HIGH ENERGY LINE BREAK/ CONTROL SYSTEMS FAILURE ANALYSIS

REPORT ON LIMERICK GENERATING STATION UNIT 1

PREPARED FOR

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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this study was to determine the effects of a High Energy Line Break (HELB) on any non-safety-related control systems in Limerick Generating Station Unit 1. In particular, the purpose was to determine whether any adverse effects initiated by a HELB could result in an event more severe than the transient and accident events analyzed in Chapter 15 of the Limerick Generating Station Final Safety Analysis Report (FSAR). The analysis presented in this report responds to the IE Information Notice 79-22, as published by the NRC in September 1979.

1.2 SCOPE OF STUDY

The scope of this HELB analysis was restricted to high energy pipe breaks and their effects on components of non-safety-related control systems at Limerick Generating Station Unit 1. A computerized list of all plant components was reduced based on the system elimination criteria presented in Section 2.1 and further reduced by using the component elimination criteria of Section 2.2. The basis for considering a line as being "high energy" and the effects of postulated pipe ruptures are detailed in Sections 2.3 and 2.5, respectively. Zones containing both control systems components of interest and high energy lines were defined (Section 2.4) using the appropriate drawings and verified during a plant walkdown (Section 2.6). The effects of postulated pipe ruptures were also assessed during the walkdown. A HELB zone analysis was performed (Section 2.7) and the results summarized in Appendix A. Final conclusions and recommendations are presented in Section 3.0.

1.3 SUMMARY OF RESULTS

A comprehensive, systematic study has been conducted to determine the consequences of postulated high energy line breaks and their effects on adjacent, non-safety-related, control systems components. The Analysis Summary (Appendix A) describes each of the postulated HELB events and their limiting effects on the reactor parameters. In most cases, the effects of the postulated HELB/control systems failures events are less severe than the Unacceptable Results for Incidents of Moderate Frequency - Anticipated Operational Transients presented in FSAR Chapter 15. In all cases, the effects of the postulated events are bounded by the Unacceptable Results for Limiting Faults - Design Basis (Postulated) Accidents presented in FSAR Chapter 15. It is concluded that safe reactor shutdown is assured for all events postulated herein, and the consequences of these postulated events do not result in any significant risk to the health and safety of the public.

2.0 METHODOLOGY

The methodology contains criteria, assumptions, and a scope of work developed to be consistent with the intent of IE Information Notice 79-22. The procedure followed was to:

1. Identify any non-safety control systems and components within these systems which could impact the critical reactor parameters (e.g. water level, pressure, critical power ratio);
2. Establish assumptions and criteria for identification of high energy lines, location of postulated breaks, and evaluation of consequences;
3. Identify the locations (area/elevation/room), referred to as zones, containing both high energy lines and control systems components determined in 1. above;
4. Perform a plant walkdown to verify the location of the control systems components and their proximity to high energy lines;
5. Postulate pipe breaks in the zones defined and determine which control systems components are affected by each possible pipe break;
6. Analyze the potential effects on the control systems components impacted and determine the effects on any controlled components;
7. Combine the effects of the HELB with potential, simultaneous malfunctions of adjacent control systems components and determine the effects on the critical reactor parameters;
8. Compare the effects with the transient and accident analyses in Chapter 15 of the FSAR, considering an additional single active component failure.
9. Identify postulated events that are beyond Chapter 15 analyses and recommend corrective actions.

2.1 SYSTEM ELIMINATION

The scope of this HELB analysis was restricted to non-safety-related control systems components. Safety systems and safety-related components of control systems were eliminated from consideration. The effects of piping failures on safety-related equipment are documented in FSAR 3.6. The criteria for further eliminating systems from the detailed HELB analysis are listed below. These criteria were applied to a complete list of plant systems provided by Bechtel Power Corporation (BPC).

1. Non-electrical systems, i.e., mechanical and structural systems comprised only of structural steel, piping, tanks, cranes, and like equipment are excluded.

2. Instrumentation systems with no direct or indirect controlling function (i.e, systems which provide monitoring, status, and alarm indications only) are excluded. Instrumentation and dedicated inputs into the process computer, as well as the process computer itself, are excluded.

3. Control systems which have no direct or indirect interaction with reactor operation or reactor parameters are excluded. Examples are communication, lighting, and external building ventilation systems.

4. Control systems that interact or interface with the reactor operating systems directly, but which cannot affect the critical reactor parameters either directly or indirectly in the short term are excluded. Systems which can only indirectly affect the reactor parameters through long term effects (such as water quality) are excluded. An example is the Condensate Filter/Demineralizer System. The effects of failures in these systems will surface slowly in comparison to the dynamic effects associated with a HELB event.

5. Systems not used during normal operation in the "Startup" or Run" modes are excluded. Normal plant conditions also include operation in the "Refuel" and "Shutdown" modes, however the fact that there are no high energy lines with the plant operating in these modes precludes the possibility of a HELB event.

6. Electrical systems involved in power generation and distribution, the loss of which will not impact the reactor parameters or safety system performance (e.g., the station auxiliary transformers), are excluded.

The following list details control systems not eliminated via the above criteria. These were included in the HELB analysis. Any systems which could possibly be eliminated, but were questionable, were retained for analysis purposes.

MPL	System
B21	Nuclear Boiler Process Instrumentation
B21	Steam Leak Detection
C11	Control Rod Drive/Reactor Manual Control
D12	Process Radiation Monitoring
D22	Area Radiation Monitoring
C32	Feedwater Control
B32	Reactor Recirculation/Jet Pump Instrumentation
C51	Neutron Monitoring
G31	Reactor Water Cleanup
M01	Main Steam
M02	Extraction Steam
M05	Condensate
M06	Feedwater
M09	Circulating Water

M10	Service Water
M12	RHR Service Water
M13	Reactor Enclosure Cooling Water
M14	Turbine Enclosure Cooling Water
M15	Compressed Air
M19	Lube Oil
M25	Plant Leak Detection
M26	Plant Process Radiation Monitoring
M28	Generator H_2 Cooling and CO_2 Purge
M57	Containment Atmospheric Control
M59	Primary Containment Instrument Gas
M75	Turbine Enclosure HVAC
M76	Reactor Enclosure HVAC
M77	Drywell HVAC
M78	Control Enclosure HVAC
M79	Radwaste Enclosure HVAC
M87	Drywell Chilled Water
---	Turbine Control Systems
---	Main Turbine Generator System
---	Turbine Bypass System

2.2 COMPONENT ELIMINATION

The computerized list of all plant components (References 1 and 2) was reduced not only by system but also on a component basis. The following elimination criteria were applied to the remaining components to arrive at the final list of components considered in the detailed HELB analysis. The appropriate system Piping and Instrumentation Diagrams and Elementary Diagrams were used to aid in this elimination.

1. Mechanical components (e.g., structural steel, tanks, pipes, valves) are not considered control system components subject to failure. However, instrument taps, tubing, and control components not excluded via these component elimination criteria which may be physically located on mechanical components, are included.

2. Instruments and other dedicated inputs to the process computer are eliminated.

3. Components which provide position status information only, and do not perform any control function, are eliminated. This includes position switches on air and motor operated valves which are not interlocked with other equipment.

4. Components which provide indication and/or inputs for alarms or recording devices only, are eliminated.

In general, "initiating" type control components such as elements, switches, transmitters, controllers, and converters were included in the detailed HELB analysis, along with their related taps and process tubing.

Switchgear and Motor Control Centers (MCC) were included as components subject to failure, and control systems components supplied by the

affected switchgear and MCC were analyzed for loss of power as necessary.

2.3 HIGH ENERGY PIPE CRITERIA

The criteria for determining high energy lines used in this study are based on criteria established in Reference 3 and Section 3.6.3 of the Limerick Generating Station FSAR. High energy piping is defi; l as including those fluid systems that, during normal plant conditions, are either in operation or maintained pressurized under conditions where either or both of the following are met:

a. Maximum operating temperature exceeds 200°F.

b. Maximum operating pressure exceeds 275 psig.

Those lines that operate above these limits for less than 2% of the time they are required to perform their intended function are classified as moderate energy lines and are therefore excluded from the scope of this study. Piping whose diameter is 1 inch NPS or smaller is also excluded.

The following table details the list of high energy piping systems in which breaks were postulated as the HELB initiating event. This table is consistent with the high energy piping systems defined in Section 3.6.1 of the Limerick Generating Station FSAR.

HELB ANALYSIS - INITIATING HIGH ENERGY PIPING SYSTEMS

FLUID SYSTEM	EXTENT OF HIGH ENERGY PIPING
Reactor Recirculation	From reactor vessel suction nozzle to recirculation pump to reactor vessel discharge nozzles
Main Steam	From reactor vessel nozzles to high pressure turbine and bypass valve manifold; from high pressure turbine through moisture separators to low pressure turbine and condenser inlet valves
Feedwater	From condensate filter/demineralizers through feedwater heaters and feedwater pumps to reactor vessel nozzles
Condensate	From condensate pump discharge through steam jet air ejector condenser, steam packing exhauster, and condensate filter/demineralizers
Reactor Water Cleanup	From shutdown cooling suction line through RWCU pumps, regenerative and nonregenerative heat exchangers, and cleanup filter/demineralizers to feedwater lines
Reactor Vessel Drain	From reactor vessel bottom head nozzle to reactor water cleanup line inside primary containment
HPCI Steam Supply	From main steam line "C" to HPCI turbine steam supply valve
RCIC Steam Supply	From main steam line "B" to RCIC turbine steam supply valve
Main Steam Drain Lines	From main steam lines inside drywell to inboard containment isolation valve; from main steam lines outside drywell to outboard containment isolation valve and drain line isolation valves
RPV Head Vent Line	From reactor vessel head nozzle to main steam line "C"
Standby Liquid Control	From reactor vessel nozzle to first upstream check valve

INITIATING HIGH ENERGY PIPING SYSTEMS (CONTINUED)

FLUID SYSTEM	EXTENT OF HIGH ENERGY PIPING
RHR Shutdown Cooling Suction	From reactor recirculation loop to inboard containment isolation valve
RHR Shutdown Cooling Return	From reactor recirculation loop to first upstream check valve
LPCI Injection	From reactor vessel nozzle to first upstream check valve
Core Spray Injection	From reactor vessel nozzle to first upstream check valve
Control Rod Drive Hydraulic	From drive water pump to master control station to hydraulic control units
Auxiliary Steam	From auxiliary boiler to various steam consuming components
High Pressure Drains	From final feedwater heater to associated drain valve in each feedwater heater string
Extraction Steam	From main steam line "B" to feedwater pump turbines; from crossaround steam lines to feedwater heaters and feedwater pump turbines; from moisture separators to feedwater heaters and condenser inlet valves; from high and low pressure turbines to feedwater heaters
Air Removal	From main steam line "C" to steam seal evaporator
Turbine EHC	From electro-hydraulic control power unit to turbine stop valves (MSV's), combined intercept valves (CIV's) and bypass control valves

2.4 ZONE DETERMINATION

The Turbine and Reactor Enclosures for Limerick Unit 1 were separated into definable sections referred to as zones. The zones were defined in terms of area, elevation, and grid location. The area designation corresponds to the scheme shown in Figure 1 of Appendix B. The major plant elevations, as shown in the remaining figures of Appendix B, were used to define the elevation. The grid location was used to further define the zone with a grid designation which approximates the center of the location of concern. A zone need not exist entirely within one area or one elevation.

The zones were initially constructed along existing boundaries such as concrete walls and floors using the appropriate Architectural Drawings (Reference 5) as guides. Zones were initially maintained as large as possible for conservatism in applying the "sacrificial" approach in the analysis. The "sacrificial" approach assumes that any HELB within the defined zone would impact all control system components in the zone. Using this approach, the effects of pipe whip, jet impingement and adverse environment are enveloped. Further divisions of zones were performed where a pipe break was judged to affect the components in only a confined portion of an "architecturally" defined zone. The bases for these judgements are detailed in Section 2.5.2. One example is the main turbine condenser bay areas. A high energy line break postulated to occur on the south side of the condenser area at Elevation 217 (see Figure 3 of Appendix B) is assumed not to affect control systems components on the north or south side of the condensers at any major elevation other than that at which the pipe break occurs. The bays allow for the adverse environment associated with the break to spread throughout the condenser bay up to the turbine main floor, which is also a large, open zone, minimizing the environmental effects on other areas within the condenser bay. Therefore, even though no air/steam/water boundary exists in the condenser bays between Elevation 217 and other elevations, the zone is defined in terms of the condenser bays at Elevation 217, for which the "sacrificial" approach is used. The Analysis Summary in Appendix A reflects this approach.

For the Reactor Enclosure, the zones of influence defined in the FSAR Chapter 3.6 were used. The figures in Appendix B detail the final zones used for the study.

2.5 PIPE BREAK LOCATION AND EFFECTS

2.5.1 PIPE BREAK LOCATION

The high energy pipes defined by the table in Section 2.3.1 of this report are assumed to break at all locations where control systems components of concern (defined in Section 2.2) are physically located in the vicinity of the high energy piping, unless piping runs subject to high stress have been specifically identified and analyzed as a result of the studies in FSAR 3.6.1. Piping evaluated via previous HELB studies (see FSAR 3.6) are considered to break as defined in those studies. Only one pipe break is postulated to occur at any one time and only during normal plant conditions. Normal plant conditions

are defined as the plant operating conditions during reactor startup, operation at power or reactor cooldown to cold shutdown excluding upset, emergency, faulted, or testing conditions (see Section 2.1, Item 5). As part of the detailed analysis described in Appendix A, the worst case combination of a specific HELB and consequential control systems failures is examined for the reactor in the limiting condition (i.e., "Startup" or "Run" mode) for that postulated event.

2.5.2 PIPE BREAK EFFECTS

Pipe breaks and consequential control systems failures are evaluated considering the effects of pipe whip, jet impingement and adverse environment on the control systems components. The effects associated with any adverse environment (increasing humidity, temperature, pressure, radiation) are enveloped by employing the "sacrificial" approach. The "sacrificial" approach assumes that any HELB within the defined zone (area/elevation/grid location) would adversely impact all control systems components in the zone. Using this approach, environmental effects are enveloped in the detailed analysis presented in Appendix A.

2.5.2.1 PIPE WHIP CONSIDERATIONS

The criteria used for evaluating the effects of pipe whip are consistent with the analysis performed in Reference 4. Movement of a circumferentially broken pipe is assumed to occur in the direction of the jet reaction while the pipe hinges at the nearest rigid support, anchor, or penetration, producing an arc of motion. The pipe is allowed to move in an arc with a radius from the break to the hinge point and motion is assumed to be limited by pipes of equal or greater diameter or reinforced concrete walls, floors, or columns. The whipping pipe is assumed capable of incapacitating any control systems component within the arc of motion. The "sacrificial" approach detailed in Section 2.4 envelopes these pipe whip considerations.

2.5.2.2 JET IMPINGEMENT CONSIDERATIONS

Jet impingement is considered for both circumferential and longitudinal breaks. The criteria used for evaluating the effects of jet impingement are consistent with those listed in Reference 4. The basic approach assumed is that the jet from a postulated break is sufficient to fail all impacted components within the jet cone of influence for a distance of 25 feet, except in those areas where major structures provide natural barriers. The "sacrificial" approach used in this analysis (see Section 2.4) envelopes these jet impingement considerations.

2.6 PLANT WALKDOWN

2.6.1 WALKDOWN PREPARATION

The appropriate Architectural, Piping and Mechanical, and Instrument Location Drawings (Reference 5) were gathered in preparation for a plant walkdown. The drawings were used to define preliminary zones

where control systems components of concern (Sections 2.1 and 2.2) and high energy lines (Section 2.3) coincide.

2.6.2 WALKDOWN EFFORT

The plant walkdown was performed to accurately define appropriate zones, verify the location of control systems components, and assess the proximity of the components and associated taps and tubing to high energy lines.

Using the pipe break criteria established in Section 2.5.2, control systems components affected by a HELB were determined for each high energy line in each zone. The "sacrificial" approach envelopes the effects of pipe whip, jet impingement and adverse environments on instruments which exist within the same zones as high energy lines. During the walkdown, the pipe whip and jet impingement criteria were conservatively applied in judging which instrument taps and tubing could be adversely affected. In some cases, no high energy lines existed in the vicinity of controlling components. A number of zones and many components were eliminated from the detailed analysis as a result of the plant walkdown.

All areas of the Radwaste and Diesel Generator Enclosures were eliminated from the detailed analysis since no high energy lines are routed through these enclosures. The Auxiliary Boiler Enclosure was eliminated since only Auxiliary Steam System components exist within the enclosure. Specific zones of the Reactor and Turbine Enclosures eliminated are noted in the analysis presented in Appendix A.

2.7 ZONE ANALYSIS

The detailed analysis was performed on a zone by zone basis. The following description is representative of the analysis performed for each zone. Appendix A, which presents the summary of the analysis for each zone, follows this format.

I. High Energy Systems

A list was made which identified all the high energy piping in the zone. Each high energy line was reviewed to determine the effects of a piping failure upon its own system. This was done for each high energy line independently, since only a single pipe break is postulated as the initiating event. The effect of the break itself on reactor parameters was examined and the bounding FSAR Chapter 15 event identified, where appropriate.

II. Control Systems

A list was made of all control systems components within the zone. The failure mode(s) of each component and the effect(s) of its failure on all controlled components were reviewed. Controlled components are assumed to operate in the worst possible mode as a result of the failure.

III. Combined Effects

The postulated piping failure for each high energy line in the zone was examined in combination with the resulting, worst case failures of control systems components in the zone to determine if any combination of possible failures could exacerbate the postulated HELB. The "sacrificial" approach detailed in Section 2.4 was used, and the worst case combined HELB and possible consequential control systems failures were defined. The consequences of these events were then compared to the accident and transient analyses presented in the FSAR, Chapter 15, which include discussions of a single additional active component failure, to ensure they are less severe than the existing analyses.

3.0 CONCLUSIONS AND RECOMMENDATIONS

The Analysis Summary of Appendix A presents a summary of the results of the analysis performed for those zones of the Turbine Enclosure and Reactor Enclosure which required the detailed analysis described in Section 2.7. The "sacrificial" approach, as outlined in Section 2.4, has been applied, and conservative assumptions have been applied to all analyses of system failures. No credit has been taken for operator action in any event beyond those already assumed in the existing FSAR Chapter 15 analyses.

The worst-case combined effects of the postulated HELB and consequential control systems failures have been examined. In many cases, the postulated HELB is not exacerbated by any combination of control systems failures in the zone. The "Combined Effects" portion of the analysis for each zone in Appendix A describes the conditions resulting from each HELB and the associated control systems failures in each zone. The "Combined Effects" sections also define the appropriate FSAR Chapter 15 events, which discuss the effects of a single additional active component failure, which exhibit the same or more severe effects than the postulated events (i.e., "bounding" events).

The worst postulated combination of events presented in the analysis of Appendix A occurs from a pipe break in the Turbine Enclosure, Areas 1,2/Elevation 217/Grid Q15, the moisture separator drain tank area. A HELB within this zone may cause a partial loss of feedwater heating and an eventual turbine trip, if the appropriate instrumentation and controls are disabled leading to improper valve positioning.

Using the "sacrificial" approach, which assumes that all control systems components in the zone could fail in the worst possible combined manner, the loss of feedwater heating which could occur is less than 30°F. This assumes the break occurs in the most critical location of an Extraction Steam line and the resulting pipe whip or jet impingement causes failure in the worst case combinations of instruments on all six moisture separators. Data compiled during the plant walkdown effort indicates that such an event is unlikely. Even a circumferential break in the most critical line/location discussed above could impact, via pipe whip and/or jet impingement, instruments on only three moisture separators. This is due to the physical distance between the two sets of three moisture separators.

For this event, the reduction in feedwater inlet temperature causes a gradual rise in reactor power. Depending on the specific timing involved, the turbine trip may occur at power level elevated from the initial operating value. Investigation has shown that, should this unlikely worst case combined sequence occur, the reactor may experience a change in the critical power ratio greater than that shown in the Unacceptable Results for Incidents of Moderate Frequency - Anticipated Operational Transients of FSAR Chapter 15, but only for a short time. However, the effects of this accident event, even considering an additional single active component failure, pose no threat to the Unacceptable Results for Limiting Faults - Design Basis (Postulated) Accidents presented in the FSAR, Chapter 15.

All other "Combined Events" are bounded by the accident and transient events analyzed in FSAR Chapter 15, as noted in Appendix A. It is concluded that a postulated high energy line break and resulting control systems failure event poses no threat to the transient and accident limits set forth in the FSAR Chapter 15, and does not result in any significant risk to the health and safety of the public. No further accident analysis or design modifications are recommended.

4.0 REFERENCES

1. Bechtel Power Corporation, "Mechanical and Electrical Equipment List for Limerick Generating Station Units 1 and 2", Revision 44, November 4, 1983.

2. Bechtel Power Corporation, "Instrument Index List - EBOP Data Base", Revision 50, November 14, 1983.

3. Nuclear Regulatory Commission, "Standard Review Plan 3.6.2 - Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping", Revision 1, July 1981.

4. Bechtel Power Corporation, "High Energy Pipe Break Report", by A. V. Benamou and J. Berry (no date).

5. Bechtel Power Corporation, "Architectural Drawings - Air/Steam/ Water Boundaries":

Drawing	Revision
A-305	10
A-306	9
A-307	7
A-308	7
A-309	7
A-310	6
A-311	5

(Reference 5, Continued)

Bechtel Power Corporation, "Instrument Location Drawings":

Drawing	Revision	Drawing	Revision
M-150	52	M-197	18
M-151	34	M-198	8
M-152	27	M-200	12
M-153	24	M-201	16
M-154	14	M-202	27
M-155	14	M-203	9
M-157	71	M-485	44
M-158	80		
M-159	68		
M-160	40		
M-161	27		
M-162	37		
M-163	71		
M-164	53		
M-165	52		
M-167	44		
M-168	32		
M-169	17		
M-170	21		
M-172	15		
M-173	53		
M-174	22		
M-175	24		
M-176	16		
M-177	23		
M-178	12		
M-179	14		
M-180	28		
M-181	16		
M-182	11		
M-183	44		
M-184	65		
M-185	44		
M-186	35		
M-187	39		
M-188	31		
M-189	24		
M-190	13		
M-191	7		
M-193	22		
M-195	56		
M-196	28		

(Reference 5, continued)

Bechtel Power Corporation, "Instrument Location Drawings":

Drawing	Revision	Drawing	Revision
M-675	13	M-726	17
M-676	11	M-727	14
M-677	8	M-728	3
M-678	7	M-729	4
M-679	14	M-731	5
M-680	8	M-732	8
M-681	14	M-733	3
M-682	6	M-734	5
M-683	6	M-749	6
M-685	5	M-750	4
M-686	9	M-752	8
M-687	6	M-753	7
M-688	4	M-754	9
M-689	10	M-766	0
M-690	5	M-843	0
M-691	7	M-844	2
M-693	7	M-848	4
M-694	2	M-850	2
M-695	12		
M-696	13		
M-697	7		
M-699	9		
M-700	2		
M-704	14 (Sh. 1)		
	4 (Sh. 2)		
M-705	12		
M-706	12		
M-707	17		
M-708	16		
M-709	16		
M-710	7		
M-711	8		
M-712	12		
M-713	13		
M-714	19		
M-715	18		
M-716	3		
M-717	13		
M-718	16		
M-719	18		
M-720	17		
M-721	12		
M-722	6		
M-723	15		
M-724	12		
M-725	11		

6. General Electric - LSTG, "High Pressure Hydraulic Fluid Piping" Diagrams:

Drawing	Revision
824E519	3
838E889	2

APPENDIX A

ANALYSIS SUMMARY

Note that the format followed throughout this Appendix is presented and described in Section 2.7.

TURBINE ENCLOSURE

The Turbine Enclosure was divided into the zones listed below. These zones are represented in Figures 2 through 7 of Appendix B. Also noted below are the zones eliminated from the detailed analysis for at least one of the following two reasons:

1. No high energy lines are routed through this zone.

2. All control systems components which reside within this zone have been eliminated per the criteria detailed in Sections 2.1 and 2.2 of this report. Therefore, no applicable control systems components reside within this zone.

Zone	Eliminated (?)	Reason
Area 2/Elevations 189,200/Grid Q15	No	
Areas 2,3/Elevations 189,200,217/Grid R20	No	
Areas 6,7,2/Elevation 200/Grid M12	No	
Area 8/Elevation 200/Grid M21	Yes	2
Area 1/Elevation 217/Grid Q6	No	
Areas 1,2/Elevation 217/Grid Q15	No	
Areas 2,3/Elevation 217/Grid Q20	Yes	2
Areas 2,3/Elevation 217/Grid P20	Yes	2
Areas 2,3/Elevation 217/Grid P22	Yes	1
Areas 6,7/Elevation 217/Grid M15	No	
Area 8/Elevation 217/Grid M21	Yes	1
Area 1/Elevation 239/Grid Q7	Yes	1
Areas 1,2/Elevation 239/Grid P14	No	
Areas 2,3/Elevation 239/Grid P20	Yes	1
Area 6/Elevation 239/Grid M7	No	
Areas 6,7/Elevation 239/Grid M12	Yes	2
Area 7/Elevation 239/Grid M16	Yes	2

Zone	Eliminated (?)	Reason
Areas 6,7/Elevation 239/Grid J14	Yes	1
Area 8/Elevation 239/Grid K22	Yes	1
Area 1/Elevation 269/Grid Q(n)10	Yes	2
Areas 1,2,3/Elevation 269/Grid Q15	No	
Area 6/Elevation 269/Grid N9	No	
Area 7/Elevation 269/Grid N14	Yes	2
Area 7/Elevation 269/Grid N16	No	
Areas 6,7/Elevation 269/Grid M12	No	
Area 8/Elevation 269/Grid M22	Yes	1
Areas 6,7/Elevation 302/Grid M12	Yes	1
Area 7/Elevation 302/Grid K14	Yes	1
Area 8/Elevation 304/Grid M22	Yes	1
Area 8/Elevation 321/Grid K(f)23	Yes	1
Area 8/Elevation 332/Grid M23	Yes	1
Area 8/Elevation 350/Grid K(f)23	Yes	1

Area 2/Elevations 189,200/Grid Q15

I. High Energy Systems

A. Extraction Steam

1. 10" GBD-103

a. Function. Six lines designated GBD-103 carry inventory from the six moisture separator drain tanks to feedwater heaters 14AE104, 14BE104, and 14CE104.

b. Effect of Break: A break in any of these six lines results in a loss of inventory through one of the moisture separators and a loss of some (<100°F) feedwater heating. The effects of this break are bounded by the Loss of Feedwater Heating event (FSAR 15.1.1).

2. 6" GBD-131; 6" GBD-133

a. Function: Six lines tap off from the six 10" GBD-103 condensate lines discussed above. These lines carry inventory from the moisture separator drain tanks to the high pressure or low pressure condensers. These lines are high energy up to normally closed, fail open valves upstream of the condensers.

b. Effect of Break: A break in any of these six lines results in a loss of inventory through one of the moisture separators and a loss of some (<100°F) feedwater heating. The effects of this break are bounded by the Loss of Feedwater Heating event (FSAR 15.1.1).

B. Condensate

1. 30" GBD-116

a. Function: Condensate supply line from the condensate filter demineralizers to the inlet nozzle of the feedwater drain coolers 1AE107, 1BE107, and 1CE107.

b. Effect of Break: Line break results in a feedwater line break event. The effects of this break are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

2. 20" GBD-117

a. Function: Three lines designated GBD-117 carry condensate from the three drain coolers to the first feedwater heater in each string of heaters.

b. Effect of Break: Line break results in a feedwater line break event. The effects of this break are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

C. Auxiliary Steam

1. 8" GBD-176

a. Function: Provides steam for heating the LP, IP, and HP condenser shells on the low pressure turbines "C", "B", and "A", respectively.

b. Effect of Break: Loss of the above discussed heating capabilities.

II. Control Systems

A. Extraction Steam

1. ZS-02-112C,113C

a. Function: Control position of level control valves LV-C 02-112C and 02-113C which are normally open, fail closed valves in lines leading from two moisture separator drain tanks to feedwater heater 14CE104.

b. Failure Effects: These position switches could cause LV-Cs 112C and 113C (normally open) to close. Effect of closure is a loss of some (<100°F) feedwater heating.

III. Combined Effects

A. An Extraction Steam line break would result in a gradual loss of inventory through the Main Steam system, and a reduction in feedwater heating. Closure of the valves in the lines supplying extraction steam to the 14CE104 feedwater heater could result in an additional loss in feedwater heating capability. The total loss of feedwater heating is less than 100°F, and the effects of this event are bounded by the Loss of Feedwater Heating event analyzed in FSAR 15.1.1. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.1.1.

B. A Condensate line break in this zone is bounded by the Feedwater Line Break Outside Primary Containment event analyzed in FSAR 15.6.6. The possible failures of control systems components in this zone will not exacerbate this event. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.6.6.

C. The Auxiliary Steam system functions are required during reactor startup and pre-startup operations. Such a break could abort a startup, but would not have an adverse impact on the reactor parameters. If the line break adversely affects the control system

components in the zone, a partial loss of feedwater heating (<100°F) could result. The effects of this event are bounded by the Loss of Feedwater Heating event analyzed in FSAR 15.1.1. An additional single active failure in a mitigating system also results in bounded event, as discussed in FSAR 15.1.1.

I. High Energy Systems

A. Auxiliary Steam

1. 12" GBD-176; 4" GBD-135

a. Function: Provide steam for heating the LP, IP, and HP condenser shells on the low pressure turbines "C", "B", and "A", respectively.

b. Effect of Break: Loss of the above discussed heating capabilities.

B. Condensate

1. 18" GBD-109

a. Function: Three 18" lines designated GBD-109 carry condensate from the outlet of the condensate pumps to common header 30" GBD-109 which carries condensate to the steam jet air ejector condensers.

b. Effect of Break: A break in any of the three GBD-109 lines results in a feedwater line break event. The effects of such a break are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

II. Control Systems

A. Condensate

1. HY-05-110A,B,C; XC-05-110A-1,A-2,B-1,B-2,C-1,C-2

a. Function: Control normally-closed, fail-open valves (HV-C 05-110A,B,C) on the three lines designated 10" GBD-108 from main steam to the condenser hotwell spargers on LP turbines "A", "B", and "C". However, HV 01-109 is a normally closed valve upstream (i.e., closer to the main steam tapoff) than the controlled valves such that there is no steam downstream of HV 01-109.

b. Failure Effects: Instrument failure could cause the HV-C 05-110 valves to open during a time when they are normally closed. The opening of these valves has no effect due to HV 01-109 being closed. HV 01-109 is unaffected.

2. PSL-05-107,108

a. Function: Monitor pressure on condensate pump "A" discharge and control valves LV-C 05-104 (fail-closed) in the

condensate reject line and FV-C 05-103 (fail-open) in the condensate recirculation line.

b. Failure Effects: Failure of both pressure switches would generally result in closure of LV-C 05-104, the reject line, and opening of FV-C 05-103, the recirc line. This would result in a slight reduction in feedwater flow. If failure of the instruments resulted in opening both the condensate recirc and reject lines, a larger reduction in feedwater flow would be realized.

III. Combined Effects

A. The Auxiliary Steam system functions are required during reactor startup and pre-startup operations. Such a break could abort a startup, but would not adversely impact the reactor parameters. A break in this system in this zone which affects the control system components in the zone could result in a loss of some feedwater flow. The effects of this partial loss of feedwater flow are bounded by the Loss of Feedwater Flow event analyzed in FSAR 15.2.7. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.2.7.

B. A break in the Condensate system piping in this zone results in a feedwater line break event. The effects of this event are bounded by the Feedwater Line Break Outside Primary Containment event analyzed in FSAR 15.6.6. The event is not exacerbated by the failure of any control system components within this zone. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.6.6.

Areas 6,7,2/Elevation 200/Grid M12

I. High Energy Systems

A. Condensate

1. 30" GBD-111; 30" GBD-116

a. Function: Condensate supply lines from the steam packing exhauster through the condensate filter demineralizers to the feedwater drain coolers.

b. Effect of Break: A break in this line results in a loss of condensate supply to the Feedwater system. This break is bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

2. 12" GBD-115

a. Function: Condensate reject line.

b. Effect of Break: A break in this line results in a loss of some condensate supply to the Feedwater system. This break is bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

B. Auxiliary Steam

1. 10" JBD-7

a. Function: Supply steam to the condensate storage tank (CST) and refueling water storage tank heaters.

b. Effect of Break: Loss of heating capability for these tanks.

2. 4" GBD-136

a. Function: Test steam supply for the RCIC and HPCI turbines.

b. Effect of Break: Loss of test steam supply to RCIC and HPCI turbines. Line is blind flanged during operations other than testing.

II. Control Systems

A. Extraction Steam

1. HY-02-115

a. Function: Controls one normally closed, fail open valve in a 2" line from the HP turbine to the HP condenser.

b. Failure Effects: A slight loss of feedwater heating (<100°F) would result if the valve were opened during normal operation.

B. Condensate

1. LT-05-101A,B

a. Function: Control throttle valves which are fail-closed valves in the condensate lines from the condensate storage tank (CST) to the HP condenser shell on LP turbine "A." They also control normally-closed, fail-closed valves in the condensate reject line.

b. Failure Effects: The worst case failure of these components would be to open the above valves. Opening the first set would send CST water to the condenser, which may affect condenser vacuum in the long term (>15 minutes). Opening the second set of valves results in a possible reduction of feedwater flow.

2. LC-05-116A,B

a. Function: Control valves in the condensate lines from the condensate drain tank to the HP condenser shell on LP turbine "A."

b. Failure Effects: The worst case failure of these components would be to close the drain tank valves, which would cause the drain tank level to rise. This will have no effect on the reactor parameters.

C. Feedwater

1. PSL-06-102A,B,C

a. Function: Provide the low net pump suction head (NPSH) trip signal to the reactor feedwater pump turbines (RFPT).

b. Failure Effects: Failure to provide the trip signal may result in pump cavitation and loss of feedwater flow. Failure of the components such that a trip signal is generated would result in a loss of feedwater flow.

2. FT-06-101A,B,C

a. Function: Control the condensate recirc flow control valve to the LP condenser shell on the LP turbine "C."

b. Failure Effects: The worst case failure of these components would be to open the above valve, resulting in a possible reduction of feedwater flow.

3. XC-06-106A,B,C

a. Function: Control feedwater flow from the reactor feedwater pumps (RFP) to the HP, IP, and LP condenser shells, i.e., the minimum flow recirculation line.

b. Failure Effects: The worst case failure of these components would be to open the valve, resulting in a possible reduction in feedwater flow.

D. Service Water

1. FSL-10-160

a. Function: Provides control of the low pressure air blower (10K105) which is the air supply to the condensate filter demineralizers and the Air Removal and Sealing Steam system.

b. Failure Effects: No adverse consequences would result from this component failure. There are normally-closed valves downstream of the blower in each of the subject lines which are not affected.

E. Compressed Air

1. PC-15-150

a. Function: Provides control of the low pressure air blower (10K105) which is the air supply to the condensate filter demineralizers and the Air Removal and Sealing Steam system.

b. Failure Effects: No adverse consequences would result from this component failure. There are normally-closed valves downstream of the blower in each of the subject lines which are not affected.

F. CRD Hydraulic

1. PSL-46-N001A,B

a. Function: Control the CRD drive water pump flow from the condensate reject line to the HCUs.

b. Failure Effects: Only long term operation of the HCUs would be impaired. No impact on scram or the reactor parameters would result.

III. Combined Effects

A. A break in any of the Condensate System lines in this zone is bounded by the Feedwater Line Break Outside Primary Containment event

analyzed in FSAR 15.6.6. The failure of any control systems components in this zone does not exacerbate this event. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.6.6.

B. The Auxiliary Steam system functions are required during reactor startup and pre-startup operations. Such a break could abort a startup, but would not have an adverse impact on the reactor parameters. The worst case effect of the HELB and its effect on control systems components is bounded by the Loss of Feedwater Flow event analyzed in FSAR 15.2.7. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.2.7.

Area 1/Elevation 217/Grid Q6

I. High Energy Systems

A. Turbine Electro-Hydraulic Control (EHC)

1. 1½"/2" FAS, Fluid Actuator Supply

a. Function: High pressure fluid lines serve to maintain the main turbine stop valves (MSV) and combined intermediate valves (CIV) open, and control the bypass control valves.

b. Effect of Break: Loss of EHC system pressure resulting in reactor scram. Reactor scram is RPS (Reactor Protection System) scram on loss of EHC pressure and/or closure of the MSV's.

II. Control Systems

A. Service Water

1. TE-10-106A,B; TIC-10-106A,B

a. Function: Control valves TC-V 10-106A,B (normally open, fail-open) which supply service water to EHC hydraulic fluid coolers.

b. Failure Effects: Failure of these instruments such that the controlled valves would close results in a loss of EHC fluid cooling.

III. Combined Effects

A break in any portion of the Turbine EHC Fluid Actuator Supply line will result in a loss of EHC system pressure. This loss of pressure will actuate RPS scram functions on loss of EHC pressure and/or MSV closure. The effects of this event are bounded by the Turbine Trip Without Bypass event analyzed in FSAR 15.2.3. The failure of any control system components in the zone which could possibly be adversely affected will not exacerbate this event. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.2.3.

Areas 1,2/Elevation 217/Grid Q15

I. High Energy Systems

A. Extraction Steam

1. 10" GAD-108

a. Function: Low pressure steam supply for the three reactor feedwater pump turbines from crossaround steam.

b. Effect of Break: Loss of inventory through the break and a loss of low pressure steam supply to the feed pump turbines. The high pressure backup supply is available.

2. 10" GJD-101

a. Function: Two lines designated GJD-101 supply feedwater heater 14CE104 with steam from two moisture separators.

b. Effects of Break: Loss of inventory through one moisture separator and a loss of some (<100°F) feedwater heating. The effects of this break are bounded by the Loss of Feedwater Heating event (FSAR 15.1.1).

3. 10"/8" GBD-103

a. Function: Six lines designated GBD-103 carry inventory from the six moisture separator drain tanks to feedwater heaters 14AE104, 14BE104, and 14CE104.

b. Effect of Break: A break in any of these six lines results in a loss of inventory through one of the moisture separators and a loss of some (<100°F) feedwater heating. The effects of this break are bounded by the Loss of Feedwater Heating event (FSAR 15.1.1).

4. 6" GBD-131; 6" GBD-133

a. Function: Six lines tap off from the six 10" GBD-103 condensate lines discussed above. These lines carry inventory from the moisture separator drain tanks to the high pressure or low pressure condensers. These lines are high energy up to normally-closed, fail-open valves upstream of the condensers.

b. Effect of Break: A break in any of these six lines results in a loss of inventory through one of the moisture separators and a loss of some (<100°F) feedwater heating. The effects of this break are bounded by the Loss of Feedwater Heating event (FSAR 15.1.1).

B. Main Steam

1. 6"/4" EBD-113

a. Function: High pressure steam supply for the three reactor feedwater pump turbines. This is a backup steam supply.

b. Effects of Break: Loss of inventory through the main steam system and a loss of the backup high pressure steam to the feed pump turbines.

C. Feedwater

1. 20" GBD-116

a. Function: Condensate supply line from the condensate filter demineralizers to the inlet nozzle of the feedwater drain coolers 1AE107, 1BE107, and 1CE107.

b. Effect of Break: Line break results in a feedwater line break event. The effects of this break are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

2. 20" GBD-117

a. Function: Three lines designated GBD-117 carry feedwater from the three drain coolers to the first feedwater heater in each string of heaters.

b. Effect of Break: Line break results in a feedwater line break event. The effects of this break are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

D. Auxiliary Steam

1. 6" GBD-146

a. Function: Supply steam to various steam consuming components used during startup operations.

b. Effect of Break: A break in this line may abort a startup, but will not adversely affect the reactor parameters.

E. Turbine Electro-Hydraulic Control (EHC)

1. 1½"/2" FAS, Fluid Actuator Supply

a. Function: High pressure fluid lines serve to maintain the main turbine stop valves (MSV) and combined intermediate valves (CIV) open, and control the bypass control valves.

b. Effect of Break: Loss of EHC system pressure resulting in reactor scram. Reactor scram is RPS (Reactor Protection System) scram on loss of EHC pressure and/or closure of the MSV's.

II. Control Systems

A. Main Steam

1. LT-01-101A-F; LT-01-103A-F

a. Function: Provide level control in the six (A through F) moisture separator drain tanks by opening/closing valves in the exhaust lines to feedwater heaters 14AE104, 14BE104, and 14CE104, and the HP, IP, and LP condensers of low pressure turbines "A", "B", and "C". The controlled valves in the lines to the condensers (LV-C 01-103A-F) are normally closed and fail open. The controlled valves in the lines to the feedwater heaters (LV-C 01-112A,B,C; LV-C 01-113A,B,C) are normally open and fail closed.

b. Failure Effects: These level transmitters could fail in such a manner that the exhaust lines to the condensers open and the lines to the feedwater heaters close. If the instruments fail in such a manner that both exhaust paths from at least one moisture separator are closed, a partial loss of feedwater heating (<100°F) would occur, and a turbine trip could result from high level in the moisture separator.

2. LSHH-01-115A-F; LSHH-01-116A-F; LSHH-01-117A-F

a. Function: Three switches per moisture separator provide a turbine trip signal when two out of three level switches register high-high level in any of the six moisture separators.

b. Failure Effects: Failure of any two level switches on one moisture separator may result in a turbine trip. These switches could also fail in a manner that would incapacitate a turbine trip.

B. Condensate

1. Instrument process tubing for all of the following components: HY-05-110A,B,C; XC-05-110A-1,A-2,B-1,B-2,C-1,C-2

a. Function: Control normally-closed, fail-open valves (HV 05-110A,B,C) on three lines designated 10" GBD-108 from main steam to the condenser hotwell spargers on LP turbines "A", "B", and "C". However, HV 01-109 is a normally-closed valve upstream (i.e., closer to the main steam tapoff) than the controlled valves such that there is no steam downstream of HV 01-109.

b. Failure Effects: Severance of the instrument tubing can result in opening of one or more of the HV-C 05-110 valves during the time they are normally closed. The opening of these valves has no effect due to HV 01-109 being closed.

C. Feedwater

1. Instrument process tubing for FE-06-101A,B,C

a. Function: Monitor feedwater flow between the second and third feedwater heaters in each of the "A", "B", and "C" feedwater heater strings to control valve FV-C 05-103 in the condensate recirculation line.

b. Failure Effects: A severance of one or more of these instrument tubes would result in low flow signal into a flow summer which produces a signal to control the position of bypass valve FV-C 05-103. This would result in an opening of the bypass valve and a possible reduction in feedwater flow.

III. Combined Effects

A. A break in any of the Extraction Steam lines results in a loss of inventory through one of the moisture separators and could result in a combination of a partial loss of feedwater heating, a slight reduction in feedwater flow (though the feedwater controller is not affected), and a turbine trip.

If a turbine trip is effected as a result of the HELB and simultaneous failure of appropriate control systems components, the consequences of this event are bounded by the Turbine Trip Without Bypass event analyzed in FSAR 15.2.3. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.2.3.

It is possible that the HELB will affect the control systems components in such a manner that a loss of some feedwater heating occurs due to improper valve alignment, and a turbine trip does not occur simultaneously with the HELB. In this case, the maximum loss of feedwater heating that can occur is less than 30°F, given the worst case combination of failures. A turbine trip on high-high level in at least one of the moisture separators would occur at some time after the reactor stabilized at a power level elevated from its initial value. If turbine trip on high-high level in at least one of the moisture separators does not occur, a turbine trip due to moisture carryover to the LP turbines would likely occur at some later time, without operator action.

Such an event may be outside the bounds of the Turbine Trip Without Bypass and Loss of Feedwater Heating transient events analyzed in FSAR 15.2.3 due to the elevated power level. However, the effects of this postulated accident are within the bounds of accident criteria

set forth in FSAR Chapter 15. No further analysis of this event is required. See Section 3.0 for additional discussion.

B. A break in the high pressure steam supply line to the feedwater pump turbines will result in a loss of some inventory through the break and could result in a combination of a partial loss of feedwater heating, a slight reduction in feedwater flow, and a turbine trip. The effects of such an event are the same as discussed in A above.

C. A break in any Condensate line in this zone constitutes a feedwater line break event. The effects of this event are bounded by the Feedwater Line Break Outside Primary Containment event analyzed in FSAR 15.6.6. The failure of any control systems components in the zone will not exacerbate this event. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.6.6.

D. The Auxiliary Steam system functions are required during reactor startup and pre-startup operations. Such a break could abort a startup, but would not have an adverse impact on reactor parameters. If the HELB adversely affects the control systems components in the zone, a combination of a partial loss of feedwater heating, a slight reduction in feedwater flow, and a turbine trip could occur. The effects of such an event are the same as discussed in A above.

E. A break in any portion of the Turbine EHC Fluid Actuator Supply line will result in a loss of EHC system pressure. This loss of pressure will actuate RPS scram functions on loss of EHC pressure and/or MSV closure. The effects of this event are bounded by the Turbine Trip Without Bypass event analyzed in FSAR 15.2.3. The failure of any control system components in the zone which could possibly be adversely affected will not exacerbate this event. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.2.3.

Areas 6,7/Elevation 217/Grid M15

I. High Energy Systems

A. Main Steam

1. 4" EBD-113

a. Function: High pressure, backup steam supply to the reactor feed pump turbines.

b. Effect of Break: Results in a loss of inventory through the break and a loss of the backup steam supply to the RFPTs.

B. Extraction Steam

1. 10"/12" GAD-108

a. Function: Low pressure steam supply for the RFPTs from crossaround steam.

b. Effects of Break: Results in a loss of inventory through the break and a loss of the normal steam supply to the RFPTs. The high pressure, backup supply is available.

C. Condensate

1. 14" GBD-113

a. Function: Condensate recirculation line.

b. Effects of Break: Results in a feedwater line break event. A break in this line is bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

2. 30" GBD-116

a. Function: Condensate line from the condensate filter/demineralizers to the feedwater drain coolers.

b. Effects of Break: Results in a feedwater line break event. A break in this line is bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

D. Feedwater

1. 20" DBD-101

a. Function: Three lines designated DBD-101 carry feedwater from the RFPs to the sixth feedwater heaters.

b. Effects of Break: Results in a feedwater line break event. A break in this line is bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

2. 10" DBD-106

a. Function: This is the minimum flow recirculation line for RFP "A".

b. Effects of Break: Results in a feedwater line break event. A break in this line is bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

3. 20" GBD-118

a. Function: Three lines designated GBD-118 carry feedwater from the fifth feedwater heater to the RFP in each feedwater heater string.

b. Effects of Break: Results in a feedwater line break event. A break in this line is bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

E. Auxiliary Steam

1. 6"/8" GBD-134

a. Function: During startup, this line provides heating steam to a number of steam consuming components.

b. Effects of Break: A break in this line could abort the startup operation. No consequence during normal power operation.

II. Control Systems

A. Condensate

1. FY-05-103; FE-05-104; FT-05-104

a. Function: These components control condensate recirculation flow.

b. Failure Effects: The worst case failure of these components would be to open the valve in the condensate recirc line resulting in a possible loss of some feedwater flow.

III. Combined Effects

A. A break in the Main Steam piping in this zone results in a loss of some inventory through the break and a possible reduction in feedwater flow (though the feedwater controller is not affected). The effects of this event are bounded by the Loss of Feedwater Flow event analyzed in FSAR 15.2.7. An additional single active failure in a

mitigating system also results in a bounded event, as discussed in FSAR 15.2.7.

B. A break in the Extraction Steam piping in this zone is the same event as A above.

C. A break in the Condensate piping in this zone results in a feedwater line break event. The effects of this event are bounded by the Feedwater Line Break Outside Primary Containment event analyzed in FSAR 15.6.6. The failure of control system components in this zone will not exacerbate this event. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.6.6.

D. A break in the Feedwater piping in this zone is the same event as C above.

E. An Auxiliary Steam line break in this zone has no effect on the reactor parameters during power operation, but a startup could be aborted if in startup operations. The Auxiliary Steam line break coupled with the failure of the control system components in the zone could result in a slight loss of feedwater flow through the condensate recirc line (though the feedwater controller is not affected). The effects of this event are bounded by the Loss of Feedwater Flow event analyzed in FSAR 15.2.7. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.2.7.

Areas 1,2/Elevation 239/Grid P14

I. High Energy Systems

A. Crossover Steam (Main Steam)

1. 42" Crossaround Piping

a. Function: Carry main steam from HP turbine outlets to moisture separators and on to LP turbines.

b. Effect of Break: Loss of main steam. Effects of this break are bounded by the Steam System Piping Break Outside Primary Containment event (FSAR 15.6.4).

B. Main Steam

1. 26" EBB-101, EBB-102, EBB-103, EBB-104

a. Function: Carry main steam from reactor vessel to HP turbine. These are the main steam lines.

b. Effect of Break: Loss of main steam. Effects of this break are bounded by the Steam System Piping Break Outside Primary Containment event (FSAR 15.6.4).

2. 14"/18" EBB-106, EBB-107

a. Function: Provide bypass path from main steam lines (upstream of turbine stop valves) to the main steam bypass valves.

b. Effect of Break: Loss of main steam. Effects of this break are bounded by the Steam System Piping Break Outside Primary Containment event (FSAR 15.6.4).

C. Extraction Steam

1. 16"/18" GAD-101, GAD-102, GAD-103

a. Function: Extraction Steam from the HP turbine to feedwater heaters 16AE106, 16BE106, and 16CE106

b. Effect of Break: Loss of HP turbine first stage pressure and steam to LP turbines, and a loss of some (<100°F) feedwater heating.

2. 16" GAD-107; 20" GAD-105, GAD-106, GAD-107

a. Function: Extraction Steam from the 42" crossaround pipes exiting the HP turbine to feedwater heaters 15AE105, 15BE105, and 15CE105.

b. Effect of Break: Loss of steam to LP turbines, and a loss of some (<100°F) feedwater heating.

3. 12"/16" HAD-101; 20"/26" HAD-102

a. Function: The 12" HAD-101 and 20" HAD-102 are common manifold lines connecting the "A", "B", and "C" low pressure turbine outlets. The 16" HAD-101 pipes carry extraction steam from the "A", "B", and "C" low pressure turbines to feedwater heaters 14AE104, 14BE104, and 14CE104, respectively. The 26" HAD-102 pipes carry extraction steam from the "A", "B", and "C" low pressure turbines to feedwater heaters 13AE103, 13BE103, and 13CE103, respectively.

b. Effect of Break: Loss of pressure in the low pressure turbines and a loss of some (<100°F) feedwater heating.

4. 10" GJD-101

a. Function: Extraction Steam from outlet of LVCs 02-112A,B,C and 02-113A,B,C to feedwater heaters 14AE104, 14BE104, and 14CE104.

b. Effect of Break: Depressurization of the associated moisture separator and a loss of some (<100°F) feedwater heating. Effects of break are bounded by the Loss of Feedwater Heating event (FSAR 15.1.1).

D. Feedwater

1. 10" DBD-106

a. Function: Three lines designated DBD-106 provide minimum flow recirculation from each of three feedwater pumps to respective condensers.

b. Effect of Break: Partial loss of feedwater. Effect is bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

E. Condensate

1. 20" GBD-117

a. Function: Three lines designated GBD-117 carry feedwater from drain coolers 1AE107, 1BE107, and 1CE107 through the feedwater heaters to common header 20" GBD-118.

b. Effect of Break: Loss of feedwater flow. Effect is bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

F. High Pressure Drains

1. 8" GBD-104

a. Function: Three lines designated GBD-104 connect drain outlets of feedwater heaters 16AE106, 16BE106, and 16CE106 to fifth stage feedwater heaters through the modulating control valves LV-C 04-110A,B,C, respectively.

b. Effects of Break: Loss of pressure in main turbines and a loss of some (<100°F) feedwater heating. Effect of break is bounded by the Loss of Feedwater Heating event (FSAR 15.1.1).

G. Turbine Electro-Hydraulic Control (EHC)

1. 1½"/2" FAS, Fluid Actuator Supply

a. Function: High pressure fluid lines serve to maintain the main turbine stop valves (MSV) and combined intermediate valves (CIV) open, and control the bypass control valves.

b. Effect of Break: Loss of EHC system pressure resulting in reactor scram. Reactor scram is RPS (Reactor Protection System) scram on loss of EHC pressure and/or closure of the MSV's.

II. Control Systems

A. Main Steam

1. PSL-01-101 (Instrument Process Tube Only)

a. Function: Sense low pressure condition in first stage of high pressure turbine. Opens drain valves HV 01-105A,B; HV 02-103A,B,C; HV 02-104A,B,C; HV 02-105A,B,C; HV 02-107A,C; HV 02-121A,B,C; HV 02-122A,B,C; and HV 02-114.

b. Failure Effects: Severance of instrument tube causes low pressure signal output; drain valves open to allow moisture accumulation in associated main steam and extraction steam lines to drain to the condenser. This action prevents further moisture accumulation but has no impact on the reactor parameters.

2. PT-01-101A,B (Instrument Process Tubing Only)

a. Function: Sense pressure from main steam pressure averaging manifold in order to maintain constant setpoint pressure upstream of the main turbine control valves.

b. Failure Effects: Severance of either instrument tube has no effect; logic chooses either of two values (severed tube

results in zero pressure signal to associated pressure transmitter). Severance of both instrument tubes results in closure of turbine control valves and bypass valves in an effort to maintain pressure in the pressure averaging manifold and Main Steam lines.

3. PT-01-107 (Instrument Process Tube Only)

    a. Function: Sense pressure in the 42" crossaround pipe from the HP turbine to moisture separator 1B1T104. It functions to avoid turbine overspeed due to load imbalance.

    b. Failure Effects: Severance of the instrument tube would render PT-01-107 unable to sense a load imbalance. This has no effect on the reactor parameters.

B. Extraction Steam

1. Instrument process tubing for all of the following: PS-02-123A,B,C; PS-02-124A,B,C; PS-02-125A,B,C; PS-02-126A,B,C

    a. Function: Sense position of check valves on 11th stage extraction lines exiting the LP turbines and open corresponding drain lines to the condensers.

    b. Failure Effects: The effect is identical to that described for PSL-01-101 (II.A.1.b) and has no impact on the reactor parameters.

2. ZS-02-108A,B,C; ZS-02-109A,B,C

    a. Function: Sense positions of bleeder trip valves (BTVs) XV 02-108A,B,C and XV 02-109A,B,C, respectively. As BTVs close, the switches act to open drain lines to the condensers. The drains may also be opened manually or by PSL-01-101.

    b. Failure Effects: The effect is identical to that described for PSL-01-101 (II.A.1.b) and has no impact on the reactor parameters.

C. Feedwater

1. FE-06-101A,B,C (Instrument Process Tubes Only)

    a. Function: Sense feedwater flow between feedwater heaters 12(A,B,C)E102 and 13(A,B,C)E103, respectively. The outputs are summed together to control condensate recirculation back to the condensers.

    b. Failure Effects: Severed instrument lines could cause a slight reduction in feedwater flow due to inadvertently opened bypass lines.

III. Combined Effects

A. A break in the 42" Crossaround Steam piping results in the Steam System Piping Break Outside Primary Containment event analyzed in FSAR 15.6.4. The failure of any control systems components in this zone will not exacerbate this event. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.6.4.

B. A break in the Main Steam system piping in the zone is the same as discussed in A above.

C.1 A break in one of the Extraction Steam lines GAD-101, GAD-102, or GAD-103 results in a loss of steam to the LP turbines from the HP turbine and a loss of extraction steam to the sixth stage feedwater heaters. If the break affects the control system components such that the instrument tubing for both PT-01-101A and B are severed, a turbine trip would occur almost immediately such that the partial loss (<100°F) of feedwater heating would be inconsequential. The effects of this event are bounded by the Turbine Trip Without Bypass event analyzed in FSAR 15.2.3. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.2.3.

If an immediate turbine trip does not occur because the control system components are not affected in the appropriate manner, the loss of steam supplying the LP turbines will result in a generator power reversal and subsequent generator trip. The Turbine Unit Protection System will initiate a turbine trip within a time such that the loss of feedwater heating would be inconsequential. The effects of this event are bounded by the Turbine Trip Without Bypass event analyzed in FSAR 15.2.3. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.2.3.

C.2 A break in any of the other Extraction Steam lines in the zone could result in a loss of some (<100°F) feedwater heating, a partial loss of feedwater flow (though the feedwater controller is not affected), and a turbine trip.

If the HELB affects the control systems components such that a turbine trip is effected (i.e., the instrument process tubing for both PT-01-101A and B are severed), the effects of the event are bounded by the Turbine Trip Without Bypass event analyzed in FSAR 15.2.3. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.2.3.

If the HELB affects the control systems components such that the turbine trip is not effected, the effects of the event are bounded by the Loss of Feedwater Heating event analyzed in FSAR 15.1.1. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.1.1.

D. A break in any of the Feedwater lines in the zone results in a feedwater line break event. The effects of this event are bounded by the Feedwater Line Break Outside Primary Containment event analyzed in FSAR 15.6.6. The failure of the control systems components in the zone does not exacerbate this event. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.6.6.

E. A break in the Condensate line in the zone results in the same event discussed in D above.

F. A break in one of the High Pressure Drain lines could result in a turbine trip, if the instrument process tubing for both PT-01-101A and B are severed. The effects of this event are bounded by the Turbine Trip Without Bypass event analyzed in FSAR 15.2.3 (the loss of feedwater heating is then inconseqential). An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.2.3.

   If the HELB does not affect the appropriate control systems components to result in a turbine trip, the effects of the event are bounded by the Loss of Feedwater Heating event analyzed in FSAR 15.1.1. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.1.1.

G. A break in any portion of the Turbine EHC Fluid Actuator Supply line will result in a loss of EHC system pressure. This loss of pressure will actuate RPS scram functions on loss of EHC pressure and/or MSV closure. The effects of this event are bounded by the Turbine Trip Without Bypass event analyzed in FSAR 15.2.3. The failure of any control system components in the zone which could possibly be adversely affected will not exacerbate this event. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.2.3.

Area 6/Elevation 239/Grid M7

I. High Energy Systems

A. Condensate

1. 20" GBD-117; 20" GBD-118

a. Function: See I.E.1.a for Areas 1,2/Elevation 239/ Grid P14.

b. Effect of Break: See I.E.1.b for Areas 1,2/Elevation 239/ Grid P14.

B. Extraction Steam:

1. 12"/16" HAD-101; 20"/26" HAD-102; 20" GAD-107

a. Function: See I.C.2.a and I.C.3.a for Areas 1,2/Elevaticn 239/Grid P14.

b. Effect of Break: See I.C.2.b and I.C.3.b for Areas 1,2/ Elevation 239/Grid P14.

2. 10" GJD-101

a. Function: See I.C.4.a for Areas 1,2/Elevation 239/ Grid P14.

b. Effect of Break: See I.C.4.b for Areas 1,2/Elevation 239/ Grid P14.

C. High Pressure Drains

1. 8" GBD-104

a. Function: See I.F.1.a for Areas 1,2/Elevation 239/ Grid P14.

b. Effect of Break: See I.F.1.b for Areas 1,2/Elevation 239/ Grid P14.

II. Control Systems

A. Extraction Steam

1. HY-02-120

a. Function: An I/P converter which controls drain valve HV-C 02-120. This valve is parallel with automatically controlled drain valve HV 02-122A.

b. Failure Effects: Failure of HY-02-120 could cause valve HV-C 02-120 to open and provide drainage of extraction pipe 16" GAD-107 at inlet to feedwater heater 15AE105 through a 2" line to the condenser. A slight loss (<100°F) of feedwater heating may result.

III. Combined Effects

A. A break in any of the Condensate lines in this zone results in an event bounded by the Feedwater Line Break Outside Primary Containment event analyzed in FSAR 15.6.6. The failure of any control systems components in the zone does not exacerbate the event. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.6.6.

B. A break in any of the Extraction Steam lines in this zone results in a partial loss (<100°F) of feedwater heating. The failure of the control system components in the zone results in a possible additional slight loss of feedwater heating. The combined event results in a less than 100°F loss of feedwater heating and is bounded by the Loss of Feedwater Heating event analyzed in FSAR 15.1.1. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.1.1.

C. A break in any of the High Pressure Drain lines results in an event bounded by the Loss of Feedwater Heating event analyzed in FSAR 15.1.1. An additional slight loss of feedwater heating could occur as a result of the failure of the control systems components in the zone. The combined event results in a less than 100°F loss of feedwater heating and is bounded by the Loss of Feedwater Heating event analyzed in FSAR 15.1.1. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.1.1.

Areas 1,2,3/Elevation 269/Grid Q15

I. High Energy Systems

A. Main Steam

1. 26" EBB-101, EBB-102, EBB-103, EBB-104

a. Function: These are the main steam lines. Their function is explained in I.B.1.a for Areas 1,2/Elevation 239/ Grid P14.

b. Effect of Break: See I.B.1.b for Areas 1,2/Elevation 239/ Grid P14.

B. Crossover Steam (Main Steam)

1. 42" Crossaround Piping

a. Function: See I.A.1.a for Areas 1,2/Elevation 239/ Grid P14.

b. Effect of Break: See I.A.1.b for Areas 1,2/Elevation 239/ Grid P14.

C. Turbine EHC

1. 1½"/2" FAS, Fluid Actuator Supply

a. Function: See I.G.1.a for Areas 1,2/Elevation 239/ Grid P14.

b. Effect of Break: See I.G.1.b for Areas 1,2/Elevation 239/ Grid P14.

II. Control Systems

A. Main Steam

1. TT-01-104; TT-01-105

a. Function: Sense exhaust hood high temperature of LP turbines "A" and "C" and open water spray valves TV-C 05-101 to cool the exhaust hoods during startup.

b. Failure Effects: Inadvertently actuated exhaust spray. The reactor parameters will not be affected.

2. ZS-01-132A,B

a. Function: Sense closure of main steam control valves CV-3, CV-4 and open drain valves HV 01-106A,B, respectively. The

drain may also be opened manually or by redundant position switches ZS-01-101A,B,C.

b. Failure Effects: Redundancy assures proper drainage; no effect on reactor parameters.

B. Extraction Steam

1. TSH-02-101A,B,C; TSH-02-102A,B,C; TSH-02-103A,B,C

a. Function: These temperature switches are placed on all three LP turbines to sense exhaust hood high temperature. The turbine electrohydraulic control (EHC) logic initiates turbine trip from any 2-out-of-3 sensors on each LP turbine.

b. Failure Effects: High temperature turbine trip from exhaust hoods could be effected or incapacitated. (Note: The HELB upstream and the subsequent MSIV isolation for all HELBs in this zone precludes the need for this function.)

C. Condensate System

1. TY-05-101

a. Function: Works in conjunction with TT-01-104 and TT-01-105 as discussed in II.A.1.a above.

b. Failure Effects: Same as II.A.1.b above.

D. Circulating Water System

1. PSHL-09-140A,B

a. Function: Senses high pressure in the waterbox vacuum tank and gives permission to open scavenging pump seal water valve SV 09-142A and start scavenging pump 1AP133.

b. Failure Effects: This system is used only to manually draw vacuum on the water box when returning that portion of the Circulating Water System to operation. Failures have no consequences during reactor operation.

2. PSL-09-143

a. Function: Senses waterbox vacuum tank low pressure and closes scavenging pump seal water valve SV 09-142A and stops scavenging pump 1AP133.

b. Failure Effects: This system is used only to manually draw vacuum on the water box when returning that portion of the Circulating Water System to operation. Failures have no consequences during reactor operation.

E. Service Water System

1. TT-10-124

a. Function: Senses temperature of main turbine lube oil reservoir and opens valve TV-C 10-124 to employ a secondary lube oil cooler, should the temperature exceed the primary cooler's capacity.

b. Failure Effects: Failure of this device does not affect reactor parameters and is of no consequence in the short term (shutdown following HELB) because the primary lube oil cooler continues to function.

F. Turbine Enclosure Cooling Water System

1. LSHL-14-102

a. Function: Senses high level in Turbine Enclosure cooling water head tank 10T115 and subsequently closes valve LV 14-101.

b. Failure Effects: Possible overfill of head tank from demineralized water supply; excess water would drain through overfill drain pipe 2" RBD-114. No effect on reactor parameters.

G. Turbine Enclosure HVAC System

1. PDT-75-117; PE-75-117-1; PE-75-117-2; XDY-75-117

a. Function: All function together to se[illegible]ifferential pressure between Turbine Enclosure (P[illegible]17-1) and outside ambient (PE-75-117-2), and control [illegible]bine Enclosure exhaust fans to maintain diffe[illegible]al pressure setpoint.

b. Failure Effects: No effect on reactor parameters.

III. Combined Effects

A. A break in any of the Main Steam lines in this zone would not be exacerbated by the failure of any control systems components within the zone. This event is bounded by the Steam System Piping Break Outside Primary Containment event analyzed in FSAR 15.6.4. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.6.4.

B. A break in the Crossaround Steam piping results in the same event discussed in A above.

C. A break in any portion of the Turbine EHC Fluid Actuator Supply line will result in a loss of EHC system pressure. This loss of pressure will actuate RPS scram functions on loss of EHC pressure and/or MSV

closure. The effects of this event are bounded by the Turbine Trip Without Bypass event analyzed in FSAR 15.2.3. The failure of any control system components in the zone which could possibly be adversely affected will not exacerbate this event. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.2.3.

Area 6/Elevation 269/Grid N9

I. High Energy Systems

A. Extraction Steam

1. 16" GAD-103

a. Function: See I.C.1.a for Areas 1,2/Elevation 239/ Grid P14.

b. Effect of Break: See I.C.1.b for Areas 1,2/Elevation 239/ Grid P14.

B. Feedwater

1. 20" DBD-101

a. Function: Carries feedwater from reactor feed pump 1AP101 (downstream of value HV 06-105A) to inlet of feedwater heater 16AE106.

b. Effect of Break: Partial loss of feedwater. Effect is bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

C. High Pressure Drains

1. 8" GBD-104

a. Function: See I.F.1.a for Areas 1,2/Elevation 239/ Grid P14.

b. Effect of Break: See I.F.1.b for Areas 1,2/Elevation 239/ Grid P14.

II. Control Systems

A. Extraction Steam

1. ZS-02-119A

a. Function: Senses position of bleeder trip valve (BTV) XV 02-119A on extraction heating pipe 16" GAD-103 at inlet to feedwater heater 16AE106. As the BTV closes, ZS-02-119A opens drain valve HV 02-107A from 16" GAD-103 to HP condenser 1AE108. The drain valve may also be opened manually.

b. Failure Effects: Long term failure could cause moisture to accumulate in the 18" GAD-103 extraction line. However, this does not affect reactor parameters and is of no consequence in the short term.

III. Combined Effects

A. A break in the Extraction Steam line in this zone results in a partial loss (<100°F) of feedwater heating. The effects of this event are bounded by the Loss of Feedwater Heating event analyzed in FSAR 15.1.1. The event is not exacerbated by the possible control system failures in the zone. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.1.1.

B. A break in the Feedwater line in this zone results in an event bounded by the Feedwater Line Break Outside Primary Containment event analyzed in FSAR 15.6.6. The event is not exacerbated by the possible control systems failures in the zone. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.6.6.

C. A break in any of the High Pressure Drain lines in this zone results in an event bounded by the Loss of Feedwater Heating event analyzed in FSAR 15.1.1. The event is not exacerbated by the possible control systems failures in the zone. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.1.1.

Areas 6,7/Elevation 269/Grid M12

I. High Energy Systems

A. Condensate

1. 12" GBD-119

a. Function: Provides part of bypass path for feedwater from outlet of feedwater heater 15CE105 (following valve HV 06-102C) to valve HV-C 06-120 en route to the reactor.

b. Effect of Break: Results in a feedwater line break event. Effect is bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

B. Feedwater

1. 10"/20"/34" DBD-102

a. Function: The 20" DBD-102 pipes carry feedwater from final stage feedwater heaters 16AE106, 16BE106, and 16CE106 through valves to common manifold 34" DBD-102. The 10" DBD-102 is a bypass line around valve HV 06-108A used for minimum flow control during startup.

b. Effect of Break: Results in a feedwater line break event. Effect is bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

II. Control Systems

A. Reactor Recirculation

1. Recirc MG Set Panels 1AC050, 1AC051, 1AC052, 1BC050, 1BC051, and 1BC052

a. Function: These panels house instrumentation and control devices for the recirc MG sets.

b. Failure Effects: Recirc MG set panels 1AC050-52 and 1BC050-52 could be adversely affected by jet impingement from a postulated HELB of feedwater pipe 20" DBD-102. This could result in a trip of the recirc pumps.

B. Feedwater System

1. FE-06-C32-1N001A,B,C; FT-06-C32-1N002A,B,C

a. Function: Sense total feedwater flow and act in combination with steam flow and reactor level to control the feedwater flow rate.

b. Failure Effects: Each of these devices are summed together such that a postulated failure of one or more of these components would signal the controller to adjust feedwater flow rate (assuming the mode switch is in three-element control).

2. FSL-06-106A,B,C

a. Function: Sense feedwater flow and assist in seating check valves HV 06-105A,B,C, respectively, during low flow conditions.

b. Failure Effects: A postulated failure of these switches has no effect on reactor parameters.

3. LY-06-138A; XC-06-138A; XY-06-138A-1; XY-06-138A-2

a. Function: These devices act together to throttle valve LV-C 06-138A for low feedwater flow control during startup only. This is done by temporarily bypassing main feedwater control valve HV 06-108A.

b. Failure Effects: During reactor operation, the temporary bypass loop is sealed off by another normally-closed valve (HV 06-138A). Therefore, failure of any of these devices is inconsequential.

III. Combined Effects

A. A break in the Condensate line in this zone results in an event bounded by the Feedwater Line Break Outside Primary Containment event analyzed in FSAR 15.6.6. The event is not exacerbated by any possible control systems failure in the zone. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.6.6.

B. A break in any of the Feedwater lines in this zone results in the same event discussed in A above.

Area 7/Elevation 269/Grid N16

The analysis for this zone is identical with that described for Area 6/Elevation 269/Grid N9. The only component requiring analysis within the zone is position switch ZS-02-119C whose function is identical to ZS-02-119A. All high energy pipes are redundant in the "A" and "C" feedwater heater rooms represented by these two zones. All postulated events are bounded as stated in the analysis for Area 6/Elevation 269/Grid N9 in this Appendix A.

REACTOR ENCLOSURE

The Reactor Enclosure was divided into the zones listed below. These zones are represented in Figures 8 through 13 of Appendix B. The zones defined are consistent with the zones of influence defined in Chapter 3.6 of the FSAR which analyzes high energy pipe breaks and resultant effects on safety related equipment. Also noted below are the zones eliminated from the detailed analysis for at least one of the following reasons:

1. No high energy lines are routed through this zone.

2. All control systems components which reside within this zone have been eliminated per the criteria detailed in Sections 2.1 and 2.2 of this report. Therefore, no applicable control systems components reside within this zone.

Zone	Eliminated (?)	Reason
A1 - Area 12/Elevations 177,201,217 Area 15/Elevation 217	Yes	2
A2 - Area 12/Elevations 177,201,217 Area 15/Elevation 217	Yes	2
A3 - Area 11/Elevation 177	Yes	1
A4 - Areas 11,12,15,16/Elevation 177	Yes	1
B1 - Areas 11,12,15,16/Elevation 201	Yes	1
C1 - Areas 11,12,15,16/Elevation 217	Yes	1
D1 - Areas 11,15/Elevation 253	No	
D2 - Areas 12,16/Elevation 253	No	
D3 - Areas 15,16/Elevation 253	No	
D4 - Areas 11,12/Elevation 253	Yes	2
E1 - Areas 11,15/Elevation 283	Yes	2
E2 - Areas 11,12,15,16/Elevation 283	Yes	1
F1 - Areas 11,12,15,16/Elevations 313 and Above	Yes	1

Zone D1

Areas 11,15/Elevation 253

I. High Energy Systems

A. Control Rod Drive (CRD) Hydraulic

1. CRD Hydraulic Control Units (HCUs)

a. Function: The CRD HCU controls the movement of one CRD.

b. Effect of Break: Failure of one HCU may result in the inability to insert one CRD. This would not prevent total reactor scram.

II. Control Systems

A. Nuclear Boiler

1. HS-41-140,141

a. Function: Control normally closed valves on 1" drain lines originating from main steam line "B."

b. Failure Effects: Failure of these switches can affect opening of the controlled drain valves. The leakage flow would initiate isolation of the main steam lines.

2. HS 41-142,143

a. Function: Control normally open valves on a 3" line from main steam line "B" to the HP condenser shell on LP turbine "A."

b. Failure Effects: Failure of these switches can affect closure of the controlled valves; two 1" lines are still available to supply the HP condenser shell (from HPCI and RCIC steam supply).

B. CRD Hydraulic

1. FE-46-N003; FT-46-N004; FY-46-K001

a. Function: Provide input to the CRD hydraulic manual/auto control station which controls a normally-open, fail-closed valve between the drive water pumps and the HCUs.

b. Failure Effects: Failure of these components can result in closure of the controlled valves. Long-term CRD operation would be impaired, but the ability to scram the control rods would be unaffected.

C. Containment Atmospheric Control

1. FT-57-119; FY-57-119; XC-57-119

   a. Function: Control a normally-closed, fail-closed valve on a line from the liquid nitrogen facility to the primary containment atmosphere.

   b. Failure Effects: A normally closed valve downstream and a bypass line originating upstream of the controlled valve serve redundant functions. Any position of this valve following a HELB would result in no adverse consequences.

D. Primary Containment Instrument Gas

1. PDS-59-106A; PT-59-152A

   a. Function: Control the long term nitrogen supply to the Automatic Depressurization System (ADS) "H", "M", and "S" accumulators.

   b. Failure Effects: Only long term effects would result from a failure of these instruments. The ADS accumulators allow initial ADS operation. In addition, other ADS valves ("E" and "K") and the mechanical, pressure relieving capability of the Safety Relief Valves (SRV) are available.

2. TSH-59-115A

   a. Function: Controls the operation of the instrument gas compressor.

   b. Failure Effects: Failure of this temperature switch could result in a loss of instrument gas from the compressor.

III. Combined Effects

A. The limiting case failure in this zone is a CRD hydraulic line break which adversely affects TSH-59-115A, resulting in a loss of instrument gas. The effects of the break are not exacerbated by the loss of any control systems components in the zone. The loss of instrument gas is bounded by the analysis in FSAR 15.9.6.3, Anticipated Operational Transients, Event 8. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.9.6.3.

   No other combination of a CRD hydraulic line break and control systems component failures results in an event affecting reactor parameters.

Zone D2

Areas 12,16/Elevation 253

I. High Energy System

A. CRD Hydraulic

1. CRD Hydraulic Control Units (HCUs)

a. Function: One CRD HCU controls the movement of one CRD.

b. Effect of Break: Failure of one HCU may result in the inability to insert one CRD. This would not prevent total reactor scram.

II. Control Systems

A. CRD Hydraulic

1. HS-46-127,128

a. Function: These switches control valves in the reactor recirculation pump seal purge lines to both "A" and "B" recirculation pumps.

b. Failure Effects: Failure of these switches can result in closure of the controlled valves. Only long-term recirc pump performance would be affected.

B. Primary Containment Instrument Gas

1. PDS-59-106B; PT-59-152B

a. Function: Control the long term nitrogen supply to the ADS "E" and "K" accumulators.

b. Failure Effects: Only long-term effects could result from failure of these instruments. The ADS accumulators allow initial ADS operation. In addition, other ADS valves ("H", "M", and "S") and the mechanical, pressure relieving capability of the SRVs are available.

III. Combined Effects

A. The reactor parameters will not be adversely affected by an HCU line break and any possible control systems failures in this zone.

Zone D3

Areas 15,16/Elevation 253

I. High Energy System

A. CRD Hydraulic

1. 2" DBD-108/DCD-112

a. Function: Carry CRD drive water from the CRD drive water pumps through the master control station to the HCUs.

b. Effect of Break: Loss of long-term charging water to the HCUs and loss of recirc pump seal purge flow.

II. Control Systems

A. CRD Hydraulic

1. FT-46-N004; FY-46-K001

a. Function: Provide input to the master control station to control CRD drive flow.

b. Failure Effects: Failure of these components can result in closure of the controlled valves. Long-term CRD operation would be impaired, but the ability to scram the control rods would be unaffected.

2. HS-46-127,128

a. Function: These switches control valves HV 46-127,128 in the reactor recirc pump seal purge lines to both the "A" and "B" recirculation pumps.

b. Failure Effects: Failure of these switches can result in closure of the controlled valves; recirc pump performance would not be affected since seal cooling is provided by the Reactor Enclosure Cooling Water system.

B. Containment Atmospheric Control

1. FT-57-119; FY-57-119; XC-57-119

a. Function: Control a normally-closed, fail-closed valve on a line from the liquid nitrogen facility to the primary containment atmosphere.

b. Failure Effects: A normally-closed valve downstream and a bypass line originating upstream of the controlled valve serve redundant functions. Any position of this valve following an HELB would result in no adverse consequences.

C. Primary Containment Instrument Gas

1. PDS-59-106A; PT-59-152A

a. Function: Control the long-term nitrogen supply to the ADS "H", "M", and "S" accumulators.

b. Failure Effects: Only long-term effects would result from a failure of these instruments. The ADS accumulators allow initial ADS operation. In addition, other ADS valves ("E" and "K") and the mechanical, pressure relieving capability of the SRVs are available.

2. TSH-59-115A

a. Function: Controls the operation of the instrument gas compressor.

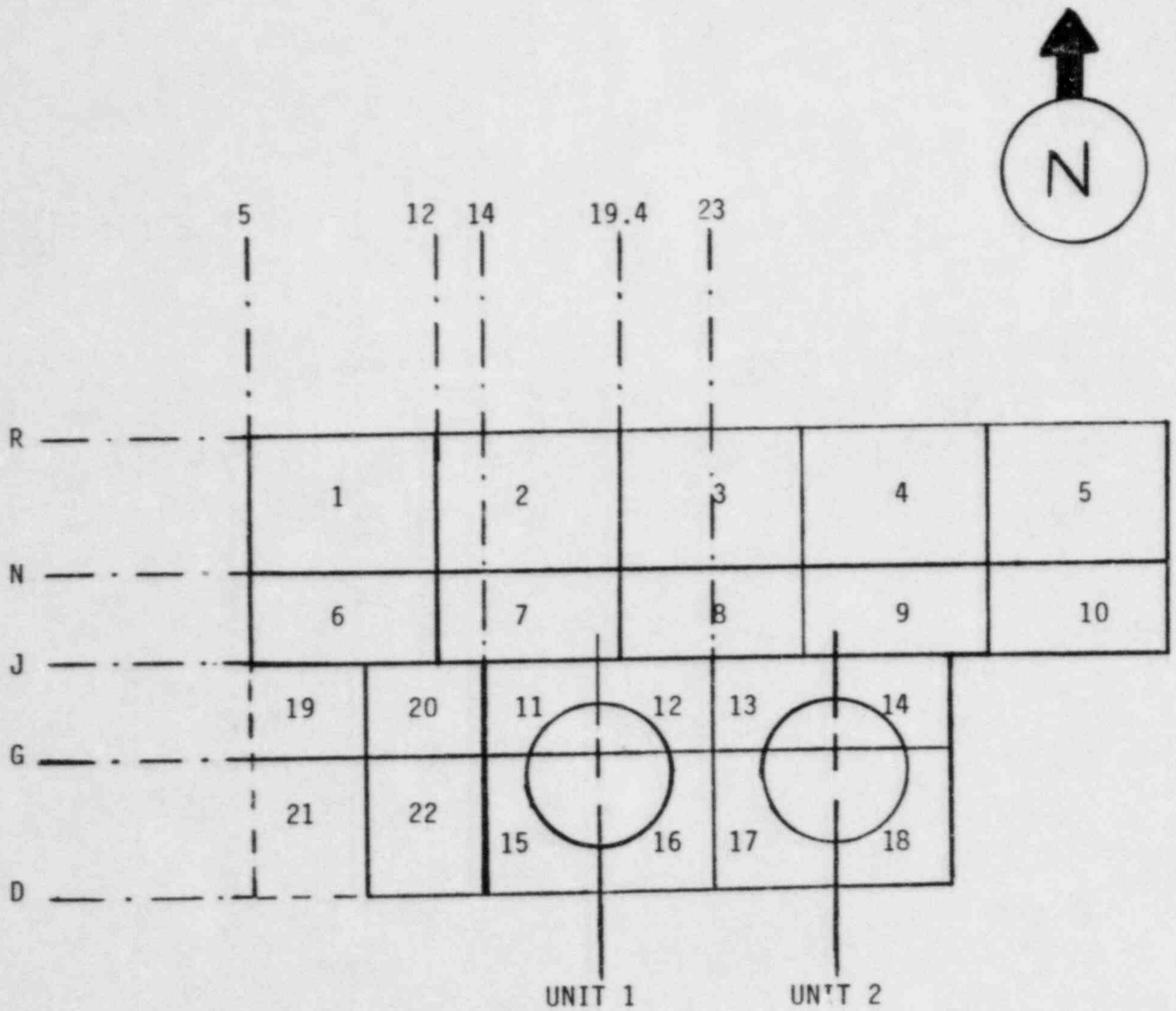
b. Failure Effects: Failure of this temperature switch could result in a loss of instrument gas from the compressor.

III. Combined Effects

A. The limiting case failure in this zone is a CRD hydraulic line break which adversely affects TSH-59-115A, resulting in a loss of instrument gas. The effects of the break are not exacerbated by the loss of any control systems components in the zone. The loss of instrument gas is bounded by the analysis in FSAR 15.9.6.3, Anticipated Operational Transients, Event 8. An additional single active failure in a mitigating system also results in a bounded event, as discussed in FSAR 15.9.6.3.

No other combination of a CRD hydraulic line break and control systems component failures results in an event affecting reactor parameters.

APPENDIX B - FIGURES



LIMERICK GENERATING STATION - DEFINED "AREAS"

FIGURE 1

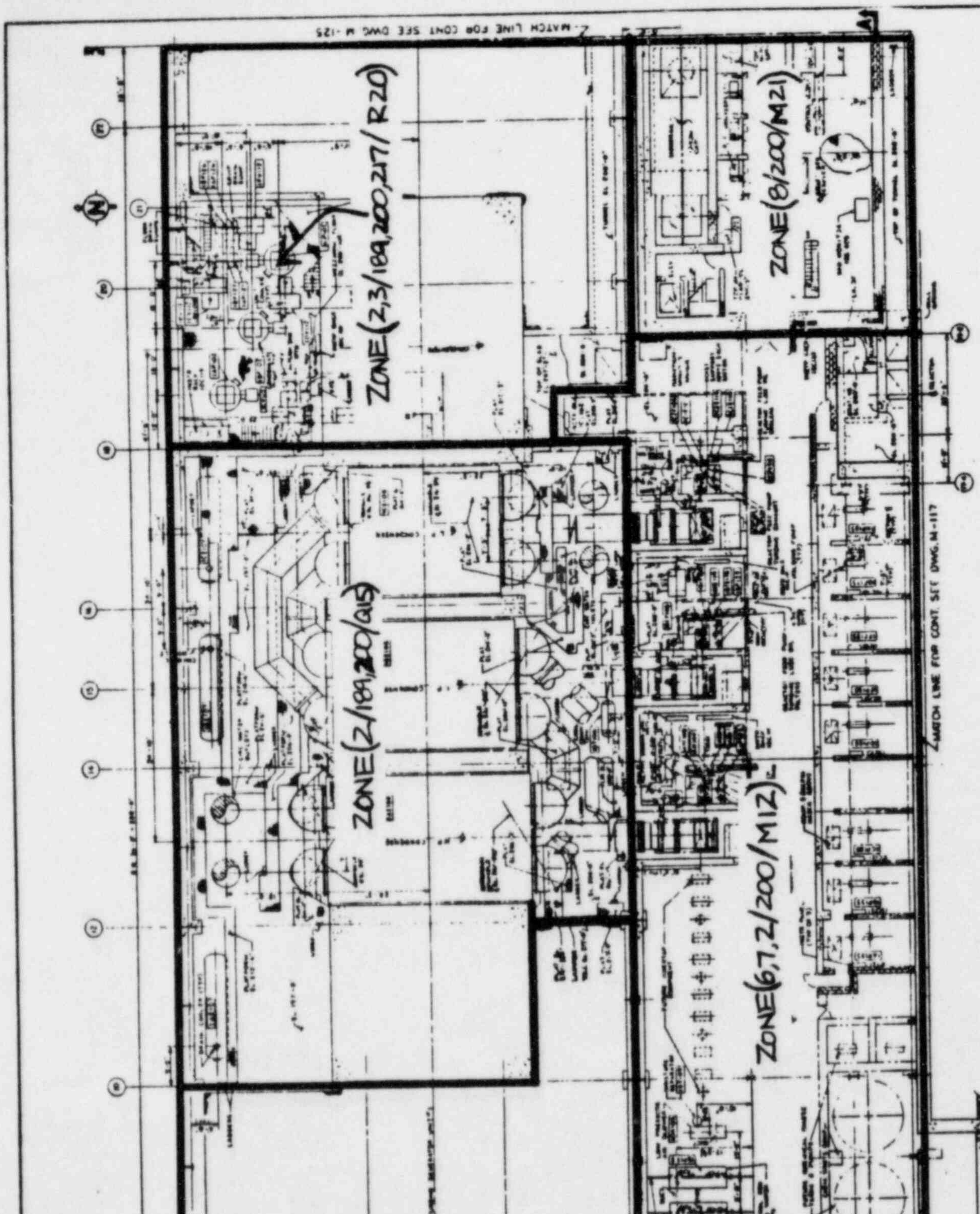


FIGURE 2

GENERAL ARRANGEMENT, TURBINE ENCLOSURE UNIT 1 AND CONTROL STRUCTURE, PLAN AT ELEV. 200 FEET

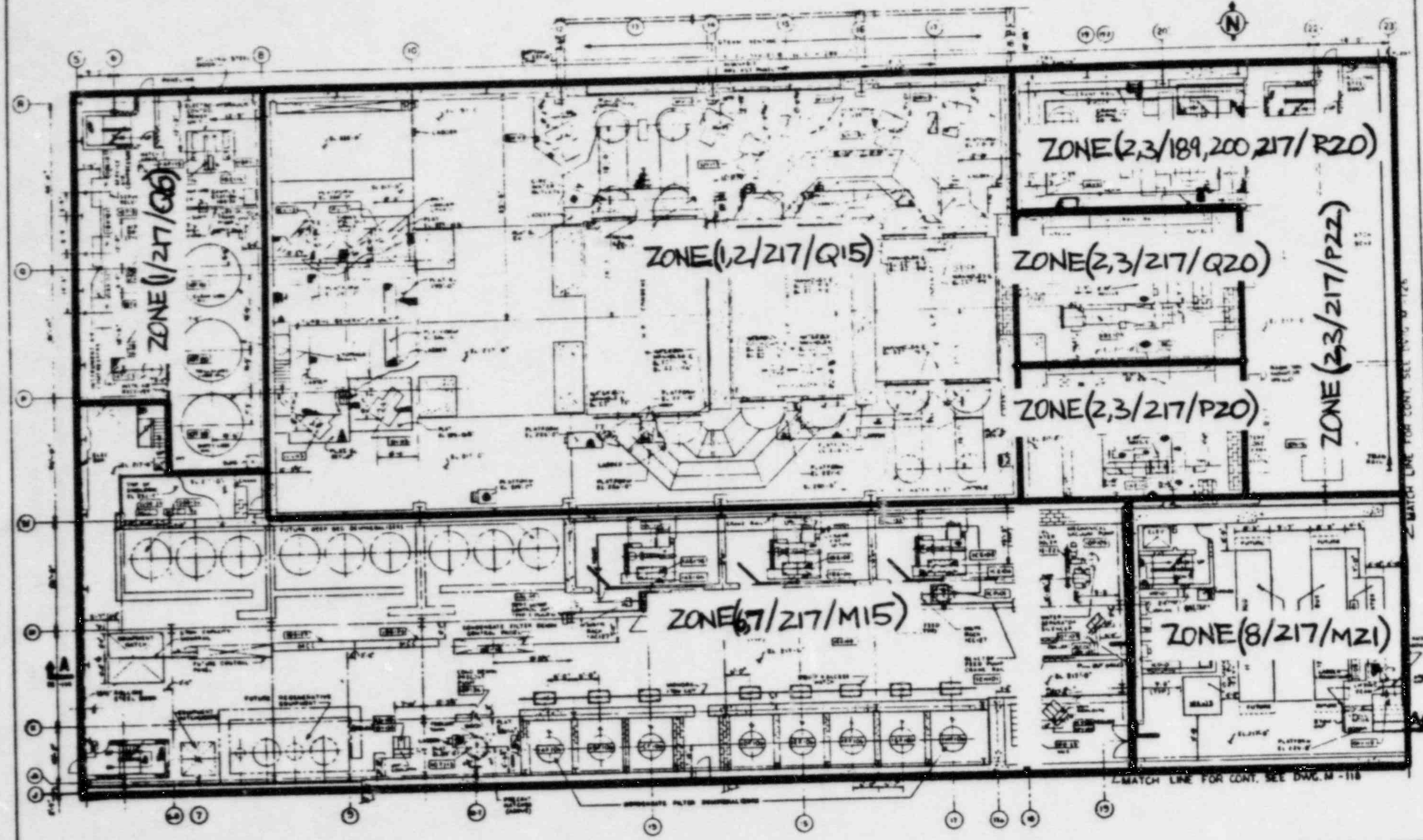


FIGURE 3

EQUIPMENT LOCATION
TURBINE ENCLOSURE,
UNIT 1, PLAN AT EL. 217'0"

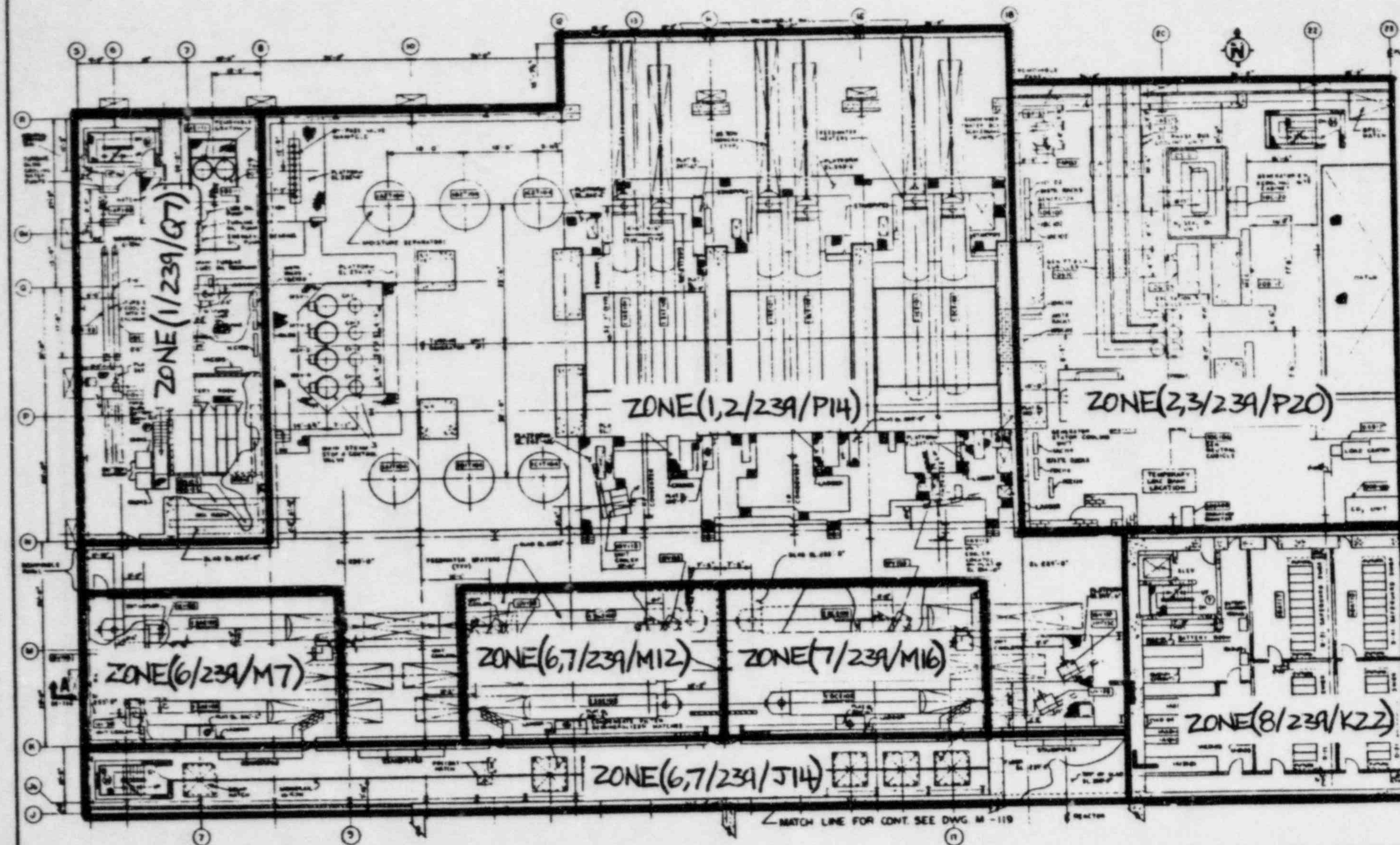


FIGURE 4

GENERAL ARRANGEMENT, TURBINE ENCLOSURE UNIT 1 AND CONTROL STRUCTURE, PLAN AT ELEV. 239 FEET

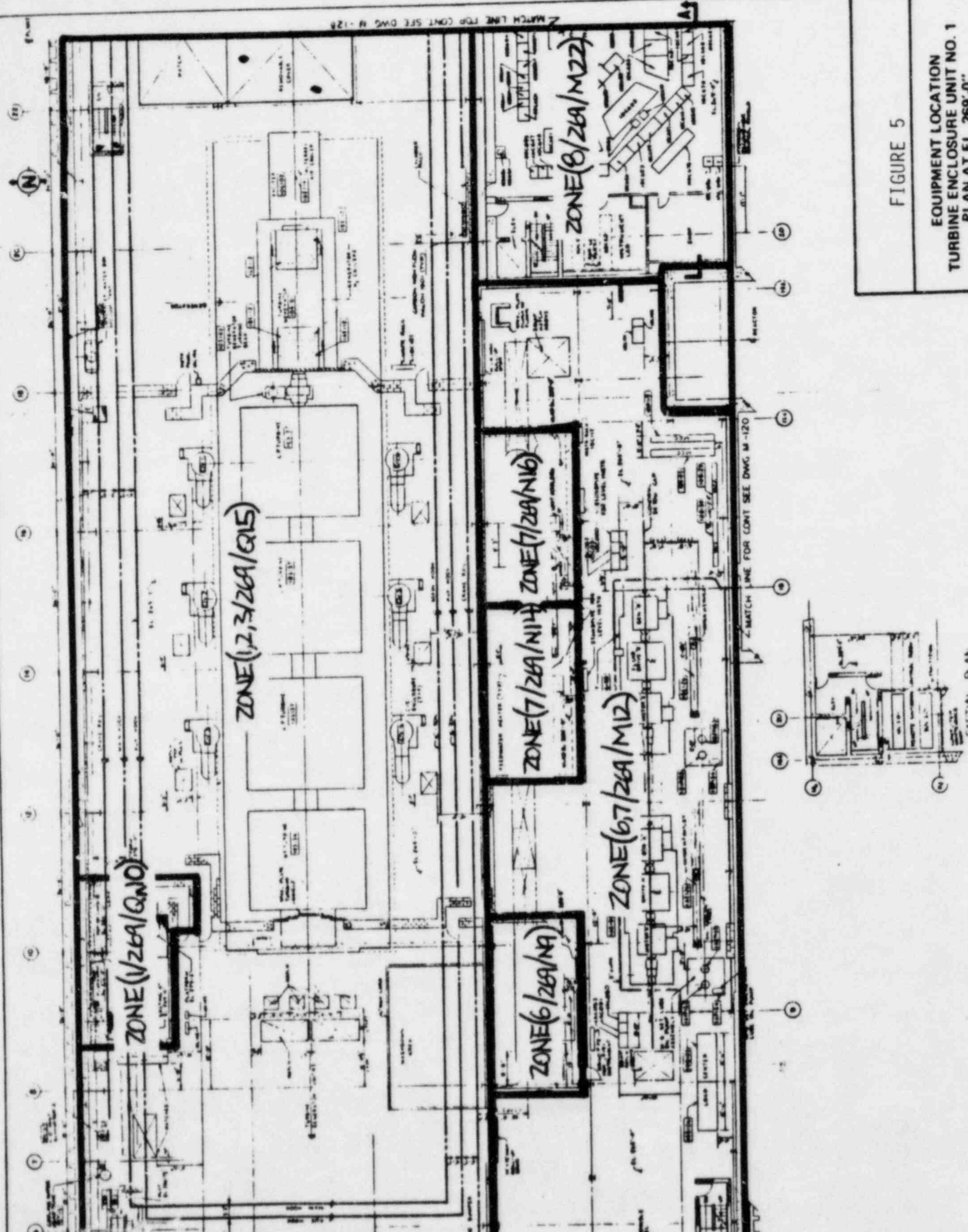


FIGURE 5

EQUIPMENT LOCATION
TURBINE ENCLOSURE UNIT NO. 1
PLAN AT EL. 269'-0"

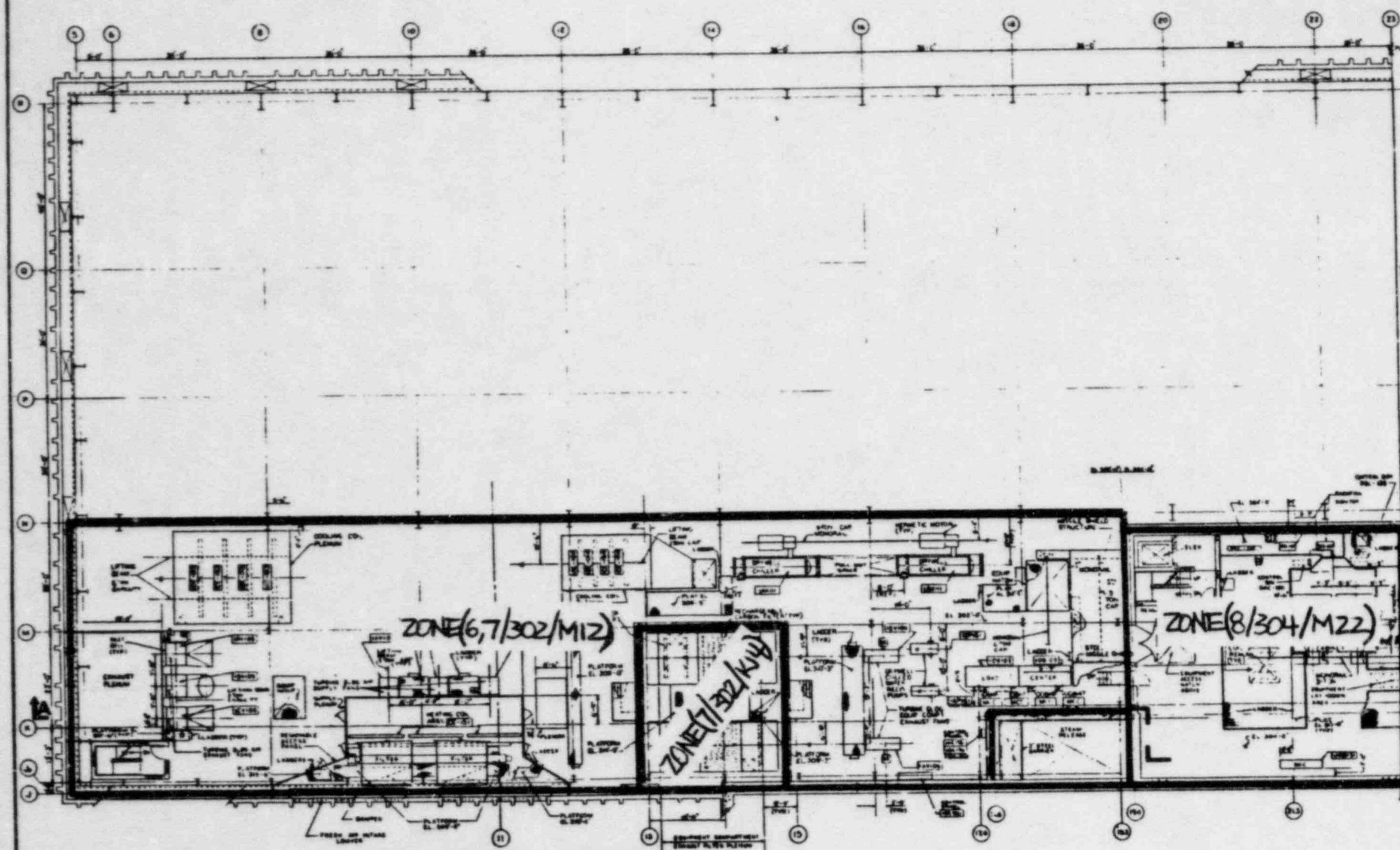


FIGURE 6

GENERAL ARRANGEMENTS, TURBINE ENCLOSURE UNIT 1 AND CONTROL STRUCTURE, PLAN AT ELEV. 302 FEET AND 304 FEET.

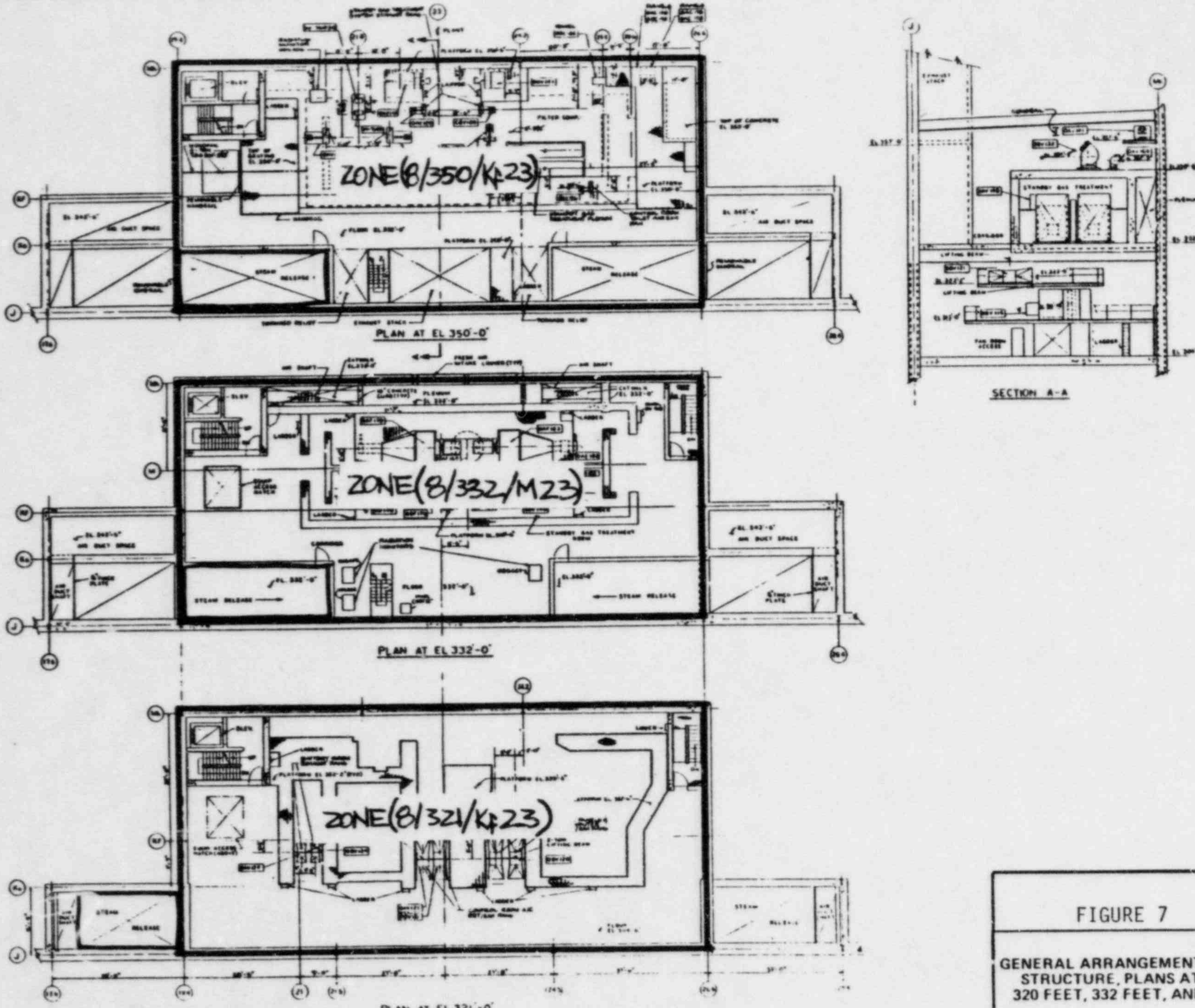


FIGURE 7

GENERAL ARRANGEMENTS, CONTROL STRUCTURE, PLANS AT ELEV. 320 FEET, 332 FEET, AND 350 FEET.

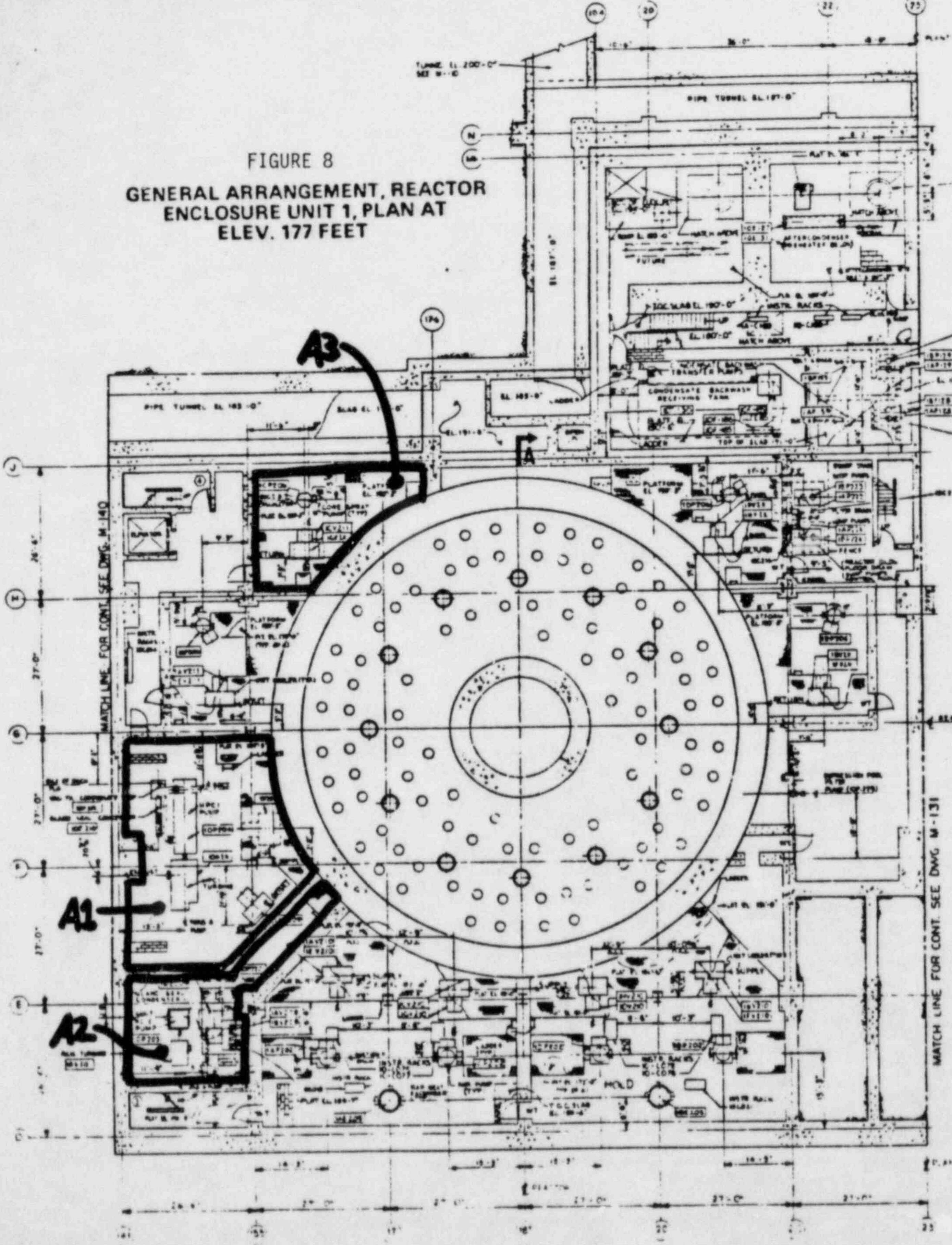


FIGURE 8

GENERAL ARRANGEMENT, REACTOR ENCLOSURE UNIT 1, PLAN AT ELEV. 177 FEET

FIGURE 9

GENERAL ARRANGEMENT, REACTOR ENCLOSURE UNIT 1, PLAN AT ELEV. 201 FEET

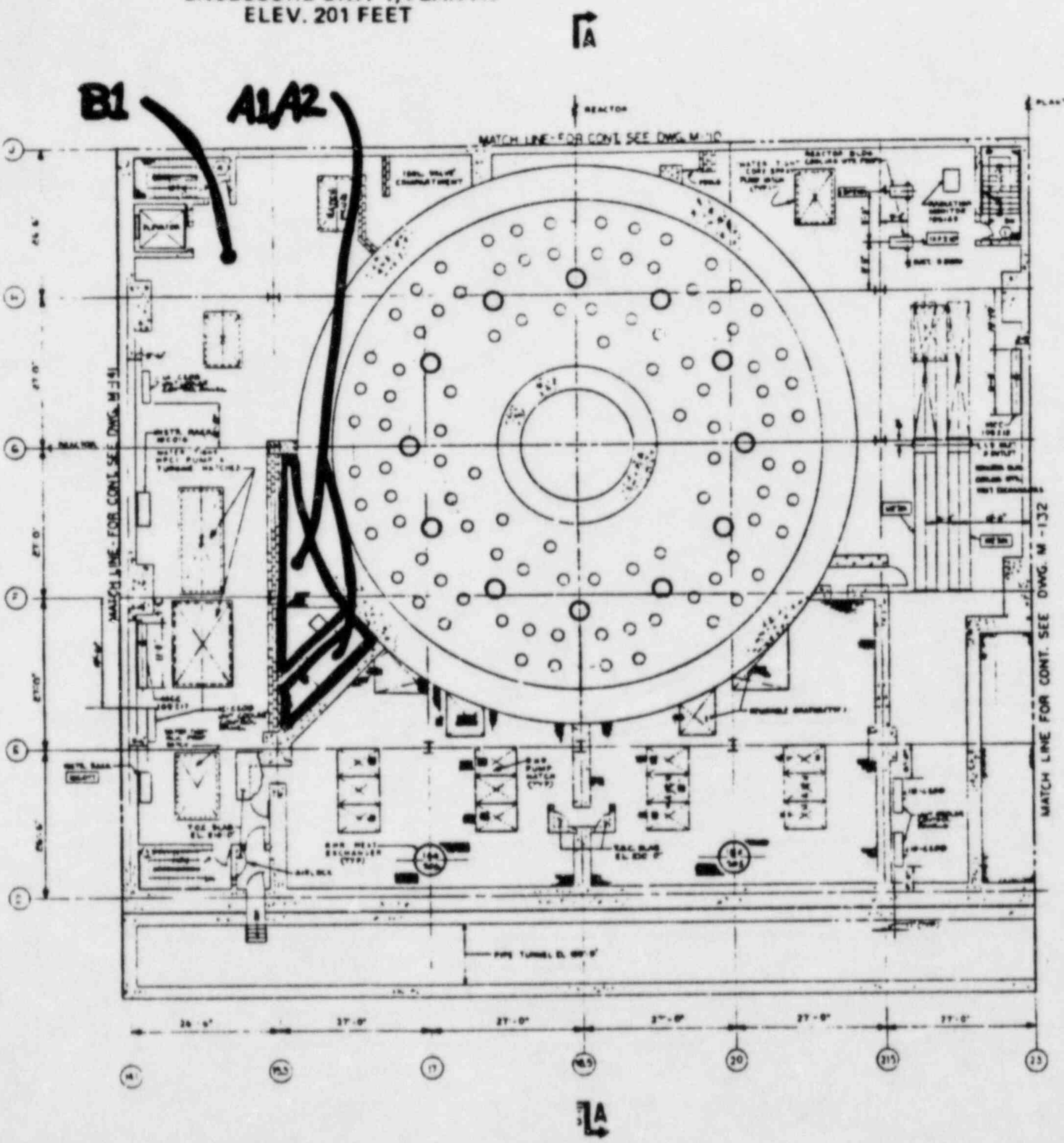


FIGURE 10

GENERAL ARRANGEMENT, REACTOR ENCLOSURE UNIT 1, PLAN AT ELEV. 217 FEET

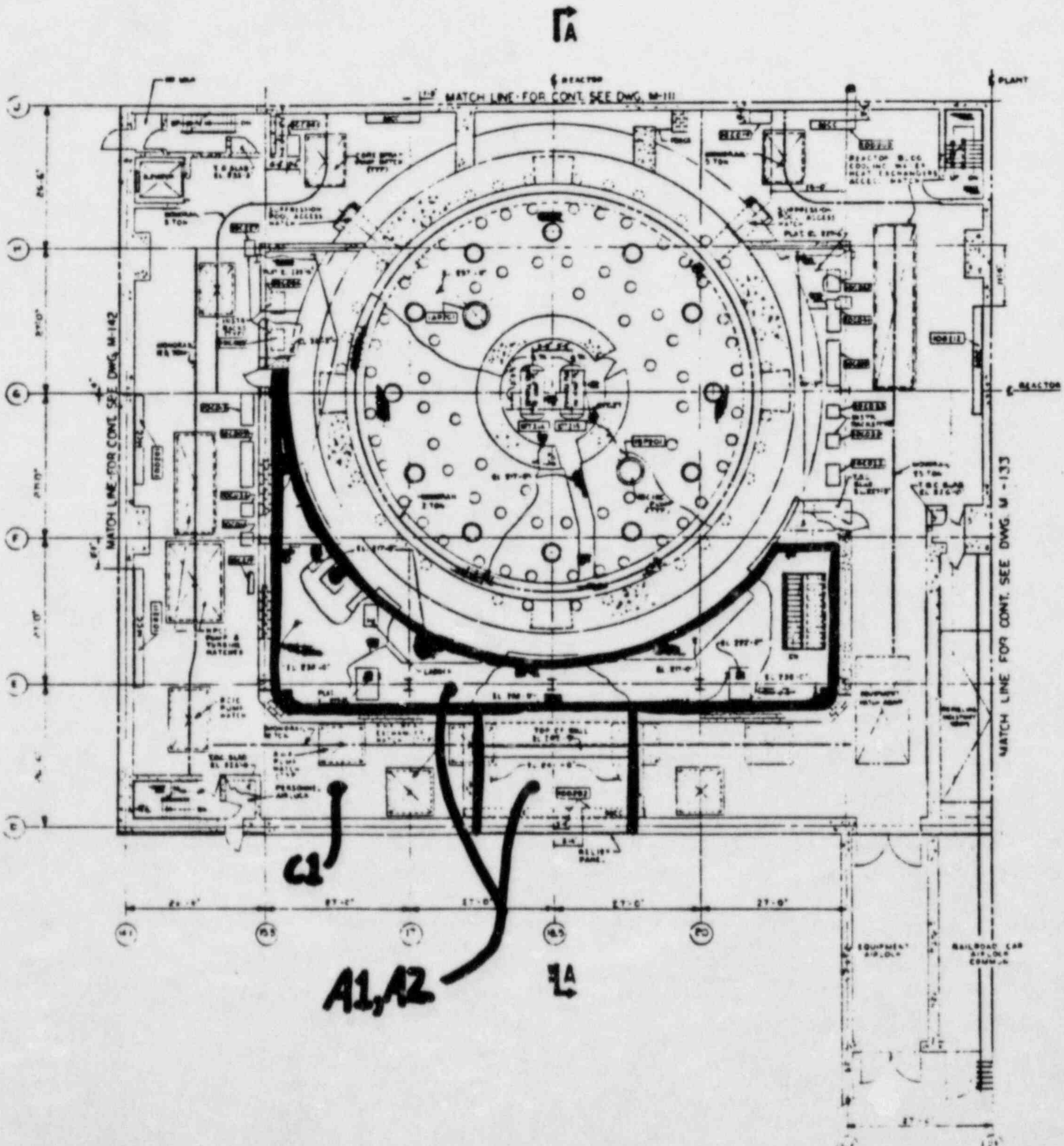
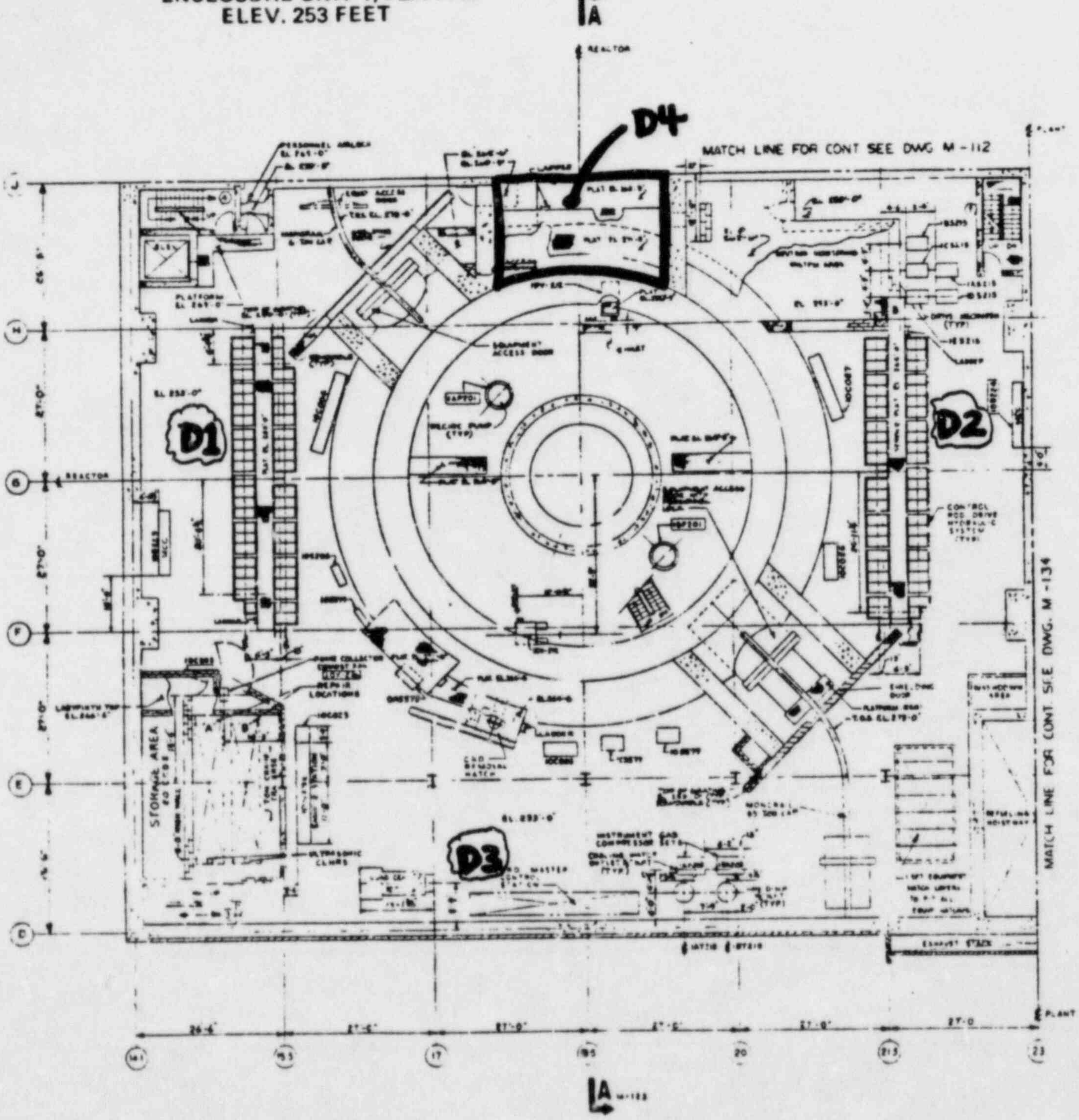


FIGURE 11

GENERAL ARRANGEMENT, REACTOR ENCLOSURE UNIT 1, PLAN AT ELEV. 253 FEET



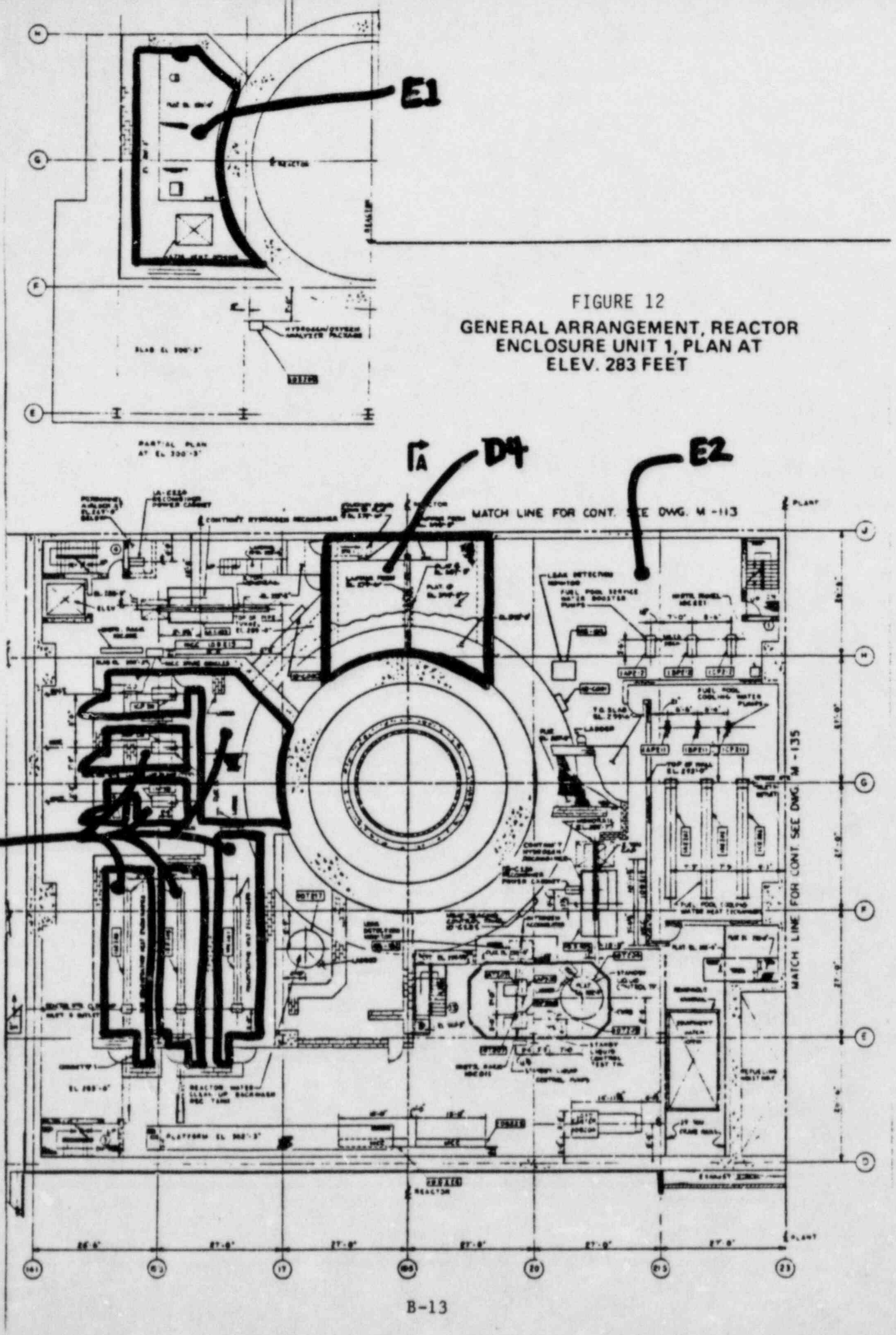


FIGURE 12

GENERAL ARRANGEMENT, REACTOR ENCLOSURE UNIT 1, PLAN AT ELEV. 283 FEET

FIGURE 13

GENERAL ARRANGEMENT, REACTOR ENCLOSURE UNIT 1, PLAN AT ELEV. 313 FEET