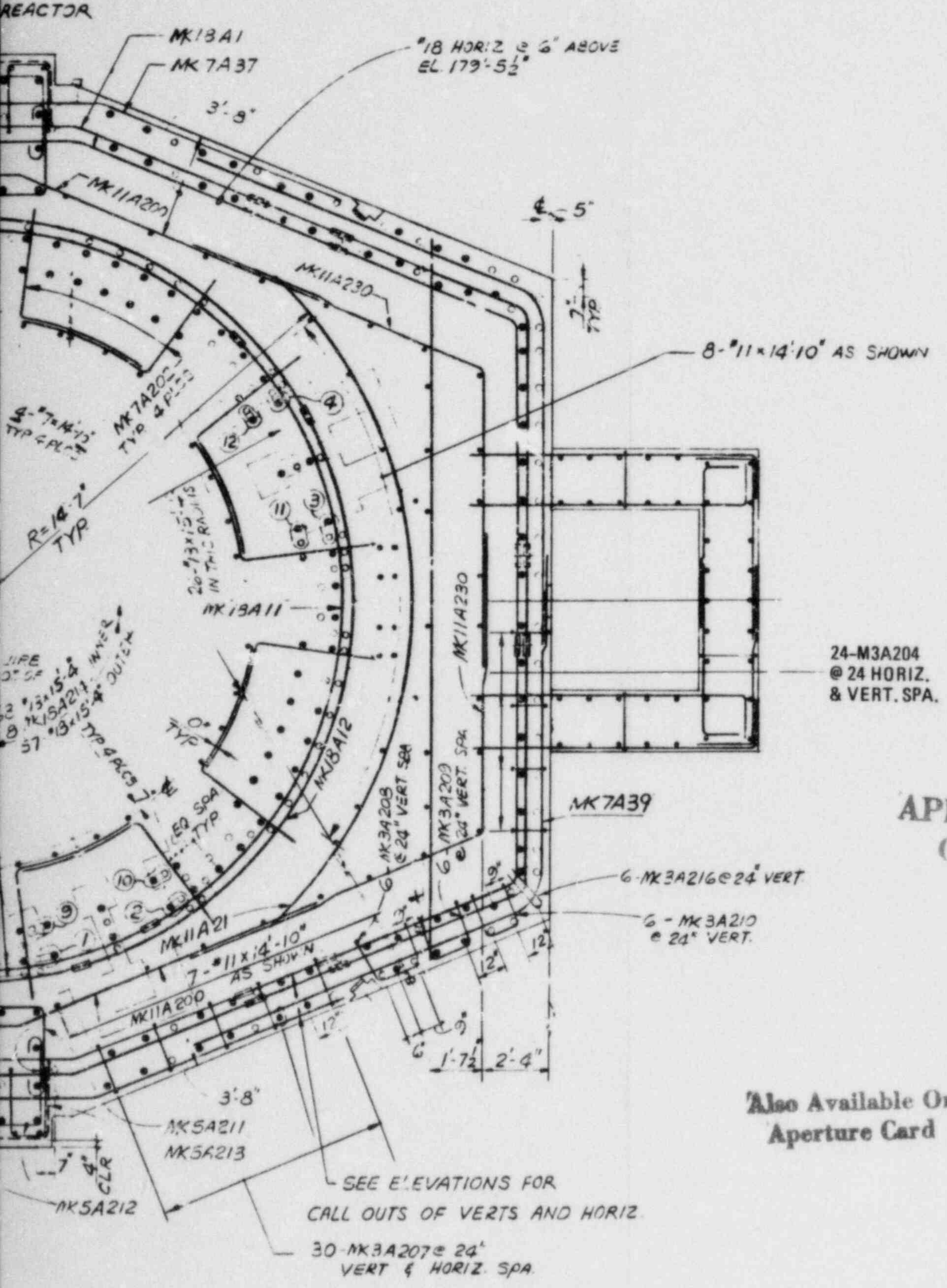
GUSSET PLATES AND STIFFENER PLATES ARE NOT SHOWN. FOR ADDITIONAL INFORMATION, SEE FIGURE 14.

SECTION THROUGH RUNWAY GIRDER

Figure 25
POLAR CRANE RUNWAY GIRDER
ANALYSIS RESULTS



AXIAL AND FLEXURA
PLAN AT E
(NOTE: SHEAR REINFORCEM



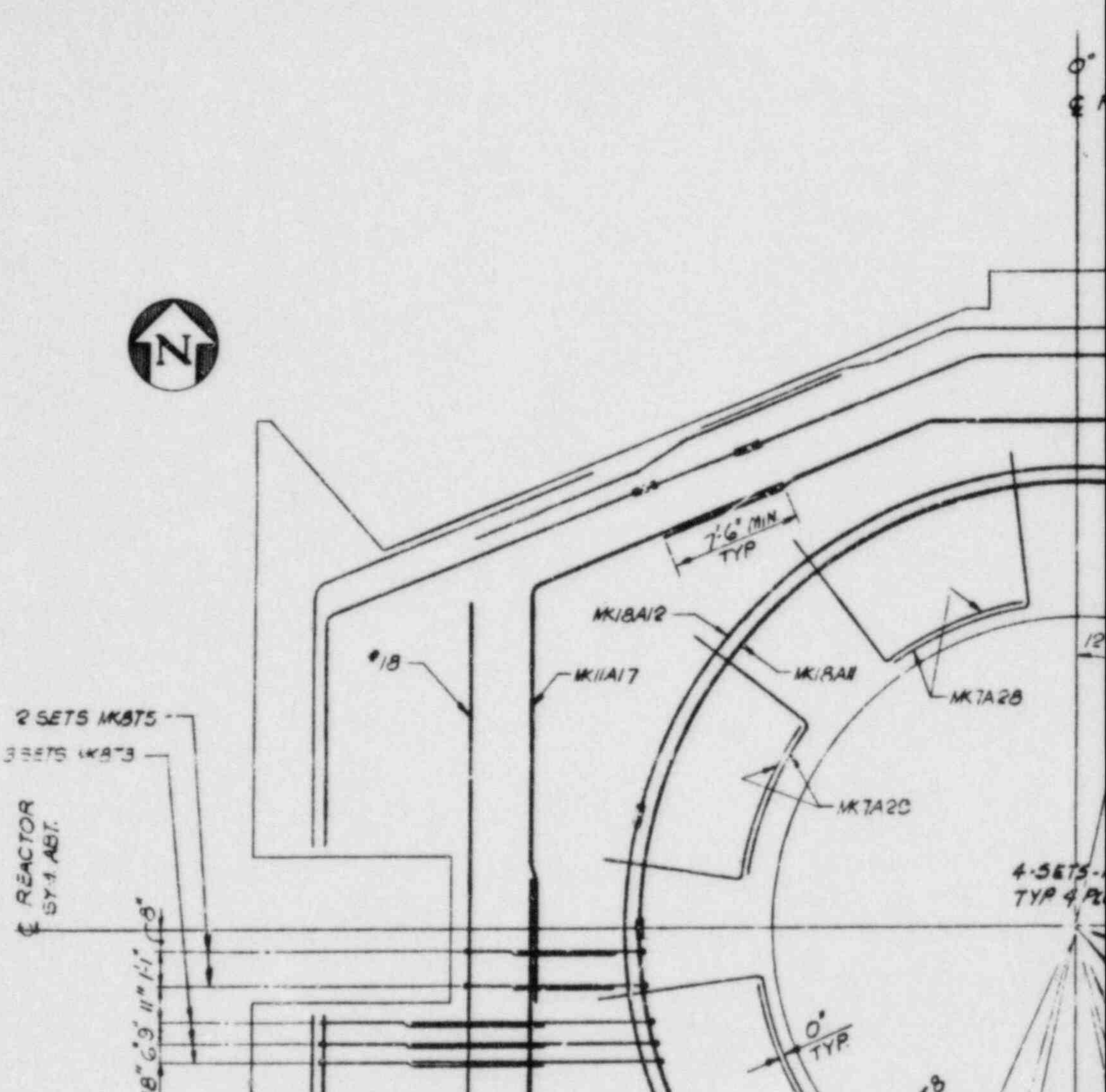
TI
APERTURE
CARD

Also Available On
Aperture Card

L REINFORCEMENT
. 175'-0"
ENT IS SHOWN ON SHEET 2)

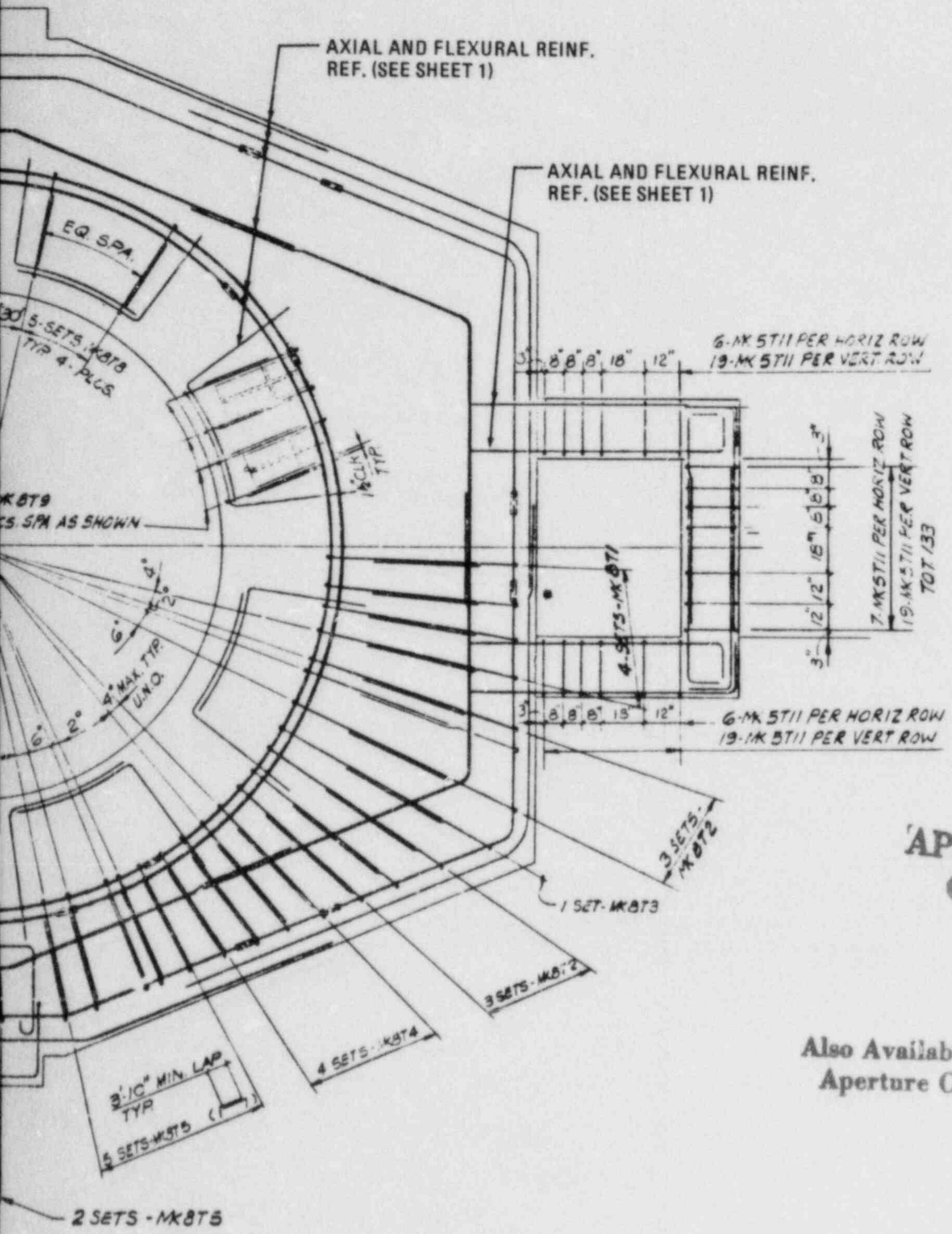
Figure 26
PSW DESIGN DETAILS
(Sheet 1 of 2)

8411050162 -08



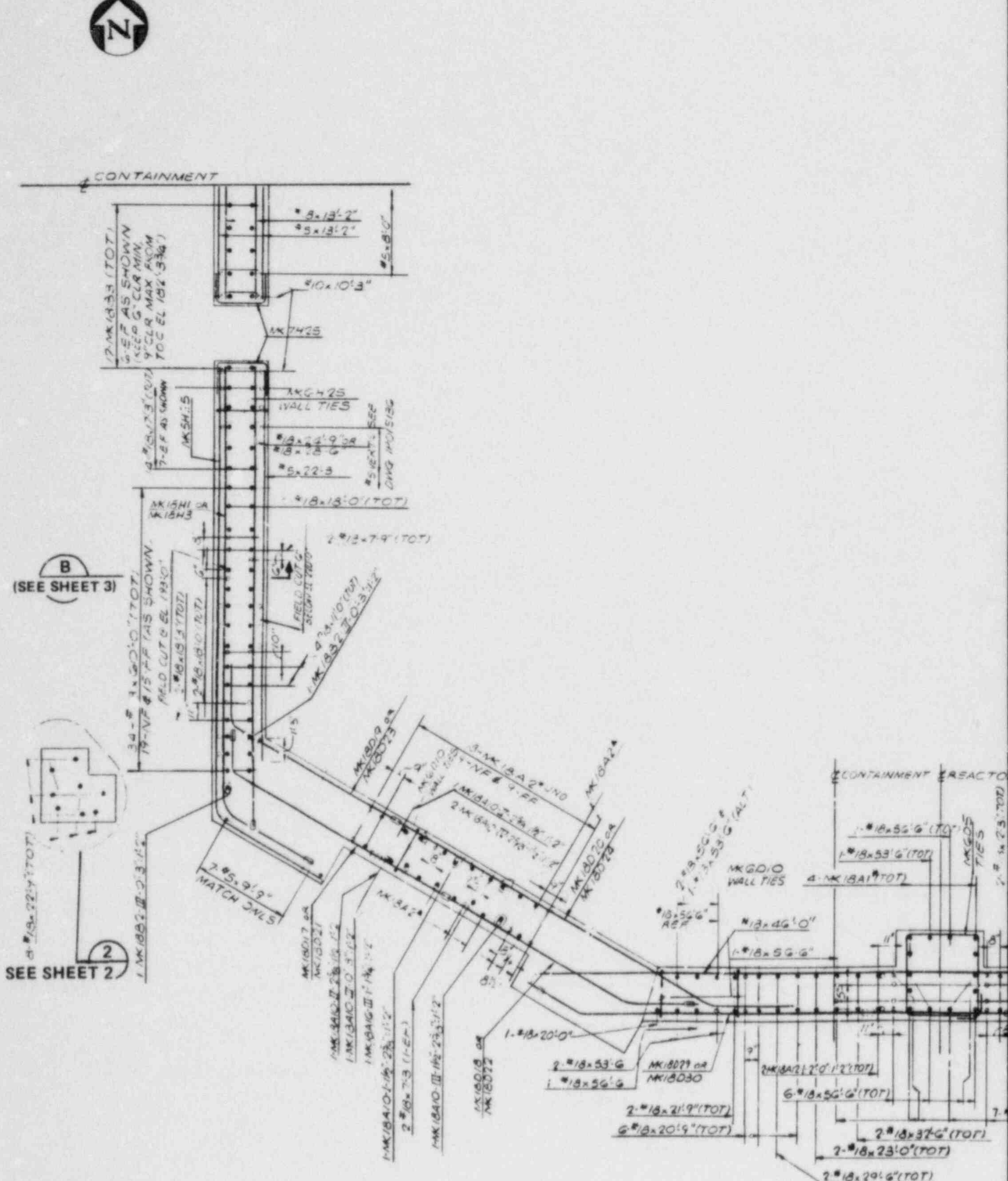
SHEAR REINF
PLAN AT EL
(HORIZ. TIES FROM
EL. 183

REACTOR

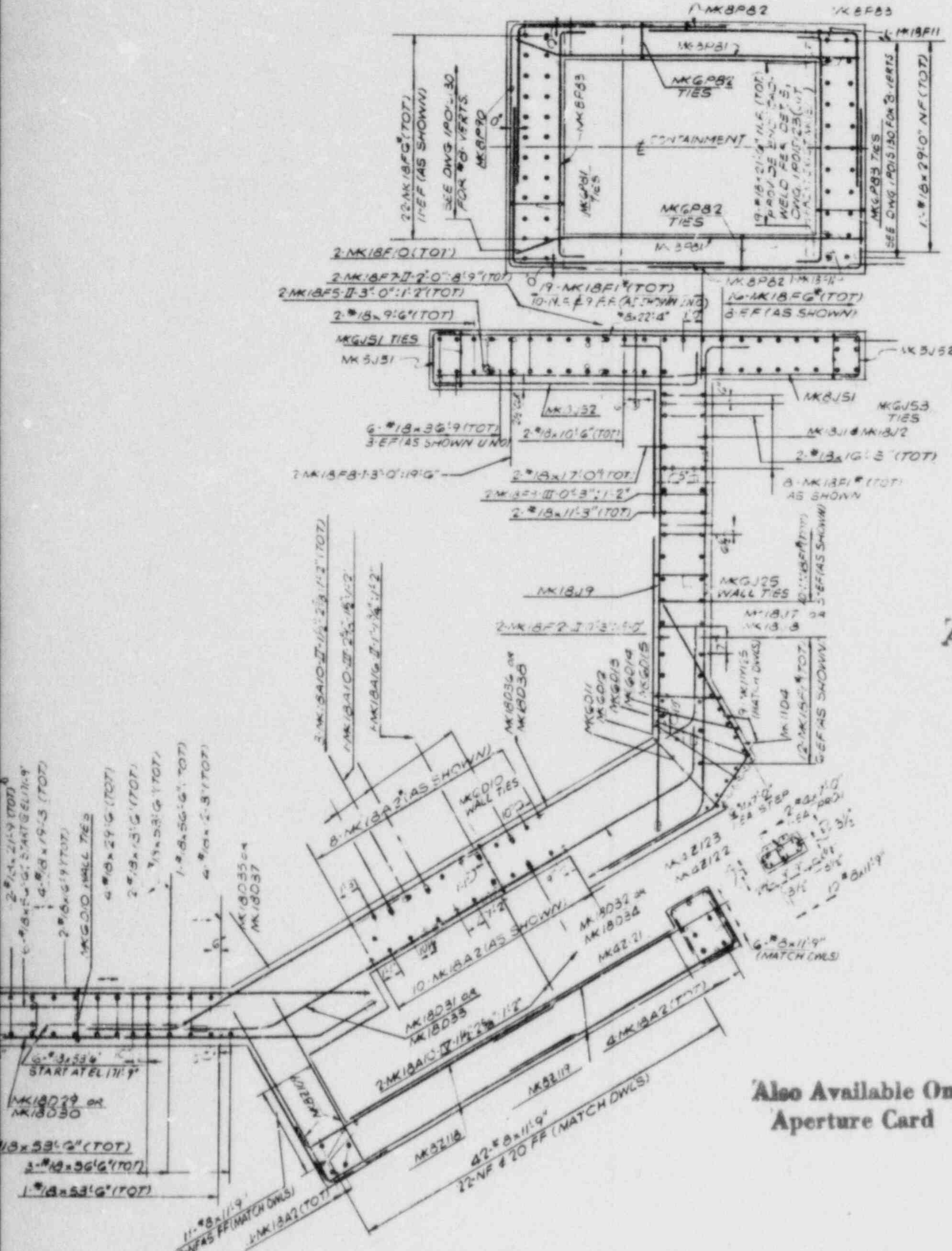


ORCEMENT
. 176'-3"
EL. 169'-0-1/4" TO
'-0")

Figure 26
PSW DESIGN DETAILS
(Sheet 2 of 2)

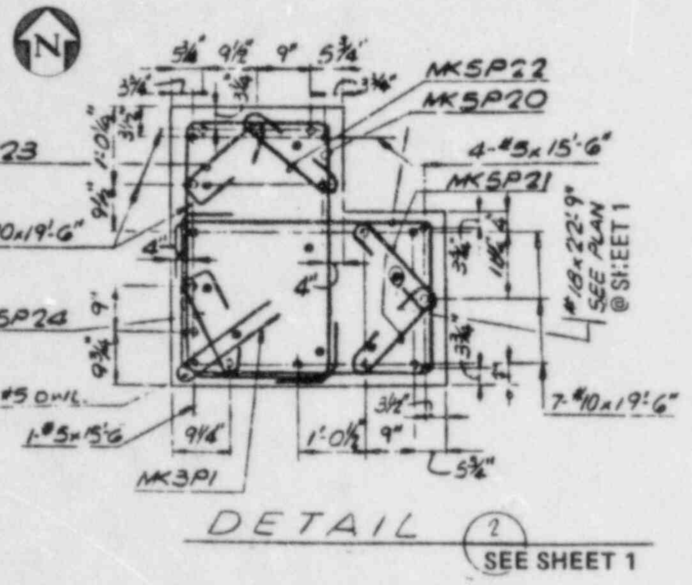


SOUTH HALF
PLAN @ EL. 17

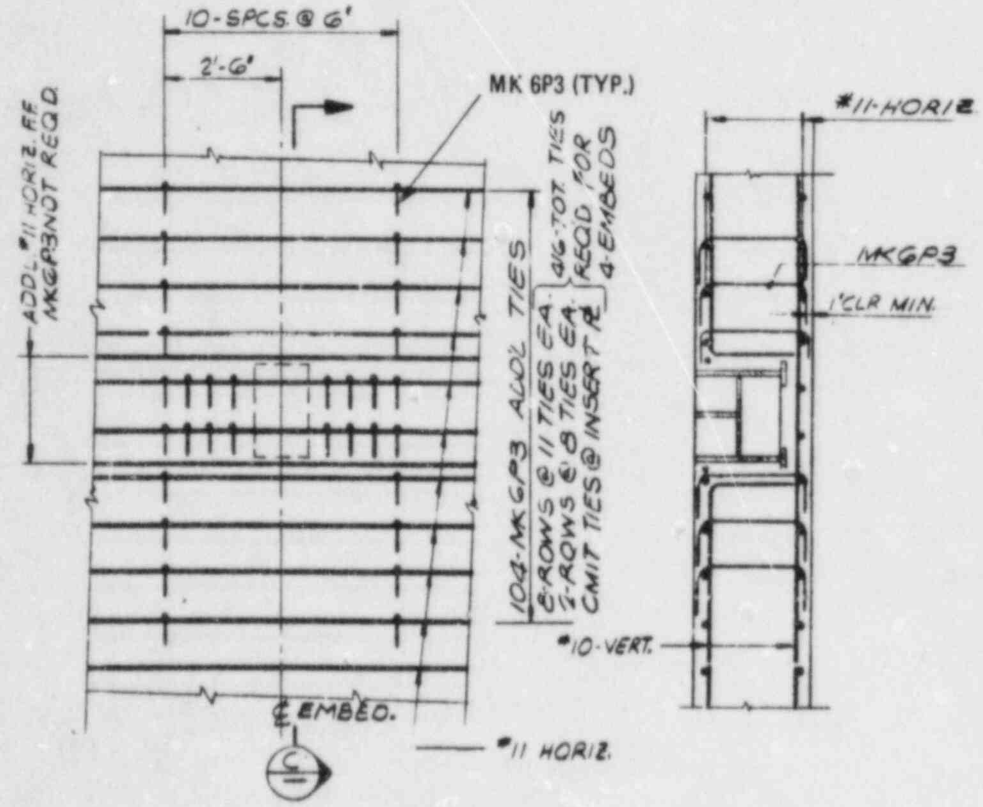


SSW
1'-9"

Figure 27
SSW DESIGN DETAILS
(Sheet 1 of 5)

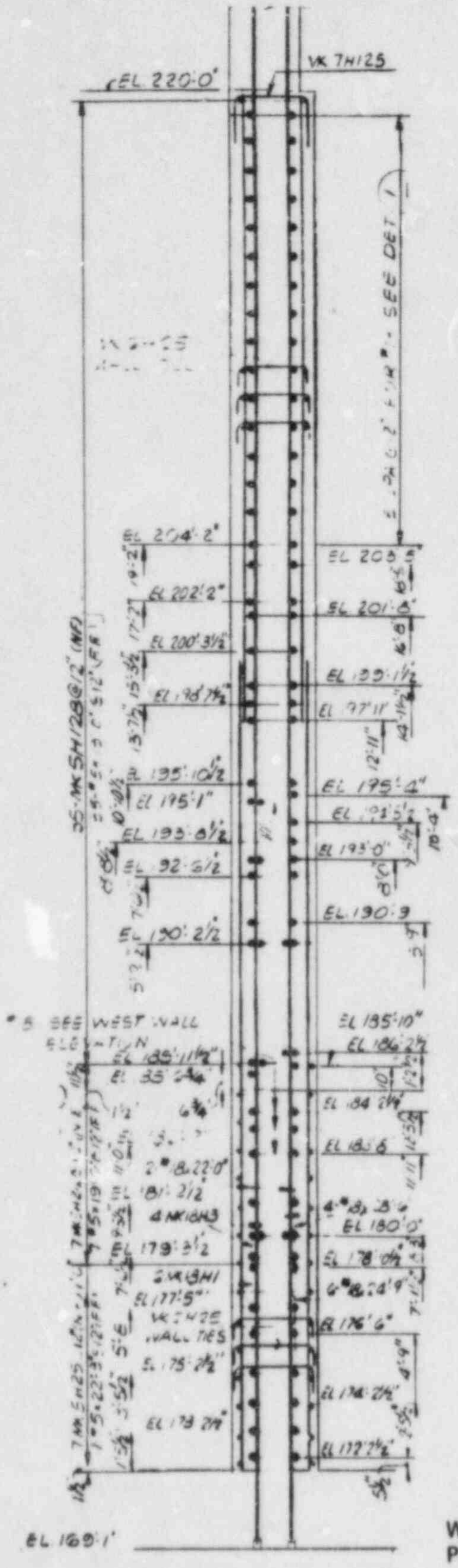


PLAN OF SUPPORT PILASTER FOR
PRESSURIZER COMPARTMENT WALLS



WALL ELEVATION – HORIZONTAL & SHEAR REINFORCEMENT
AT THE PRESSURIZER LOWER SUPPORT EMBEDS
(NOTE: VERT. REINF. IS NOT SHOWN ON DET. 1 FOR CLARITY)

Figure 27
SSW DESIGN DETAILS
(Sheet 2 of 5)

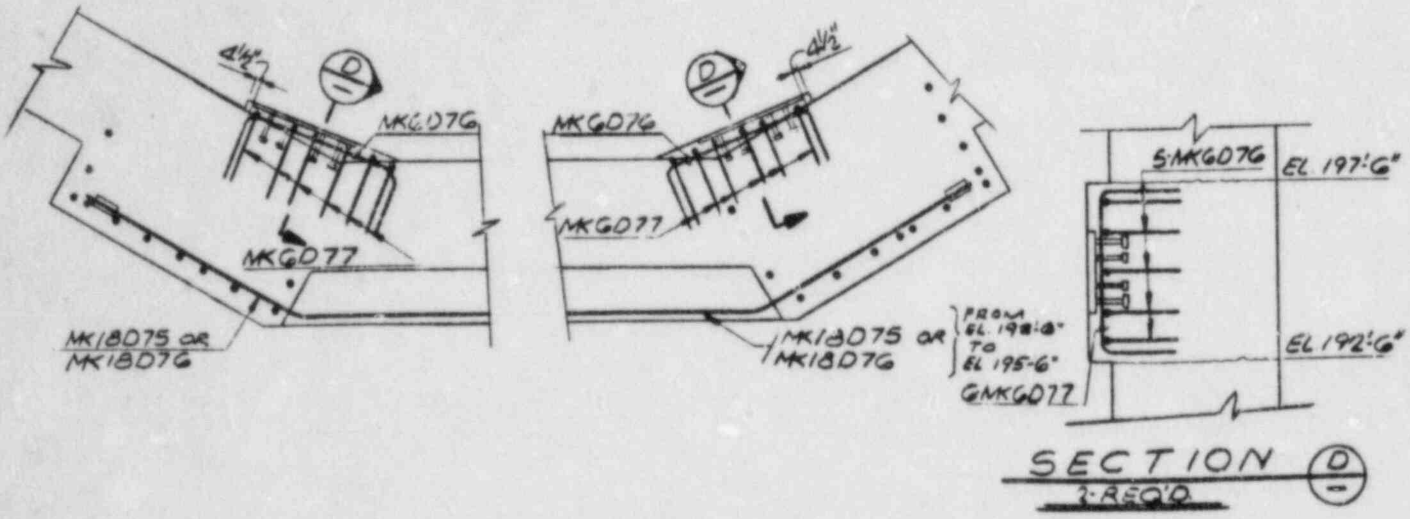


WEST SSW AT
PRESSURIZER COMPARTMENT

SECTION (B)

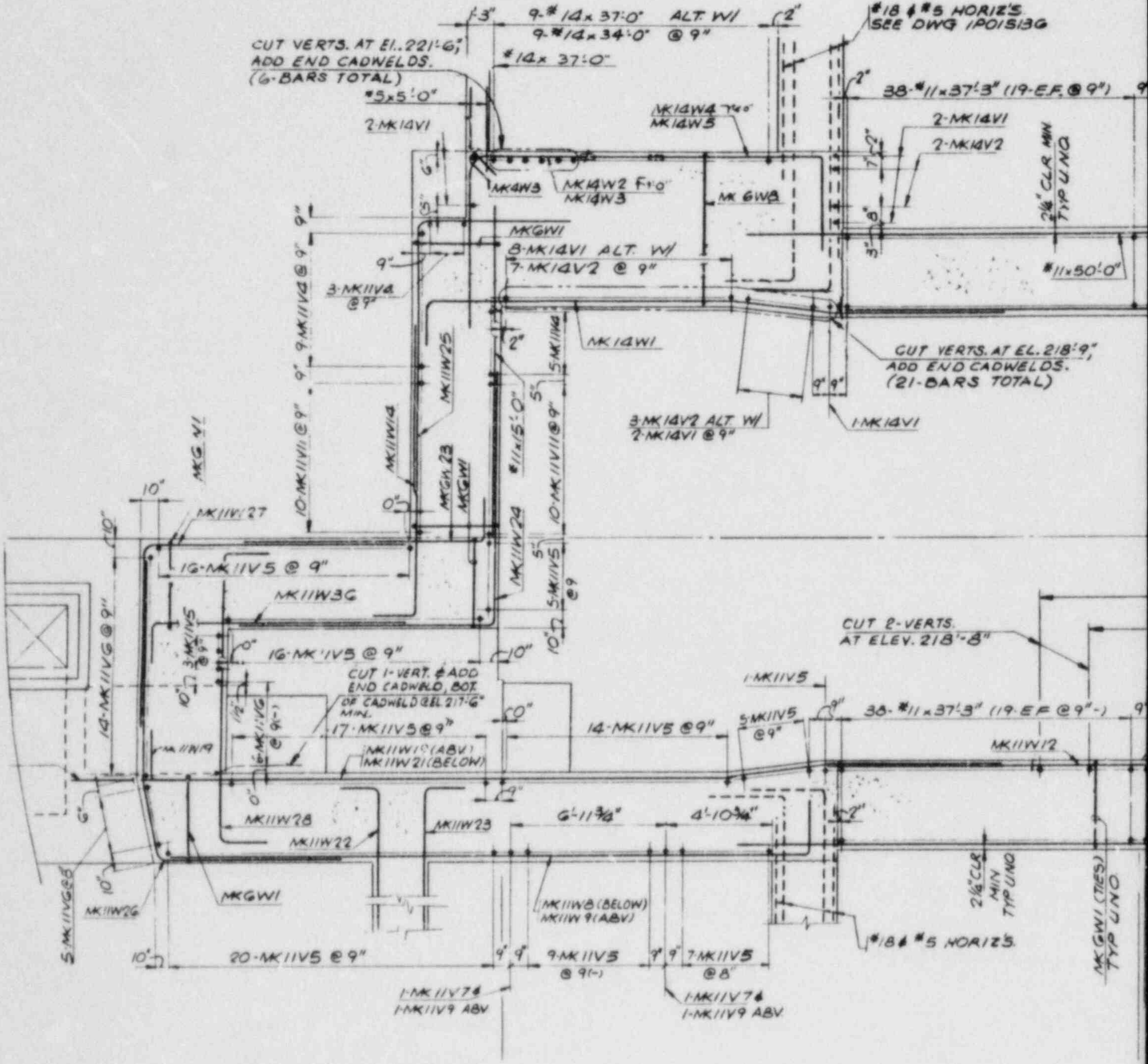
SEE SHEET 1

Figure 27
SSW DESIGN DETAILS
(Sheet 3 of 5)

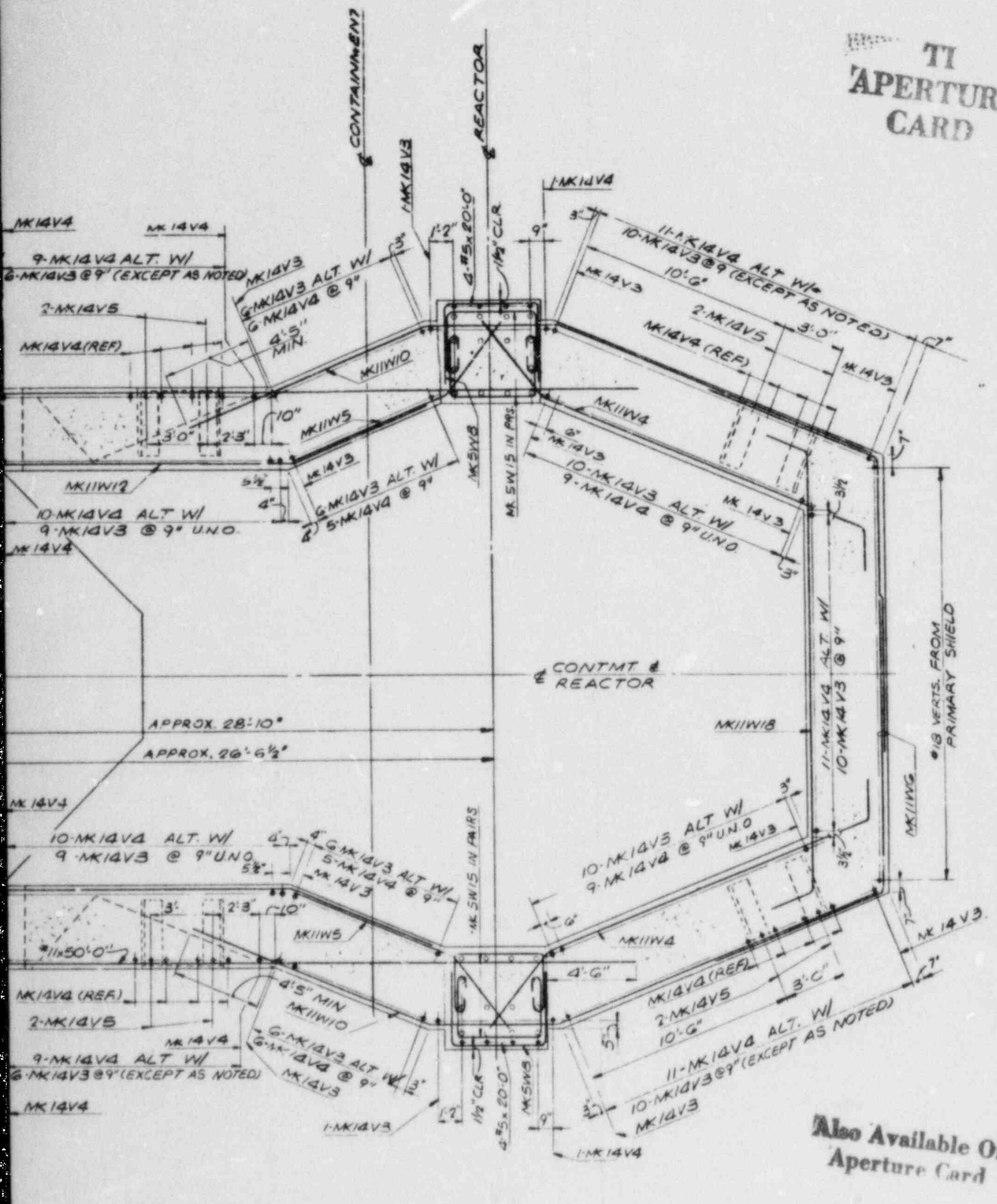


PARTIAL PLAN OF SOUTH SSW @ ELEV. 197'-6" –
LOCAL REINFORCEMENT @ LOWER STEAM GENERATOR SUPPORT EMBED

Figure 27
SSW DESIGN DETAILS
(Sheet 4 of 5)

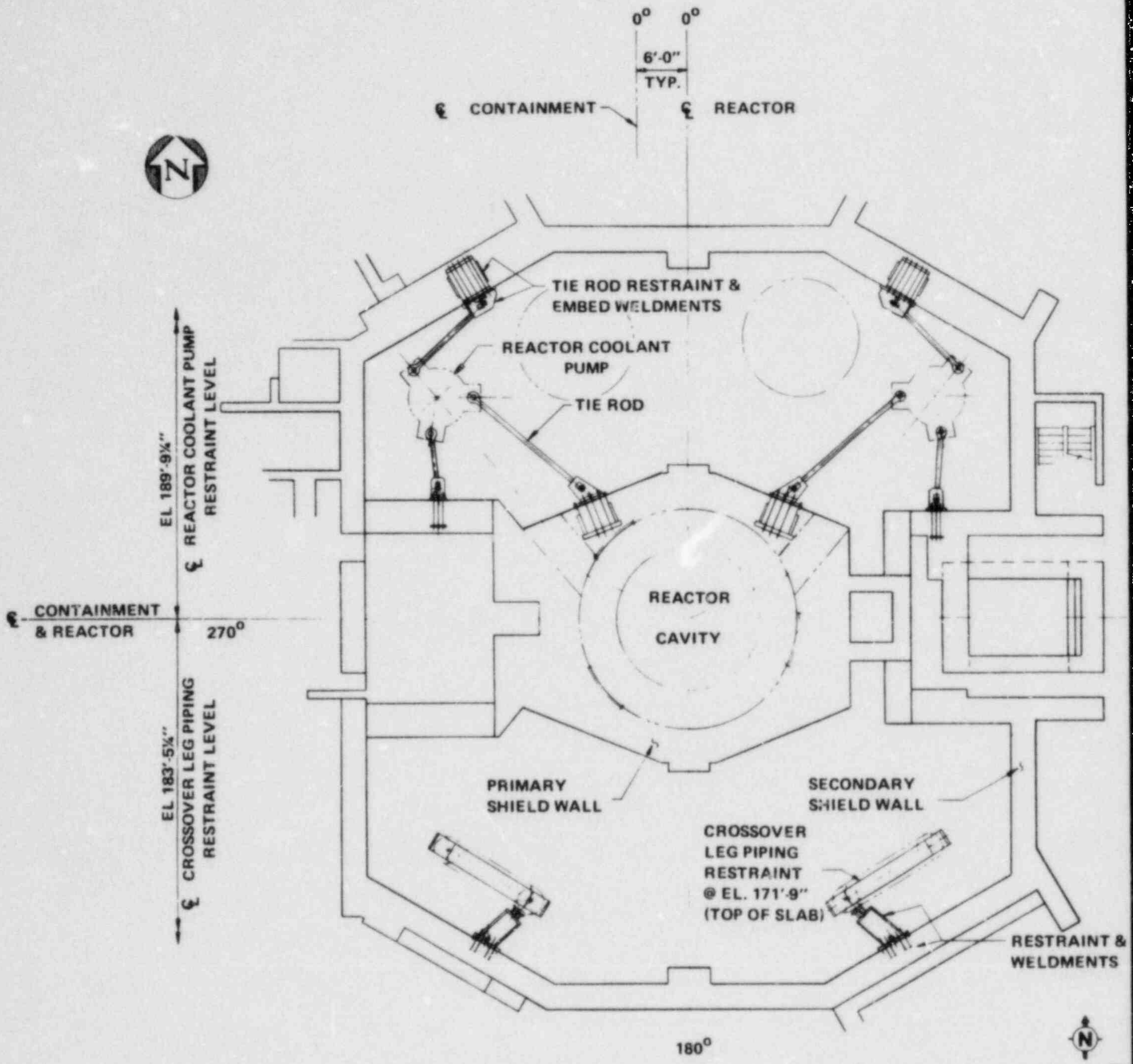


REFUELIN
SECTIONAL PLA



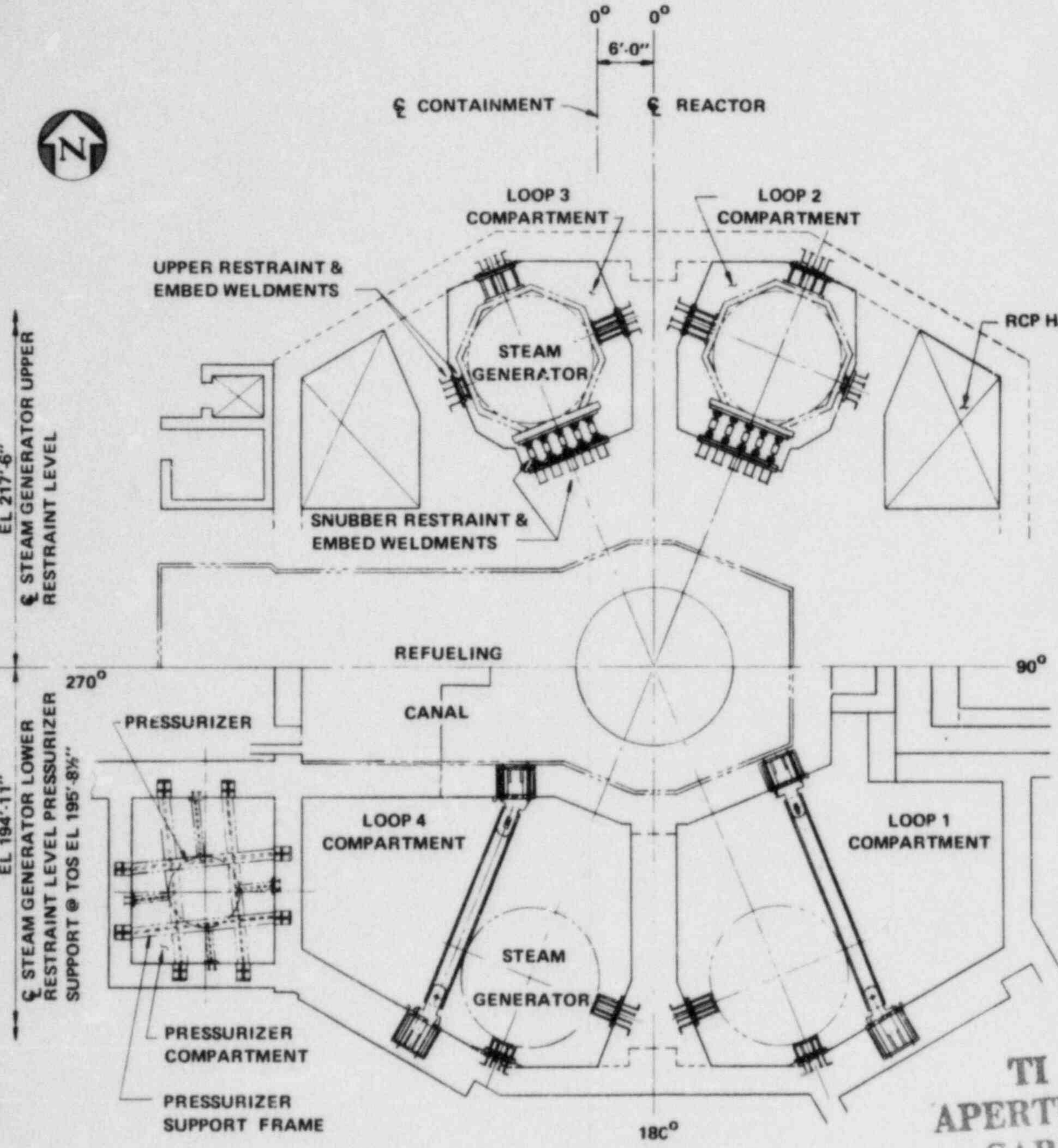
G CANAL
AN @ EL. 199'-0"

Figure 27
SSW DESIGN DETAILS
(Sheet 5 of 5)



PLAN

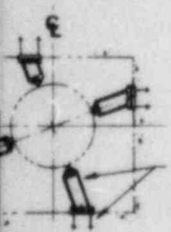
REACTOR COOLANT PUMPS AND CROSS OVER LEG PIPING AREA



PLAN

STEAM GENERATOR AND PRESSURIZER AREA

EMBED



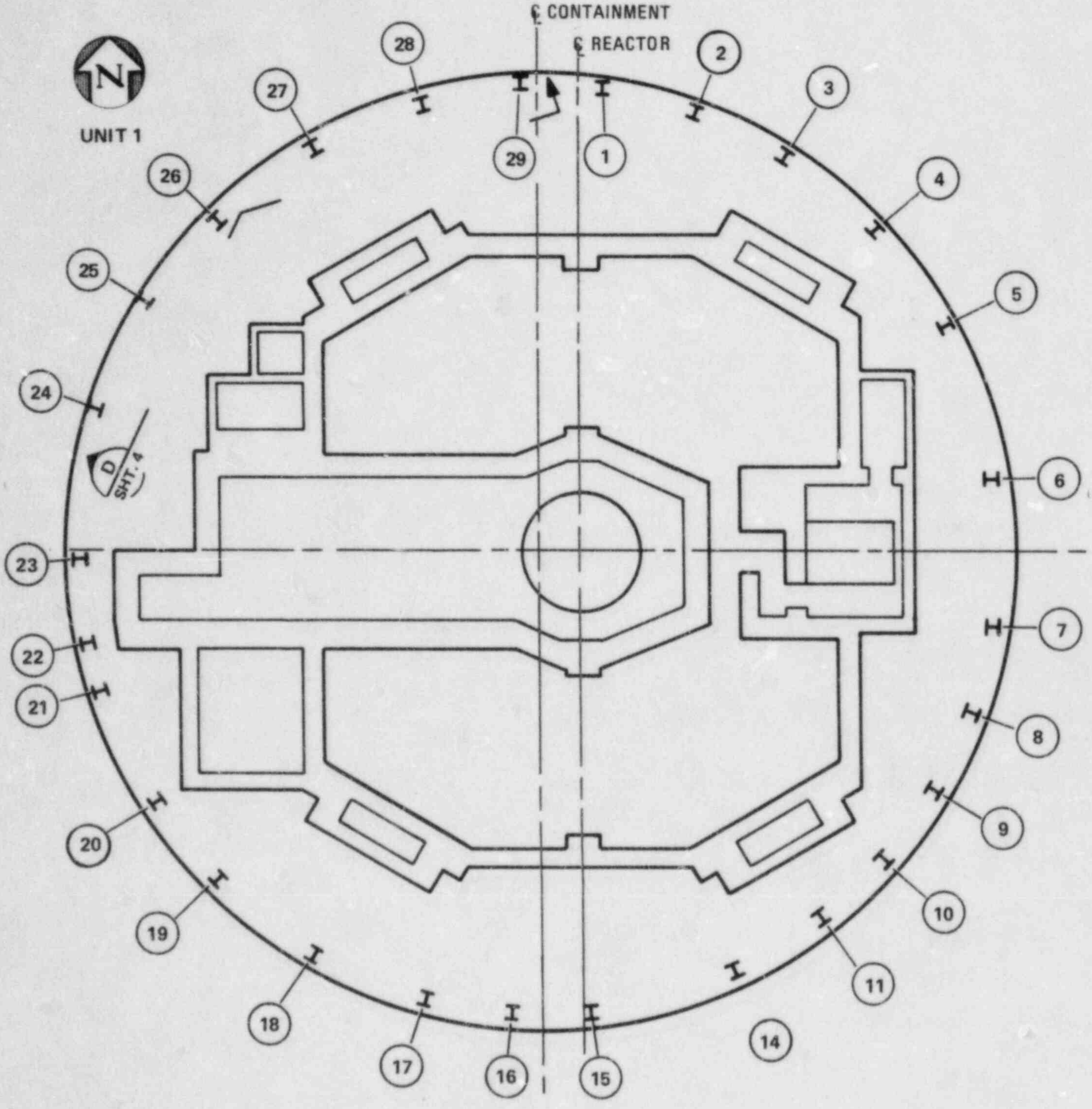
PLAN

RIZER AREA @
221'-7-7/8"

COMPARTMENTS

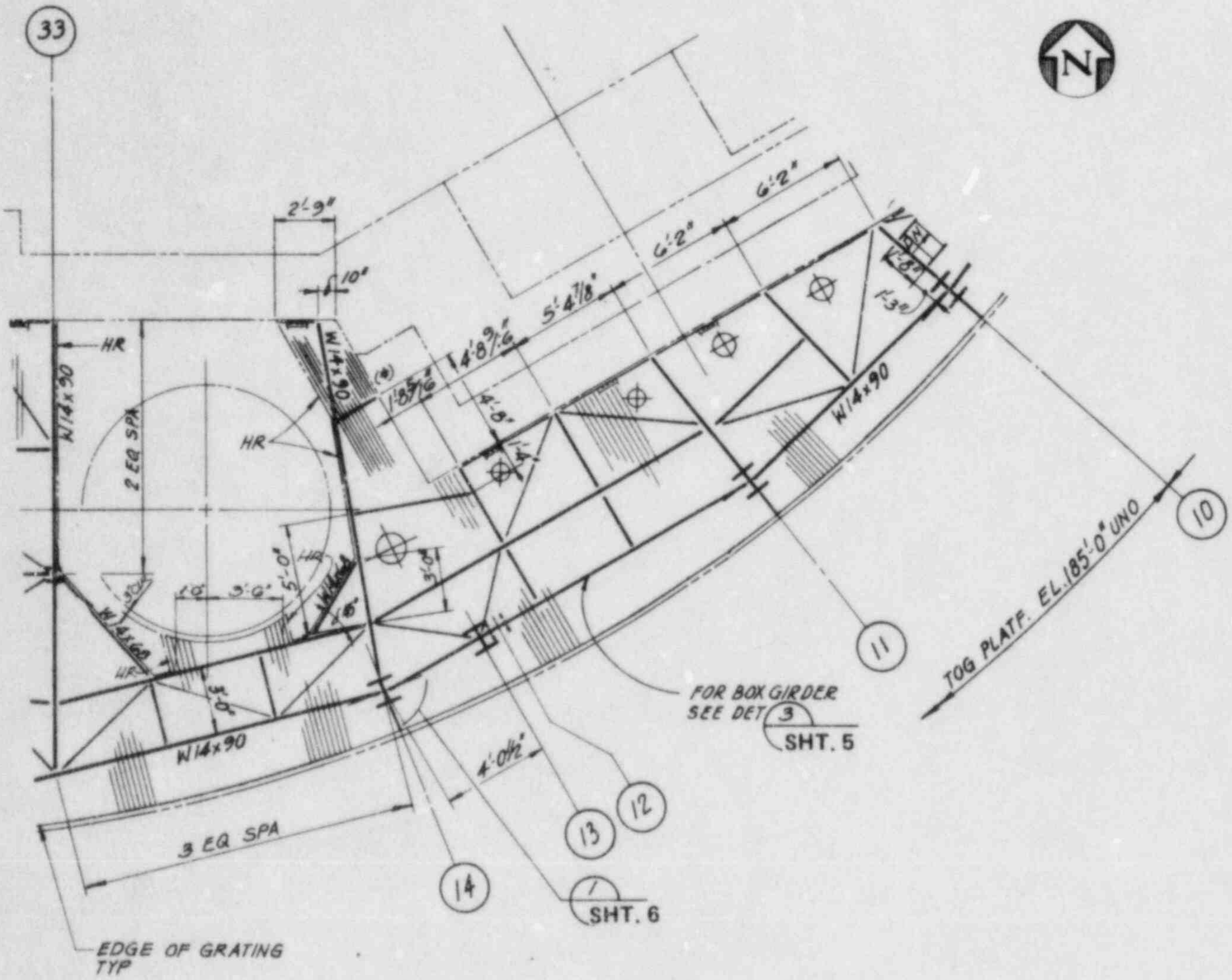
LOOP 1 OPPOSITE HAND TO LOOP 2
LOOP 4 OPPOSITE HAND TO LOOP 3

Figure 4
REACTOR COOLANT SYSTEM
SUPPORTS ARRANGEMENT (UNIT 1)



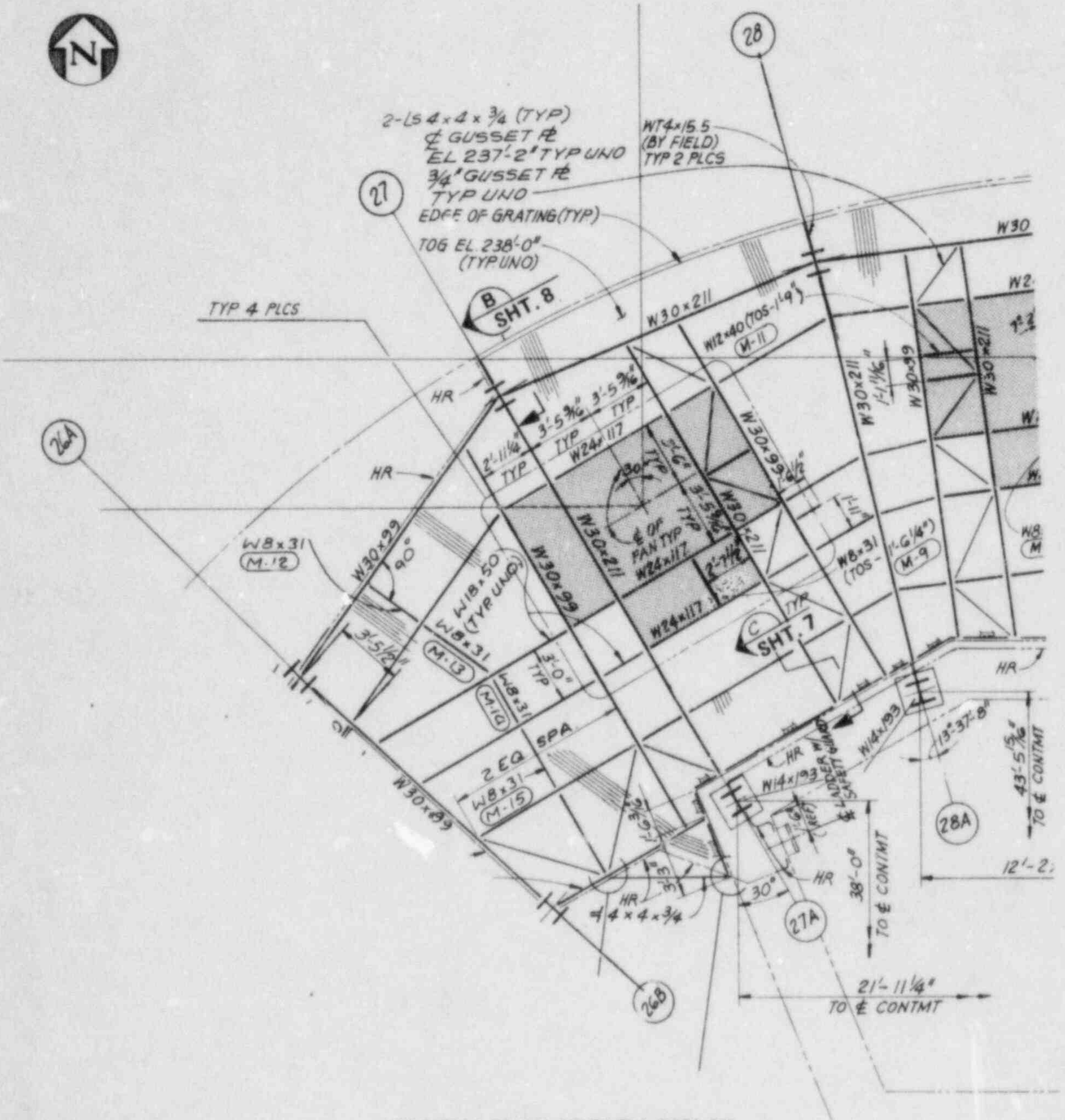
COLUMN LOCATIONS
PLAN @ EL 171′-9″

Figure 28
STRUCTURAL STEEL
DESIGN DETAILS
(Sheet 1 of 9)



PARTIAL PLAN AT ELEV. 185'-0"

Figure 28
STRUCTURAL STEEL DESIGN DETAILS
(Sheet 2 of 9)



PARTIAL PLAN AT ELEV. 238'-0"

Figure 28
STRUCTURAL STEEL DESIGN DETAILS
(Sheet 3 of 9)

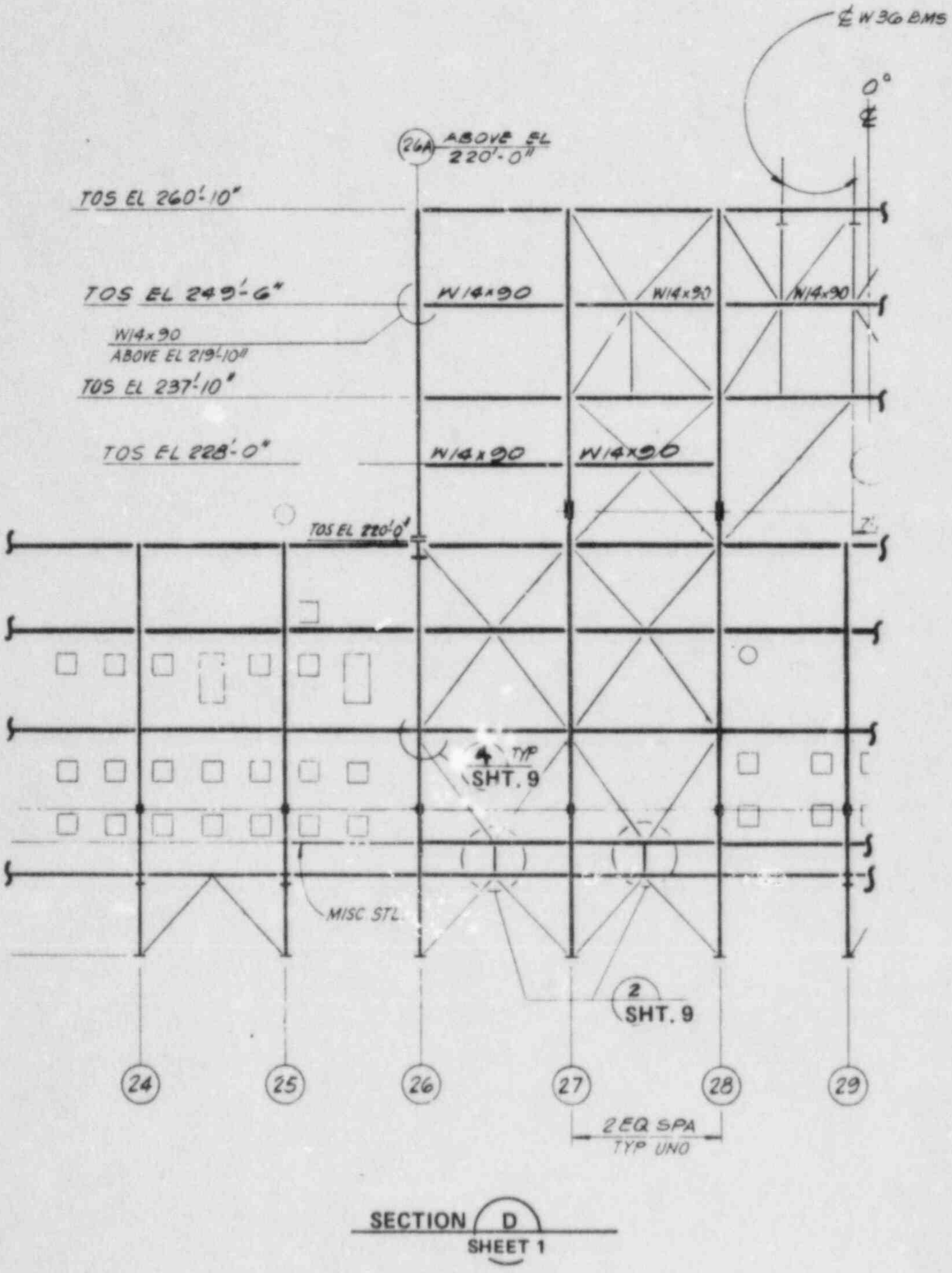
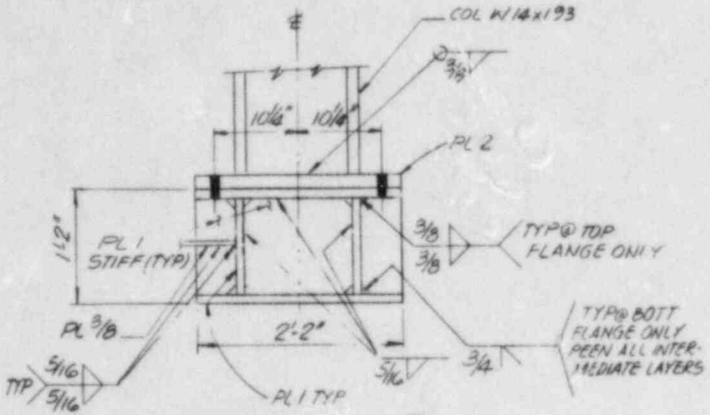
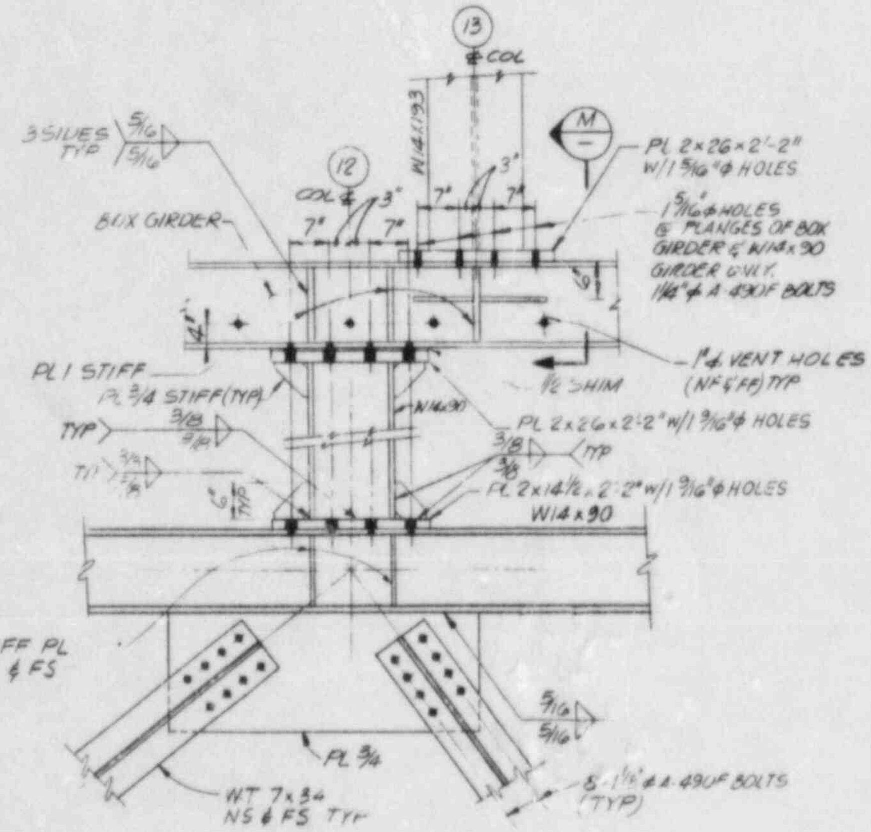


Figure 28
STRUCTURAL STEEL DESIGN DETAILS
(Sheet 4 of 9)

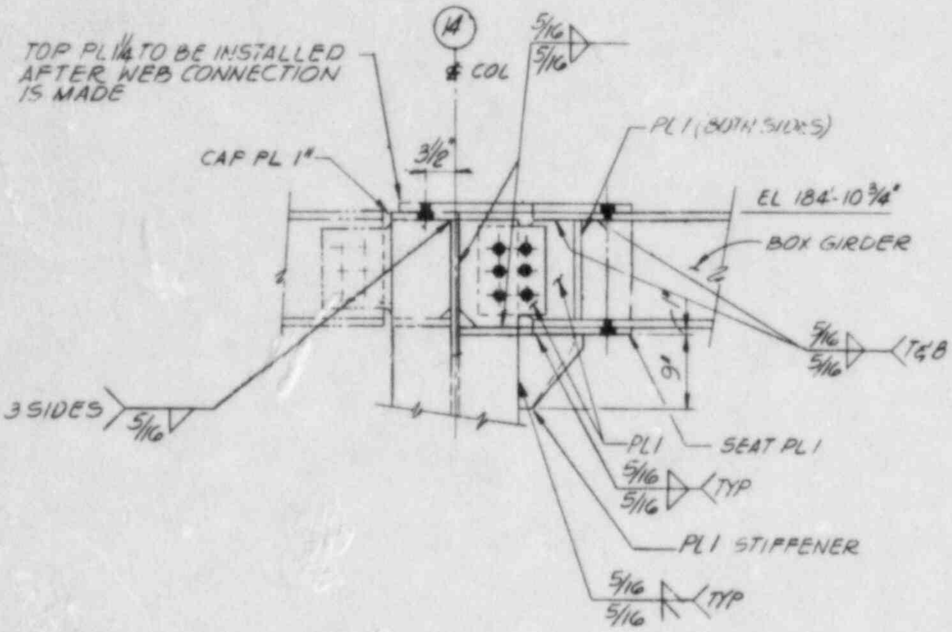


SECTION M

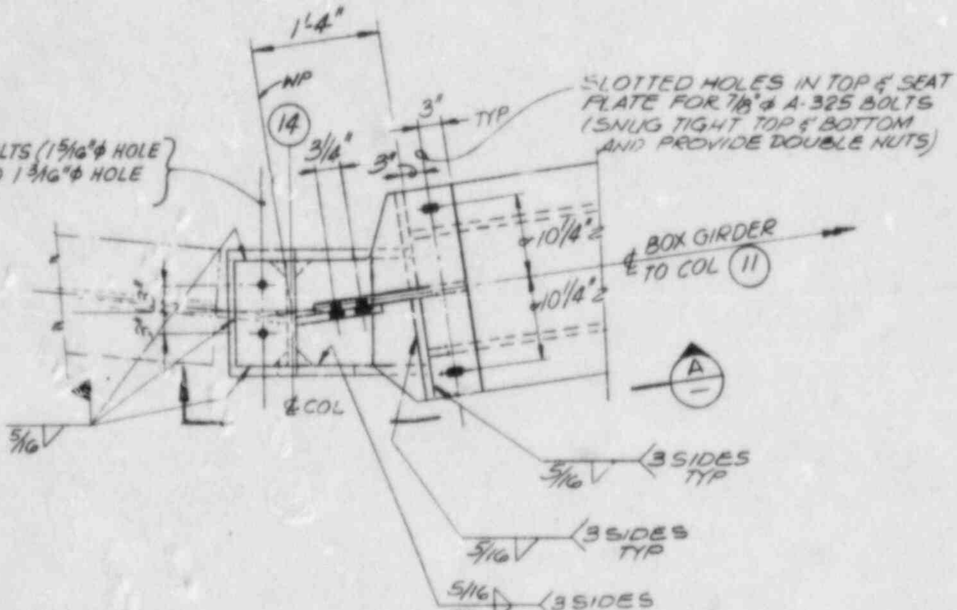


DETAIL 3
SHT. 2

Figure 28
STRUCTURAL STEEL DESIGN DETAILS
(Sheet 5 of 9)



SECTION (A)



DETAIL (1) SHT. 2

Figure 28
STRUCTURAL STEEL DESIGN DETAILS
(Sheet 6 of 9)

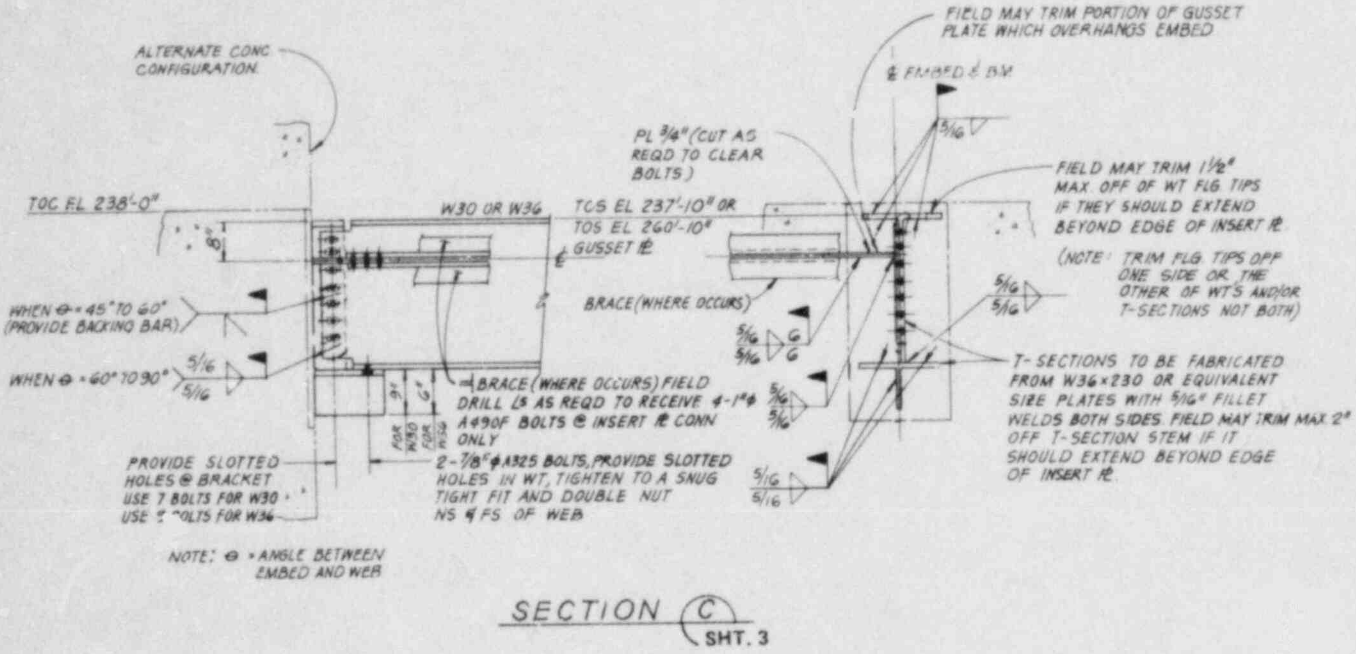
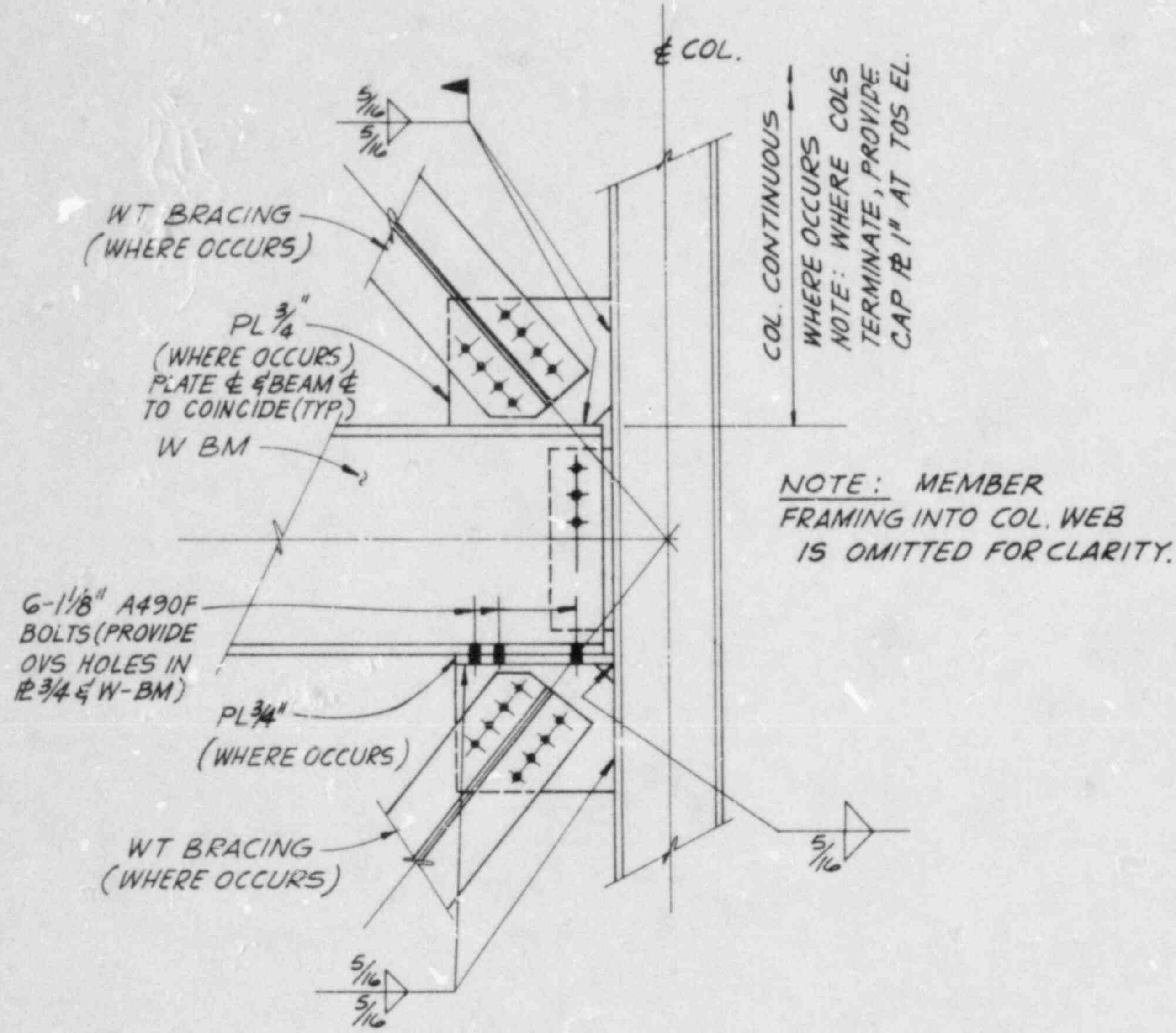


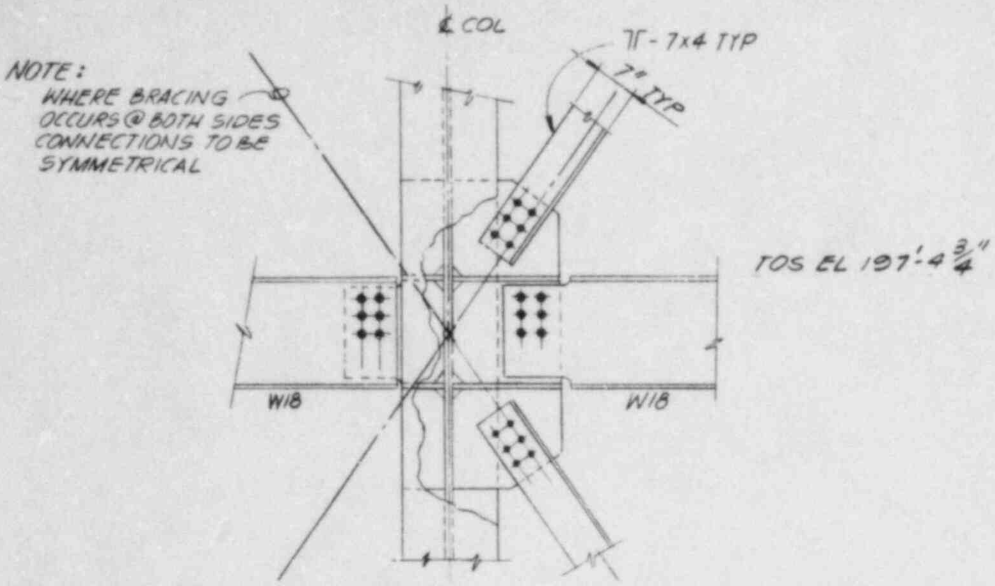
Figure 28
STRUCTURAL STEEL DESIGN DETAILS
(Sheet 7 of 9)



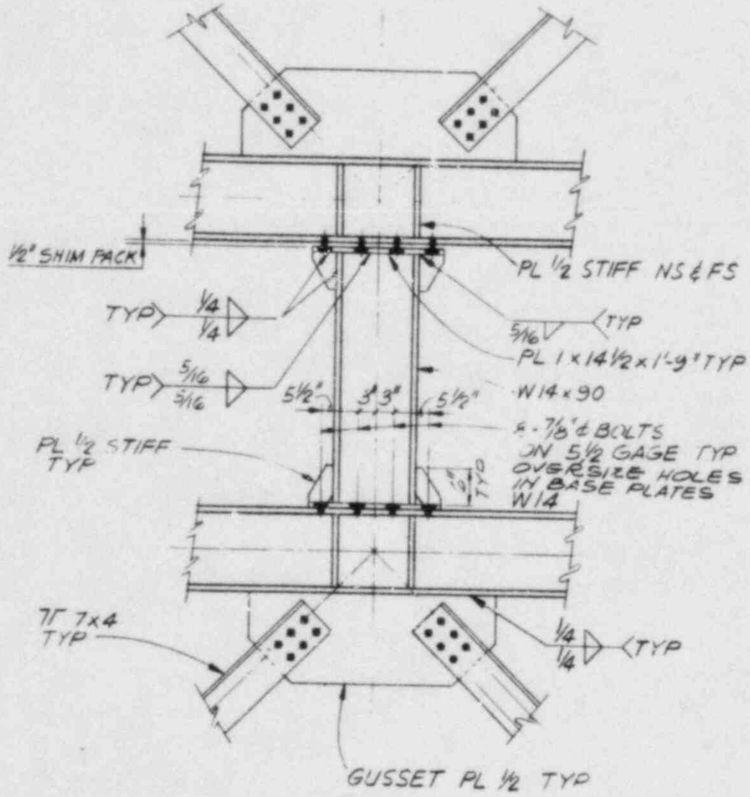
ELEVATION

SECTION (B) SHT.3

Figure 28
STRUCTURAL STEEL DESIGN DETAILS
(Sheet 8 of 9)

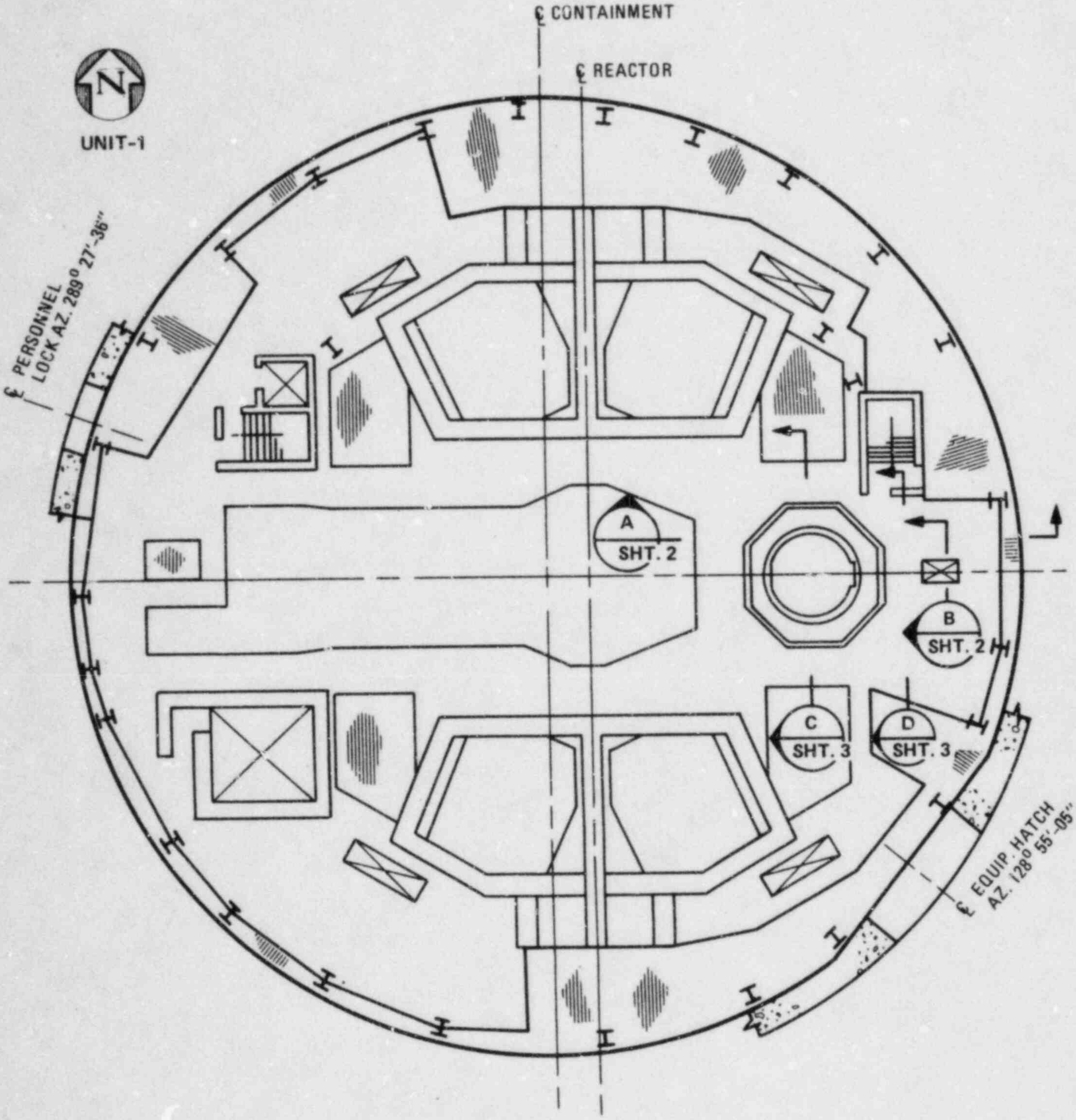


DETAIL 4
SHT 4



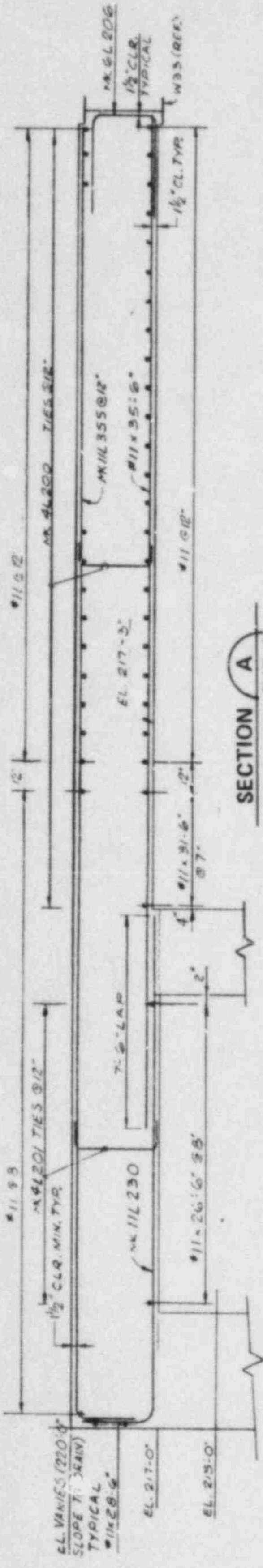
DETAIL 2
SHT 4

Figure 28
STRUCTURAL STEEL DESIGN DETAILS
(Sheet 9 of 9)

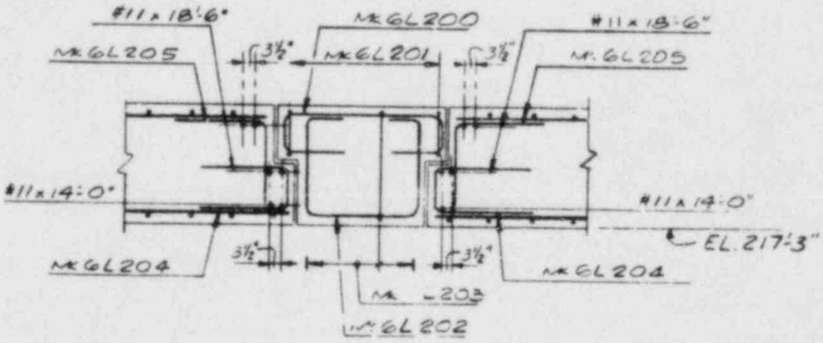


PLAN AT ELEVATION 220'
(OPERATING FLOOR)

Figure 29
REPRESENTATIVE OPERATING FLOOR
SLAB DESIGN DETAILS
(Sheet 1 of 3)

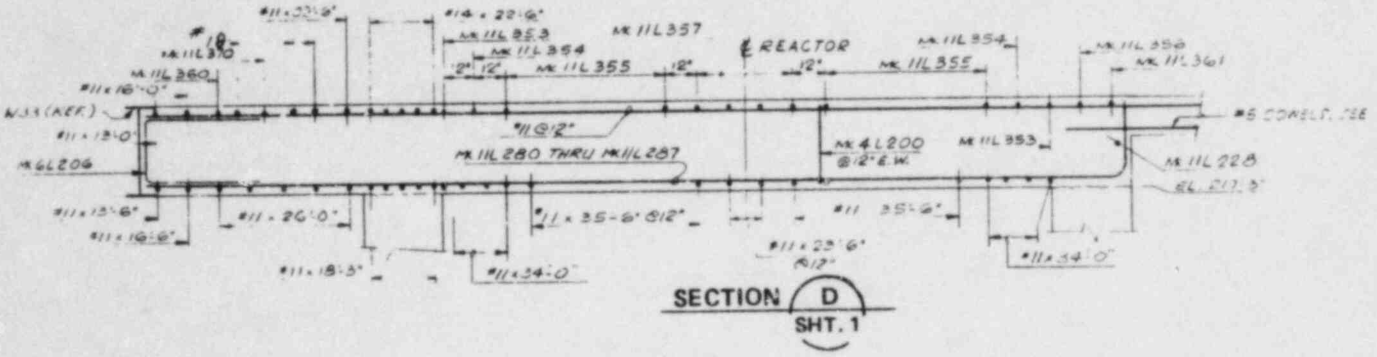


SECTION A SHT. 1



SECTION B SHT. 1

Figure 29
REPRESENTATIVE OPERATING FLOOR
SLAB DESIGN DETAILS
(Sheet 2 of 3)



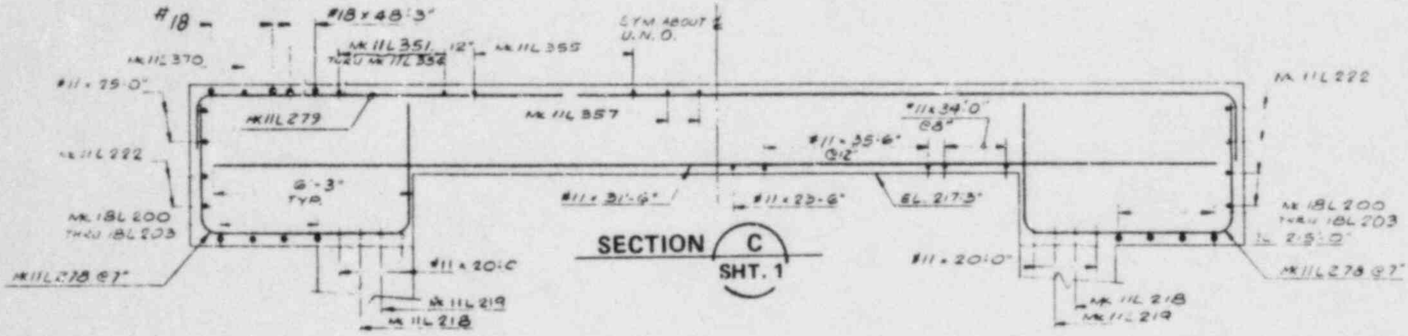


Figure 29
REPRESENTATIVE OPERATING FLOOR
SLAB DESIGN DETAILS
(Sheet 3 of 3)

APPENDIX A

DEFINITION OF LOADS

APPENDIX A

DEFINITION OF LOADS

All credible loads applicable to the design of the containment internal structures are defined as follows. As discussed in section 3.2 of this design report, wind loads (W), tornado loads (W_t), blast loads (B), and probable maximum precipitation (N) are not applicable to the design of the internal structures. Additionally, potential site proximity loads induced by floods or aircraft hazards are not applicable.

A.1 NORMAL LOADS

Normal loads are those loads to be encountered, as specified, during various construction stages, test conditions, plant operation, and plant shutdown.

D	Dead loads or their related internal moments and forces, including any permanent loads and hydrostatic loads.
L	Live loads or their related internal moments and forces, including any movable equipment loads and other loads which vary with intensity and occurrence, as lateral soil pressures. Live load intensity varies depending upon the load condition and the type of structural element.
T_o	Thermal effects and loads during normal operating or shutdown conditions, based on the most critical transient or steady-state condition.
R_o	Pipe reactions during normal operating or shutdown conditions, based on the most critical transient or steady-state conditions.

A.2 SEVERE ENVIRONMENTAL LOADS

Severe environmental loads are those loads to be infrequently encountered during plant life.

E	Loads generated by the operating basis earthquake (OBE). These include the associated hydrodynamic loads.

A.3 EXTREME ENVIRONMENTAL LOADS

Extreme environmental loads are those loads which are credible but are highly improbable.

E'	Loads generated by the safe shutdown earthquake (SSE). These include the associated hydrodynamic loads.

A.4 ABNORMAL LOADS

Abnormal loads are those loads generated by a postulated high-energy pipe break accident within a building or compartment thereof.

P_a	Pressure load within or across a compartment and/or building, generated by the postulated break.
T_a	Thermal loads generated by the postulated break and including T_o.
R_a	Pipe and equipment reactions under thermal conditions generated by the postulated break and including R_o.
Y_r	Load on a structure generated by the reaction of a ruptured high-energy pipe during the postulated event.
Y_j	Load on a structure generated by the jet impingement from a ruptured high-energy pipe during the postulated break.
Y_m	Load on a structure or pipe restraint resulting from the impact of a ruptured high-energy pipe during the postulated event.

APPENDIX B

LOAD COMBINATIONS

APPENDIX B

LOAD COMBINATIONS

The load combination tables shown on the following two pages cover two codes applicable to structural elements covered by this design report.

TABLE B.1

This table is in accordance with ACI 318-71 including the 1974 supplement. The concrete internal structures are designed in accordance with this table.

TABLE B.2

This table is in accordance with the 1969 AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings, including supplements 1, 2, and 3. The structural steel internals are designed in accordance with this table.

TABLE B.1[a][f]

CONCRETE DESIGN LOAD COMBINATIONS
STRENGTH METHOD

	EQN	D	L	P_a	T_o	T_a	E	E'	W	W_t	R_o	R_a	Y_j	Y_r	Y_m	N	B	Strength Limit
Service Load Conditions																		
	1	1.4	1.7															U
(See note b.)	2	1.4	1.7						1.7									U
(See note c.)	3	1.4	1.7				1.9											U
	4	1.05	1.275		1.275						1.275							U
	5	1.05	1.275		1.275				1.275		1.275							U
	6	1.05	1.275		1.275		1.425				1.275							U
Factored Load Conditions																		
	7	1.0	1.0		1.0			1.0			1.0							U
(See note d.)	8	1.0	1.0		1.0					1.0	1.0							U
	9	1.0	1.0	1.5		1.0						1.0						U
(See note e.)	10	1.0	1.0	1.25		1.0	1.25					1.0	1.0	1.0	1.0			U
(See note e.)	11	1.0	1.0	1.0		1.0		1.0				1.0	1.0	1.0	1.0			U
	12	1.0	1.0		1.0						1.0						1.0	U
	13	1.0	1.0		1.0						1.0					1.0		U

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a. See appendix A for definition of load symbols. U is the required strength based on strength method per ACI 318-71.
b. Unless this equation is more severe, the load combination 1.2D+1.7W is also to be considered.
c. Unless this equation is more severe, the load combination 1.2D+1.9E is also to be considered.
d. When considering tornado missile load, local section strength may be exceeded provided there will be no loss of function of any safety-related system. In such cases, this load combination without the tornado missile load is also to be considered.
e. When considering Y_j, Y_r, and Y_m loads, local section strength may be exceeded provided there will be no loss of function of any safety-related system. In such cases, this load combination without Y_j, Y_r, and Y_m is also to be considered.
f. Actual load factors used in design may have exceeded those shown in this table.

TABLE B.2[a]

STEEL DESIGN LOAD COMBINATIONS
ELASTIC METHOD

	EQN	D	L	P_a	T_o	T_a	E	E'	W	W_t	R_o	R_a	Y_j	Y_r	Y_m	N	B	Strength Limit(f_s)
Service Load Conditions																		
	1	1.0	1.0															1.0
	2	1.0	1.0				1.0											1.0
	3	1.0	1.0						1.0									1.0
	4	1.0	1.0		1.0						1.0							1.5
	5	1.0	1.0		1.0		1.0				1.0							1.5
	6	1.0	1.0		1.0				1.0		1.0							1.5
Factored Load																		
	7	1.0	1.0		1.0			1.0			1.0							1.6
(See note b.)	8	1.0	1.0		1.0					1.0	1.0							1.6
	9	1.0	1.0	1.0		1.0						1.0						1.6
(See notes c and d.)	10	1.0	1.0	1.0		1.0	1.0					1.0	1.0	1.0	1.0			1.6
(See notes c and d.)	11	1.0	1.0	1.0		1.0		1.0				1.0	1.0	1.0	1.0			1.7
	12	1.0	1.0		1.0						1.0						1.0	1.6
	13	1.0	1.0		1.0						1.0					1.0		1.6

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a. See appendix A for definition of load symbols. f_s is the allowable stress for the elastic design method defined in Part 1 of the AISC, "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings." The one-third increase in allowable stresses permitted for seismic or wind loadings is not considered.

b. When considering tornado missile load, local section strength may be exceeded provided there will be no loss of function of any safety-related system. In such cases, this load combination without the tornado missile load is also to be considered.

c. When considering Y_j, Y_r, and Y_m loads, local section strength may be exceeded provided there will be no loss of function of any safety-related system. In such cases, this load combination without Y_j, Y_r, and Y_m is also to be considered.

d. For this load combination, in computing the required section strength, the plastic section modulus of steel shapes, except for those which do not meet the AISC criteria for compact sections, may be used.