HIGH ENERGY LINE BREAK/
CONTROL SYSTEMS FAILURE ANALYSIS

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PUBLIC SERVICE ELECTRIC AND GAS COMPANY

HOPE CREEK GENERATING STATION

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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 nonsafety-related control systems in Hope Creek Generating Station (HCGS). 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 HCGS 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, and as posed to HCGS as FSAR Question 421.52.

1.2 SCOPE OF STUDY

The scope of this HELB analysis was restricted to high energy pipe breaks and their effects on components of nonsafety-related control systems at HCGS. 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 was conducted to determine the consequences of postulated high energy line breaks and their effects on adjacent, nonsafety-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 would 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 all nonsafety-related control systems and components within these systems that could impact the critical reactor parameters (e.g. reactor vessel water level, reactor pressure, and critical power ratio);

2. Establish assumptions and criteria for the identification of high energy lines, location of postulated breaks, and evaluation of consequences of pipe breaks; consider pipe whip, jet impingement, and environmental parameters such as temperature, high pressure, and high humidity;

3. Identify the locations (area/elevation/room), referred to as zones, containing both high energy lines and control systems components determined in item 1. above;

4. Perform a plant walkdown to confirm 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 in a mitigating safety system.

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 nonsafety-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 Section 3.6. The criteria for the elimination of additional systems from the detailed HELB analysis are listed below. These criteria were applied to all of the plant systems.

1. Nonelectrical 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 that provide only monitoring, status, and alarm indications) are excluded. Instrumentation and dedicated inputs into the process computer, as well as the process computer itself, are excluded.

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

4. Control systems that interact or interface with the reactor operating systems directly, but that cannot affect the critical reactor parameters either directly or indirectly in the short term, are excluded. An example is process sampling. 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 such systems would 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 primary 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.

7. Safety systems and safety-related portions of control systems are excluded.

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

MPL	M-System	System
B21	M42	Nuclear Boiler Vessel Instrumentation/Jet Pump Instrumentation System
B21	M25	Plant Leak Detection
B31	M43	Reactor Recirculation System
C11	M46/M47	Control Rod Drive Hydraulic System
C11	-	Reactor Manual Control System
C32	-	Feedwater Control System

C51	-	Neutron Monitoring System
G33	M44/M45	Reactor Water Cleanup System
-	M1	Main Steam System/Main Turbine System/Turbine Control System
-	M2	Extraction Steam System
-	M3/M4	Heater Vent and Drain System
-	M5	Condensate System
-	M6	Feedwater System
-	M7	Condensate Air Removal System
-	M9	Circulating Water System
-	M10	Service Water System
-	M11	Safety Auxiliary Cooling (Reactor Building)
-	M12	Safety Auxiliary Cooling (Auxiliary Building)
-	M13	Reactor Auxiliary Cooling
-	M14	Turbine Auxiliary Cooling
-	M15	Compressed Air System
-	M19	Lube Oil System
-	M20	Auxiliary Boiler Fuel Oil System
-	M21	Auxiliary Steam System
-	M26	Radiological Monitoring System
-	M28	Generator Gas Control System
-	M29	Turbine Sealing Steam System
-	M31	Reactor Feed Pump Turbine Steam System
-	M57	Containment Atmosphere Control System
-	M59	Primary Containment Instrument Gas System
-	M69/M70	Gaseous Radwaste System
-	M82	Turbine Building Supply and Exhaust Vent System
-	M83/M84	Reactor Building Supply and Exhaust Vent System
-	M86	Drywell Vent Control System
-	M87	Chilled Water System
-	M89	Auxiliary Building - Control Area Vent Control System
-	M90	Auxiliary Building - Control Area Chilled Water System
-	-	Generator System
-	-	Generator Excitation System
-	-	Class 1E AC System
-	-	Class 1E DC System
-	-	Non-Class 1E AC System
-	-	Non-Class 1E DC System

2.2 COMPONENT ELIMINATION

The computerized list of all plant components (References 1 and 2) was reduced not only on a 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 that 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 that 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 (MCCs) were included as components subject to failure, and control systems components supplied by the affected switchgear and MCCs 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 were based on criteria established in Reference 3 and in Section 3.6.3 of the HCGS FSAR. High energy piping is defined 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 were classified as moderate energy lines and were, therefore, excluded from the scope of this study. Piping whose diameter is 1 inch NPS or smaller was also excluded.

The following table details the 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 HCGS 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 reactor feedpump suction through feedwater heaters to reactor vessel nozzles
Condensate	From primary condensate pump discharge through steam jet air ejector condensers, steam packing exhauster, condensate filter/demineralizers, and secondary condensate pumps to reactor feedpump suction
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 "A" to RCIC turbine steam supply valve
Main Steam Drain Lines	From main steam lines inside drywell to outboard 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 "A"
Standby Liquid Control	From core spray injection line "A" to inboard 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 inboard check valve
LPCI Injection	From reactor vessel nozzle to inboard check valve
Core Spray Injection	From reactor vessel nozzle to inboard check valves
Control Rod Drive Hydraulic	From drive water pump to master control station to hydraulic control units
High Pressure Drains	Cascading drain lines through feedwater heater trains and dump lines from each feedwater heater to its associated control valve
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 through feedwater heaters to condenser inlet valves; from high and low pressure turbines to feedwater heaters
Air Removal	From main steam line "A" to steam jet air ejector
Turbine EHC	From electro-hydraulic control power unit to turbine stop valves (MSVs), control valves, combined intercept valves (CIVs) and bypass control valves
Plant Heating Steam	From auxiliary boiler steam header to air handling units in various locations
RPV Head Spray Line	From reactor vessel top head to check valve V263
Emergency Diesel Generator Starting Air Line	From starting air skids to emergency diesel generators
Auxiliary Boiler and Steam	From auxiliary boiler to various steam consuming components; from auxiliary boiler generator through auxiliary boiler feed pumps to auxiliary boiler

INITIATING HIGH ENERGY PIPING SYSTEMS (CONTINUED)

FLUID SYSTEM	EXTENT OF HIGH ENERGY PIPING
Solid Radwaste Auxiliary Steam	From the solid radwaste auxiliary boiler to extruder "A" and "B" and asphalt line heat tracing
Turbine Sealing Steam	From auxiliary steam pressure reducing station to HP and LP turbine steam seals
Main Steam Isolation Valve Sealing Steam	From main steam leads A through D to primary instrument gas isolation valves
Solid Radwaste Asphalt Recirculation	From asphalt storage tank to asphalt recirc pumps A and B and return to storage tank
Solid Radwaste - Volume Reduction	From crystallizer vapor compressor discharge to crystallizer heater, entrainment separator, vapor condenser, recirculation pump, distillate pumps A and B, and condensate tank
Liquid Radwaste	From decontamination solution evaporator to south plant vent; from waste concentrators A and B to concentrator waste tanks A and B and waste neutralizer tanks A and B
Gaseous Radwaste	From steam jet air ejector discharge to recombiner feed gas cooler condenser including feed gas recombiner preheater drains

2.4 ZONE DETERMINATION

The Turbine and Reactor Buildings in the HCGS 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. 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.

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

The Auxiliary and Radwaste Buildings were not divided into zones as were the Turbine and Reactor Buildings. After eliminating components per the criteria in Sections 2.2 and 2.3 and considering the high energy lines in the Auxiliary and Radwaste Buildings, only one identifiable HELB/non-safety control component interaction "zone" emerged. Only this zone-location was analyzed in Appendix A.

2.5 PIPE BREAK LOCATIONS AND EFFECTS

2.5.1 PIPE BREAK LOCATIONS

The high energy pipes defined by the table in Section 2.3.1 of this report were 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 reactor building studies in FSAR Section 3.6.1. Piping evaluated via previous HELB studies (see FSAR Section 3.6) were considered to break as defined in those studies. Only one pipe break was 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 was 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 were 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, and/or radiation) were enveloped by employing the "sacrificial" approach as defined in Section 2.4. 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 guidance of FSAR Section 3.6. Movement of a circumferentially broken pipe was 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 was assumed to move in an arc with a radius from the break to the hinge point and motion was assumed to be limited by pipes of equal or greater diameter or reinforced concrete walls, floors, or columns. The whipping pipe was assumed capable of incapacitating any control systems component within the arc of its motion. The "sacrificial" approach defined in Section 2.4 envelopes these pipe whip considerations.

2.5.2.2 JET IMPINGEMENT CONSIDERATIONS

Jet impingement was considered for both circumferential and longitudinal breaks. The criteria used for evaluating the effects of jet impingement are consistent with those listed in FSAR Section 3.6. The basic approach assumed was that the jet from a postulated break is sufficient to fail all impacted components within the jet's cone of influence as calculated by the Bechtel Jet 2 Code/Moody Methodology, except in those areas where major structures provide natural barriers. The "sacrificial" approach defined in Section 2.4 envelopes these jet impingement considerations.

2.6 PLANT WALKDOWN

2.6.1 WALKDOWN PREPARATION

The Architectural, Piping and Mechanical, and Instrument Location Drawings (Reference 4) 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, to confirm the location of control systems components, and to assess the proximity of the components and associated taps and tubing to high energy lines.

Using the pipe break criteria described 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 that 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.

2.7 ZONE ANALYSIS

A 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 that 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 were 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 HCGS FSAR Chapter 15 to ensure they are less severe than the existing analyses. The discussions of single failures in FSAR Chapter 15 were reviewed, considering the high energy line break, to determine whether or not an additional single active component failure in a mitigating safety system could exacerbate the original event.

3.0 CONCLUSIONS AND RECOMMENDATIONS

Appendix A presents summaries of the results of the analysis performed for those zones of the Turbine, Reactor, Auxiliary, and Radwaste Buildings that required the detailed analysis described in Section 2.7. The "sacrificial" approach, as defined in Section 2.4, was applied, and conservative assumptions were applied to all analyses of system failures. No credit was 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 were examined. In many cases, the consequences of the postulated HELB would not be 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 identify the appropriate FSAR Chapter 15 events that discuss the effects of a single additional active component failure in a mitigating safety system, and that exhibit the same or more severe effects than the postulated events (i.e., "bounding" events).

The analyses for Zones F, H, U, W, X, Y, and CC uncovered an accident scenario that is not specifically addressed in the Chapter 15 analyses. In particular, by reducing the feedwater temperature, a delayed turbine trip could be initiated at a power level higher than that assumed in FSAR 15.2.3. The worst case transient is a turbine trip at a power level just below the high thermal power monitor scram setpoint. A computer analysis was performed for this worst case transient that used the initial conditions, assumptions, and computer codes identified in the HCGS FSAR Section 15.0. The transient effects, as defined by this FSAR-type computer analysis, remain within the allowable limits for Infrequent Incidents (FSAR 15.0.3.1.2), even though the postulated event would be classifed as a Limiting Fault.* An additional single active component failure in a mitigating safety system would not exacerbate this event.

As noted in Appendix A, all other combined effects are bounded by the accident and transient events analyzed in FSAR Chapter 15. It is concluded that all postulated high energy line breaks and resulting control systems failure events would pose no threat to the transient and accident limits set forth in FSAR Chapter 15, and would not result in any significant risk to the health and safety of the public. No additional accident analyses or design modifications are recommended.

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*An "Infrequent Incident" is defined in the FSAR as an incident that can occur occasionally during the life of the plant, spanning once in 20 years to once in 100 years. They are referred to as "abnormal (unexpected) operational transients." A "Limiting Fault" is defined in the FSAR as an incident that is not expected to occur during the life of the plant. They are referred to as "design basis accidents." The allowable limits for Infrequent Incidents are more stringent than the allowable limits for Limiting Faults.

4.0 REFERENCES

1. HCGS, "Equipment Report," run date: 12/3/83

2. HCGS, "Instrument Report," run date: 5/10/84

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. HCGS, "Architectural Drawings," "Instrument Location Drawings," and "Piping Area Drawings"

APPENDIX A

ANALYSIS SUMMARY

The format followed throughout this Appendix is described in Section 2.7.

TURBINE BUILDING

The Turbine Building 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 located within this zone were eliminated per the criteria detailed in Sections 2.1 and 2.2 of this report. Therefore, no applicable control systems components are located within this zone.

Zone Designation	Area(s) Contained (See Figure 1)	Elevation(s) Contained	Reason for Elimination
A	1,2,4,5,8,9,10,11,12	54	-
B	3,4	54	1,2
C	9,10,11,12	54	2
D	6,7	54	1
E	1,2,5,7	54,77	-
F	2,3,4,6,7,8 1,2,3,4,5,6,7,8 2,3,4,6,7,8	54,77 102 120	-
G	4	77	1,2
H	1,2,4,5,8,9,10,11,12	77,81	-
I	11,12	77,81	2
J	11,12	77	-
K	10,11	77	-
L	9,10	77	-
M	9	77	-
N	4,8,12	102	-
O	8	102	1,2
P	11,12	102	-
Q	10,11	102	-
R	9	102	-
S	9,10,11,12	102	-
T	4,8,12	120	1
U	10,11,12	120	-

Zone Designation	Area(s) Contained	Elevation(s) Contained	Reason for Elimination
V	1,2,5,6,9,10	120	-
W	10	137	-
X	9,10	137	-
Y	11,12	137	-
Z	11	137	-
AA	12	137	1
BB	9,10,11,12	171	-
CC	1,2,3,4,5,6,7,8,9,10,11,12	137	-

Zone A

I. High Energy Systems

A. Condensate

1. 14"/20" AD-111, 112, 113

a. Function: Secondary condensate pump discharge lines to common header 20" AD-107.

b. Effect of Break: Loss of condensate/feedwater flow to vessel. Feedwater pumps trip on low suction pressure. A line break would result 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).

B. Gaseous Radwaste

1. 8"/12" HA-012

a. Function: SJAE A&B discharge common header to Unit 1 gaseous radwaste recombiner, startup preheat drain (through closed valve HV-5664) and to common gaseous radwaste recombiner (thru closed valve HV-5694-1).

b. Effect of Break: Loss of SJAE flow to gaseous radwaste recombiner.

II. Control Components

A. Condensate

1. PDT, PY-1719

a. Function: Control PDV-1719 in bypass line around steam packing exhauster condenser.

b. Failure Effects: Valve is normally closed; it could remain closed or go open.

2. HV-1648A,B,C

a. Function: Inlet valves for secondary condensate pumps from condensate filter/demineralizer system and primary condensate pumps.

b. Failure Effects: Normally open valves could remain open or go closed.

3. PT-1645A,B,C

   a. Function: Trip off secondary condensate pumps on low suction pressure.

   b. Failure Effects: The secondary condensate pumps could either trip or a trip condition could go unmitigated.

4. FE-1650A,B,C; FSL-1650A2,B2,C2

   a. Function: Trip off secondary condensate pumps on low inlet flow.

   b. Failure Effects: The secondary condensate pumps could either trip or a trip condition could go unmitigated.

5. FSL-1650A1,B1,C1

   a. Function: Control minimum flow recirc line valve FV-1650A,B,C for each of the secondary condensate pumps.

   b. Failure Effects: Valves are normally closed; they could remain closed or go open.

B. Condenser Air Removal

1. PT, PY-1964A,B

   a. Function: Control valves PV-1964A,B in bypass line from third stage SJAE discharge to condenser (bypass Gaseous Radwaste recombiner). Opens bypass valve on high pressure.

   b. Failure Effects: Valves are normally closed; they could remain closed or go open.

2. FT-1971B

   a. Function: Controls HV 2016B, normally closed valve in main steam supply line to SJAE Train B.

   b. Failure Effects: Valve could remain closed or go open.

C. Circulating Water

1. PSL-2110

   a. Function: Trips condenser dewatering pumps 1AP106, 1BP106 on low suction pressure.

   b. Failure Effects: Unable to drain water boxes during shutdown only. No effect during startup or power operations.

2. RE, RY-4557; XC-7852; HS-7852A,B

   a. Function: Controls for tripping circulating water sump pumps 1AP168, 1BP168 (floor and equipment drains). Pumps discharge to cooling towers and are used for pumping floor drains and condensate water box vents.

   b. Failure Effects: No effect during startup or power operations.

III. Combined Effects

A. The Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6) would not be exacerbated by the control component failures in this zone. An additional single active failure in a mitigating safety system would also result in a bounded event, as described in FSAR 15.6.6.

B. A break in the Gaseous Radwaste piping in this zone could incapacitate control system components such that, in the worst case, a loss of condensate/feedwater flow could result. This event is bounded by the Loss of Feedwater Flow event (FSAR 15.2.7). An additional single active failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.2.7.

Zone E

I. High Energy Systems

A. Condensate

1. 14" AD-111,112,113

Same as Zone A (A.1).

II. Control Components

A. Condensate

1. HV-1639A,B,C

a. Function: Inlet valves for primary condensate pumps

b. Failure Effects: These are normally open butterfly valves that can remain open or go closed.

2. HV-1680A,B,C

a. Function: Primary condensate pump discharge valves.

b. Failure Effects: Normally open gate valves remain open or go closed.

III. Combined Effects

A. The Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6) would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.6.6.

Zone F

I. High Energy Systems

Due to the number of high energy lines in this zone, each line's failure effects will not be detailed. Rather, the bounding events will be defined following this list of affected HELs.

28" AB-001,002,003,004

Main steam lines (MSLs)

14"/18" AB-005,006

From MSLs to bypass valve manifold

16" AC-011

HP turbine extraction steam to sixth feedwater heaters

14"/18" AC-012

Crossaround steam to fifth feedwater heaters

8"/12"/14" AC-031,042

From moisture separator drain tanks to fifth feedwater heaters

24"/30" AD-061

Common header from second feedwater heaters to third heaters

24" AD-104,105,106

From secondary condensate pumps to first feedwater heaters

24"/30" AD-107

Common header from secondary condensate pumps to feedwater heater trains

14" AD-111,112,113

From secondary condensate pumps to AD-107 (above)

8"/10" AD-119

Auxiliary boiler steam to condenser deaeators

10" AD-152

Main steam supply to condenser hotwell steam spargers

12" AE-014,015,016

Minimum flow recirculation line for feed pumps (return to condenser)

26" AF-001,003,019,034

LP turbine extraction steam from ninth stage to third feedwater heaters

16" AF-004

Eighth stage LP turbine extraction steam to fourth feedwater heaters

16" AF-005,021,036

Inlet of extraction steam to fourth feedwater heaters from AF-004 above

32" AF-009,010,017,018,024,025,032,033,039,040,047,048; 18"/26" AF-013; 20" AF-011,012,015,016,026,027,030,031,041,042,045,046; 18" AF-028,043; 16" AF-014,029,044

LP turbine extraction steam to first and second feedwater heaters

14" AF-051,055,059

HP turbine extraction steam to sixth feedwater heaters

8"AF-072,073,074

Sixth feedwater heater dumps to condenser

3" AF-078,079,080

Fifth feedwater heater vent lines to condenser (startup)

14" AF-090,091,092

Fifth feedwater heater dumps to condenser

3" AF-096,097,098

Fourth feedwater heater vent lines to condenser (startup)

16" AF-105,106,107

Fourth feedwater heater dumps to condenser

4" AF-117,118,119

Third feedwater heater vent lines to condenser

18" AF-120,121,122

Drain lines from fourth feedwater heaters to third heaters

16" AF-138,139,140

Third feedwater heater dumps to condenser

16" AF-141,142,143; 24" AF-144,145,146

Drain lines from third feedwater heaters to second heaters

6" AF-180

HP turbine packing leakoff to third feedwater heaters

3"/8" CA-006

Steam seal return from CIVs to condenser

6" CA-012

Auxiliary steam to sealing steam system

3" CA-019

Steam seal evaporator to third feedwater heaters and to condenser

8"/12" CA-030

Sealing steam drain from HP turbine to condenser

8" CG-028

Auxiliary steam to SJAE train A

The following Chapter 15 events bound the consequences of the above listed line breaks:

- FSAR 15.1.1, Loss of Feedwater Heating
- FSAR 15.2.3, Turbine Trip
- FSAR 15.2.5, Loss of Condenser Vacuum
- FSAR 15.2.7, Loss of Feedwater Flow
- FSAR 15.2.8, Feedwater Line Break
- FSAR 15.6.4, Steam System Piping Break Outside Primary Containment
- FSAR 15.6.6, Feedwater Line Break Outside Primary Containment

II. Control Components

Due to the number of control components in this zone, only the overall, worst case failure effects will be detailed, ordered by system.

A. Main Steam

1. HV-1005, 1013A-D, 1015, 1017A,B, 1018A,B, 1026, 1041A,B,C, 1042A,B,C, 1043A,B,C, 1065; SV-1017A,B, 1018A,C; LV-1039A,B

   The worst case failure would be to abort a startup; there would be no effects during normal operations.

2. SV-7089 to 7096, 7099A-D, 7100A-D, 7101A-D, 7102A-D; PSLL-3588A,B, 3589A,B,C

   The failure effects of these components include: inadvertent bypass valve opening, turbine trip, recirculation runback, and a startup abort.

B. Extraction Steam

1. HV, SV-1355A,B,C, 1359A,B,C, 1365A,B,C, 1373A,B,C, 1377A,B,C, 1387A,B,C, 1388A,B,C; HV-1357A,B,C, 1358A,B,C; SV, XV-1369A,B,C, 1374A,B,C, 1375A,B,C

   A slight loss of feedwater heating could result from the failure of these components.

C. Vents and Drains

1. HV, SV-1450A,B,C; HV, SV, ZS-1455A,B,C, 1459A,B,C, 1461A,B,C, 1462A,B,C, 1477A,B,C, 1479A,B,C, 1480A,B,C; HV-1468A,B,C, 1469A,B,C, 1511A,B,C, 1520A,B,C, 1529A,B,C; LT-1451A,B,C, 1453A,B,C, 1457A,B,C, 1458A,B,C, 1464A,B,C, 1481A,B,C; LV, SV-1451A,B,C, 1505A,B,C, 1513A B,C, 1521A,B,C, 1531A,B,C, 1532A,B,C; LY-1451A,B,C, 1464A,B,C, 1505A,B,C, 1532A,B,C; LV-1464A,B,C

   The potential effects of failure include a loss of feedwater flow and a loss (<100°F) of feedwater heating.

D. Condensate

1. HV-1620A,B,C, 1625, 1692, 1746B,C; HCV-1692, 1695; FV, SV-1650A,B,C; FY-1650A2, A4, B2, B4, C2, C4; LT-1657B,C, 1658B,C; LV-1686, 1687

   The potential effects of failure include a loss of feedwater flow, a loss (<100°F) of feedwater heating, and a startup abort.

E. Feedwater

1. FV, SV, FY, ZS-1783A,B,C

Failure of these components, such that the recirculation flow control valves open, would result in a loss of feedwater flow.

F. Condenser Air Removal

1. HV-1959A,B, 1972A,B,C

The worst case failure effects would result in a turbine trip.

G. Circulating Water

1. HV, SV, ZS-2138A1 to 4, B1 to 4, C1 to 4, 2139A1 to 6, B1 to 6, C1 to 6; HV-2102A,B,C, 2103A,B,C, 2104A,B,C, 2105A,B,C

A main turbine trip on low condenser vacuum or a startup abort could occur from the failure of these components.

H. Turbine Auxiliaries Cooling

1. FSL-2435; HS, HV, SV-2653A,B; HV, SV-2464A,B,C; HSS-2905, LSH-2400A,B; MSH-2429A,B, 2903; PDSH-2442A,B,C; TISH-2436A,B, 2443, 2903A,C,F; TV, TY-2625; ZS-2907A,B

There would be only long-term consequences from the failure of these components.

I. Generator Gas Control

1. Panel 10C120

Loss of this panel could result in a turbine trip.

J. Turbine Sealing Steam

1. LV-2004

If this valve were to close, a loss (<100°F) of feedwater heating would occur.

K. Reactor Feed Pump Turbine Steam

1. HV-1766A

If this valve were to close, a loss of one of the three feedwater pumps would occur.

III. Combined Effects

The bounding effects listed in Section I of this zone are of short duration, i.e., they are over in seconds; the only exception is the loss of feedwater heating event. For the "quick" transients, no control component failure or combination of failures could exacerbate the original event. An additional single failure in a mitigating safety system would also result in bounded events, as detailed in the respective FSAR sections.

The Loss of Feedwater Heating event (FSAR 15.1.1), combined with the worst case control components failures in this zone, could result in a turbine trip at an elevated power level. The results of this event are described in Section 3.0 of this report.

Zone H

I. High Energy Systems

A. Condensate

1. 16"/24"/30" AD-107

a. Function: Common header from secondary condensate pumps to feedwater heaters 1A,B,C.

b. Effect of Break: A break in the condensate piping in this zone results in loss of feedwater flow to the reactor vessel. The consequences of the transient are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

2. 24"/30" AD-061

a. Function: Common header line from feedwater heaters 2A,B,C to third feedwater heaters (3A,B,C).

b. Effect of Break: A break in the condensate piping in this zone results in loss of feedwater flow to the vessel. The consequences of the transient are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

B. Turbine EHC (Fluid Actuator Supply Lines)

1. 1½"/2" VCT-001,002,003,004,005

a. Function: Supply high pressure oil to maintain main turbine CIVs open and control the control and bypass valves.

b. Effect of Break: Loss of EHC pressure results in immediate turbine trip and scram on loss of EHC pressure and/or MSV closure. The consequences of this break are bounded by a Turbine Trip event (FSAR 15.2.3).

C. Plant Heating Steam

1. 4" GA-013

a. Function: Header from heating unit 1AVE104 to condensate return unit 10T114.

b. Effect of Break: The auxiliary boiler system must use demineralized water as makeup. The auxiliary steam/plant heating steam could continue to function normally.

D. Auxiliary Steam

1. 6" FB-001

a. Function: Auxiliary steam from auxiliary boiler units to startup sealing steam and RFPTs for startup testing, SJAEs for startup and condenser deaeration and heating for startup.

b. Effect of Break: Loss of auxiliary steam could abort a startup; no effect during power operation.

II. Control Components

A. Turbine EHC

1. TSH-7071,7073,7074; HS-7073

a. Function: Space heater and fan for EHC power unit area. Turns fan on and off to maintain temperature below 85°F.

b. Failure Effects: No effect on EHC if fan controls fail.

B. Vents and Drains

1. Feedwater Heater Control Panels 1AC102, 1BC102, 1CC102

a. Function: Controls for drain and dump valves, extraction steam supply valves, and various RFPT trip functions for each of the three feedwater heater strings A,B,C.

b. Failure Effects: Failure of a single feedwater heater control panel could result in the isolation of one train of feedwater heaters, and a reduction in feedwater flow due to the trip of one secondary condensate pump, the opening of one minimum flow recirculation valve for a secondary condensate pump, or the trip of one RFPT.

C. Condensate

1. HV-1654

a. Function: Controls bypass flow (16" line) around secondary condensate pumps directly to first feedwater heaters (1A,B,C).

b. Failure Effects: Valve is normally closed, could go open or remain closed.

2. LV-1657-2; LY-1657-4

a. Function: Control condenser hotwell level - reject line (reject to CST), valve opens on high level in condensers.

b. Failure Effects: Normally closed globe valve, could open or remain closed.

3. FE, FT, FV, FY-1677

a. Function: Controls flow to CRD pump suction.

b. Failure Effects: Lose manual control of control rods. Scram would not be affected.

4. HV-1651A,B,C

a. Function: Secondary condensate pump discharge valves leading to common header.

b. Failure Effects: Valves are normally open gate valves that could go closed or remain open.

D. Turbine Auxiliaries Cooling

1. TE, TV, TY-2661

a. Function: Control cooling water for EHC fluid coolers.

b. Failure Effects: The worst case failure would be for the valve to close, resulting in only long term consequences.

III. Combined Effects

A. The condensate line breaks are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6). This event would not be exacerbated by the control component failures in this zone. An additional single active failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.6.6.

B. The Turbine Trip event (FSAR 15.2.3) would not be exacerbated by the control component failures in this zone. An additional single active failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.2.3.

C/D. Neither the Plant Heating Steam nor the Auxiliary Steam pipe break would result in a transient event in and of itself. However, the effects on the control systems components are such that the following cases are possible:

1. The loss of specific components within one feedwater heater control panel could result in, at worst, a loss of some (<100°F) feedwater heating, without affecting feedwater flow. This event is bounded by the Loss of Feedwater Heating event (FSAR 15.1.1). An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.1.1.

2. The loss of specific components within two feedwater heater control panels could result in:

a. A loss of feedwater flow due to the isolation of feedwater flow through two feedwater heater strings (resulting in a feedwater pump trip on low suction pressure), the trip of the RFPTs on false high-high condenser pressure signals, trip of the RFPTs on false high speed and low suction pressure to the feedwater pumps, or trip of two secondary condensate pumps on false low flow or low suction pressure signals. In any of the cases noted above, the consequences are bounded by the Loss of Feedwater Flow event (FSAR 15.2.7). An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.2.7.

b. A loss of some feedwater heating. In the worst case, this loss of feedwater heating would not be coupled with lower feedwater flow (as discussed above). This would require failure of only selective components in two control panels. Such an event is described here only to present the worst case possibility, without evaluation of probability. The consequences of this event are bounded by the Loss of Feedwater Heating event (FSAR 15.1.1). An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.1.1.

3. Loss of specific components within three feedwater heater control panels could result in:

a. A loss of feedwater flow analogous to those events discussed in 2.a above, only with the isolation of three feedwater heater trains rather than two. Also, a loss of feedwater flow could be effected on the opening of the three secondary condensate pump minimum flow recirculation lines; this would cause feedwater pump trips on low suction pressure. In any of these cases, the consequences of the event are bounded by the Loss of Feedwater Flow event (15.2.7). An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.2.7.

b. A loss of three trains of feedwater heaters could be effected. In the worst case, this loss of feedwater heating would not be coupled with lower feedwater flow (as discussed above). This would require failure of only selective components in all three control panels. Such an event is described here only to present the worst case possibility, without evaluation of probability. Such a loss of feedwater heating would be mitigated by a high neutron flux scram and/or a high Thermal Power Monitoring System scram, as in the event discussed in FSAR 15.1.1. This loss of feedwater heating could result in more than a 100°F loss of feedwater heating. Although this case is not specifically addressed in the FSAR, the effects of the event are bounded by the additional transient analysis performed and discussed in Section 3.0 of this report.

Zone J

I. High Energy Systems

A. Main Steam

1. 3" AB-127

a. Function: Main steam supply to SJAE train A.

b. Effect of Break: A break in the main steam supply to SJAE would cause a main turbine trip as a result of loss of condenser vacuum.

B. Vents and Drains

1. 14" AF-090

a. Function: Dump line from feedwater heater 5A to condenser 1AE108.

b. Effect of Break: Loss of some feedwater heating capability via loss of drain to heaters 4A, 3A, 2A, and drain cooler 2A. Loss of some inventory through the break.

2. 16" AF-105

a. Function: Dump line from feedwater heater 4A to condenser 1AE108.

b. Effect of Break: Loss of some feedwater heating capability via loss of drain to heaters 3A, 2A, and drain cooler 2A. Loss of some inventory through the break.

3. 16" AF-138

a. Function: Dump line from feedwater heater 3A to condenser 1AE108.

b. Effect of Break: Loss of some inventory. Loss of some feedwater heating capability via drains to heater 2A and drain cooler 2A.

C. Condenser Air Removal

1. 8" CG-028

a. Function: Auxiliary steam (startup supply) to SJAE trains A and B.

b. Effect of Break: Loss of "startup" steam supply to SJAE. No effect during normal operation but could abort a startup.

D. Gaseous Radwaste

1. 8"/12" HA-012

Same as Zone A (B.1).

II. Control Components

A. Condensate

1. HV-1659A

a. Function: Controls condensate flow through the SJAE (A&B) inter-condenser and after-condenser.

b. Failure Effects: Normally open gate valve; could remain open or go closed.

2. HV-1666A

a. Function: Control discharge of condensate from SJAE A train inter- and after-condensers to condensate filter/demineralizer system.

b. Failure Effects: Normally open gate valve; could remain open or go closed.

B. Condenser Air Removal

1. HV-1955A

a. Function: Main steam supply to third stage SJAE.

b. Failure Effects: Normally open gate valve. If valve would close, loss of air removal through third stage SJAE would result.

2. HV-1956A

a. Function: Control offgas flow from SJAE after condenser to third stage SJAE.

b. Failure Effects: Valve is normally open butterfly valve; could remain open or go closed.

3. HV-1957A

a. Function: Control offgas discharge from third stage SJAE to gaseous radwaste recombiner.

b. Failure Effects: Normally open butterfly valve; could remain open or go closed.

4. HV-1963A

   a. Function: Controls main steam supply to second stage SJAE train A.

   b. Failure Effects: Normally open gate valve; could remain open or go closed.

5. HV-1964A

   a. Function: Controls flow in bypass line around third stage SJAE A and dump to condenser.

   b. Failure Effects: Normally closed gate valve; could remain closed or go open.

6. HV-1967A

   a. Function: Controls main steam supply from main steam line to first stage SJAE.

   b. Failure Effects; Normally open gate valve; could remain open or go closed.

7. HV-1968A1,A2,A3

   a. Function: Control offgas flow from condensers to first stage SJAEs in train A.

   b. Failure Effects: Normally open butterfly valves on line from each condenser; could remain open or go closed.

8. HV-2016A

   a. Function: Controls main steam supply to SJAE train A.

   b. Failure Effects: Normally open valve; could remain open or go closed.

9. PCV-2018A

   a. Function: Controls/regulates pressure in main steam supply line to SJAE train A.

   b. Failure Effects: Valve could assume any position from open to closed upon failure.

10. HV-2019

   a. Function: Controls auxiliary steam supply to SJAE trains A and B.

   b. Failure Effects: Normally closed gate valve; could remain closed go open.

11. HV-2020A

   a. Function: Controls auxiliary steam supply to SJAE train A and is downstream of normally closed gate valve HV-2019.

   b. Failure Effects: Valve failure open or closed is inconsequential.

III. Combined Effects

A. The main steam supply line break is bounded by the Turbine Trip event (FSAR 15.2.3). This event would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.2.3.

B. All three vents and drains line breaks would cause a loss of SJAE train A, which is normally in service. This would results in a turbine trip due to loss of condenser vacuum. The Turbine Trip event (FSAR 15.2.3) occurs because of the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.2.3.

C. The condenser air removal line break could result in a main turbine trip on loss of condenser vacuum due to the loss of normal SJAE A. This Turbine Trip event (FSAR 15.2.3) occurs because of the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.2.3.

D. A break in SJAE A&B common discharge line to the offgas recombiners could result in a main turbine trip on loss of condenser vacuum. This Turbine Trip event (FSAR 15.2.3) occurs because of the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.2.3.

Zone K

I. High Energy Systems

A. Vents and Drains

1. 14" AF-092

a. Function: Dump line from feedwater heater 5B to condenser 1BE108.

b. Effect of Break: Loss of some inventory and some heating capability through drains system is lost.

2. 16" AF-107

a. Function: Dump line from feedwater heater 4C to condenser 1CE108.

b. Effect of Break: Loss of some inventory and loss of some heating capability through the drains system.

3. 16" AF-140

a. Function: Dump line from feedwater heater 3C to condenser 1CE108.

b. Effect of Break: Loss of some inventory and loss of some heating capability through the drains system.

4. 14" AF-091

a. Function: Dump line from feed heater 5B to condenser 1BE108.

b. Effect of Break: Loss of some inventory and loss of some feedwater heating capability through the drains system.

5. 16" AF-106

a. Function: Dump line from feed heater 4B to condenser 1BE108.

b. Effect of Break: Loss of some inventory and loss of some feedwater heating capability through the drains system.

6. 16" AF-139

a. Function: Dump line from feed heater 3B to condenser 1BE108.

b. Effect of Break: Loss of some inventory and loss of some feedwater heating capability through the drains system.

B. Condenser Air Removal

1. 8" CG-028

Same as Zone J (C.1).

C. Gaseous Radwaste

1. 8" HA-012

Same as Zone A (B.1).

II. Control Components

The components in this zone are identical to the components in Zone J except they are the "B" side rather than the "A" side. The "A" side is normally used; the "B" side is not used at the same time.

III. Combined Effects

A. The worst case combined event for all six breaks is bounded by the Loss of Feedwater Heating transient (FSAR 15.1.1). This event would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.1.1.

B. The condenser air removal line break would not result in any transient event, since the SJAE "B" components are not normally in service.

C. The gaseous radwaste line break would not result in any transient event since the SJAE "B" components are not normally in service.

Zone L

I. High Energy Systems

A. Vents and Drains

1. 14" AF-092

Same as Zone K (A.1).

2. 16" AF-107

Same as Zone K (A.2).

3. 16" AF-140

Same as Zone K (A.3).

II. Control Components

A. Condensate

1. HV-1660

a. Function: Controls condensate flow from primary condensate pumps through to steam packing exhauster condenser.

b. Failure Effects: Normally open gate valve; could remain open or go closed.

2. HV-1661

a. Function: Controls condensate discharge flow from steam packing exhauster condenser.

b. Failure Effects: Normally open gate valve; could remain open or go closed.

3. PDV, SV-1719

a. Function: Control bypass around steam packing exhauster condenser.

b. Failure Effects: Normally closed butterfly valve; could remain closed or go open.

B. Turbine Sealing Steam

1. HV-1990A,B

a. Function: Control discharge of steam packing exhauster fans to turbine ventilation system.

b. Failure Effects: Normally open butterfly valves; could remain open or go closed.

III. Combined Effects

A. Due to the control component failures combined with the HELB, the worst case line break would result in a transient bounded by the Loss of Feedwater Flow event (FSAR 15.2.7). An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.2.7.

Zone M

I. High Energy Systems

A. Vents and Drains

1. 14" AF-092

Same as Zone K (A.1).

2. 16" AF-107

Same as Zone K (A.2).

3. 16" AK-140

Same as Zone K (A.3).

B. Condensate

1. 24" AD-061

Same as Zone H (A.2).

II. Control Components

A. Condenser Air Removal

1. HV, SV-1979A,B

a. Function: Inlet valves for mechanical vacuum pumps 1AP105 and 1BP105. Valves are normally closed gate valves, downstream of normally closed HVs (1973A,B,C) in lines from condensers to mechanical vacuum pumps.

b. Failure Effects: No effect if valves are open or closed during normal operation. May abort a startup if valve(s) close during mechanical vacuum operations.

2. FSL-1984A,B

a. Function: Trip mechanical vacuum pumps on low seal water flow.

b. Failure Effects: May abort a startup. No effect during normal operation.

III. Combined Effects

A. The worst case combined effect for all three breaks is bounded by the Loss of Feedwater Heating transient (FSAR 15.1.1). This event would not be exacerbated by the control component failures in this zone.

An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.1.1.

During startup, a break in any one of these lines could cause a loss of the mechanical vacuum pumps which could abort a startup, but there would be no adverse effects on reactor parameters.

B. The Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6) would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.6.6.

Zone N

I. High Energy Systems

A. Condensate

1. 8" AD-119

a. Function: Steam supply from auxiliary boiler to condenser heating and deaeration for startup.

b. Effect of Break: Not used during normal operation. Normally closed gate valve upstream, such that a break in this line would have no consequence. Could abort a startup if break were to occur during startup operations.

B. Plant Heating Steam

1. 3" GA-006

a. Function: Provide steam to various unit heaters.

b. Effect of Break: Loss of steam supply to various unit heaters. Auxiliary boiler requires additional makeup from demineralized water system.

2. 3" GA-060

a. Function: Steam supply to unit heaters on Elevation 120.

b. Effect of Break: Loss of steam supply to unit heaters. Auxiliary boiler requires additional makeup from demineralized water system.

3. 4" GA-012

a. Function: Steam supply return to condensate return units from various unit heaters.

b. Effect of Break: Loss of some unit heating capability. Auxiliary boiler requires additional makeup from demineralized water system.

C. RFP Turbine Steam

1. 8" FW-029

a. Function: Startup testing steam supply from auxiliary boiler to RFPTs. Not used during normal operation.

b. Effect of Break: No effect during normal operations. Could adversely affect startup testing.

D. Condenser Air Removal

1. 8" CG-028

Same as Zone J (C.1).

E. Turbine Sealing Steam

1. 8" CA-012

a. Function: Auxiliary boiler steam supply to main turbines and RFPT steam seals for startup only.

b. Effect of Break: No effect during normal operation. Could abort a startup.

2. 3" GA-006

a. Function: Auxiliary steam to various unit heaters.

b. Effect of Break: Loss of unit heating capability of some heaters. Auxiliary boiler requires additional makeup from demineralized water system.

F. Auxiliary Steam

a. Function: Auxiliary steam supply for auxiliary boiler deaerator.

b. Effect of Break: No effect on auxiliary steam's ability to perform its function (demineralized water makeup capable of providing adequate water supply to auxiliary boilers).

II. Control Components

A. Lube Oil

1. PSL-3118-1,2,3

a. Function: Main turbine shaft oil pump discharge pressure. Main turbine trips on low pressure with 2/3 logic.

b. Failure Effects: Failure of 2/3 would result in main turbine trip.

2. PSL-3132

a. Function: Turbine turning gear oil pump pressure.

b. Failure Effects: No effect on turbine during normal power or startup operations.

3. HS-3116-2; SV-3116

   a. Function: Motor suction pump 10P108 test controls.

   b. Failure Effects: No effect during normal power or startup operations.

III. Combined Effects

A. to F. The worst case line break would result in a Turbine Trip event (FSAR 15.2.3) due to loss of PSL-3118-1,2,3. No other control component failures could exacerbate this event. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.2.3.

Zone P

I. High Energy Systems

A. Extraction Steam

1. 8" AC-031,042

a. Function: Moisture separator drain to feedwater heater 5A.

b. Effect of Break: A break would result in a loss of some inventory through the break and a loss (<100°F) of some feedwater heating.

2. 14" AC-012

a. Function: Crossaround steam supply to feedwater heater 5A.

b. Effect of Break: Same as A.1.b above.

3. 1½" AF-008

a. Function: Steam Seal Evaporator (SSE) steam supply to feedwater heater 3A.

b. Effect of Break: Same as A.1.b above.

4. 26" AF-003

a. Function: Ninth stage turbine extraction steam to feedwater heater 3A.

b. Effect of Break: Same as A.1.b above.

5. 16" AF-005

a. Function: Eighth stage turbine extraction steam to feedwater heater 4A.

b. Effect of Break: Same as A.1.b above.

B. Vents and Drains

1. 8" AF-075; 14" AF-093; 14" AF-108; 16" AF-141

a. Function: Drain from feedwater heater 6A, 5A, 4A, 3A, respectively, to heater 5A, 4A, 3A, 2A, respectively.

b. Effect of Break: A break in any of the cascading drain lines would result in a loss of some inventory through the break and a loss of some feedwater heating capability (<100°F) through the drains system.

2. 2" AF-078; 3" AF-096, 4" AF-117

   a. Function: Operating vents for feedwater heater 5A, 4A, 3A, respectively.

   b. Effect of Break: A break in any of the vent lines noted above could result in a loss of some inventory through the break (extraction steam) and a negligible loss of feedwater heating.

C. Condensate

1. 16"/24" AD-020

   a. Function: Common header to feedwater pump suction.

   b. Effect of Break: A break in this line could result in a loss of condensate flow to the feedwater pumps, resulting in a loss of feedwater flow to the vessel.

2. 24" AD-021

   a. Function: Condensate discharge from feedwater heater 5A.

   b. Effect of Break: Same as C.1.b above.

3. 24" AD-028

   a. Function: Condensate flow from feedwater heater 4A to heater 5A.

   b. Effect of Break: Same as C.1.b above.

4. 24" AD-031

   a. Function: Condensate flow from feedwater heater 3A to heater 4A.

   b. Effect of Break: Same as C.1.b above.

5. 24" AD-058

   a. Function: Condensate inlet to feedwater heater 3A.

   b. Effect of Break: Same as C.1.b above.

6. 24" AD-061

   a. Function: Common header to feedwater heaters 3A,B,C.

   b. Effect of Break: Same as C.1.b above.

II. Control Components

A. Extraction Steam

1. LV, SV-1356A,1363A,1364A; HV-1360A,1361A,1362A

a. Function: SSE to feedwater heater 3A, moisture separator drain to heater 5A, crossaround steam to feedwater heater 5A.

b. Failure Effects: Closure of the valves will result in a slight loss (<100°F) of feedwater heating.

2. HV-1367A,B,C

a. Function: Extraction steam drain lines from extraction steam supply to feedwater heaters 6A,B,C.

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

B. Vents and Drains

1. LV, SV-1506A,1514A,1523A; LT-1514A,1523A,1525A,1532A; HV-1538A; SV-1506A

a. Function: These are the feedwater heater train A drain valves between heaters 6A and 5A, 5A and 4A, 4A and 3A, 3A and 2A, and associated level control transmitters and switches.

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

2. LT-1513A,1521A,1531A,1544A,1559A,1560A,1561A

a. Function: Level transmitters controlling feedwater heaters 5A, 4A, and 3A dump valves to condensers.

b. Failure Effects: Opening of the valves would result in a slight loss (<100°F) of feedwater heating.

3. HV, SV-1510A,1519A,1528A,1543A,1545A,1568A, LT-1543A

a. Function: Valves on startup and operating vent lines for heaters 5A, 4A, and 3A.

b. Failure Effects: The worst case failure would result in a slight loss (<100°F) of feedwater heating.

C. Condensate

1. HV-1613A

a. Function: Condensate inlet valve from common header to heater 3A.

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

2. HV-1600A,1745A

a. Function: Condensate outlet valve from heater 5A to common feed pump suction header and associated bypass.

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

3. HV-1623

a. Function: Valve controlling condensate flow bypass around heaters 3, 4, and 5.

b. Failure Effects: Same as B.2.b above.

III. Combined Effects

A/B. A break in any of these lines could result in an isolation of feedwater heaters 3A, 4A, and 5A. This flow would be diverted through the remaining two, 50% each, heater trains B and C. Feedwater heaters 3, 4, and 5 bypass valve (HV-1623), that is normally closed, could go open, bypassing some feedwater flow. Extraction steam to heater 3A, 4A, and 5A could also be isolated due to the effect of the break on the heater level control instrumentation. The loss of feedwater heaters 3A, 4A, and 5A would result in a transient bounded by the Loss of Feedwater Heating event (FSAR 15.1.1). An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.1.1.

C. Any condensate line break in this zone is bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6). This event would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.6.6.

Zones Q,R

These zones contain feedwater heater trains "B" and "C," respectively, whereas Zone P contains train "A." The analysis for these zones is the same as for Zone P (with different designations for corresponding high energy lines) except for the following:

1. Valve HV-1623: Condensate flow bypass around heaters 3,4,5 is unique to Zone P and shall not be considered a component subject to failure in Zone Q or Zone R.

2. Valves HV-1367A,B,C are unique to Zone P. No similar components exist in Zone Q or Zone R.

The "Combined Effects" section of Zone P (III) applies for these zones except as noted above.

Zone S

I. High Energy Systems

A. Plant Heating Steam

1. 3" GA-005

a. Function: Provides plant heating steam to unit heaters at Elevation 102'.

b. Effect of Break: Loss of heating steam to various unit heaters.

2. 3" GA-010

a. Function: Provides plant heating steam to unit heaters at Elevations 153' and 171'.

b. Effect of Break: Loss of heating steam to various unit heaters.

II. Control Components

A. Vents and Drains

1. LY-1506A,B,C

a. Function: I/P converters control air operated drain valves LV-1506A,B,C between feedwater heaters 6 and 5 in each of the A,B,C trains of heaters.

b. Failure Effects: Closure would result in a loss of some (<100°F) feedwater heating through the drains system.

2. LY-1514A,B,C

a. Function: Same as above for LY-1514A,B,C drain valves between heaters 5 and 4.

b. Failure Effects: Closure would result in a loss of some (<100°F) feedwater heating through the drains system.

3. LY-1523A,B,C

a. Function: Same as above for LY-1523A,B,C drain valves between heaters 4 and 3.

b. Failure Effects: Closure would result in a loss of some (<100°F) feedwater heating through the drains system.

III. Combined Effects

A. As a result of the control components failures, the worst case postulated transient is bounded by the Loss of Feedwater Heating event (FSAR 15.1.1). An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.1.1.

Zone U

I. High Energy Lines

A. Main Steam

1. 28" AB-001,002,003,004

a. Function: Carry main steam from reactor vessel to the main stop valves. 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" AB-005,006

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

3. 28" AB-138

a. Function: Connects four main steam lines upstream of main stop 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).

B. Extraction Steam

1. 16" AF-004

a. Function: Common header carries steam from LP Turbines A, B, and C to feedwater heaters 4A,B,C. Also carries steam to steam seal evaporator (SSE).

b. Effect of Break: A break in this line would result in a loss of inventory through the LP turbines, a loss of some feedwater heating, and a need for Sealing Steam to use the alternate Main Steam supply to the SSE. Loss of steam seals has no effect on reactor operation. The consequences of this break are bounded by the Loss of Feedwater Heating event (FSAR 15.1.1).

2. 2" AF-008

a. Function: Common header carries steam from SSE drain tank to feedwater heaters 3A,B,C.

b. Effect of Break: A break in this line would result in a slight loss (<100°F) of feedwater heating. The consequences of this break are bounded by the Loss of Feedwater Heating event (FSAR 15.1.1).

3. 14" AF-051,055,059

a. Function: Three lines carry steam from HP turbine to feedwater heaters 6A, 6B, and 6C.

b. Effect of Break: A break in this line would result in a loss of inventory through the HP turbine and a loss of some (<100°F) feedwater heating. The consequences of this break are bounded by the Loss of Feedwater Heating event (FSAR 15.1.1).

C. Vents and Drains

1. 8" AF-072,073,074

a. Function: Dump lines from feedwater heaters 6A, 6B, and 6C to condensers AE108, BE108, and CE108, respectively.

b. Effect of Break: A line break would result in a transient bounded by the Loss of Feedwater Heating event (FSAR 15.1.1).

2. 8" AF-075,076

a. Function: Drain lines from feedwater heaters 6A and 5B to feedwater heaters 5A and 5B.

b. Effect of Break: A line break would result in a loss of some (<100°F) feedwater heating. The consequences of this break are bounded by the Loss of Feedwater Heating event (FSAR 15.1.1).

D. Condensate

1. 20" AD-020

Same as Zone P (I.C.1).

E. Feedwater

1. 24" AE-013

Same as Zone W (I.A.1).

2. 12" AE-015

a. Function: Carries feedwater from RFF BP101 outlet to condenser BE108. This is the minimum flow recirculation line.

b. Effect of Break: The consequences of this break are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

F. Turbine Sealing Steam

1. 8" CA-001

Same as Zone Z (I.B.1).

2. 4" CA-019

a. Function: Carries steam from SSE drain tank to feedwater heaters 3A,B,C.

b. Effect of Break: A line break would result in a loss of some (<100°F) feedwater heating. The consequences of this break are bounded by the Loss of Feedwater Heating event (FSAR 15.1.1).

3. 3"/6" CA-040

a. Function: Common header carries sealing steam from SSE to RFPTs A,B,C.

b. Effect of Break: A line break would result in leakage of some turbine steam into the atmosphere, but there would be no effect on the reactor parameters.

4. 3"/6" CA-041

a. Function: · Common header carries sealing steam from RFPTs A,B,C to steam packing exhauster condenser.

b. Same as F.3 above.

G. Plant Heating

1. 6" GA-006

Same as Zone N (I.B.1).

II. Control Components

A. Main Steam

1. HV-1003

a. Function: Main Steam supply to steam seal evaporator HV-1003 is normally open, gate valve upstream of normally closed valves in line to SSE. Main Steam supply is alternate supply only.

b. Failure Effects: The effects of failure of this device are inconsequential.

B. Extraction Steam

1. HV-1370

a. Function: Normally open motor operated globe valve in line from SSE drain tank to feedwater heaters 3A,B,C.

b. Failure Effects: If valve goes closed, a loss of some (<100°F) feedwater heating would occur.

C. Turbine Auxiliaries Cooling

1. HV, SV-2469A,B

a. Function: Mezzanine pipe chase unit cooler cooling water inlet valves.

b. Failure Effects: Valves could go closed, resulting in loss of area cooling only.

III. Combined Effects

A. The Steam System Piping Break Outside Primary Containment event (FSAR 15.6.4) would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.6.4.

B. The worst case failure combination would result in a turbine trip (due to power/load unbalance) at an elevated power level. This event is discussed in Section 3.0 of this report.

C. The Loss of Feedwater Heating event (FSAR 15.1.1) would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.1.1.

D. The Steam System Piping Break Outside Primary Containment event (FSAR 15.6.4) would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.6.4.

E. The Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6) would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.6.6.

F/G. The Loss of Feedwater Heating event (FSAR 15.1.1) would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.1.1.

Zone V

I. High Energy Systems

A. Plant Heating Steam

1. 3" GA-005

Same as Zone S (A.1).

B. Service Compressed Air

1. 3" KA-003

a. Function: Blow off line to atmosphere, from Service Air Compressor (SAC) outlet lines which run from service air compressors 00K107 and 10K107 to aftercooler and moisture separators.

b. Effect of Break: A break in this line would have no effect on the compressed air system.

2. 4" KA-004

a. Function: Outlet line from SAC 00K107 and 10K107 to aftercooler and moisture separator.

b. Effect of Break: If a break were to occur, a check valve downstream would prevent excessive loss of air and the backup service air compressor engages.

C. Instrument Compressed Air

1. 6" KG-003

a. Function: Outlet from emergency instrument air (EIA) compressor (10K100) to aftercooler and moisture separator.

b. Effect of Break: This system is not used during normal operation. A break would have no effect on reactor parameters.

II. Control Components

A. Reactor Auxiliaries Cooling (RACS)

1. TSH-7570,7572

a. Function: Senses high EIA compressor cooling water outlet temperature; high temperature activates a compressor trip.

b. Failure Effects: Since this system is normally inoperative, failure of this device is inconsequential.

2. TSH-7622

   a. Function: Senses EIA compressor 10K100 oil temperature. High temperature activates alarm.

   b. Failure Effects: Since this system is normally inoperative, failure of this device is inconsequential.

3. TCV-7625

   a. Function: Controls flow from RACS pumps to EIA tercooler and moisture separator 10E100.

   b. Failure Effects: Since this system is normally inoperative, failure of this device is inconsequential.

B. Turbine Auxiliaries Cooling (TACS)

1. TV, TY-2415A,B

   a. Function: Controls outlet flow from RFPT lube oil coolers C1E118 and C2E118 (two out of six coolers).

   b. Failure Effects: If the valve closes, there will be a slight loss of RFPT lube oil cooling. This loss could result in a reactor feed pump turbine trip after a long delay.

2. PSV-2434

   a. Function: Pressure safety valve from inlet to SAC 00K107.

   b. Failure Effects: Failure of this device is inconsequential.

3. PCV-2458

   a. Function: Pressure-reducing regulatory on inlet to SAC KA-10K107.

   b. Failure Effects: Failure of this component causes backup SAC loop to engage.

C. Compressed Air/Breathing Air

1. PSL-7567

   a. Function: Senses low RACS cooling water inlet pressure, on line from RACS pumps to EIA compressor 10K100; low pressure activates a compressor trip.

   b. Failure Effects: Since this system is normally off, failure of this device is inconsequential.

2. PSH-7586

   a. Function: Senses high EIA compressor air pressure. High pressure activates a compressor trip.

   b. Failure Effects: Since this system is normally off, failure of this device is inconsequential.

3. SV-7592

   a. Function: Emergency air compressor unloader machine-mounted solenoid valve.

   b. Failure Effects: Since this system is normally off, failure of this device is inconsequential.

4. TSH-7593

   a. Function: Senses high EIA compressor air temperature; high temperature activates compressor trip.

   b. Failure Effects: Since this system is normally off, failure of this device is inconsequential.

5. PSH-7597A,B

   a. Function: Senses low instrument air pressure on instrument air supply header 3" JDD-002. Low pressure closes valve HV-7596 on service air supply line.

   b. Failure Effects: Failure of this device would result in loss of control of HV-7596; if the valve were to remain open, a loss of instrument air could result.

6. ME, MSH-7604

   a. Function: Senses high moisture on instrument air dryer outlet; high moisture trips dryers.

   b. Failure Effects: Failure could cause moisture to accumulate in instrument air lines. This would not adversely affect reactor parameters in the short term.

7. PSL-7606A,B

   a. Function: Senses instrument air dryer left (A) and right (B) chamber outlet pressures. Low pressure activates dryer trip.

   b. Failure Effects: Due to redundant systems, failure of these devices is inconsequential.

8. SV-7607

   a. Function: Controls flow on instrument air dryer regeneration bypass line.

   b. Failure Effects: Failure of this device is inconsequential.

9. PDSH-7610

   a. Function: Senses instrument air dryer inlet and outlet pressure differential.

   b. Failure Effects: Due to redundant systems, failure of this device is inconsequential.

10. PSDH-7611

    a. Function: Senses instrument air prefilter inlet and outlet pressure differential.

    b. Failure Effects: Failure of this device is inconsequential.

11. HV, SV-7612

    a. Function: Senses instrument air afterfilter pressure differential.

    b. Failure Effects: Failure of these devices is inconsequential.

12. HV, SV-7614

    a. Function: Valves control flow through instrument air dryer right chamber purge line.

    b. Failure Effects: Failure of these devices is inconsequential.

13. HV, SV-7615

    a. Function: Same as HV-7614 and SV-7614 above, except for left chamber purge line.

    b. Failure Effects: Failure of these devices is inconsequential.

14. HV, SV-7616

    a. Function: Normally closed valve controls flow into instrument air dryer right chamber.

b. Failure Effects: Failure of these valves could result in a loss of regeneration ability for the instrument air dryer train. Due to redundant system, failure in inconsequential.

15. HV, SV-7617

a. Function: Normally open valve on left dryer chamber inlet similar to HV-7616 and SV-7616 above.

b. Failure Effects: Due to redundant systems, failure is inconsequential.

16. FE, FSH, FSL-7618

a. Function: Sense flow on instrument air dryer inlet. High flow activates an alarm and the standby dryer. Low flow opens discharge valve.

b. Failure Effects: Failure of these devices are inconsequential due to redundant systems.

17. FSLL-7618

a. Function: Senses flow on instrument air dryer inlet. Low flow trips the dryer.

b. Failure Effects: Due to redundant systems, failure of this device is inconsequential.

18. HV-7618

a. Function: Controls outlet flow from instrument air after-filter.

b. Failure Effects: Due to redundant systems, failure of this device is inconsequential.

19. PY-7618

a. Function: Four way-three position valve operator controls dryer outlet butterfly valve HV-7618. This device allows the valve to fail as is.

b. Failure Effects: Failure of this device is inconsequential.

20. SV-7618A,B

a. Function: Supplies air via four-way valve operator PY-7618 to control valve HV-7618.

b. Failure Effects: Failure of these devices is inconsequential.

21. HS-7619

   a. Function: Switch on control panel 0KB-0C192.

   b. Failure Effects: Failure could result in loss of entire panel 0KB-0C192, and a subsequent loss of regeneration ability for the air dryer train. In the long term, this could result in accumulation of moisture in the instrument air lines. However, there would be no short term effect on reactor parameters.

22. PS-7669

   a. Function: Senses EIA compressor 10K100 pressure, transmits signals to control panel 10C189.

   b. Failure Effects: Since this system is normally off, failure of this device is inconsequential.

23. XV-7674

   a. Function: Emergency air compressor intercooler blowdown valve.

   b. Failure Effects: Since this system is normally off, failure of this device is inconsequential.

24. HS-7766

   a. Function: EIA compressor 10K100 load/unload switch on 10C189 panel.

   b. Failure Effects: Since this system is normally off, failure of this device is inconsequential.

III. Combined Effects

A/B/C. None of the line breaks would be of any consequence by themselves. However, when combined with the failed control components, a possible loss of Compressed Air Service and Breathing Air Service may result. The effects of this loss are bounded by the Loss of Instrument Air event (FSAR 15.9.6, Event 8). An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.9.6.

Zone W

I. High Energy Systems

A. Extraction Steam

1. 14" AF-055

a. Function: High pressure turbine extraction steam to feedwater heater 6B.

b. Effect of Break: Loss of some inventory through the break and loss of some (<100°F) feedwater heating capability.

B. Vents and Drains

1. 8" AF-073

a. Function: Dump line from feedwater heater 6B to condenser 1BE108.

b. Effect of Break: Loss of some inventory through the break and loss of some (<100°F) feedwater heating capability through the drains system.

2. 12" AF-076

a. Function: Drain line from feedwater heater 6B to feedwater heater 5B.

b. Effect of Break: Loss of some inventory through the break and loss of some (<100°F) feedwater heating capability through the drains system.

C. Feedwater

1. 18" AE-001

a. Function: Common header supplying feedwater to feedwater heaters 6A,B,C.

b. Effect of Break: Loss of feedwater flow to vessel. The consequences of this break are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

2. 16"/18"/24" AE-013

a. Function: Common header from the discharge of the sixth feedwater heaters supplying feedwater to vessel.

b. Effect of Break: Same as above (C.1).

3. 18"/24" AE-032

a. Function: Feedwater flow from common header AE-001 to feedwater heater 6B.

b. Effect of Break: Same as above (C.1).

II. Control Components

A. Vents and Drains

1. HV, SV-1502B1

a. Function: Solenoid valve controls HV-1502B1 on startup vent from feedwater heater 6B to condenser.

b. Failure Effects: No adverse effect if vent valve were to go open or cannot be opened during startup or normal power operation.

2. HV, SV-1502B2

a. Function: Solenoid valve controls HV-1502B2 on operating vent bypass line (main line from feedwater heater 6B to condenser).

b. Failure Effects: No adverse effect if vent is in either the open or closed position.

3. HV-1503B

a. Function: Motor-operated isolation valve on dump line from feedwater heater 6B to condenser. Upstream of closed valve LV-1505B.

b. Failure Effects: Valve is normally open. No adverse effect if valve goes closed.

4. LT-1505B

a. Function: Measures level in feedwater heater 6B. Provides signal which controls LV-1505B on dump line.

b. Failure Effects: Some loss (<100°F) in feedwater heating through the drains system if valve opens during power operations.

5. LT-1506B

a. Function: Measures level in feedwater heater 6B. Provides signal which controls LV-1506B on heater 6B drain line to heater 5B.

b. Failure Effects: Some loss (<100°F) in feedwater heating through the drains system if valve closes during power operations.

6. HV-1508B

a. Function: Motor operated isolation valve on FW heater 6B drain line.

b. Failure Effects: Some loss (<100°F) in feedwater heating through the drains system if valve closes during normal power operations.

7. LT-1542B,1558B

a. Function: Control HP Extraction Steam to feedwater heater 6B and feedwater heater dump valve LV-1505B.

b. Failure Effects: Some loss (<100°F) in feedwater heating capability in heater train B if valve goes closed.

B. Feedwater

1. LV, SV, ZS-1754,1785

a. Function: Startup reactor water level control valves. Bypass from common feedwater header (downstream of sixth feed heaters) directly to vessel bypassing sixth feedwater heaters. Both valves are normally closed globe valves.

b. Failure Effects: If the valves go open, a slight loss (<100°F) in feedwater heating would occur.

C. Reactor Recirculation

1. FE-N001A,B

a. Function: Taps for PDT-N001A,B. Provide feedwater flow measurement to feedwater control loop for three element control.

b. Failure Effects: Loss of flow signal (0% feedwater flow) would cause recirculation pump speed runback and maximum feedwater flow demand.

III. Combined Effects

A/B. A break in high pressure turbine extraction to heater 6B could cause an extraction isolation of feedwater heater 1BE106. This transient is bounded by a Loss of Feedwater Heating event (FSAR 15.1.1). This break could also result in the turbine extraction valve failing as is (open), resulting in a turbine trip from power/load unbalance. The worst case combination would be a turbine trip at an elevated power level due to the loss of feedwater heating. This transient is discussed in Section 3.0 of this report.

C. The Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6) would not be exacerbated by the control system component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.6.6.

Zone X

I. High Energy Systems

A. Extraction Steam

1. 14" AF-059

Same as Zone W (I.A), except from heater 6C.

B. Vents and Drains

1. 8" AF-074

Same as Zone W (I.B.1), except from heater 6C to condenser 1CE108.

2. 12" AF-077

Same as Zone W (I.B.2), except from heater 6C to heater 5C.

C. Condensate

1. 16" AD-020

a. Function: Feedwater supply from common header to feedwater pump C.

b. Effect of Break: A feedwater line break would result in a loss of feedwater flow to the vessel. The consequences of this break are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

D. Feedwater

1. 18"/24" AE-033

a. Function: Feedwater flow from common header AE-001 to feedwater heater 6B.

b. Effect of Break: Loss of feedwater flow to the vessel. The consequences of this break are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

2. 16"/18"/24" AE-013

Same as Zone W (I.C.2).

3. 18" AE-001

Same as Zone W (I.C.1).

E. Plant Heating Steam

1. 3" GA-007

a. Function: Supply heating steam from discharge of unit heaters on Elevations 137' and 171' to other unit heaters.

b. Effect of Break: Loss of space heating capability in some areas.

II. Control Components

A. Vents and Drains

1. HV, SV-1502C1

Same as Zone W (II.A.1), except heater 6C.

2. HV, SV-1502C2

Same as Zone W (II.A.2), except heater 6C.

3. HV-1503C

Same as Zone W (II.A.3), except heater 6C.

4. LT-1505C

Same as Zone W (II.A.4), except heater 6C.

5. LT-1506C

Same as Zone W (II.A.5), except heater 6C.

6. HV-1508C

Same as Zone W (II.A.6), except heater 6C.

7. LT-1542C,1558C

Same as Zone W (II.A.7), except heater 6C.

III. Combined Effects

A/B. Same as Zone W (III.A), except affecting the "C" feedwater heater train.

C/D. The Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6) would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.6.6.

E. The combined effects are bounded by the Loss of Feedwater Heating event (FSAR 15.1.1). An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.1.1.

Zone Y

I. High Energy Systems

A. Extraction Steam

1. 14" AF-051

Same as Zone W (I.A), except heater 6A.

B. Vents and Drains

1. 8" AF-072

Same as Zone W (I.B.1), except heater 6A to condenser 1AE108.

2. 12" AF-075

Same as Zone W (I.B.2), except heater 6A to heater 5A.

C. Feedwater

1. 18" AE-001

Same as Zone W (I.C.1).

2. 18" AE-013

Same as Zone W (I.C.2).

3. 18"/24" AE-031

a. Function: Feedwater flow from common header AE-001 to feedwater heater 6A.

a. Effect of Break: Loss of feedwater flow to the vessel. The consequences of this break are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

D. Plant Heating Steam

1. 4" GA-006

a. Function: Supply heating steam to various units heaters on Elevation 137.

b. Effect of Break: Loss of space heating capability in some areas.

2. 4" GA-007

Same as Zone X (E.1).

II. Control Components

A. Vents and Drains

1. HV, SV-1502A1

Same as Zone W (II.A.1), except heater 6A.

2. HV, XV-1502A2

Same as Zone W (II.A.2), except heater 6A.

3. HV-1503A

Same as Zone W (II.A.3), except heater 6A.

4. LT-1505A

Same as Zone W (II.A.4), except heater 6A.

5. LT-1506A

Same as Zone W (II.A.5), except heater 6A.

6. HV-1508A

Same as Zone W (II.A.6), except heater 6A.

7. LT-1542A,1558A

Same as Zone W (II.A.7), except heater 6A.

III. Combined Effects

A/B. Same as Zone W (III.A), except affecting the "A" heater.

C/D. The Feedwater Line Break Outside Primary Containment event would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.6.6.

E. Same as Zone X (III.E).

Zone Z

I. High Energy Systems

A. Extraction Steam

1. 8" AF-017

a. Function: Extraction steam supply to steam seal evaporator (SSE).

b. Effect of Break: Loss of normal steam supply to SSE, backup main steam supply is automatically available.

B. Turbine Sealing Steam

1. 8" CA-001

a. Function: Main steam supply to SSE.

b. Effect of Break: Loss of main steam through the break. No effect on SSE, extraction steam supply is normal supply.

2. 6"/8" CA-012

Same as Zone N (E.1).

3. 12" VAT-016

a. Function: Main steam supply to SSE.

b. Effect of Break: Loss of some main steam through the break. No effect on SSE, extraction steam is normal steam supply.

4. 12" VBT-010

a. Function: Sealing steam discharge from SSE.

b. Effect of Break: Loss of turbine steam seals, resulting in some steam leakage through the turbine seals. Only long term consequences would result.

5. 12"/16" VBT-050

a. Function: Sealing steam discharge from SSE.

b. Effect of Break: Loss of turbine steam seals, resulting in some steam leakage through the turbine seals. Only long term consequences would result.

II. Control Components

A. Turbine Sealing Steam

1. HV-1991

a. Function: Motor operated gate valve on main steam line to steam seal evaporator (SSE).

b. Failure Effects: No effect if valve goes closed during normal operation. Normal supply for steam seals is from Extraction Steam.

2. PY-1992; PIC, PV-1992A,B

a. Function: High pressure selector PV-1992 receives pressure readings from SSE steam inlet and SSE. Controls normally closed valves PV-1992A and PV-1992B in main steam supply to SSE.

b. Failure Effects: No adverse effects if these valves were to open during normal operation.

3. LIC, LT, LV-2003

a. Function: Measure level in SSE - controls normally open LV-2003 on line from secondary condensate pump discharge.

b. Failure Effects: Closure of valve results in loss of sealing steam to main turbine and RFPTs, long term consequences only.

4. LIC, LT-2004

a. Function: Measure level in SSE drain tank to control LV-2004 on line from SSE drain tank to condenser. Used for drain tank level control.

b. Failure Effects: No adverse consequences result if valve opens (negligible loss of feedwater heating) or remains closed during normal operation.

5. LIC, LT-2005

a. Function: Controls LV-1356A,B,C on lines from SSE drain tank to FW heaters 3A,B,C. Provides for drain tank level control.

b. Failure Effects: Negligible loss in feedwater heating will occur if LV-1356's close during normal operation.

6. PDISH, SV-2012; SV-2012A,B

   a. Function: Measure differential between SSE inlets from feedwater heater 4 extraction and main steam. Controls solenoid operated valve for control of check valves XV-2012A,B in line from heater 4 extraction to SSE.

   b. Failure Effects: Failure of PDISH could close bleeder trip valves XV-2012A,B, upon which main steam supply to SSE might be initiated. No adverse consequences would result.

7. HV-2013

   a. Function: Motor operated valve on line from secondary condensate pump discharge to SSE.

   b. Failure Effects: If valve closes, sealing steam will be lost, which will result in only long term consequences.

8. PIC-2038

   a. Function: Measures pressure on line from SSE to seal headers and controls PV-2038 on line from auxiliary steam to seal headers.

   b. Failure Effects: Opening of valve during normal operation will have no adverse effects on sealing steam.

III. Combined Effects

A/B. A Main Steam supply to the steam seal evaporator line break could result in a loss of steam seals to the main turbine shaft seals, control valve, bypass valve seals, and reactor feedwater turbine seals. This would result in steam leakage from the turbines into the Turbine Building. There would be no impact on the critical reactor parameters.

Zone BB

I. High Energy Systems

A. Plant Heating Steam

1. 3"/6" GA-001

a. Function: Auxiliary Steam supply to unit heaters on Elevation 171'.

b. Effect of Break: Loss of plant heating capability through units heaters downstream of heaters on Elevation 171'.

2. 2" GA-007

a. Function: Exhaust steam from unit heaters on Elevation 171' to unit heaters on Elevation 102'.

b. Effect of Break: Loss of some plant heating capability through unit heaters.

II. Control Components

A. Turbine Auxiliaries Cooling

1. PDISL-2670A,B,C,D

a. Function: Measure flow of TACS water to chiller condensers. Trip water chiller compressor motors on low flow of TACS water, resulting in loss of chiller operation.

b. Failure Effects: The worst case failure would result in a loss of chiller operation.

B. Chilled Water

1. FT, FSHL-9487A,B,C; HS-9487A2,B2,C2

a. Function: Trip chilled water circulation water pumps 1AP161, 1BP161, 1CP161 on high/low flow conditions.

b. Failure Effects: Chilled water would be lost on trip of pumps.

2. HV, SV-9503A-D; HS-9503A2,B2,C2,D2

a. Function: Control discharge of chilled water from water chillers 1AK111, 1BK111, 1CK111, 1DK111.

b. Failure Effects: If valves close, loss of chilled water would result.

III. Combined Effects

A. An Auxiliary Steam line break could result in loss of chilled water circulation pumps AP161, BP161, and CP161 and chillers AK111 through DK111 due to loss of control panel 10C152 and associated instrumentation. This would result in a reactor scram in 30 minutes due to loss of drywell coolers and subsequent high drywell pressure. Additional reactor scrams are accommodated in the reactor duty cycles estimation. No additional single failure in a mitigating safety system could exacerbate this event.

Zone CC

I. High Energy Systems

A. Main Steam

1. 8" AB-006

a. Function: Carries steam from 28" main steam lines to bypass valves. Also carries bypass steam to steam seal evaporator (SSE).

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

2. 42" AC-022,023,024

a. Function: Carry steam from moisture separator AT104 to LP Turbines A, B, and C, respectively.

b. Effect of Break: A break in one of these lines would result in a turbine trip on low condenser vacuum. The consequences of this break are bounded by the Steam System Piping Break Outside Primary Containment event (FSAR 15.6.4).

B. Reactor Feed Pump (RFP) Turbine Steam

1. 2"/10" AC-057; 6"/10" FW-005,006,007

a. Function: Common header carries low pressure steam from moisture separator BT-104 to RFPT AS105, BS105, and CS105 steam chests.

b. Effect of Break: There would be no immediate effect as a result of this break. Switchover to the HP supply for the RFP turbines would make up for the loss of the LP supply, and the loss of inventory would result in only long term consequences.

2. 8" FW-001

a. Function: Common header carries high pressure steam from 14" main turbine bypass to RFP turbines AS105, BS105, and CS105 steam chests.

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

3. 8" FW-029

   a. Function: Common header supplying startup testing steam from auxiliary boilers to RFPT AS105, BS105, and CS105 steam chests.

   b. Effect of Break: A line break could abort startup testing. After startup, removable spool pieces separate the steam supply from the steam chests; a line break would result in only long term consequences.

C. Condensate

1. 16"/20" AD-020

   a. Function: Common header from fifth feedwater heaters supplying condensate to RFP AP101, BP101, and CP101 suction and to startup bypass line. Feedwater heaters 3, 4, and 5 bypass is provided through valve HV-1623.

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

D. Feedwater

1. 4"/16"/18" AE-001

   a. Function: Common header carries feedwater from RFPs AP101, BP101, and CP101 to feedwater heaters 6A, 6B, and 6C. Also bypasses sixth feedwater heaters through startup bypass valves LV-1785 and LV-1754.

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

2. 12"/18" AE-005,006,007

   a. Function: Carries RFP AP101, BP101, and CP101 discharge to common header leading into sixth feedwater heaters. Also carries feedwater through minimum flow recirculation lines to condensers AE108, BE108, and CE108, respectively.

   b. Effect of Break: The worst case line break would result in a feedwater line break event. The consequences of this break are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6).

3. 16"/18"/24"/30" AE-013

   a. Function: Common header from sixth feedwater heaters supplying feedwater to the vessel.

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

4. 12" AE-014,015,016

   a. Function: Carries RFP turbine exhaust from RFP AP101, BP101, and CP101 outlets to condensers AE108, BE108, and CD108, respectively.

   b. Effect of Break: Failure of one of these lines would result in a reactor feed pump turbine trip on low exhaust vacuum and a main turbine trip on loss of condenser vacuum. The consequences of this break are bounded by the Turbine Trip event (FSAR 15.2.7).

5. 20" AE-017,018,019

   a. Function: Carry feedwater from fifth feedwater heater header to RFPs AP101, BP101, and CP101, respectively.

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

6. 18"/24" AE-031,032,033

   a. Function: Supply feedwater from 18" RFP header to feedwater heaters 6A, B, and C, respectively.

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

E. Turbine Sealing Steam

1. 8" CA-012

   a. Function: Supplies sealing steam from auxiliary boilers to HP turbine and LP turbines A, B, and C for startup.

   b. Effect of Break: A break in this line may abort a startup. All other effects would be inconsequential.

2. 12"/16" VBT-050; 8"/12" VBT-010

   a. Function: Carries sealing steam from SSE to HP turbine, LP turbines A, B, and C, and RFPT AS105, BS105, and CS105.

   b. Effect of Break: A line break during startup could abort the startup. During power operation, a line break would result in a steam leakage through the turbines to the atmosphere. However, there would be no effect on the reactor parameters.

F. Plant Heating Steam

1. 2"/3" GA-003

   a. Function: Supplies steam to unit heaters on Elevation 137'.

   b. Effect of Break: Loss of plant heating ability of some unit heaters.

2. 1½"/3"/4" GA-007

   a. Function: Collects steam from unit heaters at Elevations 137' and 171'.

   b. Effect of Break: Loss of plant heating ability of some unit heaters.

II. Control Systems

A. Main Generator

1. RT-6311; VT-6312; AT-6313

   a. Function: Provide a generator trip signal on generator field temperature, voltage, or current, respectively.

   b. Failure Effects: The worst case failure would be a trip of the main generator.

B. Main Turbine

1. TT-1064A,B,C; TY-1064A,B

   a. Function: Control the discharge of the exhaust hood spray to the three LP turbines.

   b. Failure Effects: The worst case failure would be the absence of hood spray, resulting in a temperature increase of the exhaust hood. This function is used during low loads, and could abort a startup if lost.

2. SV-7103A-F; 7104A-F; 7105A-C; 7106A-F; 7107A-C

   a. Function: These are solenoid test valves for the intercept and intermediate stop valves to the three LP turbines.

   b. Failure Effects: Worst case failures involve closing from one up to all six combined intermediate valves, which would result in a turbine trip.

3. LSHH-1027A,B; 1028A,B; 1029A,B

   a. Function: Three switches per moisture separator provide a turbine trip when two out of three level switches register high-high level in either moisture separator.

   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.

4. LIC, LT-1039A,B,1040A,B

   a. Function: Control a normally closed, fail open line from the moisture separators to the condenser.

   b. Failure Effects: The worst case failure would be in the open position, which would result in a slight decrease in feedwater temperature. (Loss of heating <100°F.)

5. TE-7011A1,A2,B1,B2,C1,C2; TSH-7012A-C,7013A-C,7014A-C

   a. Function: Three switches per LP turbine provide a turbine trip when two out of three temperature switches register high temperature in any LP turbine exhaust hood.

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

6. HV-1006

   a. Function: This is a normally open, fail closed, motor operated valve on the high pressure steam supply to the RFP turbines.

   b. Failure Effects: During startup, closure of this valve would result in a loss of feedwater flow. Following startup, up to about 40% turbine load, this HP steam supply is throttled such that the LP steam supply from the cross-around piping is the main steam supply to the RFP turbine. Above 40% turbine load, the HP stop valve is closed and RFP turbine steam is supplied entirely from the crossaround line. Failure of this valve would be inconsequential any time after startup.

C. Vents and Drains

1. LY, SV-1451A

a. Function: Control a normally closed, fail open valve in the line between feedwater heater 2A and drain cooler 2A to the "A" condenser.

b. Failure Effects: Failure of this valve to the open position would result in the loss of level control in the 2A heater which leads to a slight increase in feedwater temperature.

2. LY-1505A

a. Function: Controls a normally closed, fail open valve on the bypass line from feedwater heater 6A (shell side) to condenser A.

b. Failure Effects: Worst case failure would be in the open position which would result in a slight loss (<100°F) in feedwater heating.

3. LY-1532A

a. Function: Controls a normally open, fail closed valve in the drain line between feedwater heaters 3A and 2A.

b. Failure Effects: Worst case failure would be in the closed position which would result in a slight loss (<100°F) in feedwater heating.

D. Condensate

1. PSH-1056B,C

a. Function: Provide a turbine trip signal on high condenser pressure.

b. Failure Effects: Failure of either pressure switch may result in a turbine trip. These switches could also fail in a manner that would incapacitate a turbine trip.

2. PT-1664A-C

a. Function: Provide a signal to the recirculation system to initiate recirculation flow runback on low pressure.

b. Failure Effects: Failure of any one transmitter may result in recirculation runback. These transmitters could also fail in a manner that would incapacitate a recirc runback.

E. Feedwater

1. FE-1755A-C, 1770A-C; FT-N011A-C, 1755A-C, 1770A-C, 1800A-C, 1801A-C; FY-1783A; HV-1744A-C, 1753A-C, 1768A-C, 1769A-C, 1772B-C, 1781A-C, 1782A-C, 1797A-C; LY-1754, 1785; PSHH-1788 1-3; PSLL-1777A1-3, B1-3, C1-3; PSV-1758A; TE, TIC, TV-1780A-C, 1796A-C; ZE-1744A-C

   a. Function: Due to the number of feedwater system components affected by a high energy line break, only the overall failure effects will be detailed.

   b. Failure Effects: The worst case failure effects of these components would be any combination of the following:

      - 0 to 100% loss of feedwater flow through valve closure or RFP turbine trip
      - Initiation of recirculation flow runback
      - Slight decrease in feedwater temperature (<100°F)
      - A rod block signal originating from the feedwater control system

F. Turbine Auxiliaries Cooling

1. TIC-2415B,C

   a. Function: Control normally open, fail open valves in two of three RFP turbine lube oil cooler lines.

   b. Failure Effects: The worst case failure would be the closure of the cooling water inlet valves that would lead to increased RFP turbine lube oil temperature and an eventual RFP turbine trip.

2. TIC-2423

   a. Function: Controls a normally open, fail open valve in the main turbine lube oil cooler line.

   b. Failure Effects: The worst case failure would be in the closed direction that would lead to increased main turbine lube oil temperature. This would have only long-term consequences.

3. TIC, TT-2625

   a. Function: Control a normally open, fail open valve in the generator hydrogen cooler line.

   b. Failure Effects: The worst case failure would be in the closed direction that would lead to increased generator hydrogen temperature, resulting in only long-term consequences.

4. TIC, TT-2661

   a. Function: Control a normally open, fail open valve in the turbine EHC hydraulic fluid cooler line.

   b. Failure Effects: The worst case failure would be in the closed direction that would lead to increased EHC hydraulic fluid temperature, resulting in only long-term consequences.

5. HS-2662

   a. Function: Controls a normally open valve in a line supplying cooling water to the turbine EHC hydraulic fluid coolers, the main turbine lube oil coolers, the iso-phase bus coolers, the generator stator coolers, the generator hydrogen coolers, and the alterrex air cooler.

   b. Failure Effects: The worst case failure would be in the closed direction that would lead to a main turbine trip on high generator stator temperature.

G. Lube Oil

1. HS-3076-10 to 14, 3082-1 to 7; HV-3076-8,9; PSL-3075-1 to 7, 3080-1 to 9; PSV-3077-1 to 9; SV-3076-1 to 7; TSH-7083

   a. Function: These components provide control of the high pressure lift pumps which assist in rolling the turbine/generator shaft assembly during startup.

   b. Failure Effects: The worst case failure would be to abort startup. During power operation, there would be no consequences in failing any combination of these components.

2. PSL-7000A,B, 7002A-C, 7003A-C

   a. Function: These components provide a turbine trip signal on low thrust bearing pressure.

   b. Failure Effects: Failure of any pressure switch may result in a turbine trip. These switches could also fail in a manner that would incapacitate a turbine trip.

3. HS-3146A to C, 3172A to C, 3176A2, A3, B2, B3, C2, C3, 3177A2, A3, B2, B3, C2, C3, 3178A2, A3, B2, B3, C2, C3; PSL-3151A1 to 3, B1 to 3, C1 to 3, 3164A to C; PSLL-3162A1 to 3, B1 to 3, C1 to 3

   a. Function: These components provide control of the lube oil to the RFP turbines.

   b. Failure Effects: Failure of these components may result in trip of the RFP turbines. These switches could also fail in a manner that would incapacitate an RFP turbine trip.

4. SV-3187A to C, 3188A to C, 3195A to C, 3196A to C, 3197A to C

   a. Function: These are test trip solenoid and control power failure trip solenoid valves on the RFP turbines.

   b. Failure Effects: The worst case failure of these components would result in a trip of the RFP turbines.

5. TT-2415A to C

   a. Function: Control normally open, fail open valves on the RFP turbine lube oil cooler lines.

   b. Failure Effects: The worst case failure would be in the closed direction that would lead to increased RFP turbine lube oil temperature and eventual RFP turbine trip.

6. TT-2423

   a. Function: Controls a normally open, fail open valve on the main turbine shaft lube oil cooler line.

   b. Failure Effects: The worst case failure would be in the closed direction that would lead to increased turbine shaft lube oil temperature, resulting in only long-term consequences.

7. PSL-3176B

   a. Function: A low RFP turbine lube oil pressure signal which controls start of the emergency lube oil pump.

   b. Failure Effects: The worst case failure would be to obviate the starting of the emergency pump, which would have only long-term consequences.

H. Turbine Sealing Steam

1. HV-1999, 2001; PCV-2000

   a. Function: Valves on line supplying sealing steam to the HP turbine and the three LP turbines.

   b. Failure Effects: The worst case failure would be in the closed direction, ceasing sealing steam flow. Radioactive steam leakage from the Main Steam system through the turbine seals would alert the operator of this occurrence but would result in no adverse effects on reactor parameters.

2. HV-2037; PIC, PV-2038

   a. Function: Controls two "in-series" valves supplying an alternate source of sealing steam for turbine steam seals from Auxiliary Steam; one valve is normally closed, fail open, and the other is normally open.

b. Failure Effects: The worst case failure would be in the closed direction that would result in no adverse consequences. Only the alternate steam supply is affected.

3. PIC-1992A,B

a. Function: Control two normally closed, fail open "in parallel" valves supplying an alternate source of sealing steam from main steam.

b. Failure Effects: The worst case failure would be in the closed direction that would result in no adverse consequences.

I. RFP Turbine Steam

1. HS-3721A to C, 3738A to C, 3739A2, 3740A to C, 3745A to C, 3746A to C, 3747A to C, 3748A to C, 3757A to C, 3770A to C, 3778A to C; HV-1751A to C, 1752A to C, 1760A to C, 1761A to C, 1762A to C, 1767A to C, 1772A to C, 3714A to C, 3719; PSH-3709A, 3715A1 to 3, B1 to 3, C1 to 3, 3773A to C; SE-3749A1, A2, C1, C2, 3755A1, A2, B1, B2, 3775A to C, 3776A to C; SITS-3775A to C; STS-3755A1, A2, B1, B2, C1, C2; SV-1762A to C, 3737A; SY-3775A to C, 3776A to C; TSH-3712A1, A2, A3, B1, B2, B3, C1, C2, C3, 3759A to C; XSS-3775A to C; XZS-3754A to C; ZE-3754A to C; ZITS-3754A to C; ZS-1762A, 1794A1, A2, A3, B1, B2, B3, C1, C2, C3, 3763B,C, 3764B,C; ZY-3749A to C, 3754A to C

a. Function: Due to the number of RPF turbine steam system components affected by a high energy line break, only the overall failure effects will be detailed.

b. Failure Effects: The worst case failure effects of these components could be any combination of the following:

- 0 to 100% loss of feedwater flow through reduced RFP turbine steam flow, feedwater control system logic, and/or RFP turbine trip
- Initiation of recirculation flow runback
- A rod block signal originating from the feedwater control system

J. Nuclear Boiler

1. PDT-N002A,B

a. Function: Provide a differential pressure signal to the feedwater control system to indicate feedwater flow.

b. Failure Effects: The worst case failure effect would be to run back the recirculation flow based on low feedwater flow signal.

K. Reactor Recirculation

1. HS-8283A,B; PSL-8298A,B, 8299A,B, 8300A,B, 8301A,B

a. Function: Provide the means to start the MG set emergency lube oil pumps A and B, respectively.

b. Failure Effects: The worst case failure would be in a manner that would incapacitate the emergency pump start. However, the normal MG set lube oil pumps should be operating.

III. Combined Effects

The following is a summary of the non-safety control component failure effects as detailed in II above:

Control System	Worst Case Failure Effects
A. Main Generator	Main generator trip
B. Main Turbine	1. Main turbine trip/no turbine trip* 2. Feedwater temperature decrease 3. Loss of feedwater flow during startup
C. Vents and Drains	Feedwater temperature increase or decrease
D. Condensate	1. Main turbine trip/no turbine trip* 2. Recirc runback/no recirc runback*
E. Feedwater	1. Reduction in feedwater flow, possibly to 0% 2. Recirc runback 3. Feedwater temperature decrease 4. Rod block
F. Turbine Auxiliaries Cooling	1. RFP turbine trip 2. Main turbine trip
G. Lube Oil	1. Main turbine trip/no turbine trip* 2. RFP turbine trip/no turbine trip*
H. Turbine Sealing Steam	No adverse consequences

*Depending on the device's failure mode, an unwarranted trip signal could be generated or a genuine trip could be incapacitated under conditions where such a trip is required.

Control System	Worst Case Failure Effects
I. RFP Turbine Steam	1. Reduction in feedwater flow, possibly to 0% 2. Recirc runback 3. Rod block
J. Nuclear Boiler	Recirc runback
K. Reactor Recirculation	No adverse consequences

Thus, the worst case failure effects of the control components in this zone may include any combination of the following:

- Main generator trip
- Main turbine trip/no turbine trip
- RFP turbine trip/no turbine trip
- Recirc runback/no recirc runback
- Reduction in feedwater flow, possibly to 0%
- Feedwater temperature decrease
- Rod block

The combined effects of these control components failures with the initiating high energy line break are detailed:

A. Both Main Steam breaks result in a transient whose consequences are bounded by the Steam System Piping Break Outside Primary Containment event (FSAR 15.6.4). Since the MSIVs would begin to close and the reactor would scram in less than one second, none of the control component failures can exacerbate this event. An additional single active failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.6.4.

B. The RFP Turbine Steam Supply breaks would result in transients whose consequences are bounded by either the Steam System Piping Break Outside Primary Containment event (FSAR 15.6.4) or the Turbine Trip event (FSAR 15.2.7). The discussion in "A." above applies for the FSAR Section 15.6.4 event.

   The turbine trip transient event in FSAR Chapter 15 is initiated from full power level; a reduction in feedwater temperature would increase the power level past that assumed in Chapter 15. Therefore, an additional computer analysis was performed, as discussed in Section 3.0 of this report, which bounds a postulated turbine trip at an elevated power level. This event would not be exacerbated by any combination of the control component failures in this zone. An additional single active failure in a mitigating safety system would also result in a bounded event, as the discussion of Turbine Trip in FSAR Section 15.2.7 still applies.

C. The Condensate System line break would result in a transient whose consequences are bounded by the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6). The transient would be terminated by automatic action (scram, HPCI, RCIC initiate and recirc pump trip, all on low-low reactor water level) within 30 seconds of the break. If, during that time, a turbine trip were to occur due to control component failures, the consequences of the ensuing transient would be bounded by the Turbine Trip event (FSAR 15.2.7). As discussed above, a turbine trip at an elevated power level is bounded by the additional computer analysis performed for this study. No other control system component failures can exacerbate the ensuing transient. An additional single active failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.6.6 and 15.2.7.

D. All feedwater line breaks would result in a transient whose consequences are bounded by either the Feedwater Line Break Outside Primary Containment event (FSAR 15.6.6) or a Turbine Trip event (FSAR 15.2.7). The discussion in "C" above applies for both.

E. The line breaks in the Turbine Sealing Steam System would have no direct impact on reactor operator parameters. However, the effects of failing control system components as a result of the break would lead to a transient whose consequences are bounded by the Turbine Trip event (FSAR 15.2.7). The discussion in "B" above applies for all breaks.

F. The Plant Heating Steam line breaks would have no direct impact on reactor operating parameters. However, the effects of failing control system components as a result of the break would lead to a transient whose consequences are bounded by the Turbine Trip event (FSAR 15.2.7). The discussion in "B" above applies for all breaks.

REACTOR BUILDING

The Hope Creek Unit 1 reactor building is well compartmentalized with regard to high energy lines. Pressure tight doors separate rooms containing high energy lines with "check-type" blowout panels providing a common vent path for pressure relief. This common vent path includes the following elevations and rooms (labeled A-1 on Figures 8 through 14 of Appendix B):

Elevation 54: Blowout panels from the RCIC pump and turbine room (4110) and HPCI pump and turbine room (4111) would exhaust steam to the torus area (4102).

Elevation 102: The common vent path is through the steam tunnel (4316), RCIC pipechase (4319), HPCI pipechase (4327), miscellaneous pipechases (4321 and 4329), and the west-located steam vent.

Elevation 132: Blowout panels from the west-located steam vent (4409) provide the release path to the environment. In addition, a path is provided from the RWCU pump rooms (4403, 4405) to the pipechase (4402), all on Elevation 132, to the steam vent path at the lower elevations.

Elevation 145: The grating above the RWCU pump rooms on Elevation 132 would allow steam to fill the RWCU filter demineralizer holding pump rooms and heat exchanger room (4502, 4503, 4505, 4506).

Elevation 162: Steam from the lower elevations would fill the RWCU filter demineralizer areas (4620, 4621) located on this elevation.

The reactor building was divided into the zones listed below. These zones are represented in Figures 8 through 14 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 system components which reside in this zone have been eliminated per the criterion detailed in Sections 2.1 and 2.2 of this report. Therefore, no applicable control systems components reside within this zone.

Zone	Description	Eliminated (?)	Reason
A-1	The common vent path, described above, begins on Elevation 54 in the torus area.	No	

A-2	HPCI pump and turbine room; blowout panels exhaust steam to A-1.	Yes	2*
A-3	RCIC pump and turbine room; blowout panels exhaust steam to A-1.	Yes	2*
A-4	All areas on Elevation 54 other than A-1, 2, and 3.	Yes	1
B-1	CRD pumps area.	Yes	2
B-2	All areas on Elevation 77 other than A-1 and B-1.	Yes	1
C-1	All areas on Elevation 102 other than A-1.	Yes	1
D-1	All areas on Elevation 132 other than A-1.	Yes	1
E-1	All areas on Elevation 145 other than A-1.	Yes	1
F-1	All areas on Elevation 162 other than A-1.	Yes	1
G-1	All areas on Elevation 201 and above.	Yes	1

Except for the CRD hydraulic system, the high energy fluid system lines in the reactor building that interact with non-safety control components are all contained in compartmented rooms (or in the torus area) which use the above common vent path (Zone A-1). An HELB in the CRD hydraulic system would only affect CRD-related components, but in no case would inhibit rod insertion or reactor scram.

The specific analysis for Zone A-1, which has HELB and nonsafety control component interactions, follows.

*An HELB in Zone A-2 or A-3 would impact the non-safety related control components in Zone A-1 (the common vent path) via the blowout panels. The analysis for Zone A-1 considers a line break in Zone A-2 or A-3.

Zone A-1

I. High Energy Systems

A. Nuclear Boiler

The high energy lines of this system are the main steam lines and the main steam drain lines. The consequences of a break in any one of the main steam lines is bounded by the Steam System Piping Break Outside Containment event (FSAR 15.6.4). The plant is designed to immediately detect such an occurrence, initiate isolation of the broken line, and actuate the necessary protective features. The consequences of a break in one of the main steam drain lines is less severe than a main steam line break, but still leads to containment isolation and the actuation of the necessary protective features.

B. HPCI/RCIC Steam Supply

A break in the HPCI or RCIC steam supply lines outside primary containment would be immediately detected and isolated. Besides a slight loss of coolant inventory, the consequences of this break are negligible with regards to reactor parameters.

C. Feedwater

The high energy lines in this zone are the two feedwater supply lines to the reactor vessel. The consequences of a break in either line is bounded by the Feedwater Line Break event (FSAR 15.2.8).

D. RWCU

A line break in the RWCU system would be immediately detected and isolated via the RWCU isolation circuitry. Besides a slight loss of coolant inventory, the consequences of this break are negligible with regards to reactor parameters.

II. Control Systems

A. Nuclear Boiler

1. HV-3625, 3626

a. Function: Control normally closed valves originating from the feedwater line (24" DBD-013) leading to the "C" condenser which is used to "flush out" the nuclear boiler system.

b. Failure Effects: In the worst case, these valves fail open resulting in a reduction of feedwater flow to the reactor vessel.

2. HV-F069, F070A,B,C,D, F072; SV-F069

a. Function: These are valves on pressure-equalizing lines between the four main steam lines.

b. Failure Effects: There are four locked-open valves on the same lines; thus, the position of these valves is inconsequential.

B. Reactor Water Cleanup

1. FE-N040

a. Function: Flow element on RWCU outlet to feedwater loops A and B via 4" DBC-143; provides input to RWCU isolation logic.

b. Failure Effects: The worst case effect would be to isolate the RWCU system from the reactor.

III. Combined Effects

A. The Steam System Piping Break Outside Containment event (FSAR 15.6.4) would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.6.4.

B/D. The consequences of a main steam line break, as discussed above, envelope the pipe breaks in the HPCI/RCIC steam supply and RWCU lines. The control component failures in this zone would not exacerbate these isolated line breaks.

C. The Feedwater Line Break event (FSAR 15.2.8) would not be exacerbated by the control component failures in this zone. An additional single failure in a mitigating safety system would also result in a bounded event, as discussed in FSAR 15.2.8.

AUXILIARY BUILDING/RADWASTE BUILDING

The analysis for the Auxiliary Building and the Radwaste Building resulted in one identifiable HELB/non-safety control component interaction zone. An HELB in the Gaseous Radwaste System (M-69) could only affect non-safety control components of the same system. There were no other identifiable interactions. After eliminating components per the criteria in Sections 2.2 and 2.3 of this report, the following non-safety control components remained:

Area	Elevation	Components
27	54	M-11: LT-2281, SV-2281-1,2 PT-2509 PCV-2521 FCY, HV, HY, LSL, PSH, PSL, PSY-2522E,F FCY, SV-2522E1, F1 SV-2522E2, F2 PT-2523, 2545, 2546, 2587, 2593
28	54	M-11: LT-2288 SV-2288-1,2
36	54	M-69: HV, SV-5646, 5666A,B TE-5714, 5722
37	54	M-69: TSH-5714B, 5722B AE, AIS, SV, HS-5724, 5725 PSL-5724
38	54	M-70: HS-10285
76	54	M-69: PCV-5704, 5707
77	54	M-70: HV, SV-10285
34	102	M-15: XV, ZS-7654 ZS-7657

Due to the paucity of control components in these buildings, only those areas were considered; Figures 15 through 17 of Appendix B exhibit the floor plans of Areas 27, 28, 36, 37, 38, 76, 77/Elevation 54' and Area 34/Elevation 102'.

The high energy lines routed through the Auxiliary/Radwaste Buildings are associated with the following systems:

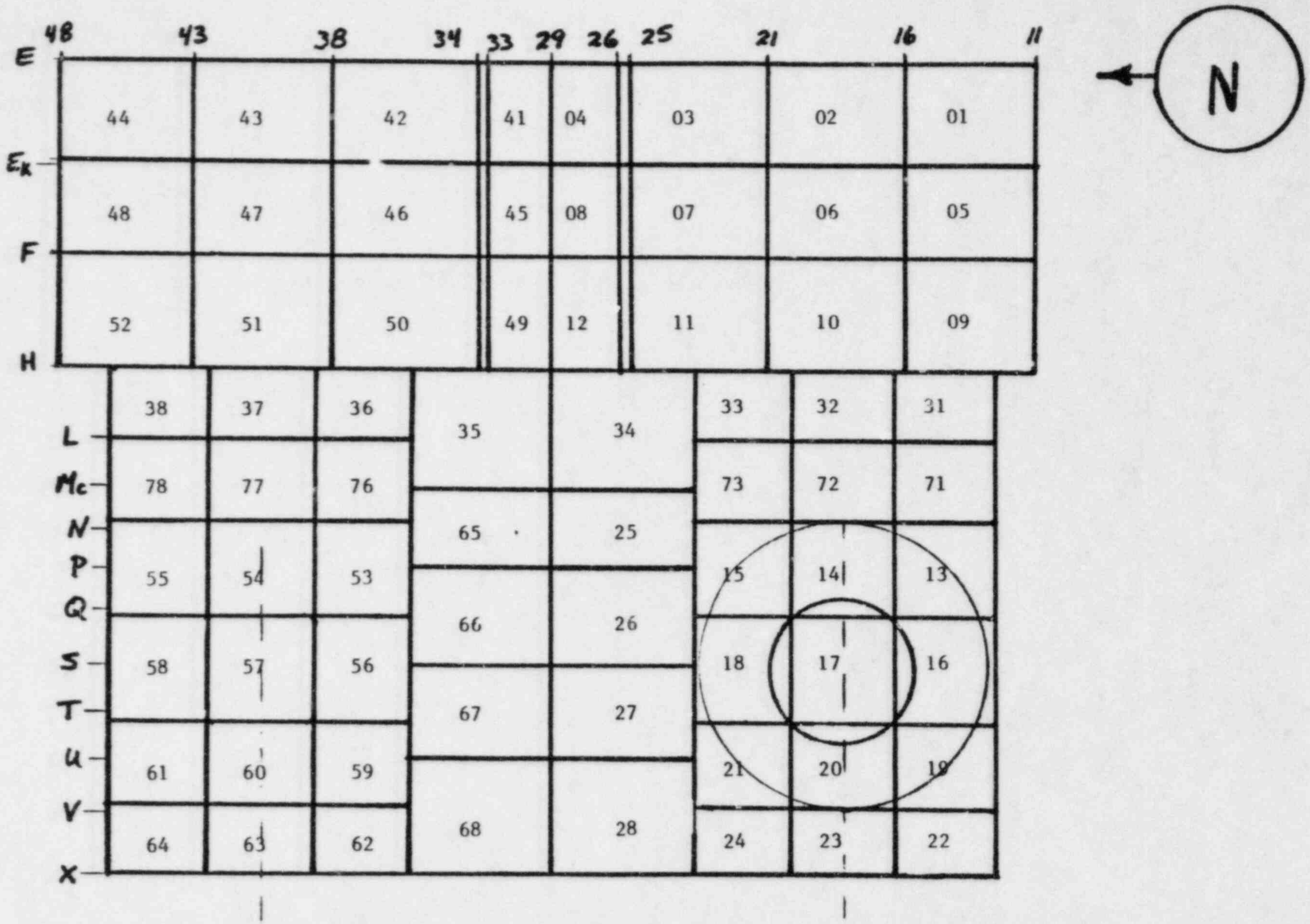
M-06, Feedwater
M-08, Condensate
M-21, Auxiliary Steam
M-41, Main Steam
M-57, Containment Atmosphere Control
M-64/65, Liquid Radwaste
M-67, Solid Radwaste
M-69, Gaseous Radwaste

M-96, Plant Heating Steam
M-98, Domestic Water System

As mentioned above, an HELB in the Gaseous Radwaste System (M-69) could only affect the non-safety control components in the same system in Area 36/Elevation 54'. There are no other identifiable interactions. No transient can be postulated that would affect reactor operating parameters and no additional single failure can exacerbate this non-transient.

APPENDIX B

FIGURES



Hope Creek Generating Station - Defined "Areas" Figure 1

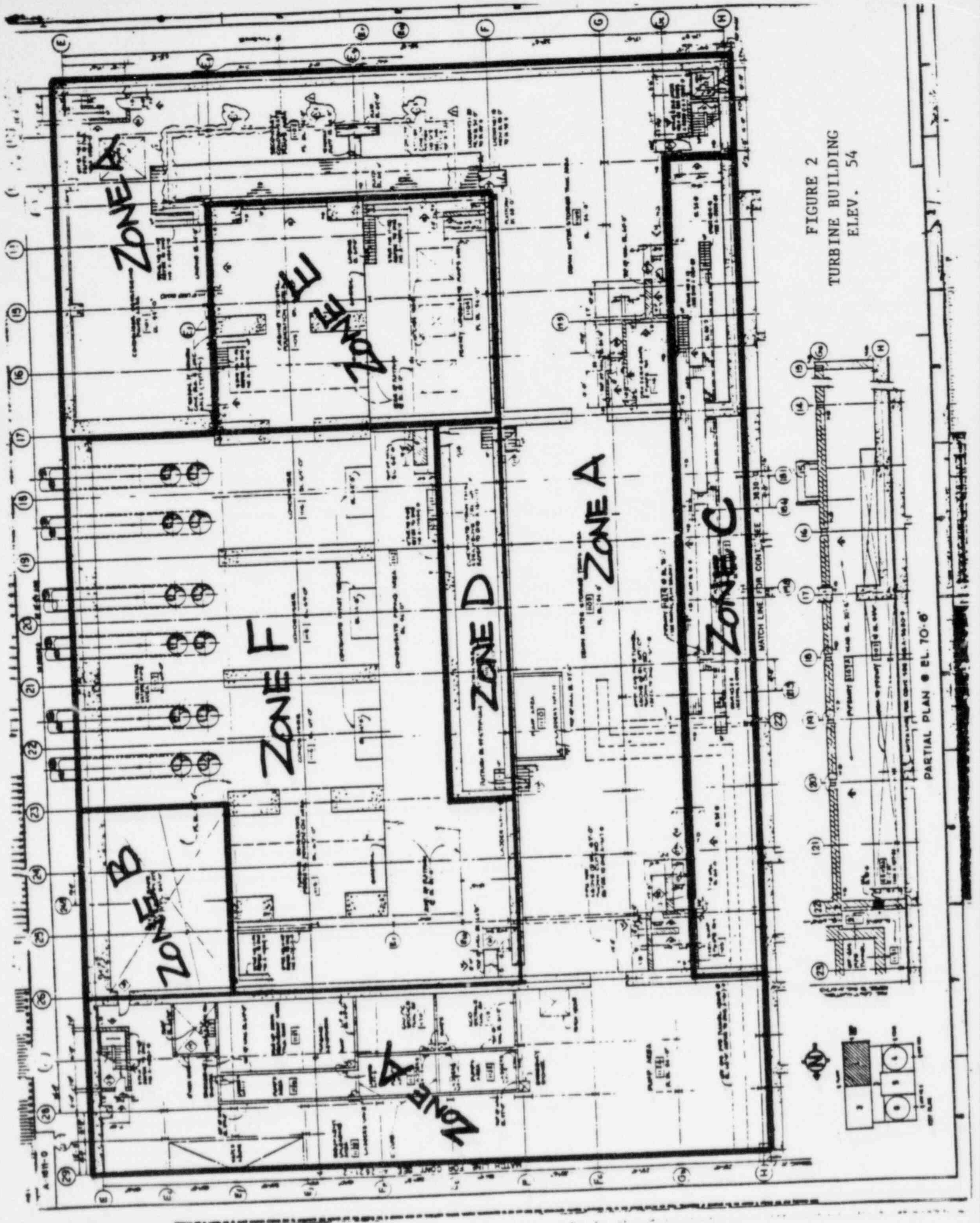


FIGURE 2
TURBINE BUILDING
ELEV. 54

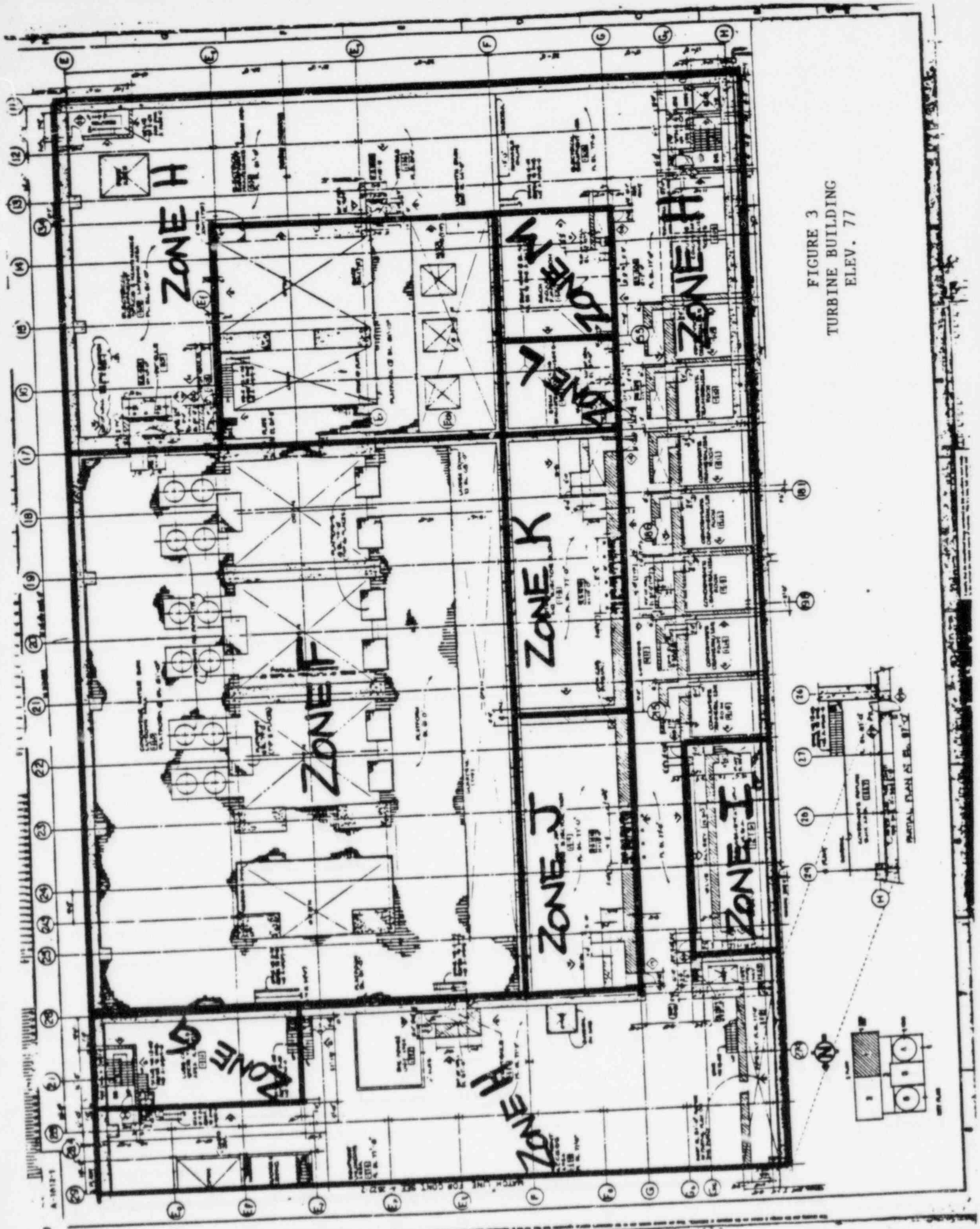


FIGURE 3
TURBINE BUILDING
ELEV. 77

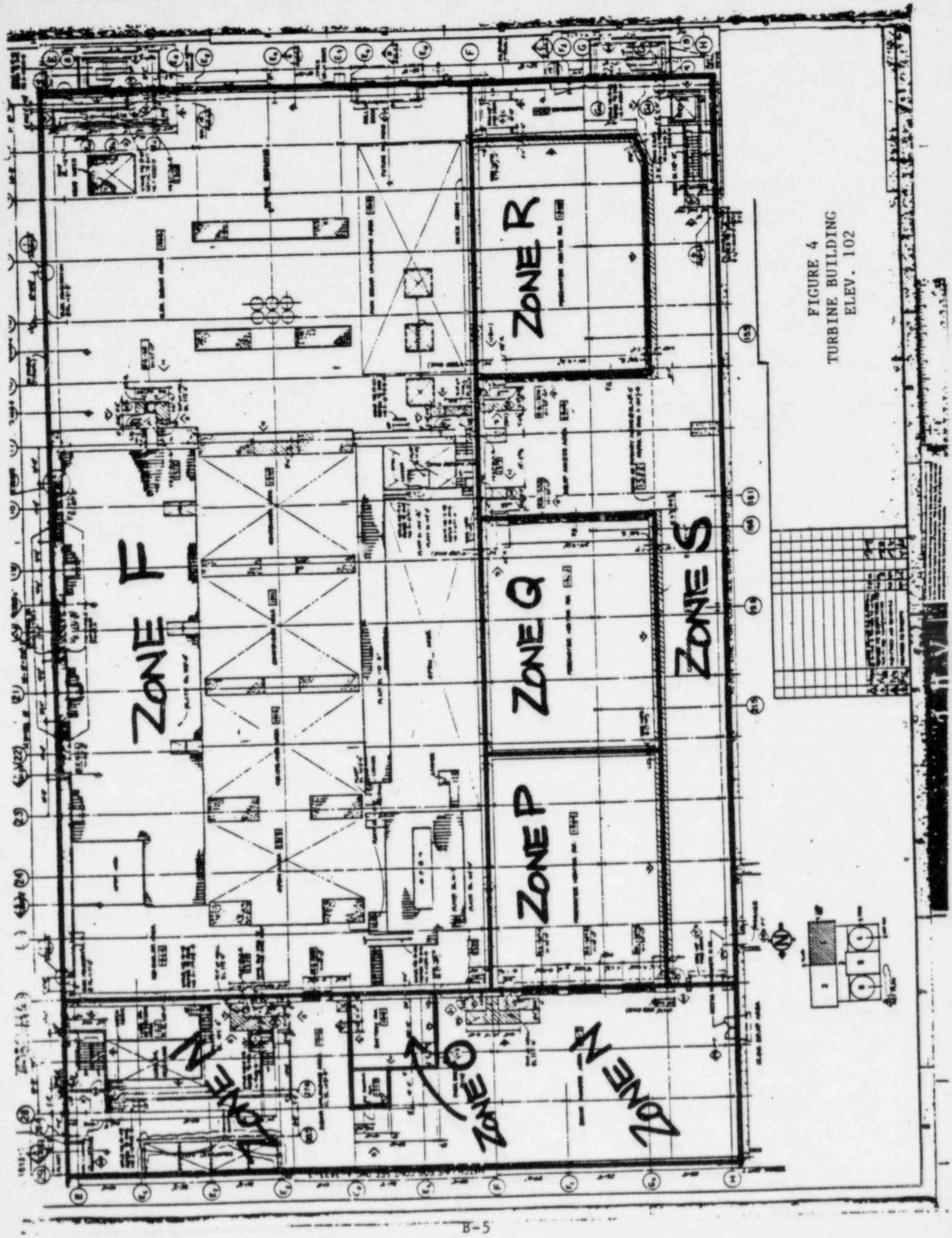


FIGURE 4
TURBINE BUILDING
ELEV. 102

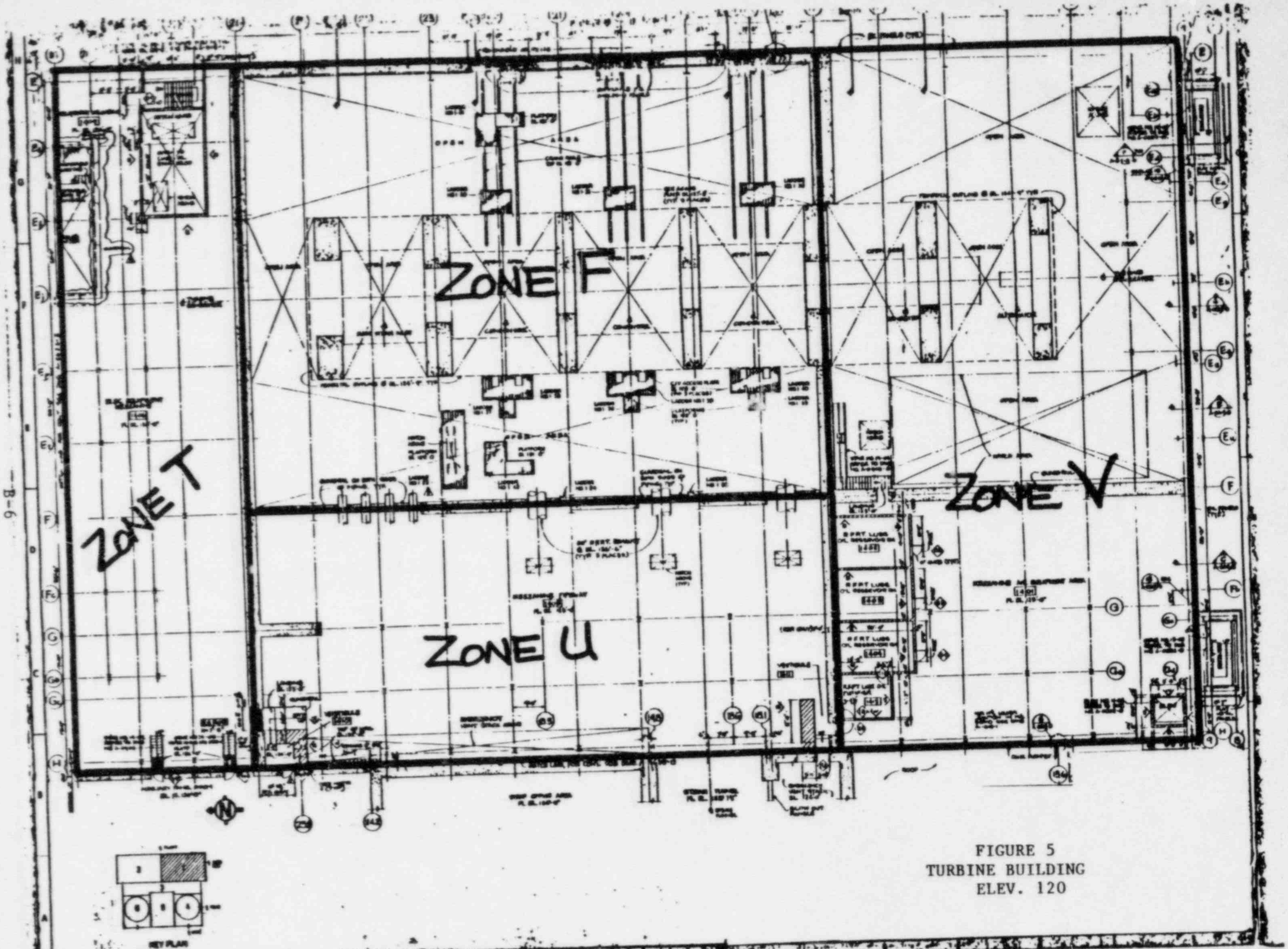


FIGURE 5
TURBINE BUILDING
ELEV. 120

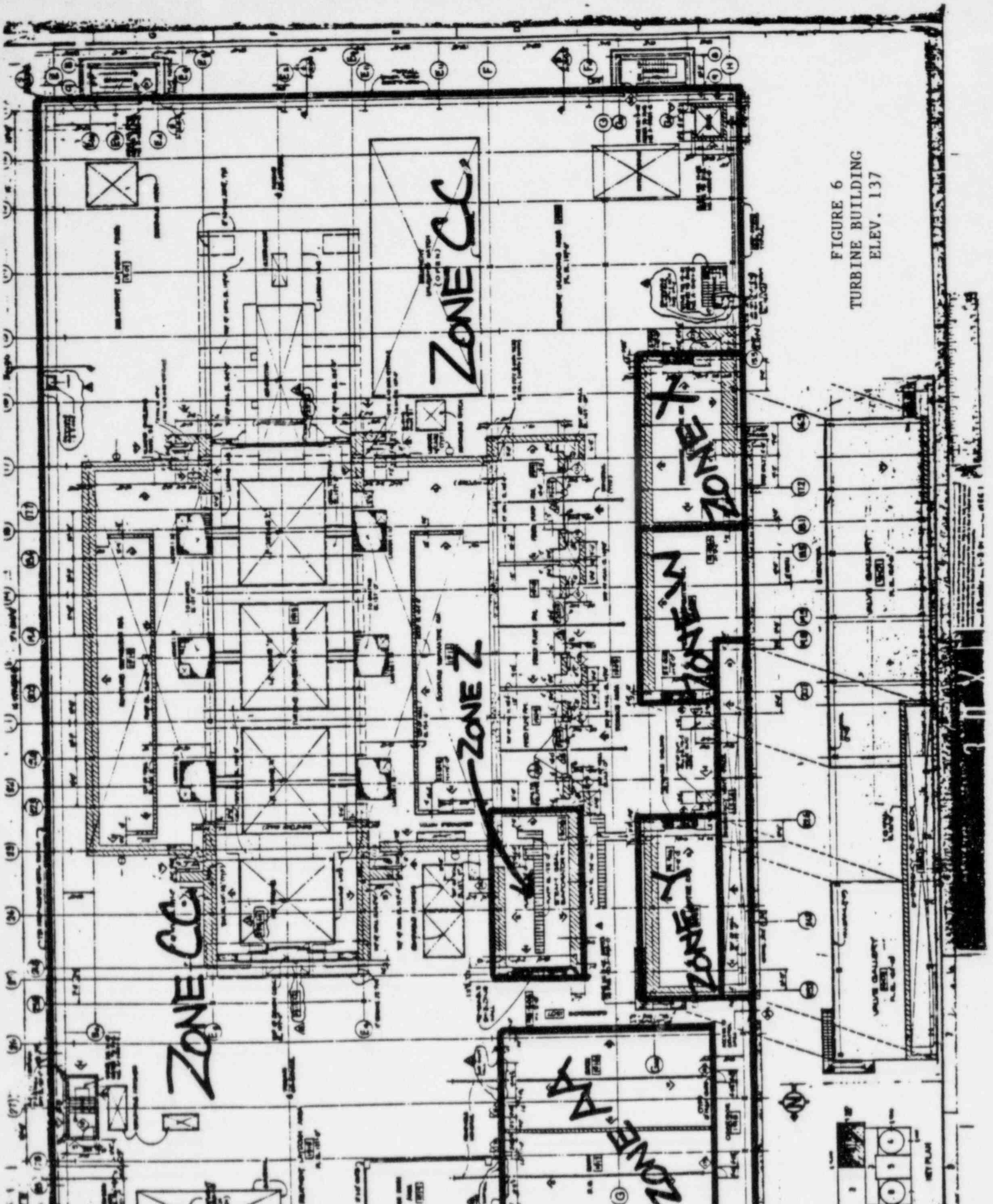


FIGURE 6
TURBINE BUILDING
ELEV. 137

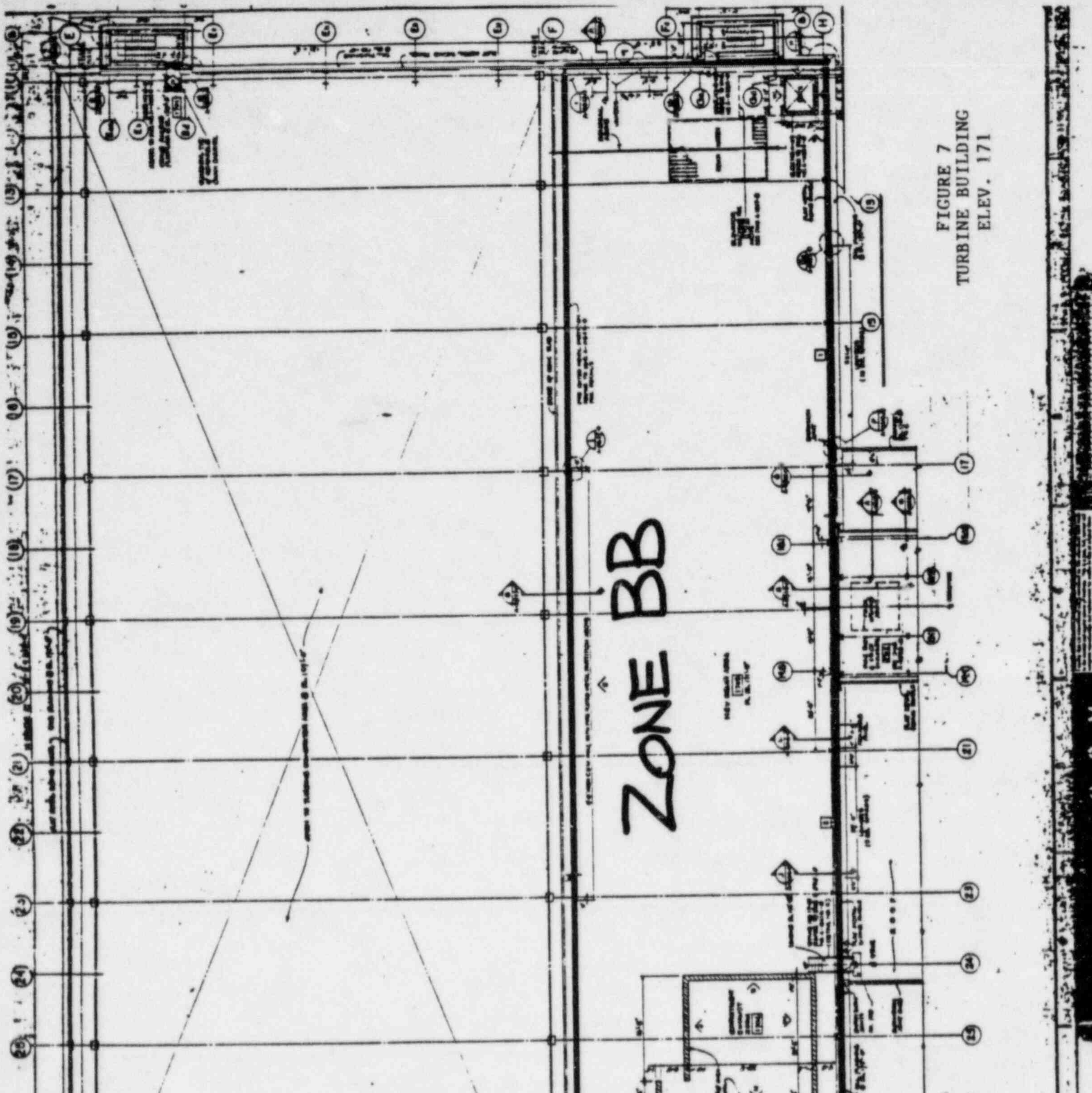


FIGURE 7
TURBINE BUILDING
ELEV. 171

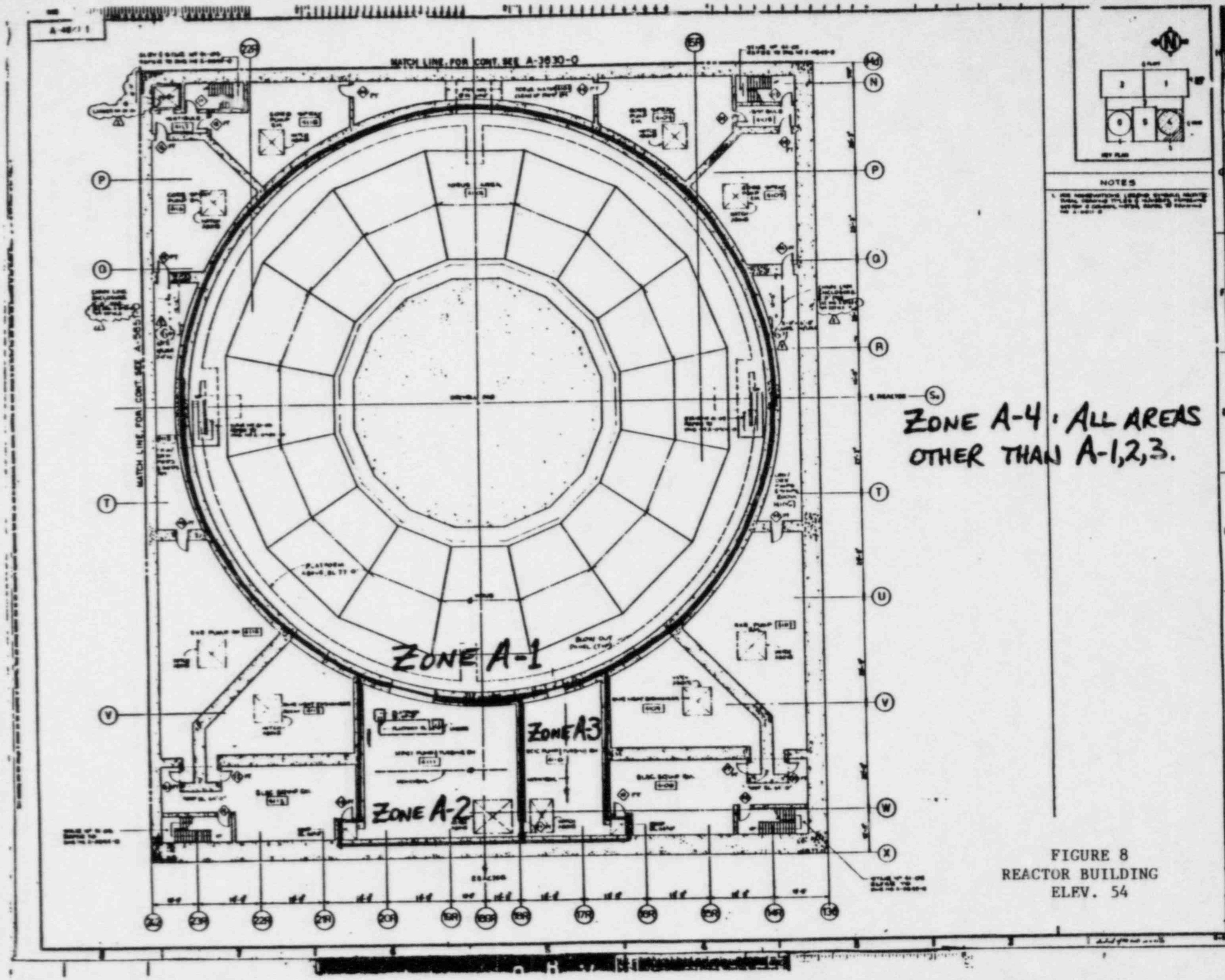


FIGURE 8
REACTOR BUILDING
ELEV. 54

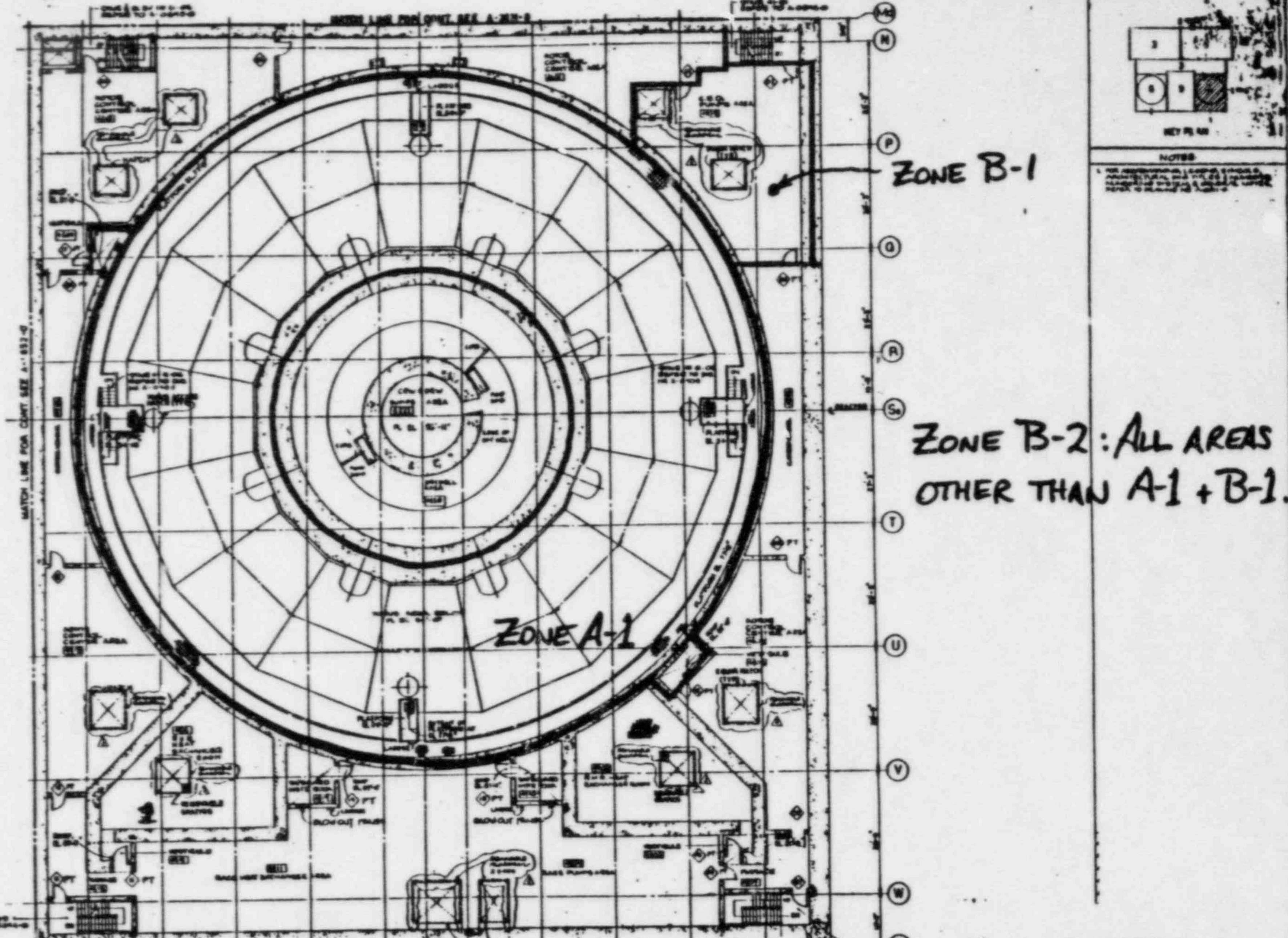


FIGURE 9
REACTOR BUILDING
ELEV. 77

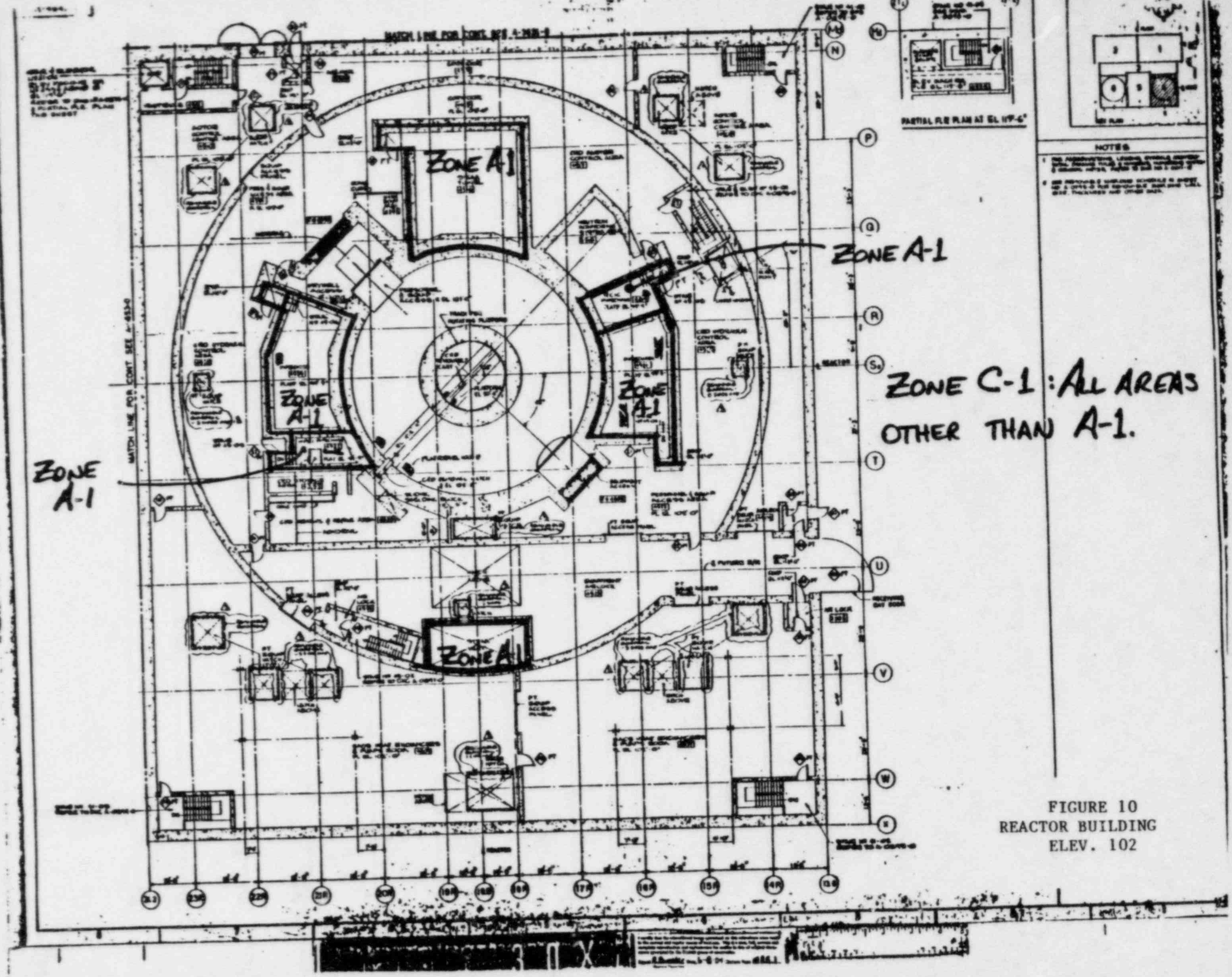


FIGURE 10
REACTOR BUILDING
ELEV. 102

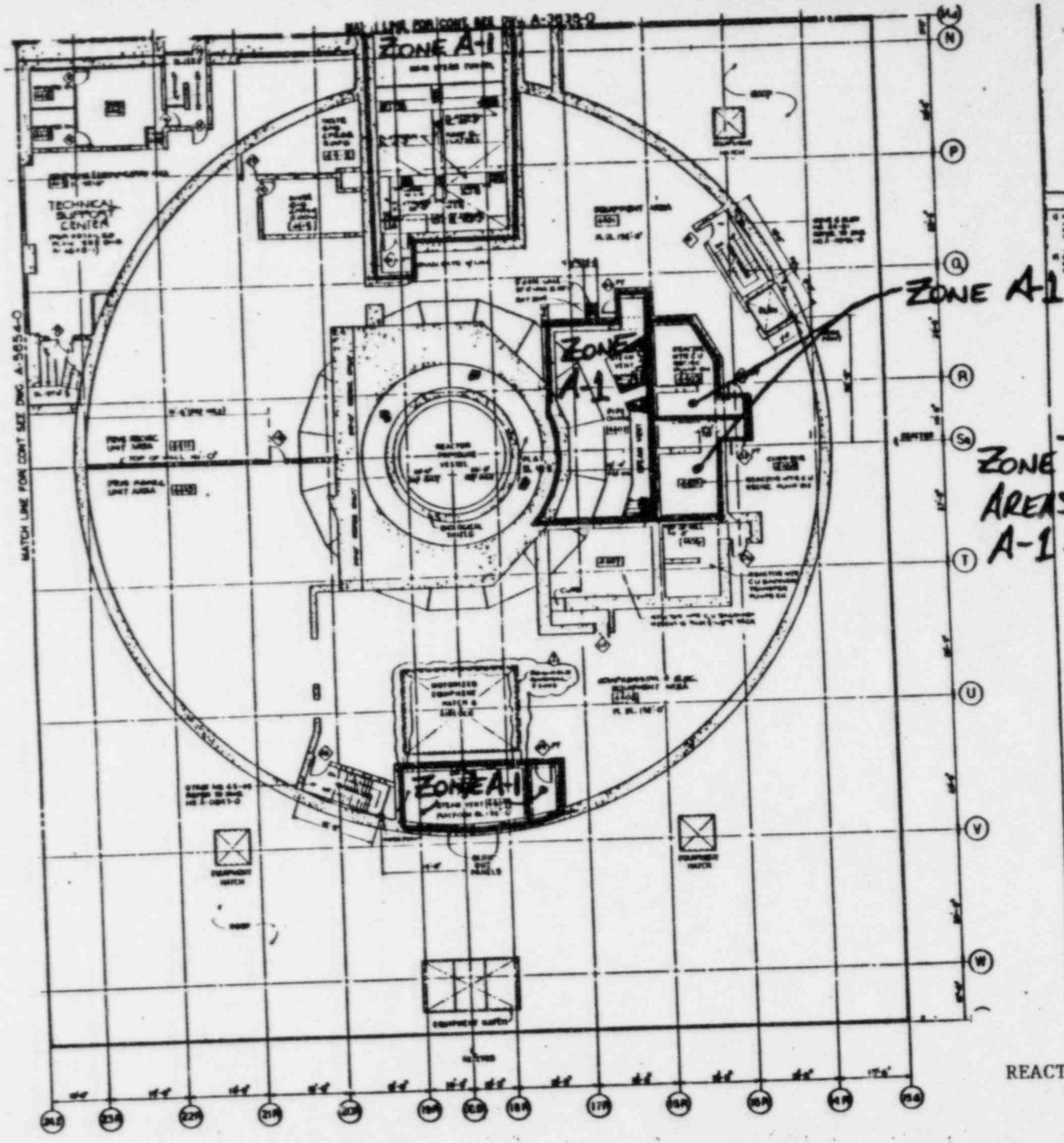


FIGURE 11
REACTOR BUILDING
ELEV. 132

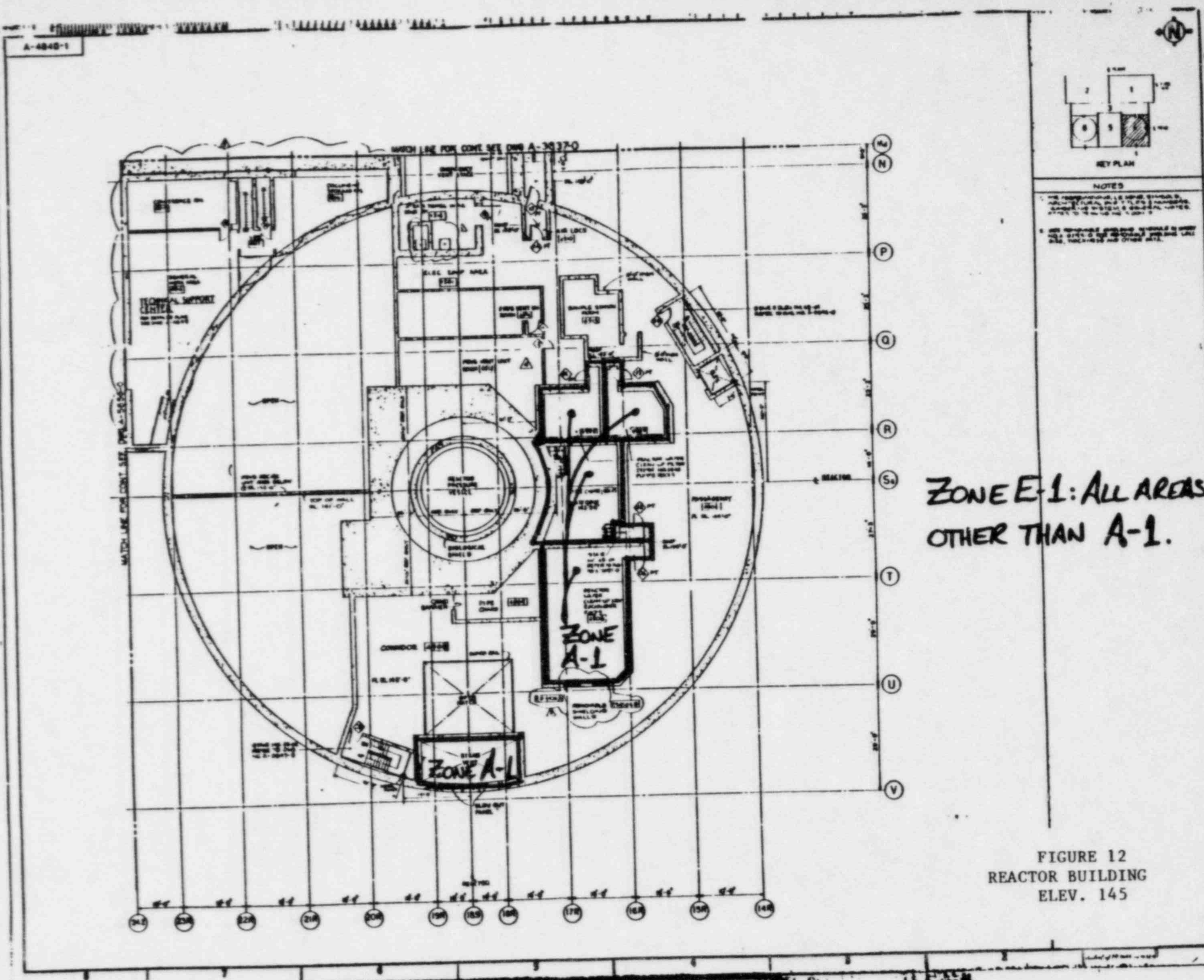


FIGURE 12
REACTOR BUILDING
ELEV. 145

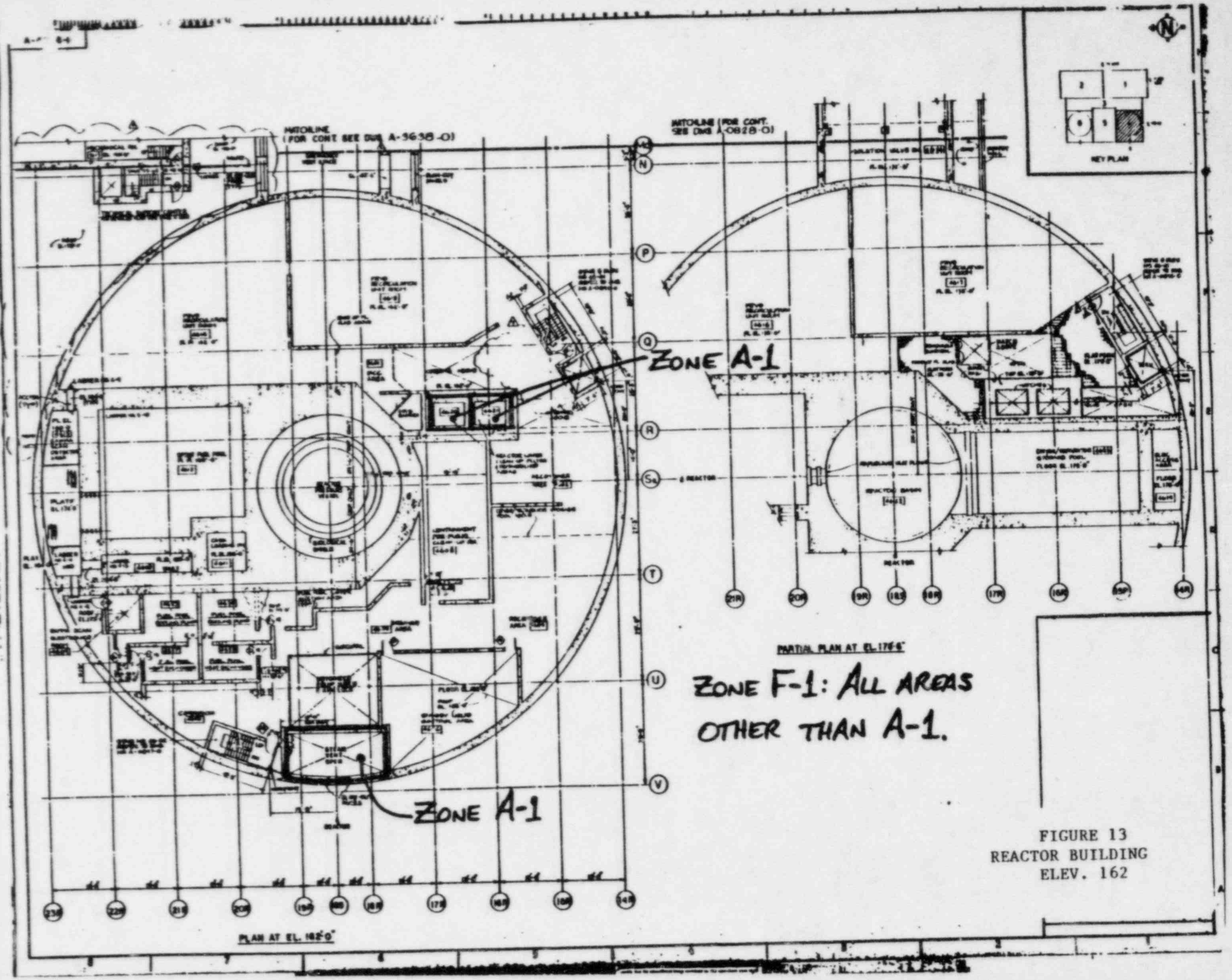


FIGURE 13
REACTOR BUILDING
ELEV. 162

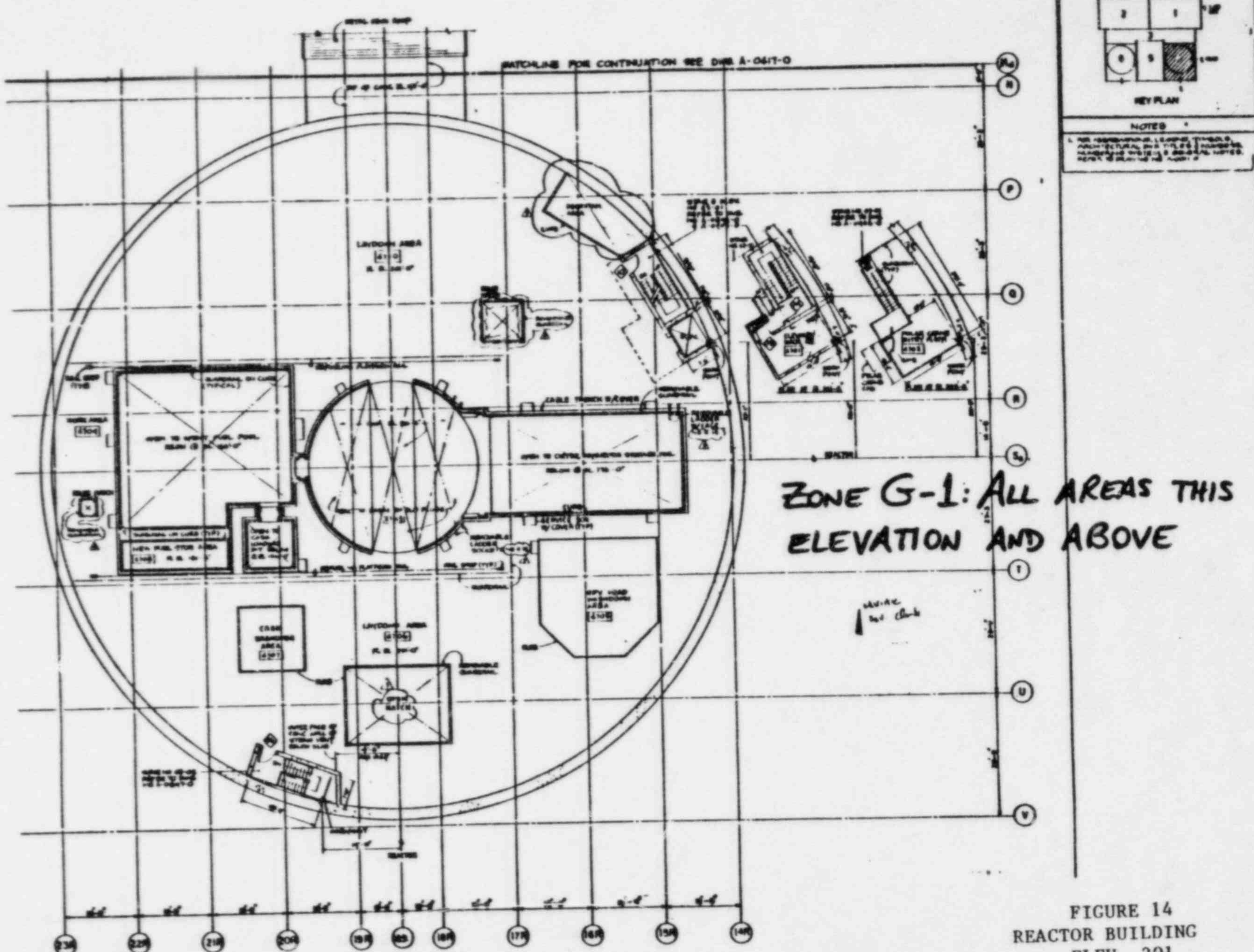


FIGURE 14
REACTOR BUILDING
ELEV. 201

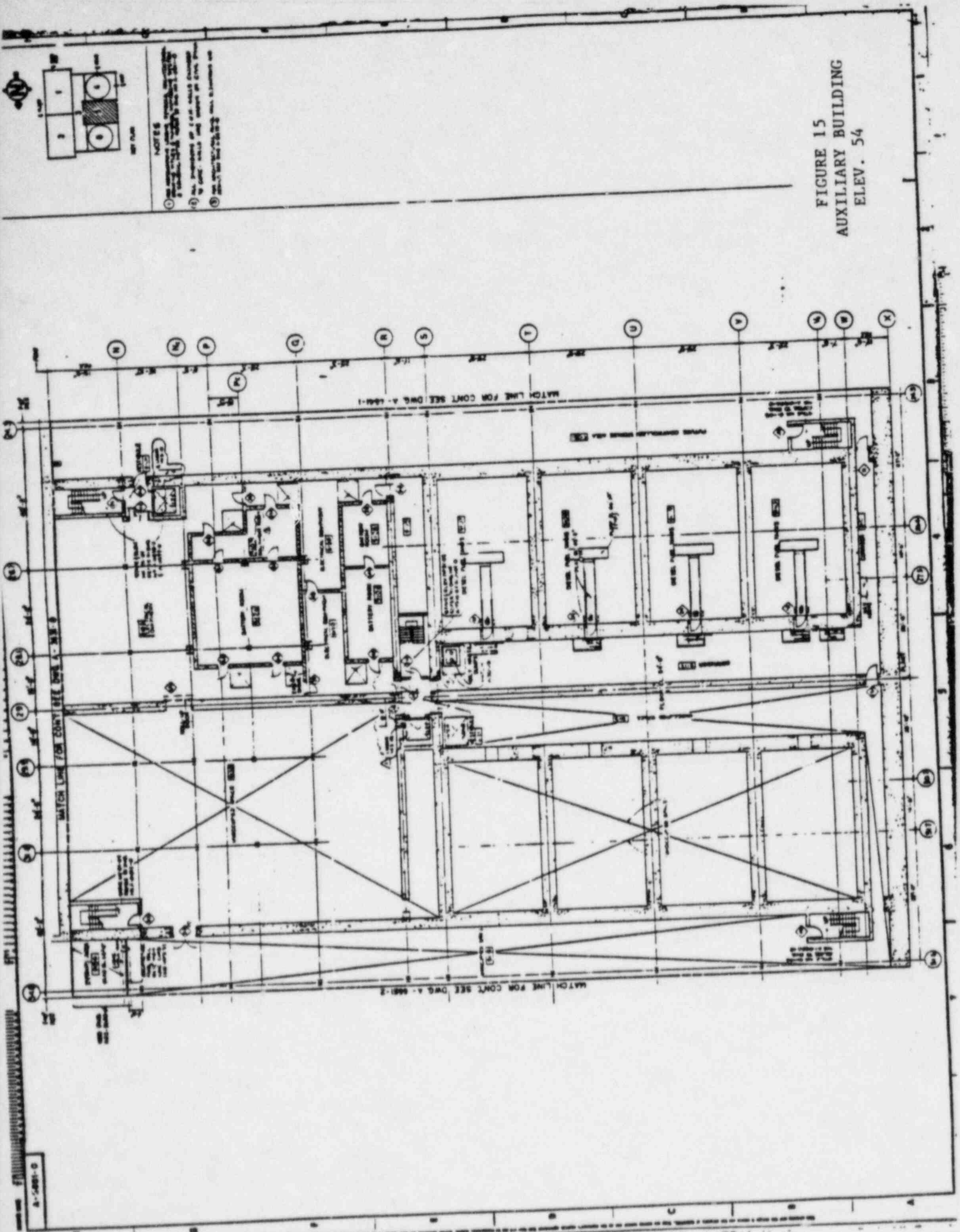


FIGURE 15
AUXILIARY BUILDING
ELEV. 54